ПЕРВОЕ ВЫСШЕЕ ТЕХНИЧЕСКОЕ УЧЕБНОЕ ЗАВЕДЕНИЕ РОССИИ

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ
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УТВЕРЖДАЮ

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МЕТОДИЧЕСКИЕ РЕКОМЕНДАЦИИ ДЛЯ ПРАКТИЧЕСКИХ ЗАНЯТИЙ ИНОСТРАННЫЙ ЯЗЫК

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PART ONE

HOW TO WRITE AN INTRODUCTION

Structure

This book is designed to help non-native speakers of English write science research papers for publication in English, and by science students who need to write a Master's dissertation or PhD thesis. It is a practical, rather than a theoretical book, and is intended as a fast do-it-yourself manual for researchers and scientists. The book is aimed at those whose English language ability is at intermediate level or above. If you have taken an IELTS test, this is equivalent to a score of above 6.0. The goal of scientific research is publication, but good scientists are not always good writers and even native speakers of English sometimes have difficulty when they write up their research. The aim of this book is to give you the information, vocabulary and skills you need quickly and easily so that you can write confidently using the style and structure you see in the journals you read. A typical paper consists of an Abstract, an Introduction, Methodology, Results and Discussion / Conclusion, his book will only focus on writing an Abstract and an Introduction.

You may want to start your Introduction by describing the problem you are trying to solve, or the aim of your work, but as you will see when you examine published work, this is not how most research papers begin — and therefore it is not the best way for you to begin. In order to help you write the Introduction to your own research, the model you build must answer the following three questions:

- How do writers normally start the Introduction?
- What type of information should be in my Introduction, and in what order?
- How do writers normally end the Introduction?

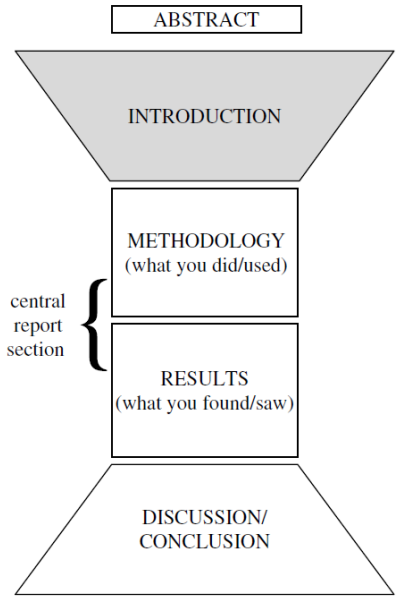

Fig. 1. The shape of a research article or thesis.

The first thing you may notice about Fig. 1 is that it is symmetrical. This is because many of the things you need to do in the Introduction are done — in reverse order — in the Discussion/Conclusion. For example, you need to write an opening sentence which enables you and your reader to 'get in' or start your paper/thesis and you also need to 'get out' at the end of the Discussion/Conclusion by finding an acceptable way to end the paper/thesis. In addition, you must look for a way to interface with the central report section at the end of the Introduction, and again — in reverse — when you move out of the central section to start the Discussion / Conclusion.

Something else you should notice about the shape of the diagram is that it narrows towards the central report section, and widens after it. This represents the way information is ordered in the Introduction and the Discussion/Conclusion: in the Introduction you start out by being fairly general and gradually narrow your focus, whereas the opposite is true in the Discussion/Conclusion.

Grammar and Writing Skills

This section deals with four language areas which are important in the Introduction.

Signaling language

Sentence connection

One of the most common errors in writing is *failing to connect one sentence or idea to the next.* Every time you end a sentence, your reader has no idea what the next sentence is going to do or say. If you don't use appropriate connectors, you create a gap in the text which will cause problems. One of your tasks as a writer is to make sure that gap is closed, so that your reader is carried carefully from one piece of information to the next. One way to connect sentences is to **overlap**, meaning to repeat something from the previous sentence:

- *The pattern of inflammation during an asthma attack is different from that seen in stable asthma. In **stable asthma** the total number of inflammatory cells does not increase.*

Another way is *to use a pronoun (it, they) or pro-form (this method, these systems) to glue the sentences together*:

- *Many researchers have suggested ways of reducing cost without affecting the quality of the image. **These methods** rely on data structures built during a preprocessing step.*

The third way is *not to finish the sentence at all*, but *to join it to the next sentence with a semicolon or a relative clause* (a 'which' clause). Joining sentences with a semicolon works well when two sentences are very closely related and one of them is quite short:

- *The procedure for testing whether components are operationally safe usually takes many hours**;** this means that tests are rarely repeated.*
- *It has received much attention over the past few decades due to its biodegradable properties, **which** offer important economic benefits.*

The fourth way is *to use a signaling sentence connector* to indicate the relationship between one sentence and the next, or one part of a sentence and the next. You know how useful sentence connectors are from your reading; when you see a word like *therefore* or *however,* you are able to process the next piece of information in the sentence correctly even if you don't understand every word. This is because the sentence connector signals the function of the information in the sentence. The opposite is also true: when the writer does not signal the function of the information with a connector, it is harder for the reader to process the information.

Here are some examples of signaling language arranged according to their function:

CAUSE

The experiment was unsuccessful _____ the measuring instruments were inaccurate.

The experiment was unsuccessful _____ the inaccuracy of the measuring instruments.

due to (the fact that) on account of (the fact that) in view of (the fact that)	as because since

NOTE:

Be careful when you use *since*; it is also often used to mean 'from that time', so if there's any possibility of confusion, choose a different connector.

All these connectors can be used at the start of a sentence, even *because* (*Because the measuring instruments were inaccurate, the experiment was unsuccessful*).

RESULT

The measuring instruments were calibrated accurately, _____ the experiment was successful.

therefore consequently hence	as a result (of which) which is why so

NOTE:

Don't start sentences with *so* to communicate a result; it's too informal.

CONTRAST / DIFFERENCE

British students are all vegetarians, _____ Norwegian students eat meat every day.

however whereas but	on the other hand while by contrast

NOTE:

On the contrary and *conversely* don't fit into this category because they don't only communicate difference; they communicate the fact that 'exactly the opposite is true', so you can't use them in the

sentence above (because *vegetarians* and *meat eaters* aren't opposites, they're just different). However, you could use them in the following sentence: *Some experiments used uncalibrated instruments and succeeded;* ***conversely****, other experiments used carefully calibrated instruments and failed.*

Be careful when you use *while*; it is also oft en used to mean 'at that/the same time', so if there's any possibility of confusion, choose a different connector.

UNEXPECTEDNESS

(*a*) _____ *it was difficult, a solution was eventually found.*
(*b*) _____ *the difficulty, a solution was eventually found.*
(*c*) *It was difficult;* _____ *a solution was eventually found.*

(A)	(B)	(C)
Although	Despite	Nevertheless
Even though	In spite of	However
Though	Regardless of	Nonetheless
	Notwithstanding	Even so

There are other connectors with the same meaning, such as *still* and *anyway*, but they are more informal.

ADDITION
We used a batch processing system because it was more effective; _____*it was faster.*

in addition	also
moreover	secondly (etc.)
furthermore	in the second place (etc.)
apart from that/which	what is more

NOTE:
Besides has more or less the same meaning as the items in the list above, but it's more powerful and is therefore better used in more persuasive contexts.

Passive/Active

Students often ask whether they can use **we** in their research articles. In the Introduction you usually say what you will be doing or presenting in the research article. You can use **we** to refer to your research group or team, but do not use it to refer to people or humanity in general. If you are referring to people in general, it's better to use a construction with *It* (*It is known / thought that…*) rather than *We know/think that…* It is also common to use the passive instead of **we**, especially in the central 'report' section (*was measured, was added, etc.*).

In a thesis, you are writing as an individual and you don't have a research group or team. Since you cannot write your thesis using **I,** you will probably write in the passive. Use words like *here* and *in this study* to let your reader know when you are referring to your own work. You can also use a 'dummy' subject to take the place of **I** or **we**:

This article *describes an algorithm for clustering sequences into index classes.*
The present paper *presents a set of criteria for selecting such a component.*

The problem with using the passive in formal writing is that the agent (the person who performed the action of the verb) is often not mentioned in the sentence. In other words, we say that something *was done* or *was identified* but we don't say 'by me' or 'by other researchers', so the reader may not know who *did* it or who *identified* it. This can cause confusion and for that reason it is sometimes clearer to use a dummy subject (*This article/the present paper*) in the Introduction rather than the 'agentless' passive *(x is presented).*

Model Introduction

Study this Model Introduction:

The synthesis of flexible polymer blends from polylactide and rubber

Introduction

1 Polylactide (PLA) has received much attention in recent years due to its biodegradable properties, which offer important economic benefits. **2** PLA is a polymer obtained from corn and is produced by the polymerization of lactide. **3** It has many possible uses in the biomedical field and has also been investigated as a potential engineering material. **4** However, it has been found to be too weak under impact to be used commercially. **5** One way to toughen polymers is to incorporate a layer of rubber particles and there has been extensive research regarding the rubber modification of PLA. **6** For example, Penney *et al.* showed that PLA composites could be prepared using blending techniques and more recently, Hillier established the toughness of such composites. **7** However, although the effect of the rubber particles on the mechanical properties of copolymer systems was demonstrated over two years ago, little attention has been paid to the selection of an

appropriate rubber component. **8** The present paper presents a set of criteria for selecting such a component. **9** On the basis of these criteria it then describes the preparation of a set of polymer blends using PLA and a hydro-carbon rubber (PI). **10** This combination of two mechanistically distinct polymerizations formed a novel copolymer in which the incorporation of PI significantly increased flexibility.

In Sentence 1 '*Polylactide (PLA) has received much attention in recent years due to its biodegradable properties, which offer important economic benefits*.' **the writer establishes the importance of this research topic.**

Most research articles begin by indicating that the research field or topic is useful or significant. They may focus on the quantity of research in this area, or how useful research in this area can be, or simply how important this research field is. If you look at your target articles, you will probably find something in the first one or two sentences that establishes the significance of the research. Phrases like *much study in recent years* or *plays a major role* are common here.

What tense to use?

Phrases like *much study in recent years* or *in the past five years* are normally followed by the Present Perfect tense (*Much study in recent years has focused on...*). Other ways of establishing significance may use the Present Simple tense (*There are substantial benefits to be gained from…*).

In Sentence 2 '*PLA is a polymer obtained from corn and is produced by the polymerization of lactide*.' **the writer provides general background information for the reader**.

Sentence 2 is in the Present Simple tense, which is used for accepted / established facts. Research articles often begin with accepted or established facts. This ensures that the reader shares the same level of background information as the writer, and is therefore ready to read the article. Remember that the background facts to your research are very familiar to you and the people you work with, but they won't be as familiar to all of your readers. Therefore, if the article is to reach a wider audience you need to state background facts which may seem obvious or well-known to you.

In Sentence 3 '*PLA has many possible uses in the biomedical field and has also been investigated as a potential engineering material*' **the writer does the same as in Sentences 1 and 2, but in a more specific/detailed way, using research references to support both the background facts and the claim for significance**.

In Sentence 4 '*However, it has been found to be too weak under impact to be used commercially.*' **the writer describes the general problem area or the current research focus of the field**.

Notice that the author is still not describing the specific problem which this research article will deal

with; s/he is describing the current focus of the field, a problem which *many* researchers in this field are interested in and which leads to the specific problem which will be addressed in this article. Remember to keep this general description of the problem area or current research focus brief.

In Sentence 5 '*One way to toughen polymers is to incorporate a layer of rubber particles.*' **the writer provides a transition between the general problem area and the literature review.**

As a general rule, you should include references to previous or current research wherever it is useful.

In Sentence 6 '*For example, Penney et al. showed that PLA composites could be prepared using blending techniques and more recently, Hillier established the toughness of such composites.*' **the writer provides a brief overview of key research projects in this area**.

You can't just 'pour' the literature review onto the page in any order; you should arrange your references and studies so that the reader is able to process them in a logical way. Here are three common options:

- **chronological:** Deal with the research in chronological order. This may be appropriate, for example, if the development of your field is related to political decisions.
- **different approaches / theories / models:** Group projects or studies according to their approach or methodology.
- **general / specific:** Start with general research in the field and gradually move to research that is closer to your own.

In Sentence 7 '*However, although the effect of the rubber particles on the mechanical properties of copolymer systems was demonstrated over two years ago,*8 *little attention has been paid to the selection of an appropriate rubber component.*' **the writer describes a gap in the research**.

This is where you begin to introduce the purpose of your paper and the specific problem you will deal with, and in order to do this it is necessary to create a research space. You can do this either by describing a problem in the previous research or by indicating that there is a gap in the research. It is conventional to introduce it with a signaling connector such as *However* or *Although.*

In Sentence 8 '*The present paper presents a set of criteria for selecting such a component.*' **the writer describes the paper itself**.

At this stage you move to the present work. You can describe it, say what its purpose or focus is, give its structure or a combination of these. You need to decide whether to write these sentences in the active or the passive. You normally use the Present Simple tense to describe the work itself (*This paper is organized as follows* or *This study focuses on*) and the Past Simple tense to talk about the aim of the work (*The aim of this project was…*), because in 'real time', the aim occurred before the work was carried out. It is

also possible to state the aim in the Present Simple (*The aim of this work is…*). This is especially true in cases where the aim is only partially achieved in the paper you are submitting and the rest of the work will be done and reported on at a later stage.

In Sentence 9 '*On the basis of these criteria it then describes the preparation of a set of polymer blends using PLA and a hydrocarbon rubber (PI).*' **the writer gives details about the methodology reported in the paper**.

In Sentence 10 '*This combination of two mechanistically distinct polymerisations formed a novel copolymer in which the incorporation of PI significantly increased flexibility*.' **the writer announces the findings**.

Although you can give information about your methodology or findings in the Introduction, be careful not to go into too much detail at this point or you will find that you have nothing to write about in the Methodology or Results sections.

Look at the way the writer begins Sentences 9 and 10. In each case the information is joined to the previous sentence with a pronoun (*On the basis of* ***these criteria*** in Sentence 9 and ***This combination*** in Sentence 10).

Our model has FOUR basic components:

1	• ESTABLISH THE IMPORTANCE OF YOUR FIELD • PROVIDE BACKGROUND FACTS/INFORMATION • DEFINE THE TERMINOLOGY IN THE TITLE / KEY WORDS • PRESENT THE PROBLEM AREA/CURRENT RESEARCH FOCUS
2	• PREVIOUS AND/OR CURRENT RESEARCH AND CONTRIBUTIONS
3	• LOCATE A GAP IN THE RESEARCH • DESCRIBE THE PROBLEM YOU WILL ADDRESS • PRESENT A PREDICTION TO BE TESTED
4	• DESCRIBE THE PRESENT PAPER

Testing the Model

The next step is to look at the way this model works in a real Introduction. Here is a full-length Introduction from a real research article. Read them through, and mark the model components (1, 2, 3 or 4) wherever you think you see them. For example, if you think the first sentence of the Introduction corresponds to number 1 in our model, write 1 after it, *etc.*

The height of biomolecules measured with the atomic force microscope depends on electrostatic interactions

INTRODUCTION

Because the atomic force microscope (AFM) (Binnig *et al*., 1986) makes it possible to image surfaces in liquids, it has become an important tool for studying biological samples (Drake *et al*., 1989). Recent reports document the observation of protein assemblies under physiological conditions at nanometer resolution (Butt *et al*., 1990; Hoh *et al*., 1991; Karrasch *et al*., 1993, 1994; Yang *et al*., 1993, Schabert and Engel, 1994; Mou *et al*., 1995b; Muller *et al*., 1995b, 1996b). As demonstrated on solids under vacuum conditions (Sugawara *et al*., 1995) and in liquid (Ohnesorge and Binnig, 1993), the AFM also makes it possible to measure sample heights with sub angstrom accuracy. However, the heights of native biological samples measured with the AFM in aqueous solution vary significantly, and may differ from values estimated with other methods (Butt *et al*., 1991; Apell *et al*., 1993; Muller *et al*., 1995b, 1996a; Schabert and Rabe, 1996). For example, the height reported for single purple membranes ranges from 5.1 ± 0 nm to 11.0 ± 3.4 nm (see Table 1). Height measurements on actin filaments (Fritz *et al*., 1995b), bacteriophage ø29 connectors (Muller *et al*., 1997c), cholera toxin (Yang *et al*., 1994; Mou *et al*., 1995b), DNA (Hansma *et al*., 1995; Mou *et al*., 1995a; Wyman *et al*., 1995), gap junctions (Hoh *et al*., 1993), GroEL (Mou *et al*., 1996), hexagonally packed intermediate layer (HPI) (Karrasch *et al*., 1993; Muller *et al*., 1996a; Schabert and Rabe, 1996), lipid bilayers (Mou *et al*., 1994, 1995b; Radler *et al*., 1994), and microtubules (Fritz *et al*., 1995a) exhibit a similar variability. Height anomalies of soft surfaces have previously been studied and attributed to the mechanical properties of the sample (Weisenhorn *et al*., 1992; Radmacher *et al*., 1993, 1995; Hoh and Schoenenberger, 1994). However thin samples such as two-dimensional protein arrays or biological membranes adsorbed to a solid support are not sufficiently compressible to explain such large height variation.

Here we demonstrate that electrostatic interactions between the AFM tip and the sample (Butt, 1991a, b) influence the measured height of a biological structure adsorbed to a solid support in buffer solution. The DLVO (Derjaguin, Landau, Verwey, Overbeek) theory (Israelachvili, 1991) is used to describe the electrostatic repulsion and van der Waals attraction acting between tip and sample (Butt *et al*., 1995). Experimental results and calculations show that the electrostatic double-layer forces can be eliminated by

adjusting the electrolyte concentration (Butt, 1992a, b), providing conditions for correct height measurements with the AFM. In addition, the observed height dependence of the biological structure on electrolyte concentration allows its surface charge density to be estimated.

Vocabulary

The vocabulary in this section is taken from over 600 research articles in different fields, all of which were written by native speakers and published in science journals. Only words/phrases which appear frequently have been included; this means that the vocabulary lists contain words and phrases which are considered normal and acceptable by both writers and editors.

We will look at vocabulary for the following areas of the model:

1. ESTABLISHING SIGNIFICANCE

This includes phrases such as *Much research in recent years*. A good list of commonly used words and expressions will encourage you to include this in your first sentences.

2. PREVIOUS AND/OR CURRENT RESEARCH AND CONTRIBUTIONS

This includes all past tense verbs describing what researchers did, *i.e. calculated, monitored, etc.* Instead of just using *did, showed* and *found*, you often need to be more specific about what a researcher actually 'did'!

3. GAP/PROBLEM/QUESTION/PREDICTION

This includes ways to say exactly how previous and/or current research is not yet complete or has not addressed the problem your paper deals with, *e.g. However, few studies have focused on…*

4. THE PRESENT WORK

This may include your purpose, your strategy and the design of your paper, using language such as *the aims of the present work are as follows:*

Vocabulary Task

Look through the Introduction in this unit and the Introductions of your target articles. Underline or highlight all the words and phrases that you think could be used in each of the four areas given above. A full list of useful language can be found on the following pages. This includes all the appropriate words and phrases from the Introductions in this unit, together with some other common ones which you may have seen in your target articles. Underneath each list you will find examples of how they are used. Read through the list and check the meaning of any you don't know in the dictionary. This list will be useful for many years.

Vocabulary for the Introduction

1. ESTABLISHING SIGNIFICANCE

(a) basic issue	economically important
(a) central problem	(has) focused (on)
(a) challenging area	for a number of years
(a) classic feature	for many years
(a) common issue	frequent(-ly)
(a) considerable number	generally
(a) crucial issue	(has been) extensively studied
(a) current problem	importance/important
(a) dramatic increase	many
(an) essential element	most
(a) fundamental issue	much study in recent years
(a) growth in popularity	nowadays
(an) increasing number	numerous investigations
(an) interesting field	of great concern
(a) key technique	of growing interest
(a) leading cause	often
(a) major issue	one of the best-known
(a) popular method	over the past ten years
(a) powerful tool/method	play a key role (in)
(a) profitable technology	play a major part (in)
(a) range (of)	possible benefits
(a) rapid rise	potential applications
(a) remarkable variety	recent decades
(a) significant increase	recent(-ly)
(a) striking feature	today
(a) useful method	traditional(-ly)
(a) vital aspect	typical(-ly)
(a) worthwhile study	usually
(an) advantage	well-documented
attracted much attention	well-known
benefit / beneficial	widely recognized
commercial interest	widespread
during the past two	

decades	worthwhile

Here are some examples of how these are used:

• A **major current focus** in population management is how to ensure of…
• **Numerous experiments have established that** ionizing radiation causes…
• Low-dose responses to radiation have **generated considerable recent research interest**.
• Analysis of change in the transportation sector is **vital** for two **important** reasons: …
• PDA accounts for **over 95%** of all pancreatic cancers.
• **It is generally accepted that** joints in steel frames operate in a semi rigid fashion.
• Nano crystalline oxide films **are attracting widespread interest** in fields such as…
• **The importance of** strength anisotropy has been demonstrated by…
• Convection heat transfer phenomena **play an important role in** the development of…
• For **more than 100 years** researchers have been observing the stress strain behavior of…
• **Much research in recent years has focused on** carbon nanotubes.

2. VERBS USED IN THE LITERATURE REVIEW TO PRESENT PREVIOUS AND/OR CURRENT RESEARCH AND CONTRIBUTIONS

achieve	develop	obtain
address	discover	overcome
adopt	discuss	perform
analyze	enhance	point out
apply	establish	predict
argue	estimate	present
assume	evaluate	produce
attempt	examine	propose
calculate	explain	prove
categorize	explore	provide
carry out	extend	publish
choose	find	put forward
claim	focus on	realize
classify	formulate	recognize
collect	generate	recommend
compare	identify	record
concentrate	illustrate	report

(on)	implement	reveal
conclude	imply	revise
conduct	improve	review
confirm	incorporate	show
consider	indicate	simulate
construct	interpret	solve
correlate	introduce	state
deal with	investigate	study
debate	measure	support
define	model	suggest
demonstrate	monitor	test
describe	note	undertake
design	observe	use
detect	prefer	utilize
determine		

Here are some examples of how these are used:

- This phenomenon **was demonstrated** by…
- In their study, expanded T-cells **were found** in…
- Initial attempts **focused on identifying** the cause of…
- Weather severity **has been shown to**…
- Early data **was interpreted** in the study by…
- The algorithm **has been proposed** for these applications…
- The results on pair dispersion **were reported in**…
- Their study **suggested** a possible cause for…
- An alternative approach **was developed** by…

3. GAP / QUESTION / PROBLEM / CRITICISM

This is often signaled by words such as *however, although, while, nevertheless, despite, but.*

ambiguous	not apparent	(to be) confined to
computationally demanding	not dealt with	(to) demand clarification
confused	not repeatable	(to) disagree
deficient	not studied	(to) fail to
	not sufficiently +	

doubtful	adjective	(to) fall short of
expensive	not well understood	(to) miscalculate
false	not/no longer useful	(to) misjudge
far from perfect	of little value	(to) misunderstand
ill-defined	over-simplistic	(to) need to re-examine
impractical	poor	(to) neglect
improbable	problematic	(to) overlook
inaccurate	questionable	(to) remain unstudied
inadequate	redundant	(to) require clarification
incapable (of)	restricted	(to) suffer (from)
incompatible (with)	time-consuming	
incomplete	unanswered	
inconclusive	uncertain	
inconsistent	unclear	
inconvenient	uneconomic	
incorrect	unfounded	few studies have...
ineffective	unlikely	it is necessary to...
inefficient	unnecessary	little evidence is available
inferior	unproven	little work has been done
inflexible	unrealistic	more work is needed
insufficient	unresolved	there is growing concern
meaningless	unsatisfactory	there is an urgent need…
misleading	unsolved	this is not the case unfortunately
non-existent	unsuccessful	
not addressed	unsupported	

Here are some examples of how these are used:

- **Few researchers have addressed the problem** of…
- **There remains a need for** an efficient method that can…

• However, light scattering techniques have been **largely unsuccessful** to date.
• The high absorbance makes this **an impractical option** in cases where…
• **Unfortunately**, these methods do not always guarantee…
• **An alternative approach** is necessary.
• The function of these proteins **remains unclear**.
• These can be **time-consuming** and are oft en **technically difficult** to perform.
• **Although** this approach improves performance, it results in **an unacceptable** number of…
• Previous work has focused **only** on…
• However, the experimental configuration was **far from optimal**.

4. THE PRESENT WORK

(to) facilitate (to) illustrate (to) improve (to) manage to (to) minimize (to) offer (to) outline (to) predict (to) present (to) propose	(to) provide (to) reveal (to) succeed (this) work begin by/with close attention is paid to here overview	simple straightforward successful valuable aim goal intention objective purpose

Here are some examples of how these are used:

• **This paper focuses on**…
• **The purpose of this study is to describe and examine**…
• **In order to** investigate the biological significance…
• **In this paper we present**…
• New correlations were developed with **excellent** results…
• **In the present study** we performed…
• **This paper introduces** a scheme which solves these problems.
• **The approach we have used in this study** aims to…
• **This study** investigated the use of…
• **In this report** we test the hypothesis that…

• **This paper is organized as follows**:…

PART TWO

HOW TO WRITE AN ABSTRACT

The structure and content of the Abstract have changed in recent decades. The Internet has influenced the way that science research is communicated and the way that scientists access published research. Abstract databases allow scientists to search and scan the scientific literature and then decide which research articles they want to read in detail. Some readers simply want to know what is going on in their research area and may not be interested in the details; others may want to know details but are only interested in research articles which are directly relevant to their own research. However, if readers are going to actually read your research article, the Abstract now needs to persuade them to obtain a copy of it, not just encourage them to keep reading a paper they have already accessed.

Abstracts compete for attention in on-line databases. Many more people will read the title than the Abstract, and many more will read the Abstract than the whole paper. This means that however 'good' and well written the Abstract is, it needs to have independent validity. It should make sense as a standalone, self-contained description of the research article, and readers should be able to understand the key points and results of the research even if they never see the whole article. The Abstract, in this sense, is a representation of the research article.

Not every Abstract follows the same model, and the title of the Abstract reflects this. Some are called Summary, some are called Background, some are called Abstract and others have no title at all. Most Abstracts are results-focused and there are basic similarities in all Abstracts, but there are two quite distinct models. The first model is similar to a summary, and is very structured. It deals with all the main subsections of the research article and can even have subtitles such as Background / Method / Results / Conclusions. The second model is more common, and focuses primarily on one or two aspect of the study, usually — but not always — the method and the results. Both models will be discussed here. Note that the models for an Abstract described here are appropriate for articles, papers, theses *etc.*

Choosing a model will most likely depend on the Guide for Authors of the journal where you want to publish your research. The decision is normally determined by the journal rather than the author. If the choice is yours, then generally speaking, the more narrow and specified your research topic, the less likely you are to use the summary format.

This is because in a narrow research field, most readers already know the background. The word limit set by each journal also has a significant effect on the structure and therefore also on the content of the

Abstract.

So we'll be looking at these three questions:

- How to start the Abstract? What type of sentence to begin with?
- What type of information should be in the Abstract, and in what order?
- How to end this section?

Here are examples of the two models we mentioned earlier. Remember that Model 2 Abstracts are more common than Model 1. Start by reading the Abstract below, which is an example of a structured Abstract using the summary format (Model 1). The title of the paper is:

Physical properties of petroleum reservoir fluids derived from acoustic measurements.

Don't worry if you have difficulty understanding terms such as *bubble point.* Just try to get a general understanding at this stage and familiarize yourself with the structure.

MODEL 1

Abstract: *The speed of sound in a fluid is determined by, and therefore an indicator of, the thermodynamic properties of that fluid. The aim of this study was to investigate the use of an ultrasonic cell to determine crude oil properties, in particular oil density. An ultrasonic cell was constructed to measure the speed of sound and tested in a crude oil sample. The speed of sound was measured at temperatures between 260 and 411 K at pressures up to 75 MPs. The measurements were shown to lead to an accurate determination of the bubble point of the oil. This indicates that there is a possibility of obtaining fluid density from sound speed measurements and suggests that it is possible to measure sound absorption with an ultrasonic cell to determine oil viscosity.*

Now look at an example of the second, more common, type of Abstract. The title of this paper is:

Effect of polymer coatings on drug release.

MODEL 2

Abstract: *This study investigated the use of a novel water-soluble polymer blend as a coating to control drug release. It was found that using a blend of methylcellulose and a water-soluble copolymer significantly slowed the release rate of ibuprofen compounds in vitro and allowed for a more consistent release rate of 10–20% per hour.*

Grammar and Writing Skills

The use of VERB TENSE is very important in the Abstract. This section also deals with the

LENGTH and LANGUAGE of the Abstract.

Verb tense

Verb tense is especially important in the Abstract because the strict word limit means that you may need to omit phrases that tell the reader whose work you are referring to, or what you think about your results. In this case, careful and accurate use of verb tense is very important.

The **gap / problem** is normally in the Present Simple tense:
The main problem, however, is…
We examine why these models have difficulty with…
However, this assessment cannot be based solely on…
Although it is known theoretically that…

When you are referring to **what the paper itself does** or **what is actually in the paper itself**, use the Present Simple tense, for example:
This paper presents a new methodology for…
In this paper we apply…
We consider a novel system of…

When you are referring to your **methodology,** or what you did during the research period, it is common to use the Past Simple tense, for example:
Two catalysts were examined in order to…
Samples were prepared for electron microscopy using…
A crystallizer was constructed using…
The data obtained were evaluated using…

It is also possible to use the Present Simple tense to talk about your **methodology**, especially when you are referring to calculations or equations which can be found in the paper itself:
Numerical examples are analyzed in detail…
The calculated wavelengths are compared to…
Several models are created using…
The accuracy is evaluated by…

Results can be expressed in either the Present Simple tense, for example:
We find that oxygen reduction may occur up to 20 microns from the interface…
The ratio shift s towards…

We show that this theory also applies to…
We find that this does not vary…

Or, more commonly, in the Past Simple tense, for example:
The Y-type was found to produce…
The hydrocarbons showed a marked increase in…
No dilation was observed…
Organized fibers were found after 6 weeks…

But be aware that the sentence may use two different tenses. Even if the first part of the sentence is in the Past Simple tense (*We found/It was found etc.*), you can decide to put the finding/result itself or the implication of the result in the Present Simple tense if you believe it is strong enough to be considered as a fact or truth:

The experiments demonstrated there are two matrices…
It was found that proteins are produced from…
The results demonstrated that the morphology is different…
This image suggested that there is a direct relationship between…

It is worth noting that the Abstract tends to present the contents of the paper in fairly direct way, not only because of the word limits imposed by editors, but also to engage the attention of the reader. This influences the decision to use the Present Simple for the results or the implications, even though those implications may have been stated in the Past Simple in the article itself.

Achievements can be expressed in the Present Perfect tense, as in the Discussion/Conclusion:
This investigation has revealed that…
We have devised a strategy which allows…
We have demonstrated the feasibility of this approach by…
A novel material has been produced which…

and also in the Present Simple tense:
This process can successfully be combined with…
The framework described here is both simple and universal…
The value of our approach lies in…
This provides a powerful tool for…

Applications are normally stated in the Present Simple tense:
This process is suitable for the production of…
This framework can be used to evaluate…
This approach can be applied to…
This demonstrates potential for general applicability to…

Length

The Abstract usually has a strict word limit. Most are between 80–150 words and are written as a single paragraph. Even longer Abstracts (150–250 words) are usually written as a single paragraph. Don't submit an Abstract that is over the word limit or it may be cut by an editor in a way that does not represent your work appropriately. For your first draft, don't worry too much about the word limit. Once you have decided which of the two Abstract models you will use, start by including whatever you think is important, and then gradually remove words, phrases and even sentences that are not essential.

Language

Think of the search phrases and keywords that people looking for your work might use. Make sure that those exact words or phrases appear in your Abstract, so that they will turn up at the top of a search result listing. The Abstract is sometimes written in a slightly less technical way than the article itself in order to attract a wider audience. This may mean that some of your readers do not know a particular technical term or acronym that you want to include. To solve this problem, you can use the acronym, abbreviation or technical term in the Abstract but you should first say what it means or stands for. For example: *Granules of hydroxyapatite (HA) were implanted.*

Model Abstract

Study this Model Abstract:

MODEL 1

Physical properties of crude oil from acoustic measurements

Abstract

1 *The speed of sound in a fluid is determined by, and therefore an indicator of, the thermodynamic properties of that fluid.* **2** *The aim of this study was to investigate the use of an ultrasonic cell to determine crude oil properties, in particular oil density.* **3** *An ultrasonic cell was constructed to measure the speed of sound and tested in a crude oil sample.* **4** *The speed of sound was measured at temperatures between 260 and 411 K at pressures up to 75 MPs.* **5** *The measurements were shown to lead to an accurate determination of the bubble point of the oil.* **6** *This indicates that there is a possibility of obtaining fluid density from sound speed measurements and suggests that it is possible to measure sound absorption with an ultrasonic cell to*

determine oil viscosity.

In Sentence 1 '*The speed of sound in a fluid is determined by, and therefore an indicator of, the thermodynamic properties of that fluid.*' **the writer provides background factual information**.

The background information that is found at the start of this type of Abstract is usually derived from the first sentences of the Introduction. In this particular Abstract, the information provides a factual background. Other types of background may also be appropriate; for example, if your field of study is wastewater treatment or air pollution, then it may be useful to mention the political background.

In Sentence 2 '*The aim of this study was to investigate the use of an ultrasonic cell to determine crude oil properties, in particular oil density.*' **the writer combines the method, the general aim and the specific aim of the study in one sentence**.

Try to combine sentences in a way that shortens the total length of the Abstract. You can reduce the number of words by combining the background information and the aim, or what this paper does and what was found, so that the sentence serves more than one purpose. Sentences such as *In order to determine x we did y* combine the aim and the method in one sentence.

In Sentences 3 and 4 '*An ultrasonic cell was constructed to measure the speed of sound and tested in a crude oil sample.* **4** *The speed of sound was measured at temperatures between 260 and 411 K at pressures up to 75 MPs.*' **the writer summarizes the methodology and provides details**.

In Sentence 5 '*The measurements were shown to lead to an accurate determination of the bubble point of the oil.*' **the writer indicates the achievement of the study**.

One of the central functions of the Abstract is to emphasize new and important achievements of the study. Almost all Abstracts also include positive language at this point (*an accurate determination*) to demonstrate the value of the work.

In Sentence 6 '*This indicates that there is a possibility of obtaining fluid density from sound speed measurements and suggests that it is possible to measure sound absorption with an ultrasonic cell to determine oil viscosity.*' **the writer presents the implications of the study**.

Another important function of the Abstract is to show how the implications of the study contribute to knowledge and information in this area, and this can be derived from the aim of the study or the gap or problem the study addressed (*The aim of this study was to investigate the use of an ultrasonic cell to determine crude oil properties, in particular oil density*).

Many types of implications can be mentioned; for example, there may be implications for associated problems or for previous studies in the light of your findings.

MODEL 2

Effect of polymer coatings on drug release

Abstract

1 *This paper reports the use of a novel water-soluble polymer blend as a coating to control drug release.* **2** *It was found that using a blend of methylcellulose and a water-soluble copolymer significantly slowed the release rate of ibuprofen compounds in vitro and allowed for a more consistent release rate of 10–20% per hour.*

In Sentence 1 '*This paper reports the use of a novel water-soluble polymer blend as a coating to control drug release.*' **the writer combines what the paper does** (*This paper reports*), **the method or materials used** (*water-soluble polymer blend*), **the contribution (***novel***) and the aim of the study (***to control drug release*). This shows why it is not a good idea just to copy sentences from the research article itself. The word limit in the Abstract means that you may not have space to write one sentence describing the method you used and another stating the aim of your study; you need to find a way of combining such elements. Look at these combinations:

GAP / ACHIEVEMENT

In contrast to traditional approaches to water distribution planning based on cost, the model proposed here allows issues such as quality of supply to be considered.

ACHIEVEMENT / METHOD

A substantial increase in catalyst productivity was achieved by Nano filtration-coupled catalysis.

PROBLEM / METHOD

In order to select the optimum strategy in an environment with multiple objectives, a decision-aid tool for optimal life-cycle assessment was used.

In Sentence 2 '*It was found that using a blend of methylcellulose and a water-soluble copolymer significantly slowed the release rate of ibuprofen compounds in vitro and allowed for a more consistent release rate of 10–20% per hour.*' **the writer refers to the method in more detail and provides numerical details of the results**.

Even when an Abstract is short it must still do almost as much work as the paper, and it should still inform potential readers whether the article is suitable for their needs. The results are probably the most important component of this type of Abstract, and you should be specific and give details of key results.

Avoid vague words such as *small* or *better*. If you provide 'naked numbers' try and include quantitative language such as ***only** 38%* or ***as high as** 15%* so that the numbers cannot be misinterpreted. In this case, the writer does not simply refer to *a more consistent release rate*, the actual numerical result (*a more consistent release rate of **10-20% per hour***) is included. For the same reason, you should not use unclear terms such as *various methods were used* when you describe your methodology.

The more structured type, **Model 1**, typically includes the first four components in the box below in approximately the order presented; in this type of Abstract, each component tends to occur separately. These structured Abstracts occasionally include the fifth component, LIMITATIONS and/or FUTURE WORK.

Model 2 selects just two or three of the components and tends to combine components in a single sentence where possible.

The components generally include RESULTS and/or ACHIEVEMENTS and frequently METHODOLOGY, but this depends on the research area and the level of specificity. A wider research focus may require BACKGROUND or AIM in the Abstract. In Model 2, the order of components is very flexible — the only pattern that is generally followed is that METHODOLOGY tends to come before RESULTS.

1.	BACKGROUND AIM PROBLEM WHAT THE PAPER DOES
2.	METHODOLOGY / MATERIALS
3.	RESULTS ACHIEVEMENT / CONTRIBUTION IMPLICATIONS
4.	APPLICATIONS

5.	LIMITATIONS FUTURE WORK

Testing the models

The next step is to look at the way this model works in some real Abstracts. Here are two Abstracts from real research articles. Read them through, and mark the model components (1, 2, 3, 4 or 5) wherever you think you see them. For example, if you think the first sentence corresponds to number 1 in the model, write 1 next to it, *etc*.

Effects of H2O on structure of acid-catalyzed SiO2 sol-gel films

Abstract

Thin silica films were deposited on silicon wafers by the sol-gel technique, using spin coating. The sols were prepared by HCl catalysis of tetraethylorthosilicate (TEOS) diluted in ethanol, using different molar ratios, *R*, of H2O: TEOS. The films were then baked at various temperatures, and characterized using ellipsometry, profilometry, optical scattering and infrared spectroscopy. It was found that the thickness, shrinkage, porosity and pore sizes all decrease with increasing *R*. it was also found that high water levels yield films of higher homogeneity and finer texture, and less tensile stress.

Limitations of charge-transfer models for mixed-conducting oxygen electrodes

Abstract

A framework is presented for defining charge-transfer and noncharge-transfer processes in solid state electrochemical systems. We examine why charge-transfer models have difficulty modelling non-charge-transfer effects, and walk through several examples including the ALS model for oxygen reduction on a porous mixed-conducting oxygen electrode. These examples illustrate that electrode 'overpotential' is oft en better described in terms of macroscopic thermodynamic gradients of chemical species. In the case of a porous mixed conducting oxygen electrode, oxygen reduction is limited by chemical reaction and diffusion, and may occur up to 20 microns from the electrochemical (charge-transfer) interface.

Now do the same in your target articles.

Vocabulary

You already have most of the information you need to write this section of your paper because you

can find the words/phrases you need in the other units of this book. However, because the Abstract needs to be understood by a wider range of people than the article itself, the Abstract tends to use simpler, more conventional language where possible. We will therefore look at the most common vocabulary in each part of the model. The vocabulary lists in this section are taken from over 600 Abstracts in different fields, all of which were written by native speakers and published in science journals. In the next section we will look at typical vocabulary for all the areas of the model.

Vocabulary for the Abstract

BACKGROUND

a number of studies	it is known that
exist(s)	it is widely accepted that
frequently	occur(s)
generally	oft en
is a common technique	popular
is/are assumed to	produce(s)
is/are based on	recent research
is/are determined by	recent studies
is/are influenced by	recently
is/are related to	recently-developed
it has recently been shown that	

AIM

in order to	to examine
our approach	to investigate
the aim of this study	to study
to compare	with the aim of

PROBLEM

(an) alternative approach	impractical
a need for	inaccurate
although	inconvenient

complicated	it should be possible to
desirable	limited
difficulty	not able to
disadvantage	problem
drawback	require
essential	risk
expensive	time-consuming
however	unsuccessful

WHAT THE PAPER DOES

In this study/paper/investigation	This study/paper/investigation
we	
or	
We	
address	considers
analyze	describes
argue	examines
compare	extends
consider	includes
describe	presents
discuss	reports
emphasize	reviews
examine	
extend	
introduce	
present	
propose	
review	
show	

NOTE: It is also possible to use many of these verbs with *it* or, i.e. *In this paper **it** is shown/argued that…* or in the passive, i.e. *A framework **is presented**…*

METHODOLOGY/MATERIALS

was/were assembled	was/were modelled
was/were calculated	was/were performed
was/were constructed	was/were recorded
was/were evaluated	was/were studied
was/were formulated	was/were treated
was/were measured	was/were used

RESULTS

caused	was/were achieved
decreased	was/were found
had no effect	was/were identical
increased	was/were observed
it was noted/observed that…	was/were obtained
	was/were present
occurred	was/were unaffected (by)
produced	yielded
resulted in	
was identified	

ACHIEVEMENT / CONTRIBUTION

accurate	achieve
better	allow
consistent	demonstrate
effective	ensure
enhanced	guarantee
exact	obtain
improved	validate
new	
novel	
significant	compare well with
simple	for the first time
suitable	in good agreement

superior	

IMPLICATIONS

The evidence/These results…	it is thought that we conclude that we suggest that
indicate(s) that mean(s) that suggest(s) that	can may

APPLICATIONS

applicability can be applied can be used	make it possible to potential use relevant for/in

LIMITATIONS and FUTURE WORK

Limitations and future work are rarely mentioned in an Abstract and then only briefly.

a preliminary attempt not significant slightly	future directions future work

Writing an Abstract

Now you will bring together and use all the information in this unit. You will write an Abstract for your target article according to the model using the grammar and vocabulary you have learned, so make sure that you have both the model and the vocabulary in front of you. In this part you have seen the two models of Abstracts and the vocabulary conventionally used has been collected. Remember that when you write, your

sentence patterns should also be conventional, so use the sentence patterns of the Abstracts in this unit and in your target articles as models for the sentence patterns in your writing. You should try to have your own answer checked by a native speaker of English if possible, to make sure that you are using the vocabulary correctly.

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