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Неличные формы глагола в научном тексте

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В научном тексте частотность употребления неличных форм глагола значительна: они входят не только в состав сказуемого, используются в функциях подлежащего, дополнения, определения и обстоятельства, но и образуют предикативные конструкции, аналогов которых нет в русском языке. Отсутствие прочных навыков идентификации неличных форм глагола и предикативных конструкций, понимания их грамматического значения и синтаксических отношений между компонентами в предложении влечет за собой ошибочное осмысление высказывания и неверный перевод на русский язык. Целью пособия и является формирование устойчивых навыков распознавания, глубокого понимания и применения неличных форм глагола в речи.

Для студентов и аспирантов, обучающихся по специальностям “фундаментальная механика” и “фундаментальная математика”.

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Вводная часть

Вводная часть данного пособия состоит из двух разделов:

I. Предисловие – общие сведения об особенностях научного стиля и его глагольной составляющей.

II. Анализ морфологических форм и синтаксических функций неличных форм глагола (инфинитива, причастия и герундия) в грамматической структуре текста научного содержания как средство овладения определенными знаниями в области грамматики, адекватными для правильного понимания текста.

I

Полное понимание текстов научного стиля невозможно без усвоения и применения знаний по английской грамматике, в частности, в области таких ее аспектов, которые описывают глагольные личные формы (т.е. изменяющиеся по лицам, числам, временам и наклонениям формы глагола, выполняющие в предложении функцию сказуемого) и неличные формы (т.е. формы глаголов, в которых процесс (действие или состояние), оставаясь по существу процессом, частично представляется как признак (причастие) или же частично опредмечивается (герундий, инфинитив)).

Как личные, так и неличные формы глаголов имеют морфологическую структуру (т.е. формы словоизменения и способы выражения грамматических значений) и могут являться частью синтаксической конструкции (т.е. соединенное по правилам грамматики целое, состоящее из слов, словосочетаний и предложений, где грамматические классы слов (части речи) выполняют синтаксическую функцию в речи). Правильная грамматическая интерпретация является ключом к глубокому пониманию информационной составляющей, что особенно важно для текстов научного содержания.

Научному стилю свойственны такие характерные черты изложения информации, как краткость, логичность и полнота доказательности, поэтому ему присущи специфические лексические и грамматические особенности. В данном пособии мы не уделяем специального внимания лексическим особенностям научных текстов, словарный состав которых содержит как общеупотребительные слова, так и специфическую терминологию, так как главной нашей целью являются грамматические особенности научного стиля изложения и конкретно текстов (учебников, монографий, статей) по математике и механике. Но поскольку весь иллюстрирующий текстовой массив пособия содержит только профессионально ориентированную литературу, то студенты будут иметь реальную возможность существенно расширить лексическую и терминологическую базу в общем процессе освоения английского языка в рамках своей специальности.

Особенности изложения и грамматическая структура научных текстов характеризуются употреблением как сложных по структуре предложений с сочинительными и подчинительными связями, так и употреблением большого количества причастных, герундиальных и инфинитивных оборотов.

Как показывает практика и реальная оценка уровня владения иностранным языком студентами, отсутствие прочных навыков идентификации неличных форм глагола и предикативных конструкций, понимания их грамматического значения и синтаксических отношений между компонентами в предложении является существенным недостатком и источником ошибок в правильном осмыслении высказывания и в переводе его на русский язык.

Глагол является частью речи, которая обозначает действие или состояние как процесс (семантический признак), и выражает это значение при помощи категорий вида, залога, времени, лица, наклонения (морфологический признак) и выполняет в предложении в основном функцию сказуемого (синтаксический признак). Небольшое детское стихотворение напомнит вам о частях речи и их английских названиях:

The Parts of Speech

A NOUN is the name of anything,
As school, garden, boy or thing.
ADJECTIVES tell the kind of NOUN,
As great, small, pretty, white or brown.
Instead of NOUNS, the PRONOUNS stand,
As she, he, us, your arm, my hand.
VERBS tell us something being done:
To read, count, laugh, carry, run.
How things are done the ADVERBS tell,
As slowly, quickly, ill or well.
CONJUNCTIONS join the words together,
As men and women, wind and weather.
The PREPOSITION stands before
A noun, as by, or through a door.
The INTERJECTION shows surprise,
As Oh! How pretty! Ah! How wise!
Three little words you often see
Are ARTICLES a, an and the.
The whole are called the PARTS OF SPEECH
Which reading, writing, speaking teach.

Обычно мы говорим и, тем более, пишем полными предложениями, в которых разные части речи выполняют разные синтаксические функции, становясь членами предложения. Члены предложения – это знаменательные слова (или словосочетания), выражающие определенные синтаксические отношения и находящиеся между собой в определенных синтаксических связях. Входящие в состав предложения слова, являющиеся различными частями речи, выполняют синтаксические функции, главные из которых – подлежащее и сказуемое, и второстепенные члены предложения – дополнение, определение, обстоятельство.

Поскольку целью нашего пособия является формирование устойчивых навыков распознавания, глубокого понимания и применения грамматического материала в речи, нам необходимо вспомнить грамматические категории, которые имеет глагол в английском языке. Грамматическая категория – это одно из наиболее общих свойств лингвистических единиц вообще или некоторого их класса, получившее в языке грамматическое выражение или, другими словами, грамматическая категория – это совокупность однородных грамматических значений. Так, например, отдельные значения форм времен объединяются в категорию времени. Грамматическое значение выступает как добавочное к лексическому значению слова и выражает различные отношения (отношение к другим словам в предложении, отношение к лицу, совершающему действие, отношение сообщающегося факта к действительности и времени, отношение говорящего к сообщению и.т.д.)

Прежде всего, у английского глагола есть категория наклонения (mood), которая выражает отношение говорящего или пишущего к содержанию предложения, т.е. считает ли говорящий действие или состояние реальным, нереальным, желаемым, необходимым и.т.п.

В английском языке есть три наклонения: изъявительное (indicative mood), повелительное (imperative mood) и сослагательное (subjunctive mood).

Изъявительное наклонение (Indicative mood) обозначает, что действие или состояние мыслится говорящим как утверждаемое или отрицаемое, как вполне реальное, действительно происходящее, происходившее или как то, которое произойдет в будущем. Оно имеет категорию времени (present, past, future), категорию лица и категорию числа. Морфологическая структура сказуемого в предложении указывает на наличие или отсутствие каких-либо грамматических значений в личной форме глагола.

1. Грамматическая категория лица.

I am (I лицо)	I read (I лицо)
He is (III лицо)	You read (II лицо)
	He reads (III лицо)

2. Грамматическая категория числа.

I am (ед. число)	I read (ед. число)
They are (мн. число)	They read (мн. число)

3. Грамматическая категория времени.

I am (Present)	I read I am reading (Present)
I was (Past)	I read I loved (Past)
He will be (Future)	I will be reading (Future)

4. Грамматическая категория вида.
   I read books daily. (Non-Continuous)
   I am reading this book now. (Continuous)
   I have been waiting for her for an hour. (Continuous)
5. Грамматическая категория перфектности.
   I read much. (Non-Perfect)
   I have read his book. (Perfect)
   I felt tired because I had been working in the garden for two hours. (Non-Perfect, Perfect)
6. Грамматическая категория залога.
   I like her. (Active)
   All these articles have been read by his students. (Passive)
   He was given a chance to visit London. (Passive)

Обычно слово имеет несколько грамматических значений и способы образования форм слова могут быть синтетическими (простыми) – выражение значений в самом слове; или аналитическими (сложными) – выражение значений вне слова (см. сс. 19-20). В английском языке преобладает аналитический способ выражения грамматических значений.

Повелительное наклонение (Imperative mood) выражает просьбу или побуждение к действию. Оно не имеет категорий времени, вида и залога, так как не означает реального действия. Форма глагола - инфинитив без частицы to. Аналитическая форма имеет вспомогательный глагол let.

Сослагательное наклонение (Subjunctive mood) это категория глагола, которую используют в речи для выражения реально несуществующих или гипотетических действий или состояний. Эти действия или состояния рассматриваются как желаемые, необходимые, возможные, предполагаемые, воображаемые или противоречащие реальности. В образовании сказуемых в предложении в сослагательном наклонении, в частности в его аналитических формах, присутствуют неличные формы глагола, а именно инфинитив, причастие I, причастие II, для обозначения таких грамматических категорий, как категория времени (non-factual forms), вида, перфектности и залога.

Приведенная ниже таблица дает полную картину всех личных форм глагола, в состав некоторых из них входят неличные формы:

	Non Perfect			
	Non continuous		**Continuous**	
	Active	**Passive**	**Active**	**Passive**
	to work	**to be worked**	**to be working**	**to be being worked**
Present	I work He She } works It You We } work They	I am worked He She } It is worked You We } They are worked	I am working He She } It is working You We } They are working	I am being worked He She } It is being worked You We } They are being worked

Past	I He She It You We They worked Или II форма неправильных глаголов	I was worked He She It was worked You We They were worked	I was working He She It was working You We They were working	I was being worked He She It Was being worked You We They were being worked
Future	I shall work He She It You We They will work	I shall be worked He She It You We They will be worked	I shall be working He She It You We They will be working	I shall be being worked He She It You We They will be being worked

	Perfect			
	Non continuous		**Continuous**	
	Active	**Passive**	**Active**	**Passive**
	To have worked	**to have been worked**	**to have been working**	
Present	I have worked He She } has It worked You We } They have worked	I have been worked He She } It has been worked You We } They have been worked	I have been working He She } It has been working You We } They have been working	

Past	I He She It You We They had worked	I He She It You We They had been worked	I He She It You We They had been working	
Future	I shall have worked He She It will have worked You We They will have worked	I shall have been worked He She It will have been worked You We They will have been worked	I shall have been working He She It will have been working You We They will have been working	

II

Основным же предметом изучения в данном пособии являются неличные формы глагола. Неличные формы глагола – это ИНФИНИТИВ, ГЕРУНДИЙ И ПРИЧАСТИЕ (Participle I, Participle II). Эти формы, а также содержащие их конструкции представляют немалые трудности для адекватного понимания и перевода, т.к. в английском языке причастия и инфинитив по форме и употреблению далеко не всегда совпадают с русскими, а формы, подобной герундию, в русском языке нет вообще. У этих форм нет части грамматических категорий, которые есть у личных форм, а именно: лица, числа, грамматического времени (tense) и наклонения, но есть категории залога (active, passive voice), перфекта (Perfect, Non-Perfect), вида (Continuous, Non-Continuous).

Лексическое значение неличных форм не отличается от значения личных форм, грамматическая же разница между ними заключается в том, что неличные формы имеют значения второстепенного действия, состояния или процесса, связанного с основным – первичным, выраженным глаголом в личной форме, т.е. сказуемым. Второстепенное действие носит характер вторичного, производного, вспомогательного, добавочного или сопутствующего по отношению к главному действию в предложении.

В предложении неличные формы глагола могут выполнять синтаксическую функцию, которой обладают как глагол, так и неглагольные части речи (существительное, прилагательное, наречие). Так инфинитив и герундий могут выполнять главные синтаксические функции существительного, а именно подлежащего, дополнения и части составного сказуемого (predicative). Причастие I выступает в роли определения, части составного сказуемого и обстоятельства. Причастие II – определения и части составного сказуемого. Причем сами они не могут быть сказуемым, но могут входить в составное сказуемое.

Все неличные формы глагола являются структурным элементом в так называемых предикативных конструкциях (predicative constructions), которые представляют собой структуру-словосочетание, относящуюся к группе конструкций с неличными формами глаголов, обозначающих вторичную номинацию. Это – двухкомпонентные синтаксические комплексы, в которых существительное или местоимение и неличная форма глагола находятся в предикативных отношениях, т.е. в отношениях между подлежащим как носителем признака и сказуемым как выражением признака. Предикативные отношения в предложении отражают отношения между субъектом и предикатом суждения.

Далее мы представляем читателям для анализа фрагмент статьи, опубликованной в журнале *The Sciences* (May/June, 1997, сс. 33-34) *

In years of teaching freshman calculus courses, I never ceased to be amazed by how many of my students' mistakes boiled down to problems with commutativity. Put the expression $(x+y)^2$ on an exam and, as ineluctably as boats spiraling into a whirlpool, even some students who know better will expand it as x^2+y^2 - as if the rules of arithmetic let them add or square numbers in either order.

What is the source of that fatal allure? Much of it, I suspect, stems from a faulty analogy. Early in primary-school arithmetic class, children learn that when they add two numbers, the order does not matter. It is understandable that years later, grappling with more complicated expressions and working under time pressure,

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students' minds may default to the familiar commutative law.

Yet it is also a peculiar thing to do. After all, nobody takes commutativity for granted outside the classroom. When you get dressed in the morning, it may not matter much whether you put on your watch before your shoes or the other way around: "put on watch" commutes with "put on shoes." "Put on socks," however, does not, and even small children know which order of operations is likely to yield more satisfactory results (though they may vary the order anyway for fun). Similarly, woe unto the poor soul who, when making chocolate, inverts the operations "heat milk in microwave oven" and "stir chocolate powder into milk." Heating milk first yields a creamy treat; adding the powder first, a lumpy mess – as I once discovered the hard way.

In mathematics the rule of thumb is that numbers commute but operations or actions generally do not. The second half of that formula, the noncommutativity of actions, is a little-known touchstone of mathematics, with implications ranging from the trivial to the profound. In many cases it injects a spark of anarchy into a tame, well-behaved theory (just as it played havoc with the expectations of Kon-Yu's customers). In other guises it keeps turning up, like a theoretical Forrest Gump, at the scene of major upheavals in the mathematical world view. Noncommutativity underlies the perplexities of quantum mechanics, including the famous uncertainty principle of the German physicist Werner Heisenberg. In recent years the subject has burst free of its roots in algebra and has given rise to a radically new kind of geometry, which might give physicists their next big boost toward a grand unified "theory of everything."

In learning to appreciate noncommutativity, you first need to know that not all noncommutative operations are alike. That may sound odd – after all, things either commute or they do not, right? Not exactly. Consider two ships that start out side by side at the equator. One ship sails 100 miles east, then turns and sails another 100 miles north. The second ship sails 100 miles north, then 100 miles east. Do they end up in the same place? No; the second ship will end about one-thirtieth of a mile east of its sister. If the ships had sailed ten times farther in each direction, the discrepancy would have been about thirty-two miles – nearly 1000 times greater. Commutativity fails because the earth is curved, and the extent of the failure depends on the actions the ships take.

The failure of commutativity becomes strikingly clear when applied to the mundane task of untying knots. Twenty-three centuries ago Alexander the Great vented his impatience with that task by slicing asunder the legendary Gordian knot. Today mathematicians continue to hatch surprising improvements on Alexander's brute-force approach. John Horton Conway of Princeton University [see "Mathemagician," by Charles Seife , *The Sciences*, May/June 1994] has harnessed the noncommutativity of actions to create an ingenious method for untying knots without swordplay.

Conway tackled a kind of knot called a tangle, which he defined as any mess of string with four ends. For convenience he assumed that those ends always fall on the four vertices of a square. The goal is to unknot the two pieces of string in such a way that they end up lying parallel to each other along the top and bottom of the square, like the bars of an equal sign: =. Conway proved that, for an important class of tangles, you can reach that goal through two simple operations. The first operation is *turn*: take the entire lump of string and rotate it ninety degrees clockwise. Suppose the ropes are still side by side but vertical: ||. Then one turn gives rise to the = sign. If you turn again, you get back the original || sign. (The strings have changed places, but because the tangle looks like the original one, it is considered the same. In general two tangles are considered equivalent if you can change one of them into the other by moving the strings around inside the square formed by the ends. But if you move an end or pull a loop over one of the ends, you might create a different tangle.)

Conway's second operation can be called *twist*. Take the tangle and – without moving the leftmost ends of the string – give the rightmost ends a twist that puts the top string over the bottom. If you twist the = configuration, you create an X-shaped tangle in which the string that starts at the top left passes over the one that starts at the bottom left (an overpass, if you will). If you twist the || tangle, you get the || tangle again. It is easy to see that the operations *turn* and *twist* do not commute. In fact, if you take the = tangle, turn it and then twist it, you get the || tangle. If you twist first and then turn, you get an X in which the string that starts at the top left crosses under the other one: an underpass.

Conway discovered a way of describing the number of twists in a tangle by a single number. Since the = tangle has no twists in it, its Conway number is zero. To compute the Conway number of more involved tangles, just add one for every twist. Thus the operation twist on tangles corresponds to the operation "add one" on numbers. (If you wanted to, you could also subtract one by doing an "untwist.")

What about operation turn? At first glance there seems to be no reason that moving a knot around should change the number of twists. Here is where Conway had an astounding insight: in fact, rotating a tangle corresponds to taking the negative of the reciprocal of the number of twists. For example, if you give a turn to a tangle with three twists, the resultant tangle is considered to have negative-one-third twist in it (a Conway number of -1/3).

Outrageous? Yes, but, amazingly, it works. Take the zero tangle, carry out any sequence of twists and turns you like, and the resultant tangle will have a Conway number. That number will be a fraction, positive or negative. A little thought will convince you that, by appropriate twisting and turning, you can generate any fraction you can name. (In some cases you end up dividing by zero. That is why the || tangle, as you might guess, has a Conway number of both plus and minus infinity.) Because mathematicians refer to fractions as rational numbers, tangles created by twisting and turning are called rational tangles.

To untie any rational tangle, all you need to do is apply any series of operations that reduces the Conway number to zero. Like magic, the strings will return to the = position. In lectures, Conway demonstrates his technique by producing two lengths of rope and leading four volunteers through an arithmetic square dance. You might prefer to experiment with shoelaces. Whatever your equipment, consider the tangle illustrated on this page (Conway number -3/5), which results from the sequence twist-twist-twist-turn-twist-twist-turn. You could untie it by an appropriate sequence of "untwists" and "turn backs"; or you could forge ahead as follows: twist (-3/5+1=2/5), then turn (-1 divided by 2/5=-5/2), then twist three times (-5/2 +3=1/2), turn (-1 divided by 1/2=-2) and twist twice more (-2+2=0). Try it!

Conway's method works because the physical manipulations of twisting and turning exactly mirror the arithmetic operations involving and calculating the Conway number. In other words, the operations *twist* and *turn* fail to commute, and the operations "add one" and "take the negative reciprocal" fail to commute in exactly the same way. That parallelism gives Conway's method great power to reveal hidden relations among tangles.

For example, note that if you start with any number and take its negative reciprocal twice, you get back the same number. Translated into the language of tangles, that fact implies that rotating any tangle twice must give the same tangle back again. But if you try rotating the -3/5 tangle twice (or, equivalently, turn the diagram upside down), the resultant tangle will not look at all the same. Nevertheless, it is possible to manipulate the strings in the upside-down version to get the right-side-up version. And even more-subtle relations among tangles can readily be proved. For example, given any rational tangle, the sequence of moves twist-turn- twist-turn- twist-turn will produce an equivalent tangle. Can you see why?

Given mathematicians' passion for generalizing, it should come as no surprise that twist, turn and their arithmetic analogues have applications extending far beyond rational tangles. Nowadays mathematicians tend to take those benefits of noncommutativity for granted. It is hard to believe that, a little more than a century and a half ago, the best mathematical minds in the world would have found them inconceivable.

Этот текст, по нашему мнению, наглядно демонстрирует частотность использования неличных форм глагола в грамматической структуре текста и их морфологическое и синтаксическое многообразие. Мы проведем грамматический анализ представленного текста с целью, прежде всего, идентифицировать все неличные формы глаголов, понять их грамматическое значение и их функцию в предложении с тем, чтобы извлечение из текста содержательной информации было адекватно намерениям автора. Анализируемые глагольные формы мы выделили в отдельные группы.

Первая группа

В первую группу мы отобрали из анализируемого нами текста фрагменты предложений, включающие в себя два главных члена предложения, т.е. подлежащее и сказуемое, в состав которого входят неличные формы глаголов как часть простого глагольного сказуемого. Такая форма сказуемого называется аналитической. Поясним: английские морфологические (т.е. основанные на различных способах образования грамматических форм) категории имеют два способа формирования: простой или синтетический, если формообразующий элемент входит в состав слова (reads, depends – 3 лицо, ед. число; tackled, involved – простое прошедшее время) и сложный или аналитический, состоящий, по крайней мере, из двух глагольных элементов: вспомогательных глаголов и значимых глаголов. Значимые глаголы представлены неличными формами. Это может быть причастие I (is reading, was writing, am thinking), причастие II (have forgotten, has shown, was involved), инфинитив в его различных формах (will go, can incorporate, will have been, might be solved). Вспомогательные глаголы в этом случае не имеют лексического значения, их роль чисто грамматическая. Обратимся к тексту и отберем для анализа и перевода фрагменты предложений с описанными выше грамматическими характеристиками:

1. …some students will expand it… – …некоторые студенты разложат его в… (Infinitive)
2. …the order does not matter… – …порядок не имеет значения… (Infinitive)
3. …when you get dressed in the morning… – …когда вы одеваетесь по утрам… (Participle II)
4. …the subject has burst free of its roots in algebra and has given rise to a radically new kind of geometry… – …этот объект изучения вырвался из крепких объятий алгебры и способствовал возникновению радикально новой геометрии… (Participle II, Participle II)
5. Do they end up in the same place? – Закончат ли они свой путь в одном и том же месте? (Infinitive)
6. … the second ship will end about one-thirtieth of a mile east… – …второй корабль закончит путь на $1/30$ долю мили восточнее… (Infinitive)
7. If the ships had sailed ten times farther in each direction, the discrepancy would have been… – Если корабли проплыли бы в каждом направлении расстояние в 10 раз большее, расхождение было бы… (Participle II, Infinitive)
8. …because the Earth is curved… – …потому что Земля имеет округлую форму… (Participle II)

9. John Horton Conway … has harnessed the noncommutativity of action… – …Джон Хортон Конвей использовал некоммутативность действий. (Participle II)
10. The strings have changed places… – Веревки поменялись местами… (Participle II)
11. …it is considered the same… – …считается, что узел остается без изменений… (Participle II)
12. …two tangles are considered equivalent… – …два узла считаются эквивалентными… (Participle II)
13. …the operations do not commute… – …операции не коммутируют… (Infinitive)
14. …the resultant tangle is considered… – …считается, что получившийся узел… (Participle II)
15. …the resultant tangle will have a Conway number… – …получившийся узел будет иметь число Конвея… (Infinitive)
16. A little thought will convince you that… – Немного подумав, вы убедитесь в том, что… (Infinitive)
17. …tangles… are called rational tangles… – …такие узлы называются рациональными… (Participle II)
18. …the strings will return to the = position… – …веревки вернутся в позицию =… (Infinitive)
19. …the resultant tangle will not look at all the same… – …получившийся узел будет выглядеть совсем не как изначальный… (Infinitive)
20. …the sequence of moves … will produce an equivalent tangle… – …последовательность движений даст в результате эквивалентный узел… (Infinitive)
21. …the best mathematical minds in the world would have found them inconceivable… – …лучшие умы мира скорее всего сочли бы их невероятными… (Infinitive)

Вторая группа

Во вторую группу мы отобрали фрагменты предложений, включающие в себя, как и в первой группе, два главных члена предложения, т.е. подлежащее и сказуемое. В эту группу включены только сказуемые, в состав которых неличные формы глагола входят как часть составного глагольного сказуемого. Напомним, что составное глагольное сказуемое состоит из глагола с ослабленным лексическим значением в личной форме, играющим вспомогательную роль и несущим грамматическое значение, и другого глагола в форме инфинитива или герундия, выражающего основное значение всей конструкции. Глаголом-связкой в составном глагольном сказуемом могут быть модальные глаголы (can, may, must, should, ought, shall, will, would, need, dare, to be to, to have to), выражения модального характера или глаголы, указывающие на начало (to begin, to start, to commence, to set about, to take to, to fall to, to come), продолжение (to go on, to keep, to proceed, to continue), повторение (would, used to) и завершение (to stop, to finish, to cease, to give up, to leave off) действия.

Обратимся к тексту и отберем для анализа и перевода фрагменты предложений с описанными выше грамматическими характеристиками:

1. …I never ceased to be amazed by how many of my students' mistakes… – …я никогда не переставала удивляться тому, как много ошибок моих студентов… (Infinitive)
2. …students' minds may default to that familiar commutative law… – …студенческие мысли автоматически приходят к знакомому закону коммутативности… (Infinitive)
3. …it may not matter much whether you put on your watch… – …вероятно, не так уж важно, надеваешь ли ты часы… (Infinitive)
4. …they may vary the order anyway for fun… – …они, возможно, меняют порядок, как захочется, чтобы повеселиться… (Infinitive)
5. In other guises it keeps turning up, like theoretical Forest Gump… – В других обличиях он постоянно

проявляет себя как теоретический Форест Гамп… (Gerund)

6. …geometry, which <u>might give</u> physicists their next big boost toward … "theory of everything"… – …геометрия, которая могла бы стать новым подспорьем для физиков на пути к созданию великой объединенной "теории всего"… (Infinitive)
7. …you first <u>need to know</u> that… – …прежде всего вы должны усвоить, что… (Infinitive)
8. That <u>may sound</u> odd… – Это звучит довольно-таки странно… (Infinitive)
9. Today mathematicians <u>continue to hatch</u> surprising improvement on… – Сегодня математики продолжают усиленно размышлять над тем… (Infinitive)
10. …you <u>can reach</u> that goal through two simple operations – …можно решить эту задачу с помощью двух простых операций. (Infinitive)
11. …if you <u>can change</u> one of them into the other… – …если вы сможете заменить одну из них на другую… (Infinitive)
12. …you <u>might create</u> a different tangle… – …вы, вероятно, сможете сделать другое сплетение… (Infinitive)
13. …second operation <u>can be called</u> twist… – …вторая операция может быть названа "кручение"… (Infinitive)
14. …moving a knot around <u>should change</u> the number of twists – …вращение узла должно изменить число кручений (Infinitive)
15. …you <u>can generate</u> any fraction you can name… – …вы можете получить любую дробь, какую захотите… (Infinitive)
16. …as you <u>might guess</u>… – …как вы, должно быть, догадались… (Infinitive)
17. …all you <u>need to do</u> is apply any series of operations… – …все, что вам необходимо сделать, это выполнить ряд операций… (Infinitive)

18. You might prefer to experiment with shoelaces. – Возможно, вам больше понравится попробовать проделать это со шнурками. (Infinitive)
19. You could untie it by an appropriate sequence of “untwists”… or you could forge ahead as follows:… – …Вы можете развязать его с помощью соответствующей последовательности раскручиваний… или вы можете действовать следующим образом… (Infinitive, Infinitive)
20. …the operations *twist* and *turn* fail to commute… – …операции скручивания и поворота не коммутируют… (Infinitive)
21. …rotating any tangle twice must give the same tangle back again. – …Поворот любого узла дважды обязательно дает исходный узел. (Infinitive)
22. …even more-subtle relations among tangles can readily be proved. – …даже более сложные зависимости между узлами могут быть легко доказаны. (Infinitive)

Третья группа

В третью группу мы отобрали изъятые из всех предложений инфинитивы в непредикативной синтаксической функции, то есть в функциях подлежащего, дополнения, определения и обстоятельства. В таблице личных форм глагола (сс. 9-12) мы видим, что инфинитив, являясь отправной формой для образования глагольных личных форм – сказуемого в предложении, обладает грамматическими категориями: совершенный–несовершенный вид (perfect–non-perfect), активный–страдательный залог (active-passive), общий–продолженный аспект (continuous–non-continuous). Эти грамматические характеристики инфинитива зафиксированы в его морфологических формах. Однако он не обладает категориями грамматического времени (Present, Past, Future), лица и числа.

Форма инфинитива	Залог	
	Действительный	Страдательный
Неопределенная	to discuss	to be discussed
Продолженная	to be discussing	
Перфектная	to have discussed	to have been discussed

Частотность употребления грамматических форм инфинитива в текстах академического стиля неравномерна. Чаще всего в этих текстах присутствуют неопределенная и перфектная формы (как действительного, так и страдательного залога). Продолженная форма встречается сравнительно редко.

Неперфектная форма инфинитива указывает на действие, одновременное с действием первичным, т.е. временем действия личной формы глагола в синтаксической функции сказуемого. Перфектный инфинитив всегда означает действие, предшествующее времени действия личного глагола – сказуемого предложения. Форма продолженного инфинитива подчеркивает продолжительность процесса во времени.

Активный и пассивный залог отличаются тем, что действие активного инфинитива исходит от субъекта (подлежащего), а пассивный инфинитив указывает на то, что действие направлено на субъект.

Приведем примеры инфинитива в функциях подлежащего, дополнения, обстоятельства, определения.

1. To solve this complicated problem is an actual task in our investigation. (подлежащее)
2. Because ordinary real and complex numbers obey the rules of arithmetic – rules such as associativity and commutativity of addition and multiplication – Hamilton expected to discover more exotic numbers that do the same. (дополнение)

3. Hamilton had been working intensely to discover new number systems "beyond" the complex number. (обстоятельство)
4. Hamilton was one of the first scientists to appreciate the importance of complex numbers – numbers that incorporate multiples of the square root of -1. (определение)

Далее мы продолжим грамматический анализ нашего текста и выпишем все предложения, в которых есть инфинитивы, причем синтаксическая функция этих неличных глагольных форм представлена в виде членов предложения, не являющихся сказуемыми. Здесь заметим, что инфинитив, обычно стоящий в начале предложения перед глаголом-сказуемым и выполняющий функцию подлежащего встречается в научных и научно-технических текстах довольно редко. Если мы правильно определили его морфологическую форму и синтаксическую функцию, он не представит серьезную проблему для понимания и перевода, если таковой потребуется.

1. Yet it is also a peculiar thing to do. – И все же это именно то, что мы намереваемся сделать.
2. In learning to appreciate noncommutativity, you first need to know that not all noncommutative operations are alike. – Для понимания некоммуникативности вы, в первую очередь, должны осознать, что не все виды некоммутативности одинаковы.
3. John Horton Conway… has harnessed the noncommutativity of actions to create an ingenious method for untying knots without swordplay. – Джон Хортон Конвей использовал некоммутативность действий при создании остроумного метода распутывания узлов, без привлечения грубой силы.
4. To compute the Convey number of more involved tangles, just add one for every twist. Thus the operation "twist" on tangles corresponds to the operation "add one" on numbers. – Чтобы найти число Конвея для более сложных плетений, нужно

посчитать число всех перекрестков. Поэтому операция скручивания нитей плетения отвечает операции +1 на множестве чисел.

5. To untie any rational tangle, all you need to do is apply any series of operations that reduces the Convey number to zero. – Все, что вам нужно сделать, чтобы распутать рациональное плетение, это применить любую последовательность операций, в результате которой число Конвея полученного плетения станет нулем.
6. You might prefer to experiment with shoelaces. – Возможно, вы предпочтете поэкспериментировать со шнурками от ботинок.
7. That parallelism gives Convey's method great power to reveal hidden relations among tangles. – Этот параллелизм дает методу Конвея большие возможности для обнаружения скрытых отношений между плетениями.
8. Nevertheless it is possible to manipulate the strings in the upside-down version to get the right-side-up version. – Тем не менее, можно произвести такие манипуляции с нитями перевернутого плетения, чтобы получить изначальное.
9. Nowdays mathematicians tend to take those benefits of noncommutativity for granted. – Сегодня математики, как правило, используют свойство некоммутативности как само собой разумеющееся.
10. It is hard to believe that little more than a century and a half ago, the best mathematical minds in the world would have found them inconceivable. – Трудно поверить, что еще полтора века назад лучшие математические умы сочли бы их невероятными.

Как мы видим из анализа нашего текста, наиболее часто встречающаяся функция инфинитива в предложении – это обстоятельство и дополнение. Предложения с такими инфинитивами не представляют трудности для понимания русскоговорящими студентами. Инфинитив же в функции определения в английском языке встречается намного чаще, чем в русском и может представлять определенную проблему. В этой функции инфинитив всегда имеет значение еще не выполненного действия, которое считается возможным, необходимым, желательным, рекомендуемым, и может переводиться на русский язык придаточным предложением.

Приведем несколько примеров.

1. Hamilton was one of the first scientists <u>to appreciate</u> the importance of complex numbers – numbers that incorporate multiples of the square root of -1. – Гамильтон был одним из первых ученых, <u>которые оценили</u> важность комплексных чисел…
2. Among those matrices (the two-by-two matrices) is one that has the vexing power <u>to change</u> either point into other one. – Среди матриц есть такая, которая обладает неудобным свойством переводить каждую точку в другую, отличную от нее, точку.

Считаем целесообразным обратить внимание читателя на то, что переводы, которые мы сделали в этой части, в основном предназначены для того, чтобы акцентировать внимание на семантике грамматической составляющей текста. Такой подход к переводу будет сохраняться и в дальнейшем. Лексическая и содержательная составляющие перевода могут, конечно, быть усовершенствованы теми, кто профессионально владеет предметом.

<u>Четвертая группа</u>

В четвертую группу мы отобрали предложения с герундием в непредикативной синтаксической функции, т.е. в функции подлежащего, дополнения, определения и обстоятельства. В русском языке нет грамматической формы, аналогичной герундию. Грамматическое значение герундия – это процесс или действие. В русском языке, как и в английском, есть отглагольные существительные: чтение, рисование (например, как школьные предметы, в рамках которых детей учат читать и рисовать). На этих уроках дети осваивают процесс "чтения" и "рисования", в этом смысле такой процесс может быть назван также "читанием" и "рисованием". В английском языке для названия процесса какой-либо деятельности есть неличная глагольная форма – герундий (gerund). Как неличная глагольная форма герундий обладает грамматическими категориями (как и инфинитив по бинарному принципу): совершенный–несовершенный вид (perfect–non-perfect), активный–страдательный залог (active-passive).

Форма герундия	Залог	
	действительный	страдательный
Неопределенная	discussing	being discussed
Перфектная	having discussed	having been discussed

Частотность употребления грамматических форм герундия в текстах научного стиля неравномерна, чаще всего в этих текстах присутствует простая форма типа *discussing.* Неперфектный герундий означает, что процесс, выраженный им, протекает в одно время с первичным действием, выраженным сказуемым предложения и соответственно личной формой глагола. Герундий не обладает категориями продолженности-непродолженности, грамматического времени (Present, Past, Future), лица, числа. Пассивный и активный залоги имеют такое же значение, как и у инфинитива. Чаще всего герундий переводится на русский язык существительным или глаголом. Проиллюстрируем употребление герундия в синтаксических функциях подлежащего, дополнения, обстоятельства и определения:

1. Other calculations – searching the Internet, modeling the national economy, forecasting the weather – likewise strain the capacities of even the fastest and most powerful computers. (подлежащее)

2. If functioning quantum computers can be built, harnessing their potential will be just a matter of creating algorithms that carry out the right operations in the right order. (подлежащее) (определение)
3. Imagine trying to find your shoes in such a quantum closet: as soon as you figured out exactly where they were from left to right, they would turn into a front-to-back blur. (дополнение)
4. Physicists and computer scientists have proved that, by stringing together single-qubit operations and two-qubit controlled – NOT gates, it is theoretically possible to build a quantum computer capable of doing anything a classical computer can do. (обстоятельство)
5. Quantum algorithms, however, are another matter. In 1994 Shor discovered one that makes factoring almost as efficient as multiplication. (дополнение)
6. Factoring is a kind of search – a search for factors. (подлежащее)
7. By reinterpreting observables as operators, Heisenberg inevitably introduced the idea of noncommutativity. (обстоятельство)
8. In Gelfand's approach (contrary to the usual way of thinking about such things) the dancer comes first and summons the dance into existence. (определение)
9. According to Gelfand's theorem, the idea of reconstructing space will work provided the shadow land of functions (which mathematicians call by uninformative name of "commutative C-star algebras") obeys a short list of specifications, or axioms. (определение)

Продолжим грамматический анализ исследуемого нами текста и теперь выделим все предложения с герундием в его синтаксических функциях.

1. In learning to appreciate noncommutativity, you first need to know that not all noncommutative operations are alike.

Для понимания некоммутативности вы, в первую очередь, должны осознать, что не все виды некоммутативности одинаковы.

2. The failure of commutativity becomes strikingly clear when applied to the mundane task of untying knots.

   Отсутствие коммутативности становится поразительно ясным во время повседневного развязывания узлов.

3. Twenty-three centuries ago Alexander the Great vented his impations with that task by slicing asunder the legendary Gordian knot.

   Двадцать три века тому назад Александр Великий проявил нетерпение, разрубив на куски легендарный Гордиев узел.

4. John Horton Conway… has harnessed the noncommutativity of actions to create an ingenious method for untying knots without swordplay.

   Джон Хортон Конвей использовал некоммутативность действий при создании остроумного метода развязывания узлов без привлечения грубой силы.

5. In general, two tangles are considered equivalent if you can change one of them into the other by moving the strings around inside the square formed by the ends.

   В общем случае два плетения считаются эквивалентными, если вы можете перевести одно в другое, двигая нити внутри квадрата, ограниченного концами нитей.

6. Take the tangle and – without moving the leftmost ends of the string – give the rightmost ends a twist that puts the top string over the bottom.

   Не двигая левые концы плетения, перекрутите правые концы так, чтобы верхняя нить прошла над нижней.

7. Conway discovered a way of describing the number of twists in a tangle by a single number.

Конвей обнаружил способ, как описать количество кручений в узле обычным числом.

8. If you wanted to, you could also subtract one by doing an “untwist”.

   Если бы вы захотели, то могли бы вычесть единицу, выполняя операцию “раскручивания”

9. Here is where Conway has an astounding insight: in fact, rotating a tangle corresponds to taking the negative of the reciprocal of the number of twists.

   Именно в этом месте обнаруживается удивительная проницательность Конвея: на самом деле повороту плетения отвечает операция взятия отрицательного обратного от числа закрученностей плетения.

10. A little thought will convince you that, by appropriate twisting and turning, you can generate any fraction you can name.

    Немного подумав, вы убедитесь, что, применяя последовательность скручиваний и поворотов, можете получить любую дробь.

11. Because mathematicians refer to fractions as rational numbers, tangles created by twisting and turning are called rational tangles.

    Поскольку математики называют дроби рациональными числами, то плетения, получаемые с помощью скручиваний и поворотов, называются рациональными.

12. In lectures, Conway demonstrates his technique by producing two lengths of rope and leading four volunteers through an arithmetic square dance.

    На лекциях Конвей демонстрирует эту технику, используя два куска каната и четырех добровольцев, которые под его руководством танцуют арифметическую кадриль.

13. Conway’s method works because the physical manipulations of twisting and turning exactly mirror the arithmetic operations involved in calculating the Conway number.

Метод Ковея работает, поскольку физические операции скручивания и поворота в точности воспроизводят операции, используемые при вычислении числа Конвея.

14. But if you try rotating the -3/5 tangle twice (or, equivalently, turn the diagram upside down), the resultant tangle will not look at all the same.

Но если попробуете повернуть -3/5 плетение дважды (или, что то же самое, перевернуть диаграмму вверх ногами), то полученное плетение не будет выглядеть точно также, как исходное.

15. Given mathematicians' passion for generalizing, it should come as no surprise that “twist” and “turn” and their arithmetic analogues have applications extending far beyond rational tangles.

Принимая во внимание присущую математикам страсть к обобщению, не должно выглядеть удивительным то, что скручивание, поворот и их арифметические аналоги имеют приложения, простирающиеся далеко за пределы теории рациональных плетений.

В нашем тексте не встретились формы герундия в страдательном (Passive) залоге и формы совершенного (Perfect) вида. Они редки в текстах научного содержания. Мы дадим примеры, иллюстрирующие эти формы:

I dislike being involved into the discussion having nothing to do with my scientific interests.

I regret having missed two seminars which I consider important for me to attend, but I was ill.

Пятая группа

В пятую группу мы отобрали из анализируемого текста все предложения с причастиями (в непредикативной синтаксической функции), которые в предложении могут исполнять роль определения или обстоятельства. В научной литературе причастия и причастные обороты используются очень широко.

Причастие имеет две формы: причастие I (Participle I), причастие II (Participle II).

Причастие I, являясь неличной формой глагола, имеет две грамматические категории: категорию совершенного-несовершенного вида (Perfect-Non-perfect) и категорию залога (Active-Passive).

Форма причастия	Залог	
	Действительный	Страдательный
Причастие I	discussing	being discussed
Причастие II		discussed
Перфектное причастие	having discussed	having been discussed

Из всех форм причастия наиболее частотные формы в текстах научного содержания – это причастие I (discussing, being discussed) и причастие II (discussed). Перфектные формы причастия I имеют значение предшествия действия причастия (которое является вторичным) по отношению к первичному действию (сказуемому), выраженному личной формой глагола.

Причастие II как неличная форма глагола обладает свойствами как глагола, так и прилагательного. Оно отличается от других неличных форм тем, что у него нет морфологических грамматических категорий других неличных форм. Главное его значение – это некоторое состояние как результат некоторого действия.

Примеры:

1. Noncommutativity underlies the perplexities of quantum mechanics, <u>including</u> the famous uncertainty principle of the German physicist Werner Heisenberg.
2. The second half of the formula, the noncommutativity of actions, is a <u>little-known</u> touchstone of mathematics, with implications <u>ranging</u> from the trivial to the profound.
3. In many cases it injects a spark of anarchy into a tame <u>well-behaved</u> theory.

4. The founders of quantum theory may have been radicals when dealing with matter and energy, but they were laissez-fair conservatives when it came to the geometry of space.
5. Having written those two numbers in the corners of a two-by-two array, he turned the ordinary functions into the tame inhabitants of a well-known noncommutative algebra, the two-by-two matrices.
6. To mathematicians, the most breathtaking thing about Connes's work may be the ease with which it fits such apparently unrelated concepts into a single framework.
7. Everything a computer does – whether synthesizing speech, calculating the billionth digit of pi or beating Garry Kasparov at chess – ultimately comes about through the transformation of bits by gates.
8. Quantum computers being discussed in the article would be so much faster than classical computers for some purposes that they could solve problems the classical computers cannot touch.

Мы дали вам примеры различных форм причастий I и II в их синтаксических функциях определения и обстоятельства. Если вы правильно определили значение грамматической (морфологической) формы и синтаксической функции причастий в предложении, то для понимания и соответственно для перевода они не представляют серьезной трудности.

Вернемся к анализу нашего текста, выпишем и переведем все предложения с причастиями I и II, не выполняющими функцию части составного сказуемого.

1. The failure of commutativity becomes strikingly clear when applied to the mundane task of untying knots.
   Отсутствие коммутативности становится поразительно ясным во время повседневного развязывания узлов.
2. Today mathematicians continue to hatch surprising improvements on Alexander's brute-force approach.

В наше время “топорный” подход Александра Великого продолжает получать интересное развитие.

3. Conway tackled a kind of knot called a tangle which he defined as any mess of string with four ends.

   Конвей использовал подобие узла, названное им плетением. Он определил его как любое множество нитей с четырьмя концами

4. The goal is to unknot the two pieces of string in such a way that they end up lying parallel to each other along the top and bottom of the square, like the bars of an equal sign =.

   Задача заключается в том, чтобы распутать два куска нити так, чтобы в итоге они располагались вдоль верхнего и нижнего оснований квадрата параллельно друг другу, как черточки в знаке равенства =.

5. Conway proved that, for an important class of tangles called the rational tangles, you can reach that goal through two simple operations.

   Конвей доказал, что для важного класса узлов, называемых рациональными узлами, можно решить эту задачу с помощью двух простых операций.

6. In general, two tangles are considered equivalent if you can change one of them into the other by moving the strings around inside the square formed by the ends.

   В общем случае два плетения считаются эквивалентными, если вы можете перевести одно в другое, двигая нити внутри квадрата, ограниченного концами нитей.

7. If you twist the = configuration, you create an X-shaped tangle in which the string that starts at the top left passes over the one that starts at the bottom left (an overpass, if you will).

   Если вы делаете скручивание =, то получаете плетение в виде креста X, у которого нить, которая начинается в верхнем левом углу, проходит над той, что начинается в левом нижнем углу (переезд, если хотите).

8. To compute the Conway number of more involved tangles, just add one for every twist.
   Чтобы вычислить число Конвея для более сложных плетений, просто добавьте единицу за каждый перекресток.
9. Here is where Conway had an astounding insight: in fact, rotating a tangle corresponds to taking the negative of the reciprocal of the number of twists.
   Но именно в этом месте обнаруживается удивительная проницательность Конвея: на самом деле повороту плетения отвечает операция взятия отрицательного обратного от числа закрученностей плетения.
10. Whatever your equipment, consider the tangle illustrated on this page (Conway number -3/5) which results from the sequence twist-twist-twist-turn-twist-twist-turn.
    Каким бы ни было ваше снаряжение, рассмотрите плетение, изображенное на этой странице (число Конвея -3/5), которое получается из последовательности кручение-кручение-кручение-поворот- кручение-кручение-поворот.
11. That parallelism gives Conway's method great power to reveal hidden relations among tangles.
    Этот параллелизм дает методу Конвея большие возможности для обнаружения скрытых отношений между плетениями.
12. Translated into the language of tangles, that fact implies that rotating any tangle twice must give the same tangle back again.
    Если этот факт перевести на язык плетений, то из него следует, что при повороте плетения на 180 градусов против часовой стрелки получается то же плетение.

13. For example, given any rational tangle, the sequence of moves twist-turn-twist-turn-twist-turn will produce an equivalent tangle.

Например, при любом рациональном узле применение последовательности движений закручивание – поворот – закручивание – поворот – закручивание – поворот к данному рациональному плетению дает эквивалентное плетение.

14. Given mathematician's passion for generalizing, it should come as no surprise that twist-turn and their arithmetic analogues have applications extending far beyond rational tangles.

Принимая во внимание присущую математикам страсть к обобщению, не должно выглядеть удивительным то, что скручивание, поворот и их арифметические аналоги имеют приложения, простирающиеся далеко за пределы теории рациональных плетений.

15. Nowadays mathematicians tend to take those benefits of noncommutativity for granted.

В настоящее время есть тенденция считать очевидными выгоды от некоммутативности..

Шестая группа

К шестой группе были отнесены предикативные конструкции (Predicative Constructions). Все неличные формы глагола могут входить в состав этих конструкций. Они являются двухкомпонентной синтаксической единицей, в которой существительное или местоимение и неличная форма глагола находятся в предикативных отношениях, подобных отношениям подлежащего и сказуемого в предложении.

Предикативные комплексы – это конструкции или структуры, занимающие промежуточную позицию между словосочетанием и предложением. Поясним: словосочетание – это соединение двух или более знаменательных слов, связанных по смыслу и грамматически выражающих единое, но расчленяемое понятие, и представляющих собой сложное наименование объективной деятельности. Основная модель предложения в английском языке – это одна субъектно-предикатная единица, т.е. предложение имеет две основные позиции – подлежащее и сказуемое, выраженное личной формой глагола.

В отличие от словосочетания в предикативных комплексах имеют место субъектно-предикативные отношения. Именная часть выражает деятеля или обладателя определенного состояния или качества, а предикативная часть может быть выражена инфинитивом, причастием или герундием. В отличие от предложений субъектно-предикативные отношения в них не имеют четкого грамматического выражения, т.е. в них нет личной формы глагола, поэтому эти комплексы не имеют ни реального подлежащего, ни реального сказуемого. Отсутствие личной формы глагола в таком комплексе демонстрирует или дает возможность показать грамматически их зависимость от главного предложения с реальным подлежащим и реальным сказуемым, указывая таким образом на их зависимый или второстепенный статус. Такие комплексы, поскольку в них есть, хотя и "нереальные", но семантически понимаемые отношения типа "подлежащее и сказуемое", могут быть трансформированы в придаточные предложения, что чаще всего происходит при их переводе на русский язык. Назовем эти комплексы:

1. Complex Subject или the Subjective-with-the-Infinitive Construction – сложное подлежащее.
2. Complex Object или the Objective-with-the-Infinitive Construction – сложное дополнение.
3. For-to-Infinitive Construction, "for"-complex with the infinitive – инфинитивная конструкция с предлогом for.
4. Absolute Participle Construction или the Nominative Absolute Participial Construction – самостоятельный (абсолютный) причастный оборот.

5. Gerundial complex – герундиальный комплекс.

Рассмотрим последовательно каждую структуру в порядке их нумерования, представленном выше.

Сложное подлежащее (Complex Subject).

Этот оборот состоит из существительного или местоимения и инфинитива смыслового глагола, выступающего в качестве вторичного предиката (нереального сказуемого). Эта конструкция, являясь потенциальным эквивалентом дополнительного придаточного предложения, входит в состав простого предложения, сказуемое которого выражено личной формой глагола. Таким образом в предложении с Complex Subject мы имеем два вида предикации – личную форму глагола, характеризующую отношение автора к высказыванию, и инфинитив, обозначающий действие, которое совершает подлежащее. Реальное сказуемое в предложениях с Complex Subject выражает лишь личное отношение автора, его оценки, суждения, умозаключения и мнения автора по отношению к действию или состоянию, имеющему грамматическую форму инфинитива.

Конструкции со сложным подлежащим используются в речи только с ограниченным числом личных глаголов, как в пассивном, так и в активном залоге.

I группа – Глаголы, употребляемые только в пассивном залоге:

to think (is thought) – полагать, думать
to believe (is believed) – полагать, считать
to assume (is assumed) – полагать, предполагать
to suppose (is supposed) – полагать, предполагать
to expect (is expected) – ожидать, предполагать
to consider (is considered) – считать, полагать
to estimate (is estimated) – подсчитывать, устанавливать, оценивать
to say (is said) – говорить, сообщать, утверждать
to report (is reported) – сообщать
to state (is stated) – сообщать, утверждать

to know (is known) – знать, устанавливать
to find (is found) – находить, устанавливать
to show (is shown) – показывать
to observe (is observed) – наблюдать
to see (is seen) – видеть

II группа – Глаголы, употребляемые только в активном залоге и имеющие модальное значение:
to seem – казаться
to appear – оказываться
to prove – оказываться
to happen – оказываться
to turn out – оказываться

III группа – Сочетание глагола to be с модальными прилагательными:
to be likely – вероятно
to be unlikely – маловероятно, вряд ли
to be sure – конечно
to be certain – конечно

Такая грамматическая структура, как сложное подлежащее, достаточно часто встречается в предложениях, принадлежащих к текстам научного содержания, т.е. в текстах разъяснительного, пояснительного и описательного характера (expository writing), где сказуемое дает возможность автору показать личностное отношение к сообщаемому факту.

Неопределенная форма инфинитива (типа to correspond) переводится глаголом настоящего или будущего времени; перфектная форма (to have solved) – глаголом в прошедшем времени.

В анализируемом нами фрагменте статьи есть примеры предложений с Complex Subject (сложным подлежащим)

1. Put on socks, however, does not (commute), and even small children know which <u>order of operations is likely to yield</u> more satisfactory results (though they may vary the order anyway for fun).

Однако операция “надеть носки” не коммутирует с последней (“надеть ботинки”) и даже малые дети, должно быть, знают в какой последовательности следует выполнять эти действия, чтобы вернее получить лучший результат (хотя в любом случае они могут изменить порядок действий ради развлечения).

2. At first glance there seems to be no reason that moving a knot around should change the number of twists.

   На первый взгляд, кажется, нет причины полагать, что перемещение узла должно изменить число закрученностей.

3. For example, if you give a turn to a tangle with three twists, the resultant tangle is considered to have negative-one-third twist in it (a Conway number of -1/3).

   Например, если вы повернули плетение с тремя перекрутами, то считается, что количество перекрутов у полученного плетения равно -1/3 (число Конвея -1/3).

Сложное дополнение (Complex Object)

Дополнение является третьим по значимости членом предложения. Субъектно-предикатная структура, т.е. подлежащее и сказуемое в предложении, часто не является законченной, т.к. сказуемое (личная форма глагола) требует обязательного употребления дополнения для придания смысловой законченности. Способы выражения дополнения в русском и английском языках часто совпадают. Но в случае, когда дополнение выражено словосочетанием с неличными формами глагола, обозначающими вторичную предикацию (т.е. действие или состояние второстепенного, по сравнению со сказуемым, порядка), мы имеем так называемую единицу несоответствия.

Иными словами, грамматика русского языка не имеет такой конструкции, как сложное дополнение. В этой конструкции инфинитив в одной из своих форм стоит после существительного или личного местоимения в объектном падеже (me, you, him, her, them…), которому предшествует глагол определенного типа. Чаще всего эта конструкция используется после следующих глаголов:

I После глаголов чувственного восприятия (to see, to hear, to feel, to watch, to observe, to notice и др.)

Примечание: инфинитив после этих глаголов имеет только форму не перфектную, не продолженную, в активном залоге, без частицы to.

Примеры:
No one has ever seen this phenomenon occur in real life.
The colleagues were listening to her attentively speak.

II После глаголов умственной деятельности (to think, to believe, to consider, to expect, to understand, to suppose, to find и др.)

Примечание: Инфинитив после этих глаголов может иметь любую форму и всегда с частицей to.

Примеры:
We know him to be the most talented student in his group.
I expected her to be working on her first publication.

III После глаголов эмоционального восприятия (to love, to hate, to dislike и др.)

Примечание: Инфинитив всегда с to, возможны его любые формы.

Примеры:
I dislike her to be out of reach frequently.

I love him to be working with me on this project.

IV После глаголов, выражающих желание или намерение (to want, to wish, to desire, to intend, to mean и др.)

Примечание: Инфинитив после этих глаголов имеет только не перфектную и не продолженную форму с частицей to.

Примеры:
I want him to be in this program.
My friend is intended to be sent to work to Berlin.

V После глаголов оповещения (to declare, to pronounce и др.)

Примеры:
I declare you to come in due time to attend the opening ceremony.
The chairman reported the conference to be held at 11a.m.

VI После глаголов принуждения (to have, to make, to get, to order, to tell, to ask и др.)

Примечание: После глагола to make – заставлять инфинитивная форма употребляется без частицы to, после глагола to get – заставлять инфинитив употребляется как с частицей to, так и без нее.

Примеры:
I cannot get him come earlier.
My scientific adviser made me finish my article by the end of this month.

Далее мы предлагаем вам фрагмент из известной книги Билла Брайсона (Bill Bryson) *A Short History of*

Nearly Everything. В этом отрывке есть два предложения, в которых автор использовал Complex Subject и Complex Object.

"In 1907 or so, it has sometimes been written, Albert Einstein saw a workman fall off the roof and began to think about gravity. Alas, like many good stories this one appears to be apocryphal. According to Einstein himself, he was simply sitting in a chair when the problem of gravity occurred to him."

Иногда пишут, что примерно в 1907 году Альберт Эйнштейн увидел, как рабочий упал с крыши, и после этого задумался над проблемой гравитации. Увы, оказывается, что, как и многие другие занимательные истории, эта история совершенно недостоверна. В соответствии со свидетельствами самого Эйнштейна, он просто сидел на стуле, когда вдруг проблема гравитации осенила его.

Как в случае Complex Subject, так и в случае Complex Object, из-за отсутствия в русском языке таких конструкций, они, обычно, переводятся придаточными предложениями, но отметим. что в научных текстах намного чаще встречаются конструкции с Complex Subject. По всей видимости, это можно объяснить особой модальностью научных текстов, т.е. личной ответственностью автора за высказывания, которые он излагает в письменной форме. Если мы сравним два предложения с почти одинаковой информационной составляющей, но имеющие разную форму выражения, например:

He is considered to be the most outstanding scientist.

I consider him to be the most outstanding scientist.

то в первом случае мы понимаем, что мнение автора, должно быть, разделяет и какое-то сообщество его единомышленников, то есть это мнение коллективное. Во втором же случае всю ответственность за высказывание автор берет на себя и, вероятно, он имеет достаточное количество аргументов, чтобы произносить такое высказывание.

Инфинитивная конструкция с предлогом for

Одним из видов синтаксических комплексов с инфинитивом является оборот с for (for-phrase, for-to-infinitive construction). Он состоит из трех компонент: предлога for, существительного или местоимения в объектном падеже и инфинитива глагола. В научной и научно-технической литературе эта конструкция употребляется в предложении чаще всего в функции обстоятельства. Также она может выполнять функцию подлежащего, если в предложении есть вводное it:

It is impossible for this problem to be solved within a short period of time.

За короткое время эту задачу не решить.

Эта конструкция также может быть именной частью составного сказуемого:

The task of great importance is for our team to find the adequate solution of the problem.

Задача чрезвычайной важности заключается в том, чтобы наша команда сумела найти правильное решение этой проблемы.

Эта конструкция может выступать в функции дополнения:

We were sure for the solution to be found in the nearest future.

Мы были уверены, что решение будет найдено очень скоро.

Определение также может быть выражено оборотом for-phrase:

I am sending my article for you to read and comment.

Я посылаю тебе мою статью с тем, чтобы ты ее прочитал и высказал свое мнение.

Функция же обстоятельства в предложениях с этой конструкцией наиболее частотна в научной прозе:

We are seeking for the solution of this particular problem for the whole project to be realized as soon as possible.
Мы ищем решение этой проблемы с тем, чтобы как можно скорее завершить весь проект.

Понимание грамматики предложения с for-phrase не представляет сложности для русскоговорящих студентов и вторичная предикация, передаваемая различными формами инфинитива, достаточно транспорантна.

Самостоятельный (абсолютный) причастный оборот
Absolute Participle Construction

Причастие I (Participle I) может образовывать причастные обороты, которые выполняют функцию обстоятельства в предложении, в русском языке это деепричастные обороты. Они не вызывают никаких затруднений в понимании у русскоговорящих студентов. Например, в тексте, который был предложен для грамматического анализа их достаточно много.

It is understandable that years later, grappling with more complicated expressions and working under time pressure, students' minds may default to the familiar commutative law.

Можно понять, что годы спустя, решая задачи более сложного порядка и при этом выполняя их в условиях жесткого временного ограничения (экзамен, контрольная работа), ход размышления над решением задачи такого рода может пойти по ложному пути, ведущему к хорошо ими усвоенному закону коммутативности.

В случае, если в предложении есть абсолютный причастный оборот, мы сталкиваемся с несоответствием в русском и английском языках. В этом случае причастный оборот имеет существительное или местоимение, выполняющее функцию подлежащего в этом обороте, а причастие, не являясь личной формой глагола, выполняет функцию сказуемого, то есть предиката. То, что предикация передается через неличную форму, говорит нам о том, что этот оборот зависит от главного предложения и носит вторичный характер по отношению к реальному сказуемому предложения. Этот оборот по смыслу связан с основной частью предложения и связь эта зависит от контекста (то есть “когда”, “по какой причине”, “при каких условиях” совершается действие). В текстах научного содержания они немногочисленны, но представляют определенную трудность для понимания. Приведем пример из статьи, фрагмент которой мы выбрали для грамматического анализа неличных форм глагола.

By the end of the nineteenth century, quaternions had been largely superseded by more versatile tools. But their discovery left at least one enduring legacy: it freed mathematicians to make up new algebraic structures that flouted some of the rules of conventional arithmetic. Such structures – which go by names such as groups, rings and Clifford algebras (<u>the latter being the most successful modern generalization of quaternions</u>) – are now part of the stock-in-trade of the research mathematicians.

К концу девятнадцатого века вместо использования кватернионов стали применять более универсальные методы и это позволило математикам создать новые алгебраические структуры, в которых не соблюдались правила общепринятой арифметики. Такие структуры, как группы, кольца и Клифордовы алгебры (последние представляют собой наиболее успешное современное обобщение кватернионов), являются одними из базовых инструментов для математиков-исследователей.

<u>Gerundial Complex</u>

Комплексы с герундием встречаются в научных текстах довольно редко. Это, по-видимому, объясняется самой природой и стилем того, что мы называем текст научного содержания (expository writing).

Герундий по своей природе очень близок по значению к существительному. Он еще не называет действие, как это делает отглагольное существительное (чтение и рисование как предметы в рамках школьной программы), но в нем сохраняется обозначение процесса, то есть опредмечивание некоторого действия, например: Чтение вслух полезно. Курение в этом здании запрещено. Конечно, такой формы как “читание”, “бежание” от глаголов читать и бежать в русском языке нет, в английском же есть – reading, running.

Если мы рассмотрим цепочку неличных форм глагола от инфинитива, причастия и герундия до отглагольного существительного, то мы можем представить ее как некоторый постепенный переход, назовем его “от динамики к статике”:

to read – действие – читать; reading – как причастие – состояние, в котором пребывает некоторый объект (читающий, читая); reading – как герундий (такой формы нет в русском языке, поэтому мы реконструируем) – читание, процесс чтения, то есть выполнение некоторого действия; reading – как отглагольное существительное – наименование некоторого процесса, читание.

Герундий и инфинитив в предложении практически выполняют одинаковые функции, отличаясь только внутренним характером самого действия, поэтому в случае, если мы хотим сделать акцент на факт того, что действие представляется как процесс его протекания, мы в речи выражаем его формой герундия.

Вторая часть пособия состоит из упражнений, цель которых – дать многочисленные примеры использования неличных форм глаголов в английской научной речи; сформировать грамматические речевые навыки с учетом функционирования грамматических структур неличных форм глагола в речи через 1) ознакомление и первичное закрепление; 2) тренировку; 3) применение. Целью же нашей вводной части было, и мы надеемся, что нам это удалось, раскрыть значение, формообразование и употребление грамматических структур с неличными формами глагола в английской научной литературе.

Exercises
I
Infinitive

Ex.1 Study the functions of the infinitives. State their forms. Translate the sentences into Russian.

A

1. He considered the conic sections to form five species, from the line-pair to the circle.
2. Mathematics continued to languish during the fourteenth century.
3. In his endeavour to draw a circle whose circumference shall be equal to the sum of the sides of a triangle he obtains for π the value 3.142337, which is more accurate than the Archimedean value $3\frac{1}{7}$.
4. We wish to find the curves (if any exist) that extremize $J(x)$.
5. It is certain that he was not the first European to solve a cubic equation.
6. Wallis was the first to discuss conics as curves of the second degree... .
7. The moment of a force F about the centre O is a measure of the tendency of that force to turn a body.

8. Amongst Descartes' contemporaries the one who did most to extend mathematics was Pierre de Fermat (1601-65).
9. Which geometry could be most simply applied to the external world became a question to be decided by experiment.
10. To be more specific, physicists are checking whether string theory predicts a scalar field with two properties.

B

1. The Paris meeting was partly an attempt to recreate history, but not entirely.
2. An important name yet to be mentioned which belongs to this century is that of the Frenchman Chuquet.
3. The way in which the method is to be modified for equations of different orders is easily seen.
4. Generally, one attempts to find points where the differential vanishes – a necessary condition for an extremum at an interior point of D.
5. It's not that the human mind requires time to come to terms with new levels of abstraction.
6. The solution was invented to deal with the equation set by Da Coi.
7. Queen Dido of Carthage was apparently the first person to attack a problem that can readily be solved by using variational calculus.
8. It is worth mentioning that Stifel defines negative, or, as he calls them, absurd, numbers to be numbers less than zero.
9. Now, let us test to see if the property of additivity is satisfied.
10. To answer this question consider the function δx.

C

1. The ratio of the sides $ab : aq$ is given, viz. $3:5$. It remains to determine ab and aq.
2. The manner in which he applied this knowledge to determine π is of great interest.
3. The Hindoos endeavored to find all possible integral solutions.
4. In algebra he was the first to discuss negative and even imaginary roots.
5. Vieta was also a good geometrician, but his attempts to determine the value of π and his trigonometrical work are of greater interest.
6. Christian Huygens (1629-95) was the first to construct a watch whose motion was regulated by the balance spring.
7. Notice that Δf depends on both q and Δq, in general, so to be more explicit we would write $\Delta f(q, \Delta q)$.
8. String theorists continue to seek ways to test their theory.
9. He only recognized positive roots, however, and even attempted to prove that none but positive roots could exist.
10. To begin, let us review the definition of a function.

Ex.2 Make the sentences complete using suitable infinitives from the box. State their function.

to determine(2), to change, to acquire, to find, to regard(2), to describe, to divide, to say, to illustrate, to read, to stabilize, to give, to consider, to occupy, to trace

1. Fermat's first example is _______ B into two parts such that their product is a maximum.

2. If some of these equilibria are unstable, one also uses suitable feed-back laws in order _______ them.
3. _______ a precise meaning to the term “close” we next introduce the concept of a norm.
4. Indeed, a current trend, initiated by John A. Wheeler of Princeton University, is _______ the physical world as made of information, with energy and matter as incidentals.
5. His method is _______ an area or volume as made up of an infinite number of parts.
6. _______ my book, all you need by way of background is a good high school knowledge of mathematics.
7. He managed _______ a copy of Euclid’s *Elements* and translated this into Latin.
8. We now come _______ one of the most interesting advances in the early history of mathematics.
9. _______ the method we will apply it to curve (b).
10. Let us show that these assumptions imply that the increment ΔJ can be made _______ sign in an arbitrary small neighbourhood of x.
11. The analogous problem in calculus is _______ a point that yields the minimum value of a function.
12. It is desired _______ the function x.
13. While it would not be just _______ that the Arabs merely conserved the mathematical learning they had obtained from the Greeks and Hindoos, it is nevertheless true that Arabian mathematicians were, on the whole, more learned than original, and that they made no mathematical discovery of the first importance.
14. _______ the wave and current forces requires knowledge of the water particle velocities and accelerations as well as the motions of the main structural elements and other basic components… .
15. The difficulty in these cases is _______ properly the transition that marks the moment of the big bang.

16. Questions are here raised which were _______ mathematicians for centuries, and which did not receive a final solution until very recent times.
17. The object of this book is _______, in outline, the development of mathematics from its beginnings in Europe to the invention of the differential and integral calculus.

Ex.3 Write a sentence to say why you are studying at the Faculty of Mechanics and Mathematics (To get a better job? To…?)

Ex.4 Make up sentences using the following infinitives and infinitive phrases parenthetically.
To begin, to be more specific, to sum up, to simplify matters, so to speak, to put it differently, that is to say, to cite one example among many.

Example: To begin, Ribet's proof depends on a geometric method for "adding" two points on an elliptic curve.

Ex.5 Point out the Objective-with-the-Infinitive Construction. Translate the sentences into Russian.

A

1. Henry IV asked Vieta to decipher a Spanish dispatch which had been intercepted.
2. Many physicists today consider electrons and quarks to be excitations of superstrings, which they hypothesize to be the most fundamental entities.
3. In our initial efforts, we had assumed the size and shape of extra-dimensional space to be fixed as the branes moved around.
4. It is appropriate to consider these gravitational forces to be represented as a system of parallel forces.
5. In what follows I shall have no regard to time formally considered, but I shall suppose some one of the

quantities proposed, being of the same kind, to be increased by an equable fluxion, to which the rest may be referred, as it were to time.

6. Euler has proved it to be true for $n=3$, and Fermat has elsewhere given an early proof for the case $n=4$.
7. His zeal for knowledge, and his industry, led him to translate over ninety Arabic works.
8. The analogy with the tendency of entropy to increase led me to propose in 1972 that a black hole has entropy proportional to the area of its horizon.
9. To the Greeks, numbers began with counting (the "natural numbers"), and in order to measure lengths you extended them to a richer system (the "rational numbers") by declaring that the result of dividing one natural number by another was itself a number. The discovery that the rational numbers were not in fact adequate for measuring lengths led later mathematicians to abandon this picture, and instead declare that numbers simply *were* the points on the line.
10. In the first part *La Géométric* Descartes discusses the problem which led him to invent coordinate geometry.
11. Determine the reactions at A and C, considering AD and CB to be homogeneous.

B

1. I have thought it well to give specimens of actual solutions and sometimes of notation from early mathematicians, as this enables the reader to understand much more clearly the nature of their difficulties and the quality of their achievements.
2. The calculus of variations enables us to prove this fact and, in addition, other results that are more useful, since real estate transactions are performed somewhat differently today.
3. The invention of printing enabled knowledge to be disseminated with unprecedented rapidity.

4. In a deep sense, the typical artist's rendering of quarks as clusters of coloured billiard balls and DNA as a spiral staircase might well be (in fact are) "wrong", but as mental pictures that enables us to visualize the science they work just fine.
5. The GSL allows us to set bounds on the information capacity of any isolated physical system, limits that refer to the information at all levels of structure down to level X.
6. Hawking's radiation process allowed him to determine the proportional constant between black hole entropy and horizon area: black hole entropy is precisely one quarter of the event horizon's area measured in Planck areas.
7. An astonishing theory called the holographic principle holds that the universe is like a hologram: just as a trick of light allows a fully three-dimensional image to be recorded on a flat piece of film, our seemingly three dimensional universe could be completely equivalent to alternative quantum fields and physical laws "painted" on a distant, vast surface.
8. We also present a classical abstract setting which allows us to treat the well-posedness and the controllability of many partial differential equations in the same framework.
9. This chapter develops the quasi-static deformation method, which allows one to prove in some cases that one can move from a given equilibrium to another given equilibrium if these two equilibria are connected in the set of equilibria.
10. In this case the theorem of three forces has helped us to determine the unknown direction of the reaction of hinge A.

C

1. The problem is to find the shape of the wire that causes the bead to move from A to B in minimum time.

2. The moment of a force about an axis is the measure of the tendency of the force to cause a body to rotate about that axis.
3. German teachers and scholars in Paris were on the side of Rome, and this difference of opinion caused many of them to return to Germany, where several universities were founded at this time.
4. The discovery is causing scientists to rethink why some creatures survived the so-called KT extinction while others did not.
5. The scalar field that drove inflation, dubbed the “inflation” field, evidently caused the expansion to accelerate for a long period before switching off abruptly.
6. It is notoriously difficult to get a universe full of regular forms of matter to accelerate in its expansion.
7. Curiosity is part of human nature. … And that is what makes mathematics work, makes people commit their lives to it.
8. Being able to visualize multiplication by *I* may enable us to visualize Fourier transformation.
9. One of the simulations we have performed is a diffusion process – that is, we let a suitable analogue of an ink drop fall into the superposition of universes and watch how it spreads and is tossed around by the quantum fluctuations. Measuring the size of the ink cloud after a certain time allows us to determine the number of dimensions in space.
10. If, therefore, the value $f(x)$ be equated to the value $f(x-e)$, we can make this equality correct by letting e assume the value zero.
11. “Humanistic” and “mathematics” is what made me want to read and review this book.
12. In Dido’s problem, and in the brachistochrone problem, curves are sought which cause some criterion to assume extreme values.

Ex.6 Translate the sentences into Russian paying attention to the Objective-with-the-Infinitive Construction.

1. The task of finding a good inference procedure then reduces (formally) to a decision theory problem, allowing the extensive machinery of decision theory to be brought to bear.
2. Assuming the questions to be phrased so that “yes” and “no” have consistent interpretations meaningful matching coefficients can be computed from the two patterns.
3. We will idealize the sliding puck to be a point mass and neglect the width of the robot link as well.
4. In a previous article we have reported our failure to achieve experimental success with any implementation of a locally stabilizing feedback strategy based on discrete impact state measurements for these reasons.
5. We anticipate some of the insights developed here to generalize to the problems of active gait stabilization in legged locomotion.
6. However, these require a dynamic model of the object to be caught, and our simple PD controller does not.
7. This stroke-time was computed assuming each toroid-core air-gap to be spaced $3mm$ apart (center-to-center distance) and assuming the next electromagnet to be “energized” when the ferrofluid end reaches the center of the $0.5mm$ space separating the two adjacent air-gaps.
8. We may consider the replacement of the essentially infinite number of specific structural variables by averaging variables to have been accomplished a priori, or instead to be later accomplished once the complete constitutive framework is formulated in terms of the specific variables.
9. In a capillary, the fluid is distributed into a long, thin cylinder which allows small fluid volumes to be easily sensed and manipulated.

10. The upshot of this is that we define a Lie subgroup of a Lie group G to be a subset that is simultaneously a subgroup and a closed submanifold; and we define an immersed subgroup to be the image of a Lie group H under an injective morphism to G.

Ex.7 Complete the following sentences using the Objective-with-the-Infinitive Construction.

These examples enable…
I consider…
The force causes…
It is difficult to imagine…
That is what makes…
The theorem allows…
We saw…

Ex.8 Paraphrase the given sentences using the Objective-with-the-Infinitive Construction. Translate into Russian.

1. In the rest of this paper, we assume that the data have been preprocessed by centering and whitening.
2. Considering that the retention level is dynamically controlled, we arrive at the following diffusion control method.
3. In this first place we may imagine that the string is brought from rest in its equilibrium position to rest in any assigned form by means of lateral pressures applied to it.
4. I believe that the most important problems in algebraic geometry are those arising from old-fashioned varieties in affine or projective space.
5. We can expect that the simple picture suggested only for special clans holds.
6. Suppose that the j-th feature value in the i-th pattern vector is missing.

7. I hope that these applications justify the effort needed to absorb all the technical apparatus in the two previous chapters.
8. I assume that the reader is familiar with basic results about rings, ideals, modules noetherian rings, and integral dependence.

Ex.9 Paraphrase the given sentences using the Objective-with-the-Infinitive Construction. Translate into Russian.

1. I believe that the study of particular examples is inseparable from the development of general theories.
2. We expect that the range of the magnetic force exerted on the beads is less than $0.6mm$ in our present configuration, and thus, the electromagnetic post separation should also be in this range.
3. Suppose that the raw data consist of an $n \times d$ pattern matrix in which all features are continuous and on a ratio scale.
4. We hope that this new approach will open many useful opportunities for ultimate efficient biological and chemical analysis systems on a single chip.
5. The equation assumes that the ferrofluid flow in the pipette tubing is laminar with a constant pressure drop across the length of the tube.
6. Assume that the robot is able to asymptotically track the desired trajectory.
7. We see from this table that the approximate values are very close to the true values. We have observed that this is the case for other values of b but we also found that for a given value of β, accuracy improves as b increases.
8. We found that a significant portion of the beads remained near the middle post after its current was cut off and the bottom post current was turned on.

Ex.10 Paraphrase the given sentences using the Objective-with-the-Infinitive Construction. Translate into Russian.

1. We assume that all proximity matrices are symmetric, so all pairs of objects have the same proximity index, independent of the order in which they are written.
2. To set up a cohomology theory requires a lot of work, but I believe that it is well worth the effort.
3. We do not seriously expect that all robot tasks at any level are forced into the geometric formalism developed here.
4. Consequently, we might expect that excess of loss reinsurance eliminates large claims and hence increases both the expected time to ruin and the expected present value of net income.
5. Suppose that some of the pattern vectors have missing feature values.
6. We assume that the data are presented as in a pattern matrix.
7. We feel that this approach is particularly suited to robotics in an intermittent dynamic environment.
8. Suppose, without loss of generality, the velocity matching robot-puck contact occurs at $b = 0$.

Ex.11 Translate into English using the Objective-with-the-Infinitive Construction.

1. Я полагаю, читатель знаком с результатами данного эксперимента.
2. Далее в работе мы предполагаем, что данные подверглись предварительной обработке.
3. Из этой таблицы мы видим, что приблизительные значения очень близки к истинным.
4. Мы обнаружили, что для данного значения β точность растет с увеличением b.

5. Предположим, что робот способен прослеживать желаемую траекторию.
6. Мы надеемся, что этот новый подход откроет много возможностей для эффективного биологического и химического анализа данных систем.
7. Я полагаю, что изучение конкретных примеров неотделимо от развития общих теорий.
8. Мы чувствуем, что этот метод хорошо подходит для работы в определенных условиях окружающей среды.
9. Мы предполагаем, что эти данные представлены так же, как и в модели.
10. Мы не считаем, что все задачи робота на любом уровне сводятся к разработанному здесь геометрическому формализму.

Ex.12 Translate into English using the Objective-with-the-Infinitive Construction.

1. Эта проблема очень сложна для изучения, но я считаю, что она вполне стоит затраченных усилий.
2. Мы считаем, что в данном случае все матрицы симметричны.
3. Эксперименты доказали, что давление газа при постоянной температуре зависит от его концентрации.
4. Мы считаем, что этот закон справедлив только для газов в нормальных условиях.
5. Можно считать, что это предположение вполне обосновано.
6. Мы считаем, что эта работа является наиболее серьезной попыткой интерпретировать экспериментальные результаты при помощи данной теории.
7. В своей работе он предположил, что это вещество обладает всеми требуемыми свойствами.
8. Они считали, что скорость различна для различных тел, но это было не так.

9. Принято считать, что электрический ток течет в направлении, противоположном движению электронов.
10. Для данного анализа мы будем считать, что полупроводник характеризуется единственным индексом рефракции.

Ex.13 Point out the Subjective-with-the-Infinitive Construction and translate the sentences into Russian.

1. As first emphasized by Wheeler, when matter disappears into a black hole, its entropy is gone for good, and the second law seems to be transcended, made irrelevant.
2. They seemed to be perfectly matched in every way.
3. Remote as it often appears to be from all else that interests men, mathematics yet satisfies some deep human need. For this reason its history is worth studying.
4. These would appear to be all the problems of this kind discussed by Fermat, but Pascal went on to consider other and more complicated cases.
5. Can we show that this fundamental idea yields a unique theory with the unique solution, which happens to be the world as we know it? Is it possible to test these ideas through astronomical observations or through accelerator-based experiment?
6. Ask anybody what the physical world is made of, and you are likely to be told "matter and energy".
7. The search is hampered by our ignorance of what might be going on at the incredibly high energies that are likely to be relevant.
8. It is a challenge that is sure to be taken up in the near future.
9. But even if such devoted souls are bound to appear in every generation it is greatly to the advantage of science that their energies should be more economically employed.

10. The bad news is that the first calculations for the various scalar fields were not encouraging. Their energy density proved to be very low – too low to drive information. The energy profile more resembled a train sitting on level ground than a slowly climbing roller coaster.
11. Taking 240 as the next approximation we get 3 for x_3, and the value 243 turns out to be exact.
12. A few of the problems Hilbert stated turned out to be much easier than he had appreciated, and they were soon solved. Several others were too imprecise to admit a definite answer. But most turned out to be mathematical problems of great difficulty.
13. In particular, the tool of iterated Lie brackets, which is quite useful for treating this case in finite dimension, turns out to be useless for many interesting infinite-dimensional control systems.
14. Some of the mathematicians of that time, it is true, seemed to take a delight in arithmetical drudgery.

Ex.14 Point out the Subjective-with-the-Infinitive Construction and translate the sentences into Russian.

1. The student is expected to consider the resolution of a given force F into two components P and Q coplanar with F if their magnitudes, P and Q, are given and if $P+Q \geq F$.
2. The moment of any fluent is defined to be its fluxion multiplied by an infinitely small quantity.
3. What is sometimes called Fermat's last theorem states that no integral values of x, y, z can be found to satisfy the equation $x^n + y^n = z^n$ if n be an integer greater than z.
4. Each of these sides is taken as the base of a triangle whose apex is the centre of the circle and the area of

the circle is taken to be the sum of the areas of these triangles.

5. Very great concentration is required to follow even a moderately long chain of reasoning.
6. Leonardo of Pisa has usually been taken to be the dominating mathematician of that century.
7. It should be emphasized that since the Euler equation is a necessary condition, further investigation is required to ascertain whether a solution x^* is a minimizing curve, a maximizing curve, or neither.
8. f is said to be differentiable at q.
9. According to Aristotle's philosophy, nature was made of four basic elements referred to as air, fire, water and earth. The very principles that presided to the motion of each of these elements were supposed to be embedded in them.
10. Newton's theory is very ingenious, and he succeeds in explaining a large number of optical phenomena. His reputation led to his theory being generally accepted, and it was not until many years later that Huygens's undulatory theory was shown to be a better instrument of research.
11. In 1999 Raphael Bousso, then at Stanford, proposed a modified holographic bound, which has since been found to work even in situations where the bounds we discussed earlier cannot be applied.
12. Of course in the history of scientific discovery an effect is commonly known before its course. And fairly often a mathematical theorem is known to be probably true before it is formally proved.
13. A perfectly rigid body, or absolutely rigid body, is said to be the one in which the distance between any pair of particles is always constant.
14. Two lines PQ and RS are said to be antiparallel with respect to the sides of an angle A if they make the same angle in the opposite senses with the bisector of that angle.

Ex.15 Fill in the blanks with the proper forms of the verbs given below. In some cases more than one verb is correct.

1. As a result, a checksum … to be totally normal, and the infection is not revealed.
2. The string … to be of uniform line-density, and to be stretched with a tension P.
3. A comparative analysis of clustering methods is useful since empirical evidence … to be the only practical guide to the selection of clustering methods.
4. We ignore the diagonal entries of a proximity matrix since all patterns … to have the same degree of proximity with themselves.
5. Accepted practice in the area of application … to be the best guide to a choice of proximity index.
6. The robot "mirroring" motion … to induce a three-dimensional invariant submanifold of the environmental control system.
7. Any general notion of derivable postcontact behavior … to be hostage to the particularity of contact material properties.
8. For such situations, the applicability of our domain splitting approach … to be somewhat questionable.
9. Those topoi which are "finitely generated" in an appropriate sense … to be coherent.
10. Heat kernel coefficients … to be very useful in this context.
11. No satisfactory theory of moduli … to exist for these objects.
12. The reader … to be familiar with the iteration theory of rational functions.

To appear, to suppose, to seem, to assume, to turn out, to say, to prove, to know, to expect.

Ex.16 Fill in the blanks with the proper forms of the verbs given below. In some cases more than one verb is correct.

1. Each of d features … to be presented as a point in an $n-$dimensional space, where n is the number of patterns.
2. The first term on the right side … to affect our ability to control the robot impact velocity solely via k, as before.
3. It … to be worth pausing to motivate such claims before proceeding with the subject proper.
4. Specification of the postcontact phase … to require a much more comprehensive model of the force interactions between the robot and puck.
5. The arithmetic genus … to be an invariant under isomorphism.
6. The bimodule H … only to be a left module.
7. The characteristic cycle … to be a well defined notion, independent of the choice of a good filtration, as is well known.
8. However to compute this set explicitly for a given module … to pose a very hard problem in general.
9. A weaker form of independence is uncorrelatedness. Two random variables y_1 and y_2 … to be uncorrelated, if their covarience is zero.
10. All readers … to have a basic knowledge of the theory of probability and stochastic processes.
11. For simplicity, both puck and robot … to be point objects.
12. Methods for studying such systems have been developed, which form what … to be perturbation theory.

To seem, to appear, to happen, to consider, to turn out, to say, to assume, to know

Ex.17 Paraphrase the following sentences using the Subjective-with-the-Infinitive Construction. Translate the sentences into Russian.

1. It has variously been regarded that Bernoulli's book is the beginning of the mathematical theory of probability and the end of the emergence of the concept of probability.
2. In most of classical statistical theory, it is assumed that random variables have gaussian distributions.
3. There are nongaussian random variables that have zero kurtosis, but it can be considered that they are very rare.
4. It is assumed that the random variable y is of zero mean and unit variance.
5. It seems that stochastic gradient methods are preferable only if fast adaptivity in a changing environment is required.
6. It seems that the theory of control processes is "tailor-made" for the problems which actuaries have struggled to formulate for more than a century.
7. It turns out that the analysis in this case depends on whether or not the claim size distribution has a bounded support.
8. It was there shown that the postulated existence of thermodynamic potentials leads to an explicit relation between inelastic strain-increments and changes in the variables.
9. It is now easily seen that each normality rule holds for the aggregate if it is asserted for all subelement materials.
10. It is not likely that results from the exterior contour are satisfactory in the presence of discontinuities in the boundary data.

Ex.18 Paraphrase the following sentences using the Subjective-with-the-Infinitive Construction. Translate the sentences into Russian.

1. It is very often thought that the situation is complicated when the notion of securing a network that relies on open system standards is contemplated.
2. It is meant that these types of packages assist in troubleshooting and diagnosing network problems.
3. Since it is likely that every program is susceptible to modification by some user of the editor, infection soon becomes universal.
4. It seems that statisticians are pessimistic creatures who think in terms of losses. Decision theorists in economics and business talk instead in terms of gains.
5. We will, for the most part, assume that it can be considered that these uncertainties are unknown numerical quantities.
6. It will be seen that the Bayes risk of a decision rule plays an important role in virtually any approach to decision theory.
7. It is further ascertained that the ratio of the two intervals is equal to that of the two segments into which the string is divided by the point.
8. It must be understood that the following statement refers to the function as continued in the manner above explained.
9. It can be considered that a value z of SMC is "unusually" large if the probability of achieving a value of z or more is sufficiently low under some baseline distribution, such as the distribution of SMC for two randomly selected $d-$vectors.
10. It has been found that this algorithm is useful in detecting certain kinds of clusters present in multidimensional data.

Ex.19 Paraphrase the following sentences using the Subjective-with-the-Infinitive Construction. Translate the sentences into Russian.

1. It may be considered that multidimensional scaling is a nonlinear representation technique and a means for estimating intrinsic dimensionality.
2. The initial magnetic susceptibility is also determined from Fig.3 and it is found that it is $x_r = 0.83$
3. In algebraic geometry, it appears that a great gap separates the intuitive ideas which form the point of departure from the technical methods used in current research.
4. It is seen that this is an affine transformation.
5. It is supposed that the closed macro-patches Ω_i are unions of entire elements of the finite element mesh T_h.
6. In this case, it can no longer be expected that the regularity estimate holds true.
7. However, it appears that the construction of a really second-order but still economical method is very difficult if one insists on independence of the viscosity parameter ε.
8. In fact, it turns out that Joseph's Goldie-rank polynomial of J has a geometric interpretation in terms of the characteristic cycle of J.
9. It turns out that Joseph's Goldie-rank polynomial of a primitive ideal J is nothing else but the Segre class of the $l-$characteristic cycle of J.
10. However, it seems that the actual computation of this subset is a hard problem in general.

Ex.20 Write a new sentence with the same meaning containing the word in brackets.

Example:

– People say that this problem has already been solved. (said)

– This problem is said to have already been solved.

1. They say that, if two points are close to one another, a geometric interpretation springs immediately to mind. *(said)*
2. The requirement is that, if Ω is the class of continuous functions, x and δx must be continuous. *(required)*
3. We may say that this work introduced the Hindoo numerical notation into Europe. *(said)*
4. They think that the solution depends on the solution of a cubic. *(thought)*
5. They suppose that the floating of solids in a liquid, for instance, should depend only on their form. *(supposed)*
6. They say that, if all the concurrent forces acting on a body lie in one plane, they form a coplanar system of concurrent forces. *(said)*

   Obviously, the requirement for such a force system is that only two equations must express the conditions of equilibrium. *(required)*
7. They advise the beginner to start the solution by determining the projects of all the forces on each of the coordinate axes and tabulating the information. *(advised)*
8. People say that the moment of a couple is positive if the action of the couple tends to turn a body counterclockwise, and negative if clockwise. *(said)*

Ex.21 Write a new sentence with the same meaning containing the word in brackets.

Example:

– It seems that it is certainly true that one of Newton's strongest desires was to be left alone. (to be)

– *It certainly seems to be true that one of Newton's strongest desires was to be left alone.*

1. Even so, a mathematical genius might have found sufficient stimulus in that early teaching to realize himself, but apparently it happened that no mathematical genius appeared during those years. *(to appear)*
2. It has turned out that the whole point of view is of the greatest importance in mathematics. *(to be)*
3. For these systems we give a sufficient condition for controllability, which as it turns out is also necessary for analytic control systems. *(to be)*
4. We study in detail the case of the driftless control systems. For these systems, it turns out that the above Lie algebra rank condition is sufficient. *(to be)*
5. It seems that the writings of the first Hindoo mathematician of note, Aryabbata, imply that he was in possession of the principle of position and of the zero. *(to imply)*
6. It seemed that more thorough investigation showed, however, that Cardano merely borrowed from Tartaglia. *(to show)*
7. It seems that the theory will give rise to many different universes, of which, ours, it seems, is only one. *(to be able to, to be)*
8. But although the holographic way of thinking is not yet fully understood, it seems it is here to stay. *(to be)*

Ex.22 Rewrite each sentence so that it begins with the words underlined. Use perfect infinitives.

1. It appears that Alkarki was quite unacquainted with the Hindoo achievements in this field.
2. It seems that in this branch of mathematics he possessed a most extraordinary intuitive faculty.
3. It seems that Van Ceulen, a contemporary of Vieta's, devoted all his energies to obtaining closer and closer approximations to the value of π.
4. It seems that he spent the rest of his life in perfecting this gift.
5. It seems that this work attracted, soon after its appearance, the notice of highly placed personages.
6. It seems the Arab caliphs had singularly open and inquiring minds.

Ex.23 Translate these sentences into English.

1. Студентам советуют внимательно читать задания.
2. Он вряд ли решит эту задачу.
3. Можно ожидать, что ваша статья будет опубликована в новом сборнике.
4. Считается, что теорема доказана.
5. Полагают, что эта экзаменационная сессия будет трудной.
6. По-видимому, условия задачи надо изменить, тогда решение будет, очевидно, найдено.
7. Маловероятно, что я смогу сдать свою письменную работу на следующей неделе.
8. Говорят, что этот профессор – крупный специалист в области теории чисел.
9. Наверняка, вы знаете ответ.

Ex.24 Translate the sentences into English using the Subjective-with-the-Infinitive Construction.

1. Маловероятно, что данная гипотеза верна.
2. Оказывается, что вирус второго поколения является совершенно другим.
3. Кажется, что эта задача имеет решение.
4. Предполагают, что матрица такого вида неизвестна.
5. Оказалось, что попытки Штейна получить решение задачи не являются продуктивными.
6. Однако могло бы показаться, что для практического использования подходят методы этого раздела.
7. Считается, что язык математики является наиболее адекватным для этой цели.
8. Оказалось, что эти коэффициенты широко используются в данной области.
9. Эта теорема и следствия, конечно, хорошо известны тем, кто работает в этой области, но они, кажется, не были подробно сформулированы ранее.
10. Полагают, что читатель не знаком с теорией асимптотических приближений.

Ex.25 Translate the sentences into English using the Subjective-with-the-Infinitive Construction.

1. Известно, что не существует ни одной удовлетворительной теории, описывающей эти объекты.
2. Оказывается, рассмотренная операция дает ответ на вопрос, поставленный нами ранее.
3. Некоторое нарушение симметрии кажется неизбежным в любой системе обозначений.
4. Хорошо известно, что такие подпространства имеют равную размерность.

5. Для изучения таких систем были разработаны методы, которые входят в теорию, известную как теория возмущений.
6. Предполагается, что как шайба, так и робот являются материальными точками.
7. Для удобства все значения параметра принимаются равными 0 или 1.
8. В технических работах предпочтительной, кажется, является евклидова метрика.
9. Таким образом, считается, что данная пара дает лучшее приближение, чем предыдущая.
10. Предполагается, что все читатели имеют базовые знания по теории вероятностей и стохастических процессов.

Ex.26 Translate the sentences into English using the Subjective-with-the-Infinitive Construction.

1. Оказалось, что давление газа при постоянной температуре зависит от его концентрации.
2. Вероятно, ошибка в этом эксперименте меньше, чем в предыдущем.
3. Полагают, что новый метод дал хорошие результаты.
4. Оказалось, что эти результаты согласуются с теоретическими предсказаниями.
5. Однако считают, что эта альтернативная точка зрения более полезна.
6. Исходя из теоретических рассуждений предполагают, что приведенные данные дают единственно возможный набор коэффициентов.
7. По-видимому, в этой статье существует путаница в употреблении терминов.
8. В древние времена некоторые философы считали, что свет является свойством глаза.
9. Снелль и Декарт обнаружили, что следующие законы справедливы для всех таких случаев.

10. Кажется, что эти результаты не согласуются между собой.

Ex.27 Translate the sentences into English using the Subjective-with-the-Infinitive Construction.

1. Оказывается, этот закон не является справедливым для всех газов.
2. Вопрос заключается в том, насколько близко эти данные представляют те результаты, которые, вероятно, будут получены на практике.
3. Постулаты этой теории имеют фундаментальное значение и, вероятно, формируют ядро будущих теорий структур молекул.
4. Полагают, что радиус орбиты увеличивается очень медленно.
5. В целях проведения анализа предполагается, что эти данные точны.
6. Оказывается, что в этом случае существуют два различных результата.
7. Маловероятно, что обычные предметы движутся со скоростью, близкой к скорости света.
8. Оказывается, что форма кривой, предсказанная теорией, близка к форме, полученной экспериментально.
9. Все обстоятельства, которые, вероятно, воздействуют на точность измерений, должны быть тщательно изучены.
10. Тело с кинетической энергией, равной нулю, не может передавать тепло какому-либо другому телу, и, следовательно, можно было бы сказать, что оно имеет абсолютную нулевую температуру.

Ex.28 Point out the for-to-Infinitive Construction, state its function, translate the sentences into Russian.

1. For a body subjected to the action of a system of concurrent forces to be in equilibrium it is necessary for the resultant of the forces to be zero.
2. By selecting δx in this manner the integral in Eq.(4.2-9) will be nonzero, thus, h must be identically zero for (4.2-9) to be satisfied.
3. Applying the fundamental lemma to (4.2-8), we find that necessary condition for x^* to be an extremal is…
4. Also, his numerous travels must have made it difficult for him to give sustained attention to his work, so that he must have possessed a very formidable energy to have accomplished so much in his short life.
5. For a rigid body to be in equilibrium (at rest) under the action of a system of forces, the system must satisfy certain conditions of equilibrium.
6. For the string to be in equilibrium the forces must be tensile, that is, they must stretch the body.
7. When Shannon cast about for a way to quantify the information contained in, say, a message, he was led by logic to a formula with the same form as Boltzmann's.
8. By 2000, all but one of genuine Hilbert Problems had been solved, and the time was ripe for mathematicians once again to take stock.
9. This was a major change, and it took two thousand years for all the details to be worked out.
10. We first give an integral necessary and sufficient condition for a linear time-varying finite-dimensional control system to be controllable.
11. The arrival of (comparatively) cheap and fast computers made it feasible for scientists and statisticians to record lots of data and to fit models to them.

Ex.29 Translate the sentences from English into Russian. Pay attention to the "for"-complex with the infinitive.

1. For the work to be done it is necessary to suppose that the frictional force is greater in the first stage than in the second. This is consistent with the known law that friction of rest is greater than friction of motion.
2. For this difficulty to be overcome, we have to change the control function.
3. In any control problem, for the solution to be completed, one always needs to find the optimal process and to go through a verification lemma like the one above.
4. In order for the above function to be concave one must have $C_2 = 0$ and $C_1 < 0$.
5. To put it another way, we intend this as a book for beginners to learn from and not as a reference.
6. It is natural for a text intended to prepare students for a career in the subject to lead up to one or more of these areas.
7. For this to be verified the reader may consult…
8. For this claim to be verified, one may proceed as follows.

Ex.30 Translate the sentences from English into Russian. Pay attention to the "for"-complex with the infinitive.

1. For the function V to be twice continuously differentiable we must have the value of the first and second derivatives to be continuous at u and u_1.
2. For this to be the case (and indeed for the above construction to be possible), the preferences among elements of P must in some sense be rational.
3. In the event that such an institution's computer systems are penetrated and information protected under the Privacy Act is disclosed, it would be highly

unlikely for the institution to acknowledge publicly the loss of such information.

4. For each security discipline to be effective it must be evaluated and examined in the network security engineering process.
5. Since the structure of a document (and therefore its nested objects) is generally hidden from the client, there is no way for these to be included in the invocation on the document.
6. To assure accountability the capability must exist for an authorized and competent agent to access and evaluate accountability information by a secure means, within a reasonable amount of time, and without undue difficulty.
7. With the advent of a world economy, it is commonplace for a number of companies across many countries to form a partnership or team to pursue jointly the development of a product or to penetrate a particular market segment.
8. This difference in charge registration is used for the position and length of fluid segments inside the capillary to be identified.

Ex.31 Rewrite these sentences using the structure with the "for"-complex with the infinitive containing the words in brackets. Make any other necessary changes.
Example: She can't solve this problem. It is impossible. $\Rightarrow$
It is impossible for her to solve this problem.

1. But Wallis did not succeed in his attempt at interpolation. Newton did this by his Binomial Theorem. *(to leave)*
2. The given system of forces is not in equilibrium because $R \neq 0$ and $M_0 \neq 0$. *(it is necessary and sufficient)*

3. Our model did not work. It turned out that we did not include from the outset a so-called cosmological constant… .*(need)*
4. At first sight, the energy density of anything will not remain constant, because the expansion of space should dilute it. *(it seems impossible)*
5. A system of forces acting on such a structure will be in equilibrium if it satisfies the conditions of equilibrium for a rigid body. *(according to the principle of solidification)*
6. The given and required forces, or their equivalents, should be applied to the body whose equilibrium is examined. *(to solve, the problem)*

Ex.32 Translate from Russian into English using the "for"-complex with the infinitive.

1. Чтобы работа была выполнена, необходимо предположить, что сила трения больше на первой стадии, чем на второй.
2. Чтобы преодолеть эту трудность, мы должны изменить функцию контроля.
3. В любой проблеме управления, чтобы решение было закончено, всегда необходимо найти оптимальный процесс и воспользоваться леммой подобной той, что дана выше.
4. Чтобы данная выше функция была выпуклой, необходимо выполнение условия $C_1 < 0$ и $C_2 = 0$.
5. Другими словами эта книга предназначена для того, чтобы начинающие учились по ней, а не для того, чтобы она была просто справочником.
6. Естественно, чтобы текст, предназначенный для подготовки студентов к работе в данной области, содержал необходимую для этого информацию.
7. Чтобы проверить это, читатель может обратиться к справочной литературе.

8. Чтобы эта задача была решена, необходимо выполнить ряд дополнительных условий.
9. Чтобы проверить данное утверждение, необходимо поступить следующим образом.

Ex.33 Translate the sentences from English into Russian. Pay attention to infinitives used as attributes.

1. The last two definitions assume that the objects to be clustered are represented as points in the measurement space.
2. The most direct visualization is a two-dimensional plot showing the objects to be clustered as points.
3. Walking humanoid robots that match the degrees of freedom and structure of a typical human have the potential to be perfectly suited to built-for-human environments.
4. Our first goal is to relate these different notions of characteristic variety by means of the following propositions to be proved below.
5. Our main point to be made here is that our irreducibility-conjecture would provide a most elegant and simple explanation for various quite different known results.
6. Probably the main feature of our presentation is that we concentrate on examples, developing the general theory sparingly, and then mainly as a useful and unifying language to describe phenomena already encountered in concrete cases.
7. “Security Policy Control Objective” – a statement of intent with regard to control over access to and dissemination of information, to be known as the security policy, must be precisely defined and implemented for each system that is used to process sensitive information.
8. Authentication cannot be forged. It is important that something be passed to the final destination to be used for access control and accountability and that

there be a mechanism not only for trusting that information be tamper-proof, but also to be verifiable.

9. Although the fact plays no role in the arguments to follow, for an understanding of negligibility observe first that a finite or countable union of negligible sets is negligible.
10. Let Ω be an arbitrary space or set of points ω. Most Ω's to be considered are interesting from the point of view of geometry and analysis as well as that of probability.
11. Suppose first that as long as a machine is in working condition it has a fixed probability p to break down at the next epoch; when it breaks down it is replaced by an identical new machine.
12. While we endorse this attitude in a certain practical sense (to be made clearer shortly), we do not endorse it fundamentally.
13. The key fact here, to be proved later, is that…
14. This matrix is just a new unknown mixing matrix to be solved by the ICA (independent component analysis) algorithms.

Ex.34 Paraphrase the sentences using infinitives instead of italic attribute clauses. Translate into Russian.

1. We see cluster analysis as a tool *that must be used*, not as a theory *that must be developed*.
2. An algorithm *that will generate clustered data* is given in one of the appendices.
3. Clearly, there is a price *that must be paid* for this flexibility.
4. This proof will then serve as a guide-line for the corresponding argument *that will be used below* in the case of convection-diffusion problems.
5. A second and related point that *should be made* concerns terminology.

6. Now let $W(u,b)$ denote the expected present value of payments *that should be made* by shareholders when the surplus falls below O.
7. One of the functions of preprocessing in ICA (independent component analysis) algorithms, *that will be covered in this section*, is to make this simplification possible.
8. Here we see that whitening reduces the number of parameters *that should be estimated*.
9. The function $A^*(x)$ is the optimal feedback control function. It shows the amount of risk *that will be taken* if the current reserve is x.
10. However, it should be emphasized that very often this step is a very difficult (or simply impossible) task *that we must accomplish*.
11. The number of parameters that *should be estimated* is often so high that suitable blind source separation techniques taking into account the available prior knowledge provide a clear performance.

Ex.35 Translate the following sentences from Russian into English using the infinitive as an attribute.

1. Исторически это была первая задача такого типа, которую необходимо было рассматривать сквозь призму этой теории.
2. Из этих замечаний должно быть ясно, что проблема классификации является весьма важной проблемой, о которой необходимо помнить при изучении алгебраической геометрии.
3. Основное замечание, которое должно быть сделано здесь, заключается в следующем.
4. У нас остался только один вопрос, на который необходимо дать ответ.
5. Первое замечание, которое должно быть сделано, касается тензоров.

6. Существует еще одно важное обстоятельство, которое должно быть упомянуто здесь.
7. Предположим, что аналитическая задача, которая должна быть решена, заключается в следующем.
8. Существуют два случая, которые будут рассмотрены в данной главе.
9. Основная теорема, которая будет доказана здесь, может быть кратко сформулирована следующим образом.
10. Несколько более простая задача, которую необходимо рассмотреть, заключается в оценке этой величины для использования, скажем, в данном случае.

Gerund

Ex.1 Study the functions of the gerunds. State their forms. Translate the sentences into Russian.

A

1. Estimating the entropy of the universe is a difficult problem, however, and much larger numbers, requiring a sphere almost as big as the universe itself, are entirely plausible.
2. The situation is analogous to taking an airplane ride with all the window shades lowered.
3. The wholly new contribution made by Descartes was in importing the idea of motion into geometry.
4. Using the parallelogram law to add more than two forces, as shown here, often requires extensive geometric and trigonometric calculation to determine the numerical values for the magnitude and direction of the resultant.
5. It is worth noting that Paciuolo, like Regiomontanus, uses algebra in the solution of geometrical problems.
6. The treatise deals with both plane and spherical trigonometry, and it is worth noting that Regiomontanus was not familiar, at this time, with the notion of the tangent of an angle.

7. Combining the integrals gives the following equation.
8. Leonardo's solution is worth quoting for its elegance.
9. It is worth noting that the work of the early Arab mathematicians makes no clear division between arithmetic and algebra.
10. But solving one problem – high temperatures – led to another.
11. A branch of mathematics that is extremely useful in solving optimization problems is the calculus of variations.

B

1. Usually such closed-loop controls (of feedback laws) have the advantage of being more robust to disturbances.
2. These days, even many nonmathematicians feel comfortable using real numbers, complex numbers, and negative numbers. That is despite the fact that these are highly abstract concepts that bear little relationship with counting, the process with which numbers began some ten thousand years ago, and even though in our everyday lives we never encounter a concrete example of an irrational real number or a number involving the square root of -1.
3. This is the basic method of solving problems of statics.
4. One step toward realizing these ideas is to study models that are simpler than our real universe.
5. Fermat translated this fact into a method for determining a maximum or minimum in the following way.
6. He also improved the notation for representing the extraction of roots.
7. In Chapter 6 we shall consider some numerical techniques for solving nonlinear, two-point boundary-value problems.
8. We shall also find it convenient to develop a formal procedure for finding the variation of a functional rather than starting each time from the definition which follows.

9. Rather than go through all of these steps, we can use Definition 4-9 to develop a rule for finding the differential of a function.
10. The preceding definitions have laid the foundation for considering the variation of a functional.

C

1. By studying the mysterious properties of black holes, physicists have reduced absolute limits on how much information a region of space or a quantity of matter and energy can hold.
2. But before considering the masterful work of Newton we must give some account of the work of two men who were in a special sense his precursors.
3. Since Eq.(4.2 – 13) is linear and has constant coefficients it can be readily solved by using classical differential equation theory.
4. A control system is a dynamical system on which one can act by using suitable controls.
5. The problem may be stated thus: Two players of equal skill wish to give up a game before finishing it. Given the number of points necessary to finish the game and the score of each player, are the stakes to be divided between them? Fermat discusses the case where A wants two points to win and B three.
6. Thus, in Galilii's dialogues on the system of the world he explains the tides by saying that they are caused by the different velocities of rotation possessed by different parts of the earth.
7. In theorem (2) above, for instance, Fermat's proof proceeds by showing that if there is a prime $4n+1$ not possessing the property, then there is a smaller prime of the same form not possessing it
8. Before leaving this century mention must be made of Simon Stevin (1548 – 1620), who was one of three or four independent inventors of decimals.
9. There are, however, certain special cases in which the Euler equation can be reduced to a first-order differential equation, or solved by evaluating integrals.

10. Let us review the concept of linearity, which will be useful to us later, by considering a function f of q, defined for $q \in D$.
11. The method *al-gebr* simply means transferring negative quantities to the other side of the equation, and the method *al mukabala* means the uniting into one term of similar terms.

Ex.2 Write 5-7 sentences so that they begin with gerunds as subjects.

Example: Solving this problem is of great importance.

Ex.3 Define the type of the adverbial modifier expressed by the gerund.

1. In this chapter, we present important tools for constructing explicit stabilizing feedback laws.
2. He used this rule to approximate to the value of an unknown quantity by taking two values, one too large and the other too small, and then repeatedly applying the rule.
3. This method is quite useful in infinite dimension for finding numerically optimal controls for linear control systems.
4. Newton's chief published works, all except the Principia, appeared years after the results embodied in them had been discovered; even so, it took mathematicians quite half a century to assimilate them. It will be useful, in discussing these writings, to give a list of their dates of publication.
5. For the first time, physicists have been able to derive concrete models of cosmic inflation rather than being forced to make uncontrolled, ad hoc assumptions.
6. It is helpful to think in terms of the analogies that exist; by doing so, we can appeal to familiar geometric ideas from the calculus.

7. The best part of string theory is that, unlike other theories of elementary particles, it organically contains gravity within itself. That is, gravity emerges naturally from the theory without having been assumed at the outset.
8. If the right side of this equation is also a perfect square, then on taking square root, we have a quadratic equation in x.
9. It is not too much to say of Kepler that, besides originating the doctrine of geometrical continuity, he also originated the infinitesimal calculus.
10. As we have seen, Paciuolo concluded his great treatise by giving two examples of cubic equations and declaring them to be impossible.

Ex.4 Complete the following sentences using the gerunds from the list below.

1. He uses what is to us the obvious method of _______ the conditions as two first order equations.
2. The same faculty is exhibited in Kepler's method of _______ areas and volumes, a method closely akin to that of the integral calculus.
3. It is extraordinary that the simple experiment of _______ stones of different weights simultaneously should have required the genius of Galileo to hit upon it.
4. He gives no less than eight methods of _______ multiplication.
5. He introduces the method of _______ from the properties of the circle to the properties of other conic sections by perspective.
6. Thus even Vieta proposed to himself entirely useless problems, apparently for the pleasure of _______ days or weeks in arithmetical calculations.
7. In spite of the extraordinary difficulty of _______ upon a general proof, nobody doubts that the theorem is

true, and it is generally supposed that Fermat really had found a proof.

8. An important part of Descartes' work is his method of _______ tangents.
9. Another problem dealt with the probability of _______ a six with a die in eight throws.
10. In the extraction of roots he gives a method of _______ to irrational values, called *surdi*.
11. Another method of _______ such problems is to divide a structure into separate bodies and write the equilibrium equations for each body as for a free body.
12. In the course of his work on Geometry he solved the problem, very difficult at the time, of _______ the sides of a right-angled triangle whose hypotenuse and area are given.
13. Barrow's method is distinguished by the innovation of _______ two infinitesimal quantities.
14. Alkarismi expounds two general methods of _______ equations, *al-gebr*, from which our word algebra is derived, and *al mukabala*.

____

Importing, constructing, solving, passing, determining, throwing, expressing, evaluating, spending, hitting, dropping, performing, approximating, treating.

Ex.5 Insert prepositions. You can use the same preposition in more than one sentence.

In, of, to, from, by.

1. His mathematical power, which never failed him to the end of his life, was employed at this period __ originating the calculus of probabilities, and __ inventing the arithmetical triangle.
2. The mathematician who came nearest __ solving the challenge questions issued by Pascal on the cycloid was John Wallis (1616 - 1703), who became Savillian Professor of Geometry in Oxford in 1649.

3. But he differs from Cavalieri __ regarding lines as made up of infinitely small lines, surfaces of infinitely small surfaces, and volumes of infinitely small volumes.
4. Leonerdo's favorite method __ solving many problems is by the method of 'false assumption', which consists __ assuming a solution and then altering it by simple proportion as in the rule of three.
5. We have succeeded __ verifying that the increment can be written in the form of Eq. (4.1 - 32).
6. His famous experiment __ dropping bodies of different weights from the leaning tower of Pisa enabled him to demonstrate that all bodies undergo the same acceleration __ falling towards the earth, a result which his experiment with light and heavy pendulum also proved.
7. Vieta succeeded __ finding 23 of the 45 roots.
8. He also discusses solids generated __ revolving a curve about an axis, and in the last section deals with problems of maxima and minima.
9. The intellectual trend of that time was such as to prevent mathematics __ becoming a popular subject.
10. Since the Euler equation usually cannot be solved analytically, one naturally thinks __ using numerical integration.

Ex.6 Change the time clause into the 'in + gerund construction'.

Example: He made a mistake when he was proving the theorem.
He made a mistake in proving the theorem.

1. The solution of cubics was, of course, unknown at that time, but Leonardo showed great ability when he obtained a very close approximate solution.
2. When he discussed this curve, a great favourite with the mathematicians of that time, Huygens made the beautiful discovery that it is tautochronous.

3. When couples are considered in space, all three characteristics must be specified in order to define any couple.
4. The middle years of the seventeenth century constitute the greatest period of mathematical activity, and when we describe the work of this period it must be remembered that mathematicians no longer worked in comparative isolation.
5. When one considers the mathematical work of J. Kepler (1571 - 1630) one is chiefly struck by the quality of his imagination.
6. We have already said that Henry IV was much struck by the ability shown by Vieta when he was solving a certain problem.
7. Diophantus was content with a single solution of such equations, and his amazing ingenuity was shown when he dealt with each equation as a particular case.
8. The fundamental theorem used when one finds extreme values of functions is the necessary condition that the differential vanish at an extreme point.
9. The variation plays the same role when one determines extreme values of functionals as the differential does when one finds maxima and minima of functions.
10. The detailed investigation of this historical question is lengthy and involved, but it is of sufficient interest and importance to warrant us when we give the main facts.

Ex.7 Answer the following questions using 'by + gerund'.
Example: How can you solve this problem? (to use Pythagoras' Theorem)
We can solve this problem by using Pythagoras' Theorem.

1. How will the author introduce new concepts concerning functionals in this section? (to appeal to some familiar results from the theory of functionals)

2. How does Napier obtain the notation of a logarithm? (to compare two motions)
3. How does Wallis reach several remarkable results in this work? (often to deduce general propositions from a number of particular cases)
4. How did he arrive at this result? (to consider that $\frac{1}{a}$ gets larger and larger as a decreases, passing through infinity when $a = 0$)
5. How did he verify this result? (to extract the square root of $(1 - x^2)$, and also to multiply the above series by itself)
6. How can we find six unknowns? (to solve the system of six equations)
7. How can we obtain the unknown quantities? (to solve the triangle)
8. How did mathematicians find a way out of the dilemma? (to change their conception of what a number is to what we nowadays call the real number)
9. How did he obtain a root of several cubics? (to use conic sections)
10. How does the search begin? (to find the curves that satisfy the fundamental theorem)

Ex.8 Translate into Russian paying attention to the predicative constructions with the gerund.

1. In peacetime, in 1947, Oppenheimer became the director of the Institute for Advanced Study in Princeton, N. J., where Einstein was still a professor. From time to time they talked. There is no record of their ever having discussed black holes.
2. One of the experts who drew up the list is Sir Andrew Wiles, whose solution of Fermat's Last Theorem six years earlier is surely the only reason for that 330-year-old conundrum not being included.

Participle

Ex.1 Study the functions of participles I. Translate the sentences into Russian.

A

1. In summary then, the Euler equation for Problem 1 is generally non-linear, ordinary, time-varying, hard-to-solve, second-order differential equation.
2. Such elements probably form an essential part of the developing human consciousness, and for that reason have an increasing significance.
3. We turn then to the case of linear time-varying finite-dimensional control systems.
4. Sir Isaac Newton used variational principles to determine the shape of a body moving in air that encounters the least resistance.
5. In this section we shall use the fundamental theorem to determine extrema of functionals depending on a single function.
6. There may also be terms involving products or powers of $\ddot{x}^*(t), \dot{x}^*(t)$ and $x^*(t)$.
7. He published a Geometry, consisting of the enunciations of the first book of Euclid, and of some propositions from the third and fourth books.
8. He regards the circumference of a circle as a polygon possessing an infinite number of sides.
9. Hence the totality of lines forming one triangle is equal to the totality of lines forming the other.
10. Entropy had long been a central concept of thermodynamics, the branch of physics dealing with heat.
11. One solution being investigated is multimode operation, with an aircraft being propelled first by an

advanced turbine engine…, then a ramjet…, and next a scramjet.

12. We recall the linear test and explain some geometrical methods relying on iterated Lie brackets when this test fails.

B

1. Choose a new variable *t* as being C in the identity.
2. As illustrating the difficulties encountered by early mathematicians we may mention that Paciuolo is much puzzled by the equation $ax = bx$.
3. The line-pair must also be regarded as possessing two foci.
4. But he also regards a surface as being generated by a moving line, and a volume by a moving plane.
5. In this work he states that parallel lines may be regarded as meeting in a point at infinity, and parallel planes in a line at infinity.
6. Two curves could be regarded as lying together in the same plane.
7. In the *Quadrature of Curves* he states that: 'I consider mathematical quantities in this place not as consisting of very small parts, but as described by a continued motion.'
8. Newton regarded geometrical magnitudes as being generated by motion.
9. There are a lot of problems that appear when studying a control system.

C

1. Assuming that there are such points and that they can be determined, then one can examine the behavior of the function in the vicinity of these points.

2. Examining the function at the end points, we see that t_0 is a relative minimum and t_f is a relative maximum.
3. He considers these cubic equations impossible in the same sense that the quadrature of the circle is impossible, meaning evidently that no known method would solve them.
4. It is, indeed, an astonishing fact that algebraic notation improved so slowly, seeing the quality of the mathematical work that was now being done.
5. Taking now the new approximate value $x_1 + x_2$ we find, in the same way, another small quantity x_3.
6. Two theorems are enunciated respecting uniformly accelerated motion.
7. Fermat also performed several integrations… evaluating the areas of parabolas and hyperbolas of different orders, and also obtaining the centre of mass of paraboloid of revolution.
8. He also investigates the compound pendulum, proving that the centres of oscillation and of suspension are interchangeable.
9. Substituting the values, $x-e, y-a$, in the equation to the curve, and neglecting squares and higher powers of e and a, the ratio of $a:e$ is obtained.
10. The discovery of this theorem meant that the inverse square law could be rigorously applied to the members of the Solar system, treating the Sun and planets as heavy particles, since the slight departures from exactitude, due to the fact that the heavenly bodies were not perfect spheres, could obviously be neglected as being much below the limits of observation.

Ex.2 State whether the -ing form is the gerund or participle I. Give your reasons.

1. He was not a professional mathematician, being an engineer and architect, but he came into contact with the greatest mathematicians of his time.
2. He repeated Torricelli's experiments, and showed that barometric readings really did depend on atmospheric pressure by obtaining, at the same moment, readings at different heights on the slope of the hill of Puy-de-Dôme.
3. Briggs tables were completed by a Dutchman, Adrian Vlacq, who published, in 1628, a table of logarithms, to ten places of decimals, for all numbers from 1 to 100000, using Briggs's logarithms, to ten places for the numbers calculated by Briggs.
4. By considering a number of special cases Cavalieri finally arrived at a theorem.
5. Assuming a solution of the form $x^*(t) = ke^{st}$ and substituting this in (4.2-13), we obtain $ks^2e^{st} + ke^{st} = 0$.
6. He had the habit common to Hindoo mathematicians, of expressing his results in verse, and the language is often very obscure.
7. In the last section of the book various theorems are proved relating to the centrifugal force on a body moving in a circle.
8. His method of solving the biquadratic which has been deprived of its cubic term is similar to Ferrari's.
9. Even today, despite the simple picture of the real numbers as the points on a line, university students of mathematics always have trouble grasping the formal (and hightly abstract) development of the real numbers.

10. Instead of having $x(t_0)$ and $\dot{x}(t_0)$ specified, we know $x(t_0)$ and $x(t_f)$.
11. Similarly, most people have difficulty coming to terms with complex numbers – numbers that involve the square root of negative quantities, such as $i = \sqrt{-1}$…
12. Intuitively speaking, the norm of the difference of two functions should be zero if the functions are identical, small if the functions are "close", and large if the functions are "far apart".
13. John Pell was a minor seventeenth-century English mathematician who was mistakenly credited by Euler with having investigated this equation.
14. An image is spatially varying function. One way to analyze spatial variations is the decomposition of an image function into a set of orthogonal functions, one such set being the Fourier (sinusoidal) functions.

Ex.3 Translate the sentences into Russian.

1. Having obtained these extremely important results, Newton simply kept them to himself.
2. From the line-pair we may reach the parabola by passing through an infinity of hyperbolas and, having reached the parabola, we may pass through an infinity of ellipses to the circle.
3. Having done this, her problem was to find the closed curve with a fixed perimeter that encloses the maximum area.
4. Dido, having been promised all of the land she could enclose with a bull's hide, cleverly cut the hide into many lengths and tied the ends together.
5. Having read the manuscript, Einstein translated it himself into German.
6. Having solved this problem, there's certainly a sense of freedom. I was so obsessed by this problem that for eight years I was thinking about it all of the time.

7. Having discussed this construction in the context of square root extraction, we can pass on to the next proposition.
8. Having seen what this rather formidable expression means, let us introduce some modern notation.
9. Having understood this, he then turned his attention to the third basic concept of Newtonian mechanics – mass.

Ex.4 Define the functions of participle II.

A

1. As indicated, the partial derivatives in Eq.(4.2-4) are evaluated on the trajectory $x, \dot{x}$.
2. Another problem of historical interest is the brachistochrone problem shown in Fig.4-1, posed by Johann Bernoulli in 1696.
3. The real number assigned by f is the distance of the point q from the origin.
4. It is a suitable norm because it satisfies the three properties given in (4.1-4.15).
5. If q and $q+\Delta q$ are elements for which the function f is defined, then the increment of f, denoted by Δf, is… .
6. If $\|q\|_2$ is used as the norm, $q^{(2)}$ must lie within the circle centered at $q^{(1)}$ having radius δ as shown in Fig. 4-2(a).
7. Given the dizzying progress in miniaturization, one can playfully contemplate a day when quarks will serve to store information, one bit apiece perhaps.
8. Consider the function of one variable illustrated in Fig.4-4.

9. The assumptions made regarding the function ρ guarantee that the term which multiplies $\delta x(t)$ in Eq.(4.2-8) is continuous.
10. As compared with, for instance, Galilei, Kepler's imagination ranges farther and is less hindered by considerations of probability.
11. Cavalieri (1598-1647) regards a line as made up of points possessing no magnitude, a surface as made up of lines without breadth, and a volume as made up of surfaces without thickness.
12. Let us now examine Eq.(4.2-10), called the Euler equation, in more detail.
13. This work, written also in verse, has two chapters on arithmetic, algebra, and geometry.

B

1. The problem is due to Pappus, and may be stated: 'Given several straight lines in a plane to find the locus of a point such that the perpendiculars, or, more generally, straight lines at given angles, drawn from the point to the given lines, shall satisfy the condition that the product of certain of them shall be in a given ratio to the product of the rest'.
2. It is certain that some of the most valuable results obtained by the Hindoos were never imported into Europe.
3. Given any implication, we can form another implication, called its contrapositive, which is equivalent to the original implication.
4. The most interesting of his results was his discovery, reached by an analysis of biblical writings, that the world was to come to an end on 3 October 1533.
5. Let this particle preserve this velocity unchanged.
6. The triangle FCD is considered as built up of lines HE, and triangle CAF of lines BM.

7. René Descartes, usually regarded as the inventor of co-ordinate geometry, was born near Tours in 1596 and died at Stockholm in 1650.
8. Even when reduced to common units, however, typical values of the two entropies differ vastly in magnitude.
9. An intuitive way of looking at this lemma is the following: Given any continuous function h that is not identically zero in the interval (t_0, t_f), a function δx, with continuous derivatives, can be selected.
10. But combined with this luxuriant imagination was a very delicate insight.
11. The roots of the equation so obtained for x will make $f(x)$ a maximum.
12. The first problem was to find a number such that its square, when increased or decreased by 5, would remain the same.
13. The work sketched above would be sufficient to rank Fermat amongst the greatest mathematicians of his time.
14. Considered as an art, it (mathematics) appeals to very few, and, on this ground alone, it is difficult to see why the ordinary run of men should pay more homage to a mathematician than to a chess champion.

Ex.5 Point out participles II used in the function of attribute.

1. One can find much more advanced material in some references given throughout this chapter.
2. The selected committee agreed that the seven problems chosen were the most significant unsolved problems of contemporary mathematics.
3. Any constrained body can be treated as a free body relieved from its constraints, provided the latter are represented by their reactions.
4. Forces treated in mechanics as concentrated are in fact the resultants of corresponding systems of distributed forces.

5. The second theorem states that the distance covered by a uniformly accelerated body is proportional to the square of the time taken in covering the distance.
6. The manner in which he discusses the problem of a weight resting on an inclined plane, a problem much discussed at that time, has often been quoted.
7. Under the influence of gravity, the bead slides along a frictionless wire with fixed end points A and B.
8. In optimal control problems the objective is to determine a function that minimizes a specified functional – the performance measure.
9. In the latter part of the fifteenth century, there were, scattered and disconnected, the beginnings of a good notation, in the absence of which the development of algebraic thought would have been yet further retarded.
10. Thus the required result is obtained.
11. The action of a given force system on a rigid body remains unchanged if another balanced force system is added to, or subtracted from the original system.
12. To any action of one material body on another there is always an equal and oppositely directed reaction.
13. For the first equation, one uses a natural fixed-point method.

Ex.6 Translate the Russian words in brackets into English using participles II.

1. This result, (называемый) the fundamental lemma of the calculus of variations, is proved in references.
2. The norm of q, (обозначенный) by $\|q\|$ satisfies the following properties… .
3. We prove the well-posedness of the Cauchy problem (связанный) to these equations.
4. For the reader who is familiar with this subject, a large part of this chapter can be omitted; most of the

methods (детально рассмотренные) here are very well known.

5. If we know the reaction of the constraints, we know the loads acting on the constraints, that is, the basic information (необходимый) to calculate the strength of structural elements.
6. We know from experience that a free body (подвергнутый) to the action of a single force cannot be in equilibrium.
7. The foundations of the theory are metaphysical and lead to ten laws of nature, of which the first two are practically the same as those (сформулированный) by Newton, and the rest are inaccurate.
8. The results (полученный) by such men as Descartes, Pascal, Fermat, were known by one another as soon as they were published.
9. Two forces (приложенный) at one point of a body have as their resultant a force (приложенный) at the same point and (представленный) by the diagonal of a parallelogram (построенный) with the two (данный) forces as its sides.
10. His work, (рассматриваемый) as a whole, is that of a man of considerable learning and ability.
11. His solution is essentially the same as the one (данный) by Euler.
12. The mathematical ability (продемонстрированный) is very considerable.
13. This theorem occurs in the section (посвященный) to the descent of heavy bodies, whether falling freely in a vacuum, or on inclined planes, or on certain smooth curves.
14. The new methods (придуманный) by Descartes and Fermat excited much attention.

Ex.7 Say which sentences contain the Nominative Absolute Participial Constructions. Translate the sentences into Russian.

1. Leonardo was born at Pisa about 1175, his father being one Bonacci, a merchant.
2. The solution, a cycloid lying in the vertical plane, is credited to Johann and Jacob Bernoulli, Newton and L'Hospital.
3. The principle of homogeneity and the principle of additivity being both satisfied, f is a linear function.
4. Again, to be more explicit, we would write $\Delta J(x, \delta x)$ to emphasize that the increment depends on the functions x and δx, δx being called the variation of the function x.
5. Paciuolo, for example, in extracting roots of compound quantities, used the *Radix universalis*, denoted by RV, the symbol R, taken by itself, meaning the square root.
6. Thus he saw a curve as described by a moving point, the point being the point of intersection of two moving lines which were always parallel to two fixed lines at right angles.
7. Now, by supposition, $x^2 - ax^2 + axy - y^2 = 0$, which therefore, being expunged and the remaining terms being devided by 0, there will remain
$$3x^2\dot{x} - 2ax\dot{x} + ay\dot{x} + ax\dot{y} - 3y^2\dot{y} +$$
$$+3x\dot{x}\dot{x}0 - ax\dot{x}0 + a\dot{x}\dot{y}0 - 3y\dot{y}\dot{y}0 + \dot{x}^3 00 - \dot{y}^3 00 = 0$$
8. In constructing a vector polygon, we should arrange all the component vectors in one sense along the periphery of the polygon, with vector R being drawn in the opposite sense.
9. Our entire observed universe could be trapped on such a brane – a so-called brane world. Other brane

worlds may float around out there, each being a universe to those trapped onboard.

10. Newton proposed to himself two classes of problems. The first was, 'the relation of the fluents being given, to find the relation of their fluxions,' i.e. to differentiate. The second was, 'an equation being proposed exhibiting the relation of the fluxions of quantities, to find the relations of those quantities, or fluents, to one another,' i.e. to solve differential equations.
11. And, that being the case, there is yet a smaller prime of the same form not possessing it (the property)… .
12. The result can also be denoted as in Fig. 3.10b, with force F neglected.
13. A simple example of his actual method is given by his proof that a parallelogram is divided by its diagonal into two triangles, each having half the area of the parallelogram.

Ex.8 Translate the sentences from English into Russian. Pay attention to the Absolute Participle Construction.

1. This is the event that the gambler's fortune $s_n(\omega)$ reaches $-a$ before it reaches $+b$; it represents ruin for a gambler with a dollars playing against an adversary with b dollars, the rule being that they play until one or the other runs out of capital.
2. Given the virus attacks to date, such a reaction would be totally unwarranted.
3. In reality the impact, even in the case of a metallic hammer, is far from instantaneous, the time of contact, though very short as measured by ordinary standards, being at all events comparable with the period of vibration of the string.
4. It is hardly necessary to say explicitly that the resolution of a periodic function of t in this form can only be effected in one way, the values of the coefficients being determinate.

5. We first consider a routine which, given details of the problem, provides only the value $y(b)$ or an indication that the solution cannot be obtained.
6. For purposes of comparison one or more additional wires may be stretched alongside the former, their tension being adjusted, as in a pianoforte, by means of pegs at the extremities.
7. Approximate integration methods are discussed in Chapter 5, their significance being increased by the fact that integrable systems occur so rarely in reality.
8. In classical statistics there are a number of such principles for developing statistical procedures: the maximum likelihood, unbiasedness, minimum variance, and least squares principles to name a few. In decision theory there are also several possible principles that can be used; the three most important being the Bayes risk principle, the minimax principle, and the invariance principle.
9. The most difficult extension of the investment possibility problem would be to the original Cramer-Lundberg model, that would require modeling of the reserve by the sum of two controlled processes, one being a compound Poisson, the other a diffusion process.
10. Had this book been written 10 years ago, we would at this point thank the people who typed it. That being no longer applicable, perhaps we should thank instead the National Science Foundation, the University of Chicago, and Harvard University for generously providing the various Macintoshes on which this manuscript was produced.

Ex.9 Replace the italic clauses with Absolute Participle Construction. Translate the sentences into Russian.

1. The literature of multidimensional scaling is large and diverse, *almost all theoretical developments and applications are in the behavioral and social sciences*.
2. Now, *when the two primary formats for representing data* – the pattern matrix and the proximity matrix – *have been established*, we turn to the characteristics of the data themselves.
3. *As the decision boundary is available*, the remaining computer science programs will be assigned to one of the two categories.
4. The properties of F and j contained in the following three lemmas are also easily verified, *the proofs for transcendental functions are analogous to those for the rational case.*
5. *If data are on an ordinal scale*, measures of rank correlation can be applied.
6. We shall often formulate statements about left characteristic varieties only, *the right hand analogue is understood*.
7. *If the analysis starts with a proximity matrix*, multidimensional scaling is applicable.
8. *As the pucks are well separated in phase angle*, their conflicting mirror laws may be relatively easily satisfied one at a time.
9. *Even if such a model is given*, the specification and control of postcontact behavior will likely depend significantly on the sensory information.

Ex.10 Replace the italic clauses with Absolute Participle Construction. Translate the sentences into Russian.

1. It will be explained how any factor on a site can be transformed, in two steps, into a sheaf, *this process of*

“sheafification” provides another basic example of a pair of adjoint functors.

2. The definition of a complex Lie group is exactly analogues, *the words “differentiable manifold” are replaced by “complex manifold” and all related notions are revised accordingly.*
3. *As the initial height – and thus the contact velocity – are being gradually increased*, the robot will eventually fail to track the reference trajectory defined so.
4. *As the coefficient of restitution is less than one*, the puck will eventually come to rest after numerous bounces.
5. Gower and Legendre show that for a metric dissimilarity matrix $[d(i, j)]$ only properties 1 and 4 are required, *other properties are derived from these two.*
6. *If the light rays pass through a capillary section containing air*, the light exiting the glass diverges and the signal is smaller.
7. *As this effect is known*, it can be calibrated out in the software by using a correction factor which is a function of the number of fluid segments.
8. *When thick-walled glass capillaries are used*, a converging lens must be placed between the light source and the capillary to obtain comparable results.
9. *As the equations of the null-cone are hard to find without computing explicitly the ring of invariant polynomials*, one must use another approach.

Ex.11 Replace the italic clauses with Absolute Participle Construction. Translate the sentences into Russian.

1. *As G is the identity matrix*, the squared Mahalanobis distance is the same as the squared Euclidean distance.

2. *As the number of groups or pattern classes is two*, the data can be transformed to a line without any increase in the scatter ratio.
3. Stress can be understood in terms of a Shepard diagram, which is a plot of M points, *each represents the (distance, dissimilarity) values for one pair of patterns*.
4. *As all features are binary*, the Manhattan metric is called the Hamming distance, or the number of features in which two patterns differ.
5. As usual, we suppose that it is in principle possible to continue the trials indefinitely, *the probabilities are defined consistently for all finite sequences*.
6. The match between dissimilarity matrix and distance matrix is perfect if the M points can be connected by a sequence of straight lines, *all have nonnegative slopes*.
7. Stenson and Knoll computed the final stress for configurations of 10, 20, 30, 40, 50 and 60 points, *each has configuration dimensionalities of 1, 2, … 10*.
8. These intervals are called dyadic intervals, *the endpoints are adjacent dyadic rationals with the same denominator.*
9. The magnet in our experiments has a relatively low displacement speed resulting in a pulsed flow; *each pumping pulse corresponds to an open/close cycle of the check-valves.*

Ex.12 Translate the sentences from Russian into English using the Absolute Participle Construction.

1. Если n не намного больше, чем m, то сравнительно легко найти требуемую конфигурацию.
2. Данные методы интегрирования обсуждаются в этой главе, причем их значимость растет

вследствие того, что изучаемые интегрируемые системы редко встречаются.

3. Что касается теории струнных инструментов, то данная коррекция не имеет здесь значения, а влияние воздуха вообще не важно.
4. Это будет зависеть от нескольких внешних факторов, причем состояние экономики является одним из них.
5. Модель эллиптической орбиты, конечно, в сущности верна, а ошибка, вызванная внешними возмущениями, минимальна.
6. Если это выполняется, то не трудно прийти к противоречию.
7. Эта конфигурация не позволяет отличить воздух от жидкости, причем плотность мало изменяется с изменением условий.
8. Поскольку данная задача не является очень сложной, мы постараемся решить ее в первую очередь.

II
Non-finite forms of the verb in scientific context

Ex.1 Read the following extract and comment on the non-finite forms of the verbs that are used in it.

It thus appears that he [Pierre de Fermat (1601-65)] had discovered the principles of analytical geometry for himself some years before Descartes' *Géométrie* appeared. Also, he was in possession, by 1628 or 1629, of his method for determining maxima and minima. Kepler had observed that the increment of a varying quantity became vanishingly small in the neighbourhood of its maximum or minimum values. Fermat translated this fact into a method for determining a maximum or minimum in the following way. If a function of x has a maximum value for the value x, then its value will be almost the same for $x-e$, if e is very small. If, therefore, the value $f(x)$ be equated to the value $f(x-e)$, we can make this equality correct by letting e assume the value zero. The roots of the equation so obtained for x will make $f(x)$ a maximum.

Ex.2 Read the following extract and comment on the non-finite forms of the verbs that are used in it.

This generalized view of conics is a very good specimen of Kepler's insight. The whole point of view has turned out to be of the greatest importance in mathematics. It initiated one of the rare and valuable departures in mathematics which result from an effort of imagination rather than from effort of ratiocination. The same faculty is exhibited in Kepler's method of evaluating areas and volumes, a method closely akin to that of the integral calculus. The year 1612 was, in Austria, an exceptionally rich wine-year, and Kepler, on purchasing his wine, was astonished at the cruid methods adopted for evaluating the volume of the barrels. He reflected on the matter, and the result of his reflections was the *Stereometria doliorum,* published in 1615. In this work he discusses the solids known to Archimedes and also some new ones, and then deals with the problems presented by the wine barrels. His method is to regard an area or volume as made up of an infinite number of parts.

Ex.3 Read the following extract and comment on the functions of participles II.

In the *Principia* Descartes expounds his celebrated theory of vortices. The foundations of the theory are metaphysical and lead to ten laws of nature, of which the first two are practically the same as those given by Newton, and the rest are inaccurate. It is not necessary to describe the theory since, in a deadly analysis in the second book of his *Principia,* Newton showed that the consequences of the theory are (1) inconsistent with the observed facts of planetary motion as described in Kepler's laws, (2) inconsistent with the fundamental laws of mechanics, and (3) inconsistent with the fundamental laws of nature assumed by Descartes himself.

Ex.4 Complete the extract by putting the verbs in brackets into the correct form, participle I or participle II. State whether ***covering*** *is the gerund, the participle or the verbal noun. Give your reasons.*

In his investigation of the form (assume)— by a heavy chain (suspend)— at its two ends, Galilei concludes that it is a parabola – a result which is definitely wrong. Two theorems are enunciated (respect)— uniformly (accelerate)— motion. The first is that the time (take)— to describe a straight line by a uniformly (accelerate)— body, which starts from rest, is the same time as would be required to cover the same distance by a body (move)—

with a uniform velocity which is one-half the final velocity (reach)— by the uniformly (accelerate)— body. The second theorem states that the distance (cover)— by a uniformly (accelerate)— body is proportional to the square of the time (take)— in **covering** the distance. How difficult the formation of correct dynamical ideas was at that time, however, is shown by the fact that even the insight of a Galilei could be led sadly astray.

Ex.5 Read the following extract and comment on the functions of the infinitives that are used in it.

What is sometimes called Fermat's last theorem states that no integral values of x, y, z can be found to satisfy the equation $x^n + y^n = z^n$ if n be an integer greater than 2. In the margin in which this theorem occurs it is accompanied by the note, 'I have found for this a truly wonderful proof, but the margin is too small to hold it.' In spite of repeated attempts by the keenest analysts, and the offer of several valuable money prizes by learned societies, the theorem still remains without proof. Euler has proved it to be true for $n = 3$, and Fermat has elsewhere given an early proof for the case $n = 4$. In 1823 Legendre gave a proof for $n = 5$. In 1832 Dirichlet proved it for $n = 14$, and Lamé and Lebesgue proved it for $n = 7$ in 1840. In spite of the extraordinary difficulty of hitting upon a general proof, nobody doubts that the theorem is true, and it is generally supposed that Fermat really had found a proof. In a paper found amongst the manuscripts of Huygens in the library of Leyden in 1879, Fermat gives a general method by which he made many of his discoveries. He calls it *la descente infinite ou indéfinie.* *

* In 1995, Andrew Wiles's proof of Fermat's Last Theorem was officially published and accepted by mathematical community.

Ex.6 Complete the following extract with the –ing, -ed or to-infinitive form of the verbs in brackets.

Many minor results, particularly in the theory of series and the problem of tangents, were (obtain)— by various men at this time; but they are not of sufficient importance (warrant)— a (detail)— discussion, and practically all these particular cases were (gather)— up in the more general theorems soon (enunciate)— by Newton. But before (consider)— the masterful work of Newton we must give some account of the work of two men who were in a special sense his precursors.

Ex.7 Complete the following extract with the –ing or to-infinitive form of the verbs in brackets.

(Illustrate)— the method we will apply it to curve (b). (Put)— the co-ordinates of Q in the equation we have

$$(x-e)^3+(y-a)^3=r^3,$$

or

$$x^3-3ex^2+3c^2x-e^3+y^3-3ay^2+3a^2y-a^3=r^3.$$

(Neglect)— all powers of e and a higher than the first this becomes

$$x^3+y^3-3ex^2-3ay^2=r^3,$$

or, since

$$x^3+y^3=r^3, 3ex^2+3ay^2=0,$$

(give)— $a/e=-x^2/y^2$.

Ex.8 Find predicative constructions with the infinitive in the following text. Translate the sentences into Russian.

Isaac Newton was born at Woolsthorpe, Lincolnshire, on Christmas Day, 1642, and died at Kensington, London, on

March 20, 1727. He was the posthumous son of a yeoman farmer, and it was at first intended that Isaac also should devote his life to farming. It became evident, however, that this prospect did not attract the boy, and as his chief delight, both at home and at his school at Grantham, lay in devising all kinds of mechanical models, in making various sorts of experiments, and in solving problems, his mother sent him back to school and afterwards, in his eighteenth year, allowed him to enter Trinity College, Cambridge. Newton had not, at that time, read any mathematics. His attention was directed to the subject through the references to geometry and trigonometry he found in a book on astrology that he picked up at Stourbridge Fair. He began with Euclid, and was surprised to find that it contained nothing but what seemed perfectly obvious. He therefore ignored it and took up Descartes' *Géométrie.* This appears to have been difficult enough to interest him, and it cost him some little trouble to master it. He also read Oughtred's *Clavis,* and discovered that mathematics was so interesting a subject that he determined to make a serious study of it rather than of chemistry.

Ex.9 Say which sentences contain predicative constructions with the infinitive. What is the function of the infinitive ***to solve****?*

We now come to consider one of the most interesting advances in the early history of mathematics. As we have seen, Paciuolo concluded his great treatise by giving two examples of cubic equations and declaring them to be impossible. The early half of the sixteenth century saw the solution. This great step forward in the creation of algebra is popularly attributed to Cardano. More thorough investigation seemed to show, however, that Cardano merely borrowed from Tartaglia, but there is reason to suppose that, after all, Cardano's reputation is largerly justified, although it is certain that he was not the first European **to solve** a cubic equation. The detailed investigation of this historical question is lengthy and involved, but it is of sufficient interest and importance to warrant us in giving the main facts.

Ex.10 Find gerunds in this text and write them down. What is the function of the infinitive ***to integrate****?*

In summary then, the Euler equation for *Problem I* is generally a nonlinear, ordinary, time-varying, hard-to-solve, second order differential equation.

Since the Euler equation usually cannot be solved analytically, one naturally thinks of using numerical integration. The characteristics of the Euler equation which make analytical solution difficult do not present serious difficulties numerically. Unfortunately, there is another factor that prevents us from simply solving the Euler equation by numerical integration – *the boundary conditions are split.* Instead of having $x(t_0)$ and $\dot{x}(t_0)$ specified [or $x(t_f), \dot{x}(t_f)$], we know $x(t_0)$ and $x(t_f)$. **To integrate** numerically, we need values for all of the boundary conditions at one end. Thus, we see that to obtain the optimal trajectory x^*, a nonlinear, two-point boundary-value problem must be solved. The problem is difficult because of the combination of split boundary values and the nonlinearity of the differential equation. Separately, either of these difficulties can be surmounted without tremendous effort, but together they present a formidable challenge. For the moment we shall consider only problems that can be solved analytically. In chapter 6 we shall consider some numerical techniques for solving nonlinear, two-point boundary-value problems.

It should be emphasized that since the Euler equation is a necessary condition, further investigation is required to ascertain whether a solution x^* is a minimizing curve, a maximizing curve, or neither.

Ex.11 Translate the following extract into Russian paying attention to the functions of the non-finite forms of the verbs that are used in it.

The object of this little history is to trace, in outline, the development of mathematics from its beginnings in Europe to the invention of the differential and integral calculus. The pace of this development was determined, of course, by the number and quality of the mathematicians working at any period, and by the inherent difficulty of the subject. Another factor of great importance was the human tendency to try complicated methods before simple ones. Early mathematics was far more complicated than it need have been, partly because arbitrary divisions between similar things were established, apparently merely for the purpose of multiplying cases, and partly because the invention of a good notation seems to have presented a very difficult and lengthy task. I have thought it well to give specimens of actual solutions and sometimes of notation from early mathematicians, as this enables the reader to understand much more clearly the nature of their difficulties and the quality of their achievements.

Ex.12 Complete the text by putting the verbs in brackets into the correct form: participle, gerund or infinitive.

A branch of mathematics that is extremely useful in (solve)— optimization problems is the calculus of variations. Queen Dido of Carthage was apparently the first person (attack)— a problem that can readily be solved by (use)— variational calculus. Dido, (promise)— all of the land she could enclose with a bull's hide, cleverly cut the hide into many lengths and tied the ends together. (Do)— this, her problem was (find)— the (close)— curve with a (fix)— perimeter that encloses the maximum area. We know that she should have chosen a circle. The calculus of variations enables us (prove)— this fact and, in addition, other results that are more useful, since real estate transactions are performed somewhat differently today.

Although the history of the calculus of variations dates back to the ancient Greeks, it was not until the seventeenth century in western Europe that substantial progress was made. Sir Isaac Newton used variational principles (determine)— the shape of a body (move)— in air that encounters the least resistance. Another problem of historical interest is the brachistochrone problem (show)— in Fig.4-1, (pose)— by Johann Bernoulli in 1696. Under the influence of gravity, the bead slides along a frictionless wire with (fix)— end points A and B. The problem is (find)— the shape of the wire that causes the bead (move)— from A to B in minimum time. The solution, a cycloid (lie)— in the vertical plane, is credited to Johann and Jacob Bernoulli, Newton, and L'Hospital.

In Dido's problem, and in the brachistochrone problem, curves are sought which cause some criterion (assume)— extreme values. The connection with the optimal control problem, wherein we seek a control function that minimizes a performance measure, should be apparent.

Ex.13 Translate the following quotations[*] *into Russian paying special attention to the non-finite forms of the verbs.*

Archimedes c.287-212 BC, *Italian-Greek mathematician and inventor*

Give me a place to stand, and I will move the earth.

F.Hultsch (ed.) *Pappus Alexandrus: Collectio* (1876-8), vol. 3, book 8, section 10, ix

Having been the discoverer of many splendid things, he is said to have asked his friends and relations that, after his death, they should place on his tomb a cylinder

[*] Oxford Dictionary of Scientific Quotations ed. by W. F. Bynum & Roy Porter. Oxford University Press, 2005.

enclosing a sphere, writing on it the proportion of the containing solid to that which is contained.

Plutarch, *Life of Marcellus,* 17.12 Trans. R. W Sharples.

Hieron asked Archimedes to discover, without damaging it, whether a certain crown or wreath was made of pure gold, or if the goldsmith had fraudulently alloyed it with some baser metal. While Archimedes was turning the problem over his mind, he chanced to be in the bath house. There, as he was sitting in the bath, he noticed that the amount of water that was flowing over the top of it was equal in volume to that part of his body that was immersed. He saw at once a way of solving the problem. He did not delay, but in his joy leaped out of the bath. Rushing naked through the streets towards his home, he cried out in a loud voice that he had found what he sought. For, as he ran, he repeatedly shouted in Greek: 'Eureka! Eureka! I've found it! I've found it!'

Vitrivius Pollio, *De Architectura*, ix, prologue, section 10.

Isaac Asimov 1920-92 *Russian-born American writer and biochemist*

The young specialist in English Lit, having quoted me, went on to lecture me severely on the fact that in every century people have thought they understood the Universe at last, and in every century they were proved to be wrong. It follows that the one thing we can say about our modern 'knowledge' is that it is wrong.

The young man then quoted with approval what Socrates had said on learning that the Delphic oracle had proclaimed him the wisest man in Greece. 'If I am the wisest man,' said Socrates, 'it is because I alone know that I know nothing.' The implication was that I was very foolish because I was under the impression I knew a great deal.

Alas, none of this was new to me (There is very little that is new to me; I wish my correspondents would realize this.) This particular theme was addressed to me a quarter of a century ago by John Campbell, who specialized in irritating me. He also told me that all theories are proven wrong in time.

My answer to him was, 'John, when people thought the Earth was flat, they were wrong. When people thought the Earth was spherical, they were wrong. But if you think that thinking the Earth is spherical is just as wrong as thinking the Earth is flat, then your view is wronger than both of them put together.'

The Relativity of Wrong (1989), 214.

Percy Williams Bridgman 1882-1961 *American physicist and philosopher of science*

If a specific question has meaning, it must be possible to find operations by which an answer may be given to it… I believe that many of the questions asked about social and philosophical subjects will be found to be meaningless when examined from the point of view of operations.

The Logic of Modern Physics (1960), 28

The results have exhibited one striking feature which has been frequently emphasized, namely that at high pressures all twelve liquids become more nearly like each other. This suggests that it might be useful in developing a theory of liquids to arbitrary construct a 'perfect liquid' and to discuss its properties. Certainly the conception of a 'perfect gas' has been of great service in the kinetic theory of gases; and the reason is that all actual gases approximate closely to the 'perfect gas.' In the same way, at high pressures all liquids approximate to one and the same thing, which may be called by analogy the 'perfect liquid.' It seems to offer at least a promising line of attack to discuss the properties of this 'perfect liquid,' and then to invent the simplest possible mechanism to explain them.

'Thermodynamic Properties of Twelve Liquids Between 20° and 80° and up to 1200 KGM. Per Sq. Cm.', Memoirs of the American Academy of Arts and Sciences, 1913, 49, 113.

Max Born 1882-1970 *German physicist*

The ultimate origin of the difficulty lies in the fact (or philosophical principle) that we are compelled to use the words of common language when we wish to describe a phenomenon, not by logical or mathematical analysis, but by a picture appealing to the imagination. Common language has grown by everyday experience and can never surpass these limits. Classical physics has restricted itself to the use of concepts of this kind; by analyzing visible motions it has developed two ways of representing them by elementary processes; moving particles and waves. There is no other way of giving a pictorial description of motions – we have to apply it even in the region of atomic processes, where classical physics breaks down.

Atomic Physics (1957), 97

To present a scientific subject in an attractive and stimulating manner is an artistic task, similar to that of a novelist or even a dramatic writer. The same holds for writing textbooks.

My Life & My Views (1968), 48

Jacob Bronowski 1908-74 *Polish-born British mathematician and science writer*

Science has nothing to be ashamed of, even in the ruins of Nagasaki.

Science and Human Values (1961), 83

Augusta Ada King, Countess of Lovelace 1815-52 *British mathematician*

The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths. Its province is to assist us in making available what we are already acquainted with.

Comment on Babbage's engines.

From 'Sketch of Analytical Engine invented by Charles Babbage, Esq.' [by I. F. Menabrea with notes by Ada Lovelace], *Scientific Memoirs,* 1843, 3, 722

John Ashworth Ratcliffe 1902-87 *British physicist*

There was, I think, a feeling that the best science was that done in the simplest way. In experimental work, as in mathematics, there was 'style' and a result obtained with simple equipment was more elegant than one obtained with complicated apparatus, just as a mathematical proof derived neatly was better than one involving laborious calculations. Rutherford's first disintegration experiment, and Chadwick's discovery of the neutron had a 'style' that is different from that of experiments made with giant accelerators.

'Physics in a University Laboratory Before and After World War II', *Proceedings of the Royal Society of London,* Series A, 1975, 342, 463.

James Joseph Sylvester 1814-97 *British mathematician*

Chemistry has the same quickening and suggestive influence upon the algebraist as a visit to the Royal Academy, or the old masters may be supposed to have on a Browning or a Tennyson. Indeed it seems to me that an exact homology exists between painting and poetry on the one hand and modern chemistry and modern algebra on the other. In poetry and algebra we have the pure idea elaborated and expressed through the vehicle of language, in painting and chemistry the idea enveloped in matter, depending in part on manual processes and the resources of art for its due manifestation.

Attributed.

Joseph John Thomson 1856-1940 *British physicist*

The study of … simple cases would, I think, often be of advantage even to students whose mathematical attainments are sufficient to enable them to follow the solution of the more general cases. For in these simple cases the absence of analytical difficulties allows attention to be more easily concentrated on the physical aspects of the question, and thus gives the student a more vivid idea and a more manageable grasp of the subject than he would be likely to attain if he merely regarded electrical phenomena through a cloud of analytical symbols.

Elements of the Mathematical Theory of Electricity and Magnetism (1895), v-vi.

Ex.14 Read the following extracts from texts. Pay attention to the non-finite forms of the verbs and the constructions with them. Translate into Russian.

1. Unfortunately, robust Bayesian analysis turns out to be quite difficult; indeed for many problems it is technically almost impossible. We thus run into the need for what Good (1983) calls “Type II rationality”: when time and other realistic constraints in performing a statistical analysis are taken into account, the optimal analysis may be an analysis which is not rigorously justifiable (from, say, the robust Bayesian viewpoint). The employment of any alternative methodology should, however, be justified from this perspective, the justification being that one is in this way most likely to be “close to” the philosophically correct analysis.

2. It is, in fact, not fruitful to try to predict just which sets probabilistic analysis will require and then assign probabilities to them in some *ad hoc* way. The successful procedure is to develop a general theory that assigns probabilities at once to the sets of a class so extensive that most of its members never actually arise in probability theory. That being so, why not ask for a theory that goes all the way and applies to *every* set in the unit interval? For an arbitrary subset A of Ω, should there not exist a well-defined probability that the random point ω lies in A? The answer turns out to be no, and it is necessary to work within certain subclasses of the class of all subsets of the unit interval. The classes of the appropriate kinds – the fields and σ-fields are defined and studied in the section to follow. The theory there covers the unit interval as treated in this section, as well as discrete spaces, Euclidean spaces, and many others.
3. We first apply De Vylder's (1978) approximation to (net of reinsurance) surplus processes. There are three main reasons for applying this approximation. First, the computational time involved in applying this procedure is negligible. This is important as conclusions in this paper are based on grid searches over a range of values for retention levels and dividend barriers. Second, it has been shown to be a remarkably accurate approximation in other studies of dividend problems. Third, it has the advantage over other types of approximation to a surplus process (such as a Brownian motion approximation) that it produces a non-zero deficit at ruin. The importance of this can be seen in the formula to follow below. However, like any approximation, De Vylder's approximation has limitations. It appears to work best when the moment generating function of the individual claim amount distribution (without reinsurance) exists. This was certainly the case in the original setting of the

approximation, all illustrated by the numerical examples in De Vylder (1978).

4. A concrete example is illuminating. The secret of this chapter is that we can tackle interest rate models in exactly the same way at stock models. The Itô manipulations are harder but they are not significant for the story – just as in Black-Scholes, the real work is carried by the martingale representation theorem. In Black-Scholes, there were only two canonical tradables (the stock and the bond), but there are now an infinite number of underlying discount bonds. To pick just two of these tradables to work with would seem to favour that pair over the rest, but such worries will prove illusory. All the tradables will still turn out to be martingales under the risk-neutral measure, which itself is independent of the apparent 'choice' of instruments to work with.
5. To analyze the ferrofluid in the gradient magnetic field, assumptions are made to simplify the computations. The ferrofluid is assumed to be viscous and incompressible; as long as the windings are sufficiently cooled, fluid flow is also considered to be isothermal. M and H were assumed to be collinear; the gravity component was assumed negligible in the direction of ferrofluid motion.
6. This is the complete form of Fourier's Theorem, and includes the others as special cases.

   We should be led directly, on physical grounds, to this form of the theorem if we were to investigate the "longitudinal" vibrations of the column of air in a reentrant circular tube.

   We have so far supposed the function $f(x)$ to be continuous, as well as finite, even when continued beyond the original range as a periodic function. But the theorems hold, with a modification to be stated immediately, even if $f(x)$ have a finite number of isolated discontinuities.

7. It is relatively rare for an actual decision problem to involve an intelligent adversary. In trying to decide which of two drugs is best, for example, no intelligent opponent is involved. In such situations there seems to be no good reason to randomize, and indeed intuition argues against it. The decision maker should be able to evaluate the relative merits of each possible action, and find the best action. If there is only one best action, there can be nothing gained by randomizing (assuming there is no need to keep an opponent guessing). If there are two or more best actions, one could randomly choose among them if desired, but there seems to be no particular point in doing so. Basically, leaving the final choice of an action up to some chance mechanism just seems ridiculous. This criticism will be seen in the chapter to follow to be valid on a rather fundamental level. Therefore, we will rarely recommend the actual use of a randomized rule.
8. The conditional approach to statistics is concerned with reporting data-specific measures of accuracy. The overall performance of a procedure δ is deemed to be of (at most) secondary interest; what is considered to be of primary importance is the performance of $\delta(x)$ for the actual data x that is observed in a given experiment. The following simple example shows that there can be a considerable difference between conditional and frequentist measures.

   This example is included for historical reasons, and also because it turns out to be a key example for development of the important Likelihood Principle in the subsection to follow. This example is a variant of the famous Cox conditioning example.

   Suppose a substance to be analyzed can be sent either to a laboratory in New York or a laboratory in California. The two labs seem equally good, so a fair coin is flipped to choose between them, with “heads” denoting that the lab in New York will be chosen. The coin is flipped and comes up tails, so the California lab is used. After a while, the experimental results come back and a conclusion and report must be developed. Should this conclusion take into account the fact that the coin could have been heads, and hence that the experiment in New York might have been performed instead? Common sense (and the conditional viewpoint) cries no, that only the experiment *actually performed* is relevant, but frequentist reasoning would call for averaging over all possible data, even the possible New York data.

Savage (1962) used the term *initial precision* to describe frequentist measures, and used the term *final precision* to describe conditional measures. Initially, i.e., before seeing the data, one can only measure how well δ is likely to perform through a frequentist measure, but after seeing the data one can give a more precise final measure of performance. (The necessity for using at least partly frequentist measures in designing experiments is apparent.)

9. The theory of the vibrations of a string when excited by bowing is somewhat difficult, but the main features have been elucidated by Helmholtz. Since the pitch is found to be that natural to the string, the vibrations are to be regarded as in a sense "free," the function of the bow being to maintain the motion by supplying energy to make up for the losses by dissipation. In the case of the violin, where the strings are of light material and pass over a bridge resting on a very sensitive surface (of the resonance cavity), these losses may be relatively considerable. The mode of action of the bow appears to be that it drags the string with it for a time by friction, until at length the latter springs back; after a further interval the string is carried forward again, and so on, the complete cycle taking place in the period of vibration.

In order to obtain data for mathematical analysis Helmholtz began by an experimental study of the character of the vibration at various points. The device was an optical one, of the kind employed by Lissajous, by which the rectilinear vibration of the point examined is compounded with an independent vibration at right angles, whose period is commensurable, or nearly so, with that of the string. A microscope whose axis is horizontal is directed to the point to be studied, the string itself being vertical. The eye-piece of the microscope is fixed, but the objective is carried by one of the prongs of a tuning fork and vibrates in a vertical direction. When the fork alone vibrates the image of a bright point on the string is drawn out into a vertical line; when the string alone vibrates the appearance is that of a horizontal line. When both vibrations coexist the result would be a closed curve if the periods were exactly commensurable. For example, if the period of the fork were exactly commensurable with that of the string, and if the vibration of the point examined were simple-harmonic, the result would be one of the corresponding series of Lissajous figures; whilst if the relation between the periods were inexact, the curve would pass in succession through the various phases of the series. In the actual circumstances the forms of the curves are modified, and it is possible from the result to make inferences as to the true nature of the vibration studied.

III
Texts

This section will give you further practice in the grammar area under consideration. Read the texts* and comment on the non-finite forms of the verbs that are used there.

Text 1

In May 2000, at highly publicized meeting in Paris, the Clay Mathematics Institute (CMI) announced that seven $1 million prizes were being offered for the solutions to each of seven unsolved problems of mathematics – problems that an international committee of mathematicians had judged to be the seven most difficult and most important in the field today. The announcement caused quite a stir, and for several weeks media interest was high. As a mathematician who writes books and articles for a lay audience and appears regularly on radio, I was approached by numerous journalists and radio producers asking for background or commentary. I was also approached by several editors interested in a book on the topic, among them Bill Frucht at Basic Books. Bill had become a good friend (and something of a hero of mine for his editorial abilities) through our work together on my previous book for a lay audience, *The Math Gene.* So I jumped at the chance to work with him again, and began at once to do the considerable research the book would require.

A short while later, Arthur Jaffe, the president of the Clay Institute, asked me if, together with fellow mathematics popularizer Ian Stewart, I would write general introductions to the seven Millennium Problems for the official book on

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* See: Keith Devlin. The Millennium Problems. The Seven Greatest Unsolved Mathematical Puzzles of Our Time. Granta Books, 2005

the problems that the Clay Institute was preparing in conjunction with American Mathematical Society. After checking that the two books would not conflict unduly, I agreed. The official CMI book consists primarily of detailed and accurate descriptions of the seven problems, each written by one of the world experts on that particular problem. With $1 million at stake for each problem, the CMI book also has the legal responsibility of stating each problem with sufficient precision that judges may determine whether a proposed solution actually meets the problem's criteria. (These problems are not remotely comparable to performing a long division sum or solving a quadratic equation, and in some cases it takes considerable effort simply to understand the individual terms that appear in the statement of the problem.) Ian and I were asked to provide short introductory accounts of the problems to make the book more accessible to mathematicians and more useful to journalists and lay readers who were interested in consulting the "official book" on the problems.

(p.7)

Text 2

Landon Clay, oddly enough, is not a mathematician. As an undergraduate at Harvard he majored in English. Yet he has funded a mathematics chair at his alma mater, then the Clay Mathematics Institute (whose endowment currently stands at $90 million), and now the Millennium Prizes. These initiatives were, he says, partly a response to what he sees as low public funding for an important subject. By offering a major cash prize and inviting the world's press to the meeting at which the competition was to be announced, Clay ensured that the Millennium Problems – and mathematics in general – would get international media attention. But why travel to Paris to do it?

The answer is history. Exactly one hundred years earlier, in 1900, Paris had been host to a similar event. The occasion was the second International Congress of Mathematicians. On August 8, the German mathematician David Hilbert, an international leader in the field, gave an invited address in which he laid out an agenda for mathematics for the twentieth century. In his lecture, Hilbert listed what he judged to be the 23 most significant unsolved problems in mathematics. The "Hilbert Problems," as they became known, were beacons guiding mathematicians forward into the future.

A few of the problems Hilbert stated turned out to be much easier than he had anticipated, and they were soon solved. Several others were too imprecise to admit a definite answer. But most turned out to be mathematical problems of great difficulty. Solving any of those "genuine" Hilbert Problems brought the solver instant fame among the mathematical community, every bit as significant as the award of a Nobel Prize, but with the added advantage that the successful mathematician did not have to wait for years before he (and all the solvers were male) could enjoy the benefits of his success. The accolades came the moment the mathematical community agreed the solution was correct.

By 2000, all but one of the genuine Hilbert Problems had been solved, and the time was ripe for mathematicians once again to take stock. What were the gold-ring problems at the end of the Second Millennium – the unsolved problems that everyone agreed were the Mount Everests of mathematics?

The Paris meeting was partly an attempt to recreate history, but not entirely. As Wiles has pointed out, the CMI's aim in drawing up the Millennium Problems list is not exactly the same as Hilbert's was. "Hilbert was trying to guide mathematics by his problems," Wiles says. "We're trying to record great unsolved problems. There are big problems in mathematics that are important but where it is very hard to isolate one problem that captures the program." The Millennium Problems, in other words, might not give you much of an idea of where mathematics is going. But they provide an excellent snapshot of where the frontier is today.

(pp.2-3)

Text 3

The Riemann Hypothesis. This is the only problem that remains unsolved from Hilbert's list in 1900. Mathematicians the world over agree that this obscure-looking question about the possible solutions to a particular equation is the most significant unsolved problem in mathematics.

The problem was formulated by the German mathematician Bernhard Riemann in 1859 as part of an attempt to answer one of the oldest questions in mathematics: What, if any, is the pattern of the prime numbers among all counting numbers? Around 350 B.C., the famous Greek mathematician Euclid had proved that the primes continue forever; that is, there are infinitely many of them. Moreover, by observation, the primes seem to "thin out" and become less common the higher up you go through the counting numbers. But can you say any more than that? The answer – as we shall see in Chapter 1 – is yes. A proof of the Riemann Hypothesis would add to our understanding of the prime numbers and the way they are distributed. And that would do far more than satisfy the curiosity of mathematicians; besides having implications in mathematics well beyond the patterns of the primes, it would have ramifications in physics and modern communications technology.

(p.4)

Text 4

Yang-Mills Theory and the Mass Gap Hypothesis. Much of the impetus for new developments in mathematics comes from science, in particular from physics. For example, it was the needs of physics that led to the invention of calculus by the mathematicians Isaac Newton and Gottfried Leibniz in the seventeenth century. Calculus revolutionized science, by providing scientists with a mathematically precise way to describe continuous motion. But although Newton and Leibniz's methods worked, it took some 250 years for the mathematics behind calculus to be properly worked out. A similar situation exists today with some of the theories of physics that have been developed over the past half century or so. The second Millennium Problem challenges mathematicians once again to catch up with the physicists.

The Yang-Mills equations come from quantum physics. They were formulated almost fifty years ago by the physicists Chen-Ning Yang and Robert Mills to describe all of the forces of nature other than gravity. They do an excellent job. The predictions culled from these equations describe particles that have been observed at laboratories around the world. But while the Yang-Mills theory works in practical terms, it has not yet been worked out as a *mathematical* theory. The second Millennium Problem asks for, in part, that missing mathematical development of the theory, starting from axioms. The mathematics would have to meet a number of conditions that have been observed in the laboratory. In particular, it should establish (mathematically) the "Mass Gap Hypothesis," which concerns supposed solutions to the Yang-Mills equations. This hypothesis is accepted by most physicists, and provides an explanation of why electrons have mass. Proof of the Mass Gap Hypothesis is regarded as a good test of a mathematical development of the Yang-Mills theory. It would help the physicists as well. They can't explain why electrons have mass either; they simply observe that they do.

(p.4-5)

Text 5

The P Versus NP Problem. This is the only Millennium Problem that is about computers. Many people will find this surprising. “After all,” this will say, “isn’t most math done on computers these days?” Well, no, actually it isn’t. True, most numerical calculations are done on computers, but numerical calculation is only a very small part of mathematics, and not a typical part at that.

Although the electronic computer came out of mathematics – the final pieces of the math were worked out in the 1930s, a few years before the first computers were built – the world of computing has hitherto generated only two mathematical problems that would merit inclusion among the world’s most important. Both problems concern computing as a conceptual process rather than any specific computing devices, although this does not prevent them from having important implications for real computing. Hilbert included one of them as number 10 on his 1900 list. That problem – which asks for a proof that certain equations cannot be solved by a computer – was solved in 1970.

The other problem is more recent. This is a question about how efficiently computers can solve problems. Computer scientists divide computational tasks into two main categories: Tasks of type P can be tackled effectively on a computer; tasks of type E could take millions of years to complete. Unfortunately, most of the big computational tasks that arise in industry and commerce fall into a third category, NP, which seems to be intermediate between P and E. But is it? Could NP be just a disguised version of P? Most experts believe that NP and P are not the same (i.e., that computational tasks of type NP are not the same as tasks of type P). But after thirty years of effort, no one has been able to prove whether or not NP and P are the same. A positive solution would have significant implications for industry, for commerce, and for electronic communications, including the World Wide Web. (pp.5-6)

Text 6

The Navier-Stokes Equations. The Navier-Stokes equations describe the motion of fluids and gases – such as water around the hull of a boat or air over an aircraft wing. They are of a kind that mathematicians call partial differential equations. University students in science and engineering routinely learn how to solve partial differential equations, and the Navier-Stokes equations look just like the kinds of equations given as exercises in a university calculus textbook. But appearances can be deceptive. To date, no one has a clue how to find a formula that solves these particular equations – or even if such a formula exists.

This failure has not prevented marine engineers from designing efficient boats or aeronautical engineers from building better aircraft. Although there is no general formula that solves the equations (say, in the way that the quadratic formula solves all quadratic equations), the engineers who design high-performance boats and aircraft can use computers to solve particular instances of the equations in an approximate way. Like the Yang-Mills Problem, the Navier-Stokes Problem is another case where mathematics wants to catch up with what others, in this case engineers, are already doing.

This talk of "catching up" might give the impression that certain problems are important only to the egos of mathematicians, who don't like being left behind. But to think that would be to misunderstand the way scientific knowledge advances. Because of the abstract nature of mathematics, mathematical knowledge about a phenomenon generally represents the deepest and surest understanding of it. And the more deeply we understand something, the better we can take advantage of it. Just as a mathematical proof of the Mass Gap Hypothsis would be a major advance in physics, so too a solution of the Navier-

Stokes equations would almost certainly lead to advances in nautical and aeronautical engineering.

(pp.6-7)

Text 7

The Poincaré Conjecture. This problem, first raised by the French mathematician Henri Poincaré almost a century ago, starts with a seemingly simple question: How can you distinguish an apple from a doughnut? Yes, all right, this doesn't seem like a question that would lead to a $1 million math problem. What makes it hard is that Poincaré wanted a *mathematical* answer that could be used in more general situations. That rules out the more obvious solutions, such as simply taking a bite of each. Here is how Poincaré himself answered the question. If you stretch a rubber band around the surface of an apple, you can shrink it down to a point by moving it slowly, without tearing it and without allowing it to leave the surface. On the other hand, if you imagine that the same rubber band has somehow been stretched in the appropriate direction around a doughnut, then these is no way of shrinking it to a point without breaking either the rubber band or the doughnut. Surprisingly, when you ask whether the same shrinking band idea distinguishes between four-dimensional analogues of apples and doughnuts – which is what Poincaré was really after – no one has been able to provide an answer. The Poincaré conjecture says that the rubber band idea *does* identify four-dimensional apples.

This problem lies at the heart of topology, one of the most fascinating branches of present-day mathematics. Besides its inherent and sometimes quirky fascination – for instance, it tells you the deep and fundamental ways in which a doughnut is the same as a coffee cup – topology has applications in many areas of mathematics, and advances in the subject have implications for the design and manufacture of silicon chips and other electronic devices, in transportation, in understanding the brain, and even in the movie industry.

(pp.7-8)

Text 8

The Birch and Swinnerton-Dyer Conjecture. With this problem, we're back in the same general area of mathematics as the Riemann Hypothesis. Since the time of the ancient Greeks, mathematicians have wrestled with the problem of describing all solutions in whole numbers x, y, z to algebraic equations like

$$x^2 + y^2 = z^2 .$$

For this particular equation, Euclid gave the complete solution – that is to say, he found a formula that produces all the solutions. In 1994, Andrew Wiles proved that for any exponent n greater than 2, the equation

$$x^n + y^n = z^n$$

has no nonzero whole-number solutions. (This was the result known as Fermat's Last Theorem.) But for more complicated equations it becomes extremely difficult to discover whether there are any solutions, or what they are. The Birch and Swinnerton-Dyer Conjecture provides information about the possible solutions to some of those difficult cases.

As with the Riemann Hypothesis, to which it is related, a solution to this problem will add to our overall understanding of the prime numbers. Whether it would have comparable implications outside of mathematics is not clear. Proving the Birch and Swinnerton-Dyer Conjecture might turn out to be important only to mathematicians.

On the other hand, it would be foolish to classify this or any mathematical problem as being "of no practical use." Admittedly, the mathematicians who work on the abstract problems of "pure mathematics" are usually motivated more by curiosity than by any practical consequences. But again and again, discoveries in pure mathematics have turned out to have important practical applications.

Moreover, the methods mathematicians develop to solve one problem often turn out to have applications to quite different problems. This was definitely the case with Andrew Wiles's proof of Fermat's Last Theorem. Similarly, a proof of the Birch and Swinnerton-Dyer Conjecture would almost certainly involve new ideas that will later be found to have other uses.

(pp.8-9)

Text 9

The Hodge Conjecture. This is another "missing piece" question about topology. The general question is about how complicated mathematical objects can be built up from simpler ones. Of all the Millennium Problems, this is perhaps the one the layperson will have the most trouble understanding. Not so much because underlying intuitions are any more obscure than for the other problems or because it is believed to be harder than any of the other six problems. Rather, the Hodge Conjecture is a highly technical one having to do with the techniques mathematicians use to classify certain kinds of abstract objects. It arises deep within the subject, at a high level of abstraction, and the only way to reach it is by way of those layers of increasing abstraction. This is why I have put this problem last.

The path to the conjecture began in the first half of the twentieth century, when mathematicians discovered powerful ways to investigate the shapes of complicated objects. The basic idea was to ask to what extent you can approximate the shape of a given object by gluing together simple geometric building blocks of increasing dimension. This technique turned out to be so useful that it was generalized in many different ways, eventually leading to powerful tools that enabled mathematicians to catalogue many different kinds of objects. Unfortunately, the generalization obscured the geometric origins of the procedure, and the mathematicians had to add pieces that did not have any geometric interpretation at all. The Hodge conjecture asserts that for one important class of objects (called projective algebraic varieties), the pieces called Hodge cycles are, nevertheless, combinations of geometric pieces (called algebraic cycles).

(pp.9-10)

Text 10

With each new conceptual leap, even mathematicians need time to come to terms with new ideas, to accept them as part of the overall background against which they do their work. Until recently, the pace of progress in mathematics was such that, by and large, the interested observer could catch up with one new advance before the next one came along. But it has been getting steadily harder. To understand what the Riemann Hypothesis says, the first problem on the Millennium list, you need to have understood, and feel comfortable with, not only complex numbers (and their arithmetic) but also advanced calculus, and what it means to add together infinitely many (complex) numbers and to multiply together infinitely many (complex) numbers.

Now that kind of knowledge is restricted almost entirely to people who have majored in mathematics at university. Only they are in a position to see the Riemann Hypothesis as a simple statement, not significantly different from the way an average person views Pythagoras's theorem. My purpose in this book, then, is not only to explain what the Riemann Hypothesis says but to provide all of the preliminary material as well.

In most cases, that preparatory material can't be explained in terms of everyday phenomena, the way physicists such as Brian Green[1] can explain the latest, deepest, cutting-edge theory of the universe – Superstring Theory – in terms of the intuitively simple picture of tiny, vibrating loops of energy (the "strings" of the theory). Most mathematical concepts are built up not from everyday phenomena but from earlier mathematical concepts. That means that the only route to getting even a superficial understanding of those concepts is to follow the entire chain of abstractions that leads to them.

[1]. See his excellent expository book *The Elegant Universe.* (pp.13-14)

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Л. Н. Выгонская, М. С. Корнеева,
Е. И. Миндели

Неличные формы глагола в научном тексте

Учебное пособие

Оригинал-макет: К. Г. Евдокимов