



Pearson  
Edexcel

New  
innovations  
and support

See inside!

# International AS/A Levels

## Mathematics



SCAN ME

First teaching September 2018



# Choosing Pearson Edexcel as your school's International AS/A Level (IAL<sup>®</sup>) partner

Equipping your students to reach the world's best universities and compete for global employment opportunities will happen throughout their school life, but is even more key when it comes to choosing their International A Levels. We want to reassure you that with Pearson as your qualifications partner, you can be certain both you and your students are setting yourselves up for future success.

In this guide, you'll learn more about who we are, the recognition and progression our Pearson Edexcel international qualifications enjoy, and we'll take a closer look at International A Level Mathematics.

We wish you the best of success for your International Advanced Level journey!

IAS = International Advanced Subsidiary.  
IAL<sup>®</sup> = International Advanced Level.  
IAL is a registered trademark of Pearson Education Ltd in the UK and other countries.

Pearson Edexcel IAL<sup>®</sup> qualifications are available to students attending International Schools (outside the UK) and any students attending Online Schools. They are not available to schools in the UK, the Channel Islands, the Isle of Man or in British Armed Forces schools overseas.



## Inside this guide

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## Key International Advanced Level Mathematics highlights



### Modular approach

Learn about the popular modular approach to Pearson Edexcel International A Levels, which gives students the flexibility to sit examinations when they feel fully prepared and ready.

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**"It's been my dream to attend a world-renowned university. Pearson Edexcel IALs have given me a solid academic foundation for further studies."**

Fei Xue, studying Computer Science, University College London



# Welcome to Pearson

## We're pleased to meet you!

Pearson is the world's leading learning company. We provide world class qualifications, assessments, digital content and learning experiences to international schools all over the world to enable more effective teaching and learning and to help learners increase their skills and global employability prospects.

We partner with more than 6,500 schools, universities, and employers worldwide:

- **at school level**, to offer Pearson Edexcel International and UK qualifications to over 3.5 million students annually;
- **at university level**, to ensure Pearson Edexcel qualifications are recognised and accepted by universities all over the world;
- **and with employers**, by building 21st century skills into our qualifications at the outset, to ensure learners have transferable skills alongside the knowledge they need to progress into the careers of their choice.

## Our qualifications heritage stretches back over 150 years

Pearson's qualifications heritage stretches back over 150 years, our qualifications are offered in over 100 countries worldwide and we mark over 10 million exam scripts per year on behalf of the UK Department for Education.

Pearson Edexcel is regulated by Ofqual, ensuring our curricula meet the highest standards and our exams follow carefully controlled procedures at every stage of their development, delivery, marking and reporting.

As the largest exam board in the UK, Pearson Edexcel regularly achieves the highest marking accuracy of all UK boards.

## What this means for you

You can trust Pearson Edexcel International Advanced Level qualifications. Thousands of students around the world take these same qualifications every year, progressing from our popular International GCSEs and on to the world's most respected universities.

**"Cambridge Colleges welcome applications from those taking International A Levels... and these are recognised as equivalent to UK Board AS and A Levels."**

The University of Cambridge



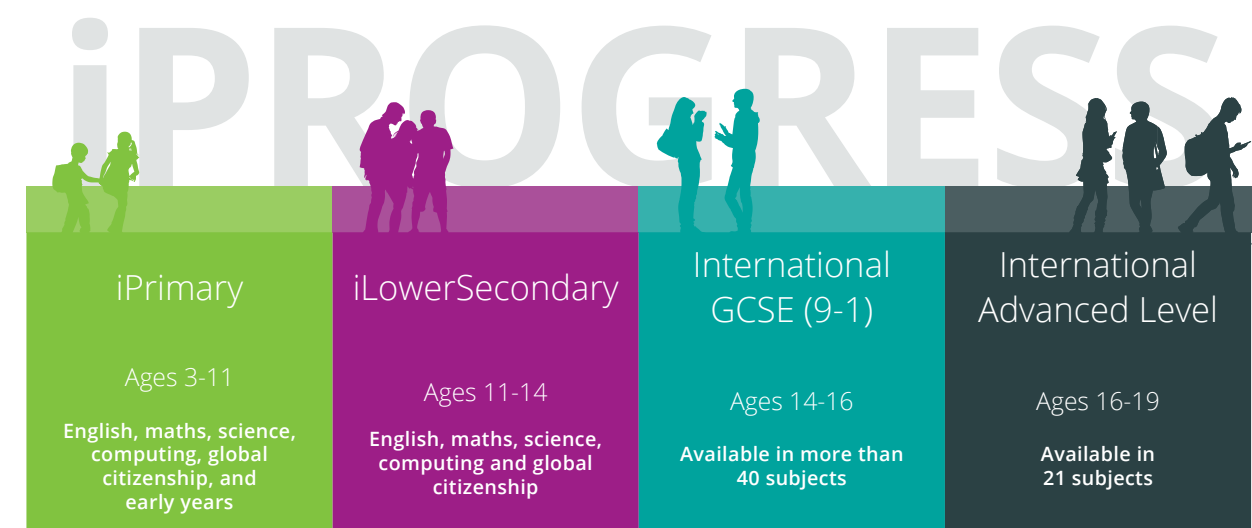
## Modern, progressive International A Level qualifications

### For globally minded learners aged 16 - 19

Renowned across the world for academic excellence, Pearson Edexcel International Advanced Levels provide learners with the skills and knowledge they need to progress onto the most prestigious universities across the world.

Pearson Edexcel International Advanced Levels are part of iProgress, our complete series of academic qualifications for 3 to 19 year-old learners at international schools following a UK curriculum.

At every stage, our iProgress continuum delivers a consistent learning journey with world class support, assessments and teaching and learning resources for students and teachers, everywhere in the world.





# Qualifications for globally minded learners

## Introducing Pearson Edexcel International AS/A Levels

Pearson Edexcel International AS/A Levels, also known as Advanced Subsidiary Level/Advanced Levels, have been developed in consultation with the international school community specifically for international learners.

They take the popular and flexible modular approach\* where exams are taken at the end of each unit of study, throughout the programme of study when a student feels prepared and ready, or all together at the end of the course. This flexibility, together with exam series in January, June and October, for most subjects, means that students have more opportunities to get feedback to improve their performance and get the grade they need to progress.

Available in 21 popular subjects, they offer progression from International GCSEs, and are comparable to the linear UK A Level, equipping students for progression to university and employment.

\*for all subjects except Law

## World class assessment design for international students

Pearson Edexcel qualifications go through a rigorous world class assessment design process, which ensures that the content is relevant for international learners, and that there is a clear and consistent relationship between command words, marks and skills. With logical progression of difficulty throughout and consistency in template and design, our question papers are clear and provide suitable challenge and support for students of all abilities.

**“I wanted to study subjects that were relevant to a future career. Pearson Edexcel iAL provides learners with a firm knowledge base.”**

Nasim Mirzajani, now studying Chemical Engineering at Yale University, USA



# Recognised worldwide for academic excellence

## Opening doors to the world's best universities

Pearson Edexcel sets the standard for worldwide recognised qualifications aligned to the British educational system. Accepted by over 650 higher education institutions across the world – including top universities such as Oxford, Cambridge, Columbia University and Yale University – and with 21st century skills embedded in the curriculum, you can be confident students will have qualifications, skills and knowledge that admissions teams and employers are looking for.

Read about some of our IAL learner journeys with Pearson Edexcel [here](#).

Learn more at [qualifications.pearson.com/progress-to-uni](https://qualifications.pearson.com/progress-to-uni)

	Pearson Edexcel GCE AS Level (UK AS Level)	Pearson Edexcel International AS Level (IAS)	Pearson Edexcel GCE A Level (UK A Level)	Pearson Edexcel International A Level (IAL®)
Structure	Linear (all exams taken at the end of a one year programme) Standalone qualification and no longer contributes to GCE A Level grades	Modular and flexible structure with all units examined Contributes 50% to the IAL grade or can be a standalone qualification	Linear (all exams taken at the end of a 2 year programme)	Modular and flexible structure with all units examined Typically studied over a 2 year period
Assessment	Mainly examination based* May/June examinations only	100% examination based Examinations in January, May/June and October	Mainly examination based* May/June examinations only	100% examination based Examinations in January, May/June and October
Grading	A – E		A* – E	
Regulator	Regulated by Ofqual	Regulated by Pearson and confirmed by UK ENIC to be comparable to UK AS standard	Regulated by Ofqual	Regulated by Pearson and confirmed by UK ENIC to be comparable to UK A Level standard

\*Other types of assessment used only where needed to test essential skills.



# Pearson Edexcel International A Level Mathematics qualifications

## Clear, flexible qualifications

### Flexibility

Unitised structure with all units equally weighted, allowing many different combinations of units and greater flexibility. Three exam series per year means students can sit unit exams when they are ready and can retake individual units. Unit results are valid for the lifetime of the qualification. A student could take their first unit in the Autumn term of year 12 and it is still valid to cash in when they finish their IAL in the summer of year 13.

### Broad and deep development of learners' skills

Pearson Edexcel Mathematics qualifications enable students to develop the ability to reason logically, to generalise, construct mathematical proofs, and apply math to real-world situations. They will also gain an understanding of coherence and progression in mathematics and of how different areas of mathematics can be connected.

These skills will help students to use maths to communicate effectively, to apply techniques in more difficult, unstructured problems, understand mathematical arguments, use technology and be aware of its limitations, and take increasing responsibility for their own learning.

### Consistent syllabus

Our Mathematics qualifications are thoroughly researched from the outset to remove the need to make mid-life revisions to either the content or the assessment.

## Clear and straightforward question papers

Our question papers are clear and accessible for students of all ability ranges. The careful ramping of the difficulty of questions in papers is designed to settle students down and helps them to work to the best of their ability. Our mark schemes are straightforward so that the assessment requirements are clear.

### Progression from International GCSE

Pearson Edexcel International A Level is the next step in the iProgress learning journey after International GCSE, continuing a consistent path for students and teachers, everywhere in the world.

### Progression of topics

There is a clear progression of topics across the Pure and Applied units.

### Progression to further study or employment

International Advanced Level qualifications enable successful progression to higher education courses in mathematics and many other subjects, and onto employment. Through our world-class qualification development process we have consulted with higher education stakeholders to validate the appropriateness of these qualifications, including content, skills and assessment structure.

### Accessible grade boundaries

Accessible grade boundaries ensure students have a positive exam experience at all grades.

### Graphical calculators

Graphical calculators are allowed in all exams, allowing students to focus on problem-solving rather than crunching the numbers.

## Unique to Pearson Edexcel IAL Mathematics qualifications

We are the only board that:

- offers dedicated IAS and IAL Pure Mathematics qualifications.
- enables students to specialise purely in Mechanics or Statistics, for IAS and IAL.
- allows students to take extra applied units to deepen their knowledge. The best applied units count towards their final grades.
- allows students to study the Decision Mathematics Unit to enable progress for Computer Science Degrees.
- has equally weighted and equal length papers to help students prepare for a consistent exam experience.
- has two separate Pure units at both IAS and IAL level. This allows students to enter for the first Pure unit as soon as they are ready, giving them an earlier indication of their progress and allowing earlier intervention for students who are struggling.
- allows applied units to be moved, at final cash in, between Mathematics and Further Mathematics to optimise final grades.





# Mathematics: a closer look

## IAS results contribute to IAL grade

With three different awards available, Mathematics, Further Mathematics and Pure Mathematics, the qualification is designed to be studied over two years, with the option of a one-year AS level course. Results of the IAS qualification can contribute to the overall IAL grade.

Students study a variety of units, following pathways to their desired qualification.

### Key qualification features

- Unitised structure with 14 equally weighted units. Each examination is timed at 1h 30m and has 75 marks available.
- Flexibility to combine units across Pure Mathematics, Further Pure Mathematics, Mechanics, Statistics and Decision Mathematics. There are 5 routes to combine units to achieve an International A Level Mathematics qualification, with additional routes for Further or Pure Mathematics.
- Three exam series per year means students can sit unit exams when they are ready.
- The IAS Level consists of 3 units. Results contribute to the IAL, which consists of 6 units.
- Scientific or graphical calculators may be used in the examinations.

100%  
externally  
assessed

# Qualification structure

## Pearson Edexcel International Advanced Subsidiary

The International Advanced Subsidiary in Mathematics, Further Mathematics and Pure Mathematics qualifications each consist of three externally-examined units:

Qualification	Compulsory units	Optional units
International Advanced Subsidiary in Mathematics	P1, P2	M1, S1, D1
International Advanced Subsidiary in Further Mathematics	FP1	FP2, FP3, M1, M2, M3, S1, S2, S3, D1
International Advanced Subsidiary in Pure Mathematics	P1, P2, FP1	

## Pearson Edexcel International Advanced Level

The International Advanced Level in Mathematics, Further Mathematics and Pure Mathematics qualifications each consist of six externally-examined units:

Qualification	Compulsory units	Optional units
International Advanced Level in Mathematics	P1, P2, P3, P4	M1 and S1 or M1 and D1 or M1 and M2 or S1 and D1 or S1 and S2
International Advanced Level in Further Mathematics	FP1 and either FP2 or FP3	FP2, FP3, M1, M2, M3, S1, S2, S3, D1
International Advanced Level in Pure Mathematics	P1, P2, P3, P4, FP1	FP2 or FP3

The certification of each qualification requires **different** contributing units. For example, students who are awarded certificates in both International Advanced Level Mathematics and International Advanced Level Further Mathematics must use unit results from 12 **different** units, i.e. once a unit result has been used to cash in for a qualification, it cannot be re-used to cash in for another qualification.

For further information and to download the specification, visit [qualifications.pearson.com/ialinfotech2018](https://qualifications.pearson.com/ialinfotech2018)



# Modular assessment

## Why is the modular approach so popular?

The modular assessment structure offers students the flexibility to sit examinations when they feel fully prepared and ready. Once they have sat a unit exam and received a unit grade, that result is banked until they have completed all units. Students then 'cash-in' the completed unit exam results to receive an overall qualification grade.

The structure of Pearson Edexcel IAL qualifications allows teachers to construct a course of study that can be taught and assessed as either distinct modular units or a linear course assessed in its entirety at the end.



## How the modular approach works

### Bank robust and ongoing evidence of performance

This 'building blocks' approach means that students can 'bank' their unit exam results throughout their period of study. This provides robust evidence of their studies and performance, providing more options to obtain the grade they need to progress.

### Multiple exam opportunities throughout the year

Students can take and re-sit individual unit assessments in any series, with examination opportunities in January, June and October in most subjects. This means students have more opportunities to get feedback to improve their performance and get the grades they need to progress.

### Students 'cash in' unit results when ready

Once a student has all their unit results for the qualification they are taking, they exchange those for a grade – this is called 'cashing in'. To cash in, all units must have been entered. International AS qualifications can be taken as a separate, standalone qualification, as well as contributing to an Advanced Level qualification.

## The benefits of a modular route

A modular approach allows students to take their exams when they feel ready and prepared. They benefit from more exam practice and familiarity. Unit exam results provide formal feedback earlier on in their studies, so students understand the standard required to reach the final level of achievement they are aiming for. This understanding motivates them to improve and builds a sense of ownership through bite-size, short-term goals.

The modular approach can help reduce the mental load and stress at exam time by allowing learners to focus on one year of curriculum content at a time and spread out their high stakes exams over two years and multiple exam series. Learners can also take advantage of multiple re-sit opportunities if needed.

A modular route provides teachers with rich mid-cycle data on learner performance. It offers international schools greater flexibility for exam administration across the school year. And where parents pay exam fees, it helps with budgeting by enabling families to spread their child's exam fees over two years.

Whilst the modular approach works well for students who want to spread the exam load and bank their performance throughout their studies, doing the exam all in one go at the end of the period of study suits others better.

This approach means assessments for all units are taken together in one exam series so students study all the content and then prepare for all the assessments at the end of their period of study, rather than a more continuous pattern of study and assessment.



## What this means for you

Pearson Edexcel were the first awarding organisation to introduce the modular International AS/A Levels, so can offer a wealth of experience and support for international schools. The modular approach is so popular with schools, teachers, parents, and students, that we now offer a modular approach for International GCSE which is great preparation for Pearson Edexcel International AS/A Level.

**"I like the modular nature of IAL, the fact that I can choose whichever core units I want to do, whichever applied units I want to do. It's very comprehensive. It opens up many doors to many international universities."**

Wang, Pearson Edexcel International Advanced Level student from Sri Lanka, studying Chemistry, Biology, Physics, and Mathematics.



# Building transferable skills

## The most in demand skills are human skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

In fact, universities and employers consider transferable skills – otherwise known as Core Competencies, or 21st century skills – to be the largest skills gap overall.



## Supporting the development of transferable skills in your school

If you follow Pearson Edexcel IAL specifications, or your students are using our IAL textbooks, you've already started integrating transferable skills into your teaching.

That's because our qualifications and resources are mapped to the National Research Council's framework for 21st century skills, which includes cognitive, intrapersonal and interpersonal skills. They are embedded and signposted in the specifications and schemes of work, with accompanying skills mapping and transferable skills definitions for every subject.

Transferable skills are also developed as part of activities in the Student Books. These are clearly labelled, so you and your learners can easily identify the skills they are building.

We help you instil and embed these skills, supporting children to grow into resilient, curious and globally connected young adults.

**No.1**

**9/10**  
of the most in-demand skills are human skills<sup>3</sup>

The highest priority for skills training is analytical thinking, followed by creative thinking<sup>2</sup>

**87%** of companies say they have skill gaps, or expect to within a few years<sup>1</sup>

# Supporting you at every stage

We provide an unparalleled level of support services, tools, resources and training alongside our qualifications, making teachers and students lives easier at every stage.

## At a glance: support for you at every stage

FREE resources and support	Planning, teaching & learning	Exam preparation and assessment	Results support
Getting started guide	✓		
Training events (face-to-face, online & downloadable content)	✓		
Subject advisor support	✓	✓	✓
Community forums	✓	✓	✓
Schemes of work	✓		
Sample assessment materials	✓	✓	
Examiner reports		✓	✓
Exemplar marked responses		✓	
Past papers		✓	
examWizard		✓	
Mark schemes		✓	
ResultsPlus mock exam analysis		✓	
ResultsPlus		✓	✓
FREE access to Scripts service (ATS)			✓

Additional paid for resources			
Printed Student Books and digital ActiveBooks	✓	✓	
Online Teacher Resource Packs	✓	✓	

<sup>1</sup> McKinsey & Company (2020) Available from: [www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/beyond-hiring-how-companies-are-reskilling-to-address-talent-gaps](http://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/beyond-hiring-how-companies-are-reskilling-to-address-talent-gaps)

<sup>2</sup> World Economic Forum (2023) Future of Jobs Report [online]. Available from: [www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs\\_2023.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf)

<sup>3</sup> Pearson (2022) Pearson Skills Outlook: Power Skills [online]. Available from: [plc.pearson.com/en-GB/news-and-insights/pearson-skills-outlook-powerskills](http://plc.pearson.com/en-GB/news-and-insights/pearson-skills-outlook-powerskills)





## Pre and post exam support for your educators

### Supporting you every step of the way - for free

As a Pearson Edexcel centre, you will have free access to a full range of integrated support services, tools and resources to support the delivery of your International A Levels. Unlike some awarding bodies, with Pearson Edexcel there are no additional costs for the following support:

- Easy, all year-round access to our specifications, sample assessment materials and teaching resources.
- **Teacher training** in-person and online including “Welcome to Pearson” sessions to help your educators make the most of our qualifications.
- **Expert subject advisors** on hand to help with any subject-specific queries you may have and available to support your educators throughout the year.
- **examWizard**: a huge bank of past papers and mark schemes to create topic tests and revision activities in minutes.
- **ResultsPlus**: our popular online results analysis tool, which also includes an insightful group analysis service.
- **Access to Scripts**: our service that allows you to view your candidates’ marked exam papers for free online or as downloaded PDFs, providing a rich source of information to inform future teaching plans and approaches.
- Plus, local, experienced Pearson Regional Development Managers who are there to support you every step of the way.

### Additional paid for support options

#### Professional development

Enhanced training combining the qualification framework, support and feedback mechanisms with teaching and learning strategies, is available.

#### Mocks Service

We provide exam papers for your students to sit in mock examinations. Marked by Pearson examiners, results are uploaded to ResultsPlus for item level analysis.

### Your free subject support

**Our subject advisors** provide fast, reliable, expert help and aim to answer all emailed questions within 48 hours and resolve 90% of issues phoned in on the first call.

Email  
**teachingmaths@pearson.com**  
or call **+44 (0) 344 463 2535**

### A valued support partner

“One of the good features of ResultsPlus is that it provides the top ten questions that students scored poorly in, so we as the lecturers can actually identify the topics that students found difficult and can incorporate a different approach when teaching our current students.”

Dr Khong Yoke Kum, A Levels Department, HELP Academy, Malaysia

“Because of ResultsPlus, students can learn about their mistakes and rectify.”

Kanagambigai, Chief Counsellor, A levels Department, HELP Academy, Malaysia commenting on the ResultsPlus mocks service.

“I used the website with its course outlines, past papers, summaries of key points, revision notes and mark schemes... they provide great tips about possible exam questions and how you could answer them.”

Alexia Kattavenos, student, The Nicosia Grammar School, Cyprus



### What this means for you

We will support you to deliver an outstanding teaching and learning experience for every student taking Pearson Edexcel International A Levels.

With examWizard, they will be able to prepare topic tests and revision activities based on past exam questions to help prepare students for their final assessments, and using ResultsPlus, they will be able to analyse their mock results to pinpoint where they may need further support and can then tailor their teaching to support them.

Post-exams, our Access to Scripts service will allow your educators to review students’ exam papers for free, providing greater visibility and a deeper understanding of individual students’ exam performance and helping them identify skills gaps to tailor teaching plans for future cohorts.



# A wide range of teaching and learning resources

## Written specifically to support our qualifications

Developed for Mathematics, Further Mathematics and Pure Mathematics, these published resources have a strong focus on progression, recognition and transferable skills. Appropriate international content puts learning in a real-world context, making it engaging and relevant for all learners.

### Student Books

- 14 books – one for each unit of the Pearson Edexcel International A Level 2018 specification.
- Each Student Book includes 2-year access to an online ActiveBook (a digital version of the Student Book).
- Packed with hints and worked examples to help preparation for examinations.
- Lots of practice of exam-style questions and each book contains a complete practice exam paper.

### Online Teacher Resource Pack

- 14 Online Teacher Resource Packs available – to accompany each Student Book.
- Available as an annual subscription.
- Range of planning, teaching and assessment resources, helping to save you time.

Title	ISBN
<b>PURE MATHEMATICS</b>	
Pearson Edexcel International A Level Mathematics Pure 1 Student Book	978 1 292244 79 2
Pearson Edexcel International A Level Mathematics Pure 1 Teacher Resource Pack	978 1 292244 83 9
Pearson Edexcel International A Level Mathematics Pure 2 Student Book	978 1 292244 85 3
Pearson Edexcel International A Level Mathematics Pure 2 Teacher Resource Pack	978 1 292244 90 7
Pearson Edexcel International A Level Mathematics Pure 3 Student Book	978 1 292244 92 1
Pearson Edexcel International A Level Mathematics Pure 3 Teacher Resource Pack	978 1 292244 93 8
Pearson Edexcel International A Level Mathematics Pure 4 Student Book	978 1 292245 12 6
Pearson Edexcel International A Level Mathematics Pure 4 Teacher Resource Pack	978 1 292245 13 3

Title	ISBN
<b>FURTHER PURE MATHEMATICS</b>	
Pearson Edexcel International A Level Mathematics Further Pure 1 Student Book	978 1 292244 64 8
Pearson Edexcel International A Level Mathematics Further Pure 1 Teacher Resource Pack	978 1 292244 58 7
Pearson Edexcel International A Level Mathematics Further Pure 2 Student Book	978 1 292244 65 5
Pearson Edexcel International A Level Mathematics Further Pure 2 Teacher Resource Pack	978 1 292244 62 4
Pearson Edexcel International A Level Mathematics Further Pure 3 Student Book	978 1 292244 66 2
Pearson Edexcel International A Level Mathematics Further Pure 3 Teacher Resource Pack	978 1 292244 63 1

Title	ISBN
<b>DECISION MATHEMATICS</b>	
Pearson Edexcel International A Level Mathematics Decision 1 Student Book	978 1 292244 56 3
Pearson Edexcel International A Level Mathematics Decision 1 Teacher Resource Pack	978 1 292244 57 0

Title	ISBN
<b>MECHANICS</b>	
Pearson Edexcel International A Level Mathematics Mechanics 1 Student Book	978 1 292244 67 9
Pearson Edexcel International A Level Mathematics Mechanics 1 Teacher Resource Pack	978 1 292244 68 6
Pearson Edexcel International A Level Mathematics Mechanics 2 Student Book	978 1 292244 76 1
Pearson Edexcel International A Level Mathematics Mechanics 2 Teacher Resource Pack	978 1 292244 78 5
Pearson Edexcel International A Level Mathematics Mechanics 3 Student Book	978 1 292244 81 5
Pearson Edexcel International A Level Mathematics Mechanics 3 Teacher Resource Pack	978 1 292244 82 2

Title	ISBN
<b>STATISTICS</b>	
Pearson Edexcel International A Level Mathematics Statistics 1 Student Book	978 1 292245 14 0
Pearson Edexcel International A Level Mathematics Statistics 1 Teacher Resource Pack	978 1 292245 15 7
Pearson Edexcel International A Level Mathematics Statistics 2 Student Book	978 1 292245 17 1
Pearson Edexcel International A Level Mathematics Statistics 2 Teacher Resource Pack	978 1 292245 16 4
Pearson Edexcel International A Level Mathematics Statistics 3 Student Book	978 1 292245 18 8
Pearson Edexcel International A Level Mathematics Statistics 3 Teacher Resource Pack	978 1 292245 19 5

## Student Books

**Exam practice** provides opportunities to assess understanding and progress, so students can achieve their potential.

**ALGEBRAIC METHODS CHAPTER 1**

**18** A circle has equation  $(x-1)^2 + y^2 = k$ , where  $k > 0$ . The straight line  $L$  with equation  $y = ax$  cuts the circle at two distinct points. Prove that  $k > \frac{a^2}{1+a^2}$ . (6 marks)

**19** Prove that the line  $4y - 3x + 26 = 0$  is a **tangent** to the circle  $(x+4)^2 + (y-3)^2 = 100$ . (5 marks)

**20** The diagram shows a square and four congruent right-angled triangles. Use the diagram to prove that  $a^2 + b^2 = c^2$ .

**Challenge**  
1 Prove that  $A(7, 8)$ ,  $B(-1, 8)$ ,  $C(6, 1)$  and  $D(0, 9)$  are points on the same circle.  
2 Prove that any odd number can be written as the **difference** of two squares.

**1.6 Methods of proof**  
A mathematical statement can be proved by **exhaustion**. For example, you can prove that the sum of two **consecutive** square numbers between 100 and 200 is an odd number. The square numbers between 100 and 200 are 121, 144, 169, 196.  
 $121 + 144 = 265$  which is odd    $144 + 169 = 313$  which is odd    $169 + 196 = 365$  which is odd  
So the sum of two consecutive square numbers between 100 and 200 is an odd number.  
You can prove a mathematical statement is true by exhaustion. This means breaking the statement into smaller cases and proving each case separately.  
This method is better suited to a small number of results. You cannot use one example to prove a statement is true, as one example is only one case.

**Example 15**  
Prove that all square numbers are either a multiple of 4 or 1 more than a multiple of 4.  
For odd numbers:  
 $(2n+1)^2 = 4n^2 + 4n + 1 = 4n(n+1) + 1$   
 $4n(n+1)$  is a multiple of 4, so  $4n(n+1) + 1$  is 1 more than a multiple of 4.  
Consider the two cases, odd and even numbers, separately.  
You can write any odd number in the form  $2n+1$  where  $n$  is a positive integer.

Worked examples show how to work through questions, and how to lay out calculations.

The embedded **transferable skills** - needed for progression to higher education and employment - are signposted so students understand what skills they are developing and therefore go on to use these skills more effectively in the future.

Each Student Book comes with 2-year access to an ActiveBook, a **digital version of the Student Book**, which can be accessed online, anytime, anywhere, supporting learning beyond the classroom.



Reviewed by a language specialist to ensure the book is **clear and accessible**.

**ALGEBRAIC METHODS CHAPTER 1**

**9** The expression  $2x^3 - x^2 + ax + b$  gives a remainder of 14 when divided by  $(x-2)$  and a remainder of  $-86$  when divided by  $(x+3)$ . Find the value of  $a$  and the value of  $b$ . (5 marks)

**10** The expression  $3x^3 + 2x^2 - px + q$  is divisible by  $(x-1)$  but leaves a remainder of 10 when divided by  $(x+1)$ . Find the value of  $a$  and the value of  $b$ . (5 marks)

**1.5 Mathematical proof**  
A **proof** is a logical and **structured** argument to show that a mathematical statement (or **conjecture**) is always true. A mathematical proof usually starts with previously **established** mathematical facts (or **theorems**) and then works through a series of logical steps. The final step in a proof is a **statement** of what has been proven.  
**Notation** A statement that has been proven is called a **theorem**. A statement that has yet to be proven is called a **conjecture**.

Known facts or theorems → Clearly shown logical steps → Statement of proof

A mathematical proof needs to show that something is true in every case.  
You can prove a mathematical statement is true by **deduction**. This means starting from known facts or definitions, then using logical steps to reach the **desired** conclusion.  
Here is an example of proof by deduction:  
**Statement:** The product of two **odd numbers** is odd.  
**Demonstration:**  $5 \times 7 = 35$ , which is odd. This is demonstration but it is not a proof. You have only shown one case.  
**Proof:**  $p$  and  $q$  are **integers**, so  $2p+1$  and  $2q+1$  are odd numbers. You can use  $2p+1$  and  $2q+1$  to represent any odd numbers. If you can show that  $(2p+1)(2q+1)$  is always an odd number then you have proved the statement for all cases.  
 $(2p+1)(2q+1) = 4pq + 2p + 2q + 1 = 2(2pq + p + q) + 1$   
Since  $p$  and  $q$  are integers,  $2pq + p + q$  is also an integer.  
So  $2(2pq + p + q) + 1$  is one more than an **even number**.  
So the product of two odd numbers is an odd number. This is the statement of proof.

- In a mathematical proof you must
  - State any information or assumptions you are using
  - Show every step of your proof clearly
  - Make sure that every step follows logically from the previous step
  - Make sure you have covered all possible cases
  - Write a statement of proof at the end of your working





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