Pearson Edexcel

International A Level Science

International A Level Physics

Getting Ready to Teach

Pearson Edexcel

Aims and objectives

In this training, you will:

- identify how the qualification is devised
- review the content of the qualification
- explore how to plan the course and/or lessons
- understand the Assessment Objectives for the qualification
- understand the question types for the qualification
- understand the mark schemes for the qualification
- practise using the mark schemes using exemplar student work
- identify the support available from Pearson.

Welcome to Pearson

Welcome to Pearson Edexcel

- We are the world's leading learning company and as the UK's largest awarding organisation, best placed to provide qualifications aligned to the British educational system.
- Our international heritage stretches back over 150 years.
- Today, we partner with schools, universities and employers worldwide, offering world-class, globally-recognised qualifications to over 3.5 million students a year.

Pearson Edexcel

Trusted and recognized qualifications partner to 6,500 schools, colleges and employers globally

We mark over 10 million exam scripts on behalf of the UK Department for Education each year

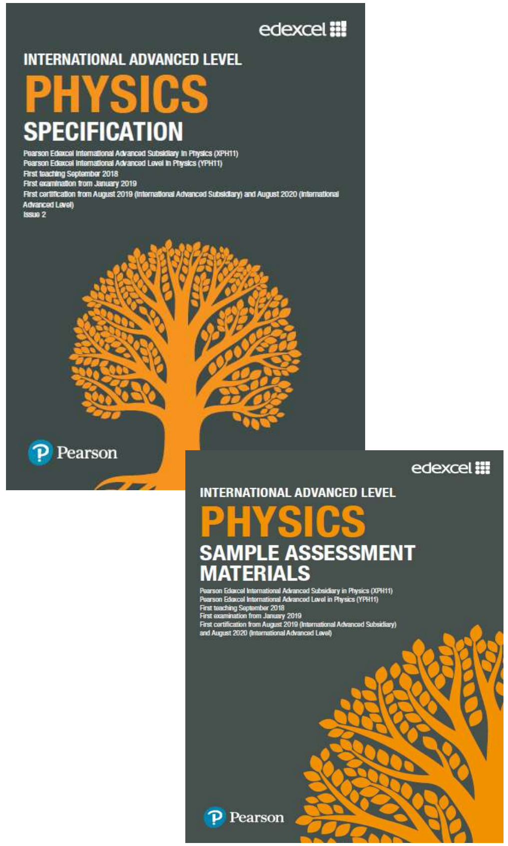
We operate in 70 countries worldwide

Specification Overview

What is the specification?

- The specification is the main document you need to teach the course.
- It outlines the aims of the course, the content you MUST cover and all the information you need about assessing your students.
- A copy of this document is in your download pack and on our website.

  - There are also Sample Assessment Materials. This document provides examples of the question papers and was especially useful when this specification was launched. Since there are now at least two series of live exam papers, it is arguable that the real papers have become a more important resource than the SAMs.



Key features

Structure: the International Advanced Subsidiary and Advanced Level in Physics are modular qualifications.

Content: the content is relevant for learners who have achieved a GCSE or IGCSE in Physics and who want to study this subject at a higher level.

Assessment: assessment consists of three written papers at IAS level that are externally assessed. The International A Level consists of three further written papers that are externally assessed.

Approach: learners will develop their knowledge and understanding of Physics by applying the concepts in this specification to a range of different problems that include a variety of contexts. Problems will require the application of mathematical skills. Learners will also develop their practical skills.

Using this specification

Compulsory content: as a minimum, all the items in the content must be taught. The word 'including' in content specifies the detail of what must be covered.

Assessments: use a range of material and are not limited to the examples given. Teachers should deliver these qualifications using a good range of examples to support the assessment of the content.

Depth and breadth of content: teachers should use the full range of content and all the assessment objectives given in the subject content section.

Practical investigation

Practical investigation

Students will be assessed on their ability to:

23	be able to use the equation density $\rho = \frac{m}{V}$
24	understand how to use the relationship upthrust = weight of fluid displaced
25	a be able to use the equation for viscous drag (Stokes' Law), $F = 6\pi\eta rv$. b understand that this equation applies only to small spherical objects moving at low speeds with *laminar flow* (or in the absence of *turbulent flow*) and that viscosity is temperature dependent
26	**CORE PRACTICAL 2: Use a falling-ball method to determine the viscosity of a liquid**
27	be able to use the Hooke's law equation, $\Delta F = k\Delta x$, where k is the stiffness of the object
28	understand how to use the relationships • *(tensile or compressive) stress = force/cross-sectional area* • *(tensile or compressive) strain= change in length/original length* *Young modulus = stress/strain.*
29	a be able to draw and interpret force-extension and force-compression graphs b understand the terms limit of proportionality, elastic limit, yield point, elastic deformation and plastic deformation and be able to apply them to these graphs
30	be able to draw and interpret tensile or compressive stress-strain graphs, and understand the term *breaking stress*
31	**CORE PRACTICAL 3: Determine the Young modulus of a material**
32	be able to calculate the elastic strain energy E_{el} in a deformed material sample, using the equation $\Delta E_{el} = \frac{1}{2}F\Delta x$, and from the area under the force-extension graph *The estimation of area and hence energy change for both linear and non-linear force-extension graphs is expected.*

Overview of the Physics specification

International Advanced Subsidiary	International Advanced Level
This qualification consists of three externally examined units. The IAS is the first half of the IAL qualification and consists of three IAS units, Units 1, 2 and 3. This qualification can be awarded as a discrete qualification or can contribute 50 per cent towards the International A Level. The qualification will include questions that target mathematics at Level 2 or above. Overall, a minimum of 40% of the marks across the papers will be awarded for mathematics at Level 2 or above.	This qualification consists of six externally examined units. The International A Level consists of the three IAS units (Units 1, 2 and 3) plus three IA2 units (Units 4, 5 and 6). Students wishing to take the International A Level must, therefore, complete all six units. The qualification will include questions that target mathematics at Level 2 or above. Overall, a minimum of 40% of the marks across the papers will be awarded for mathematics at Level 2 or above.

Unit 1: Mechanics and Materials	Unit 2: Waves and Electricity	Unit 3: Practical Skills in Physics I
Externally assessed Written exam: 1 h 30 min 80 marks 40% of IAS 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1 h 30 min 80 marks 40% of IAS 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1 h 20 min 50 marks 20% of IAS 10% of IAL This unit will assess students' knowledge and understanding of experimental procedures and techniques developed in Units 1 and 2. The paper may include short-open, open-response, calculations and extended-writing questions.

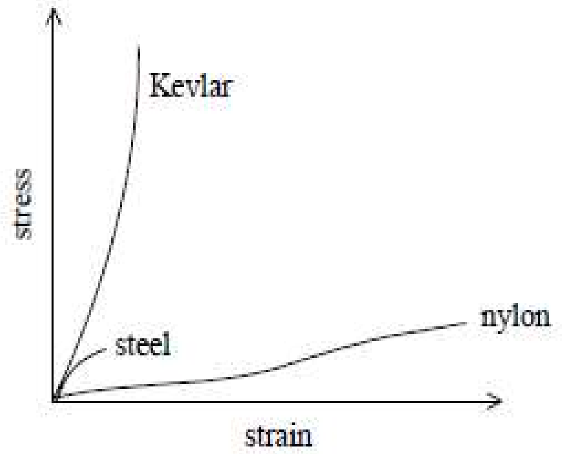
Unit 4: Further Mechanics, Fields and Particles	Unit 5: Thermodynamics, Radiation, Oscillations and Cosmology	Unit 6: Practical Skills in Physics II
Externally assessed Written exam: 1 h 45 min 90 marks 40% of IA2 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1 h 45 min 90 marks 40% of IA2 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1 h 20 min 50 marks 20% of IA2 10% of IAL This unit will assess students' knowledge and understanding of experimental procedures and techniques developed in Units 4 and 5. The paper may include short-open, open-response, calculations and extended-writing questions.

Activity

This is part of a question – what part of the content (which specification point) is being assessed?

Kevlar is a modern lightweight material. Due to its physical properties, Kevlar is being used to replace nylon and steel in many applications.

The stress-strain graphs for Kevlar, nylon and steel are shown.



(a) When pulling a heavy load, Kevlar cables are now often used instead of nylon cables.

Explain two advantages of using Kevlar in cables compared to using nylon.

Unit 1: Mechanics and Materials	Unit 2: Waves and Electricity	Unit 3: Practical Skills in Physics I
• Mechanics • Materials	• Waves and Particle Nature of Light • Electric Circuits	Students are expected to develop experimental skills, and techniques by carrying out a range of practical experiments in Units 1 and 2.
Unit 4: Further Mechanics, Fields and Particles	**Unit 5: Thermodynamics, Radiation, Oscillations and Cosmology**	**Unit 6: Practical Skills in Physics II**
• Further Mechanics • Electric and Magnetic Fields • Nuclear and Particle Physics	• Thermodynamics • Nuclear Decay • Oscillations • Astrophysics and Cosmology	Students are expected to further develop the skills and techniques acquired in Units 1 and 2 by carrying out a range of practical experiments in Units 4 and 5.

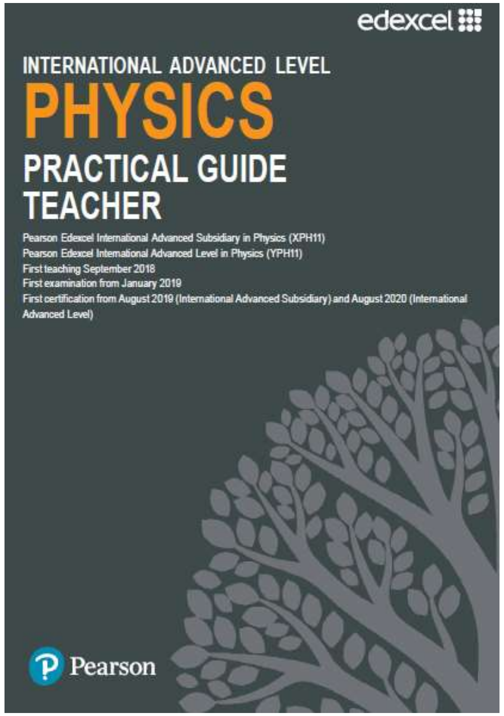
Choose one topic (or part of a topic) from the Physics specification. Plan the order in which you would teach that topic.

Share your preferred teaching order, with your reasoning.

Experimental skills

In order to prepare students for the assessment of experimental skills (Units 3 and 6), centres should give students opportunities to plan experiments, implement their plans, collect data, analyse their data and draw conclusions.

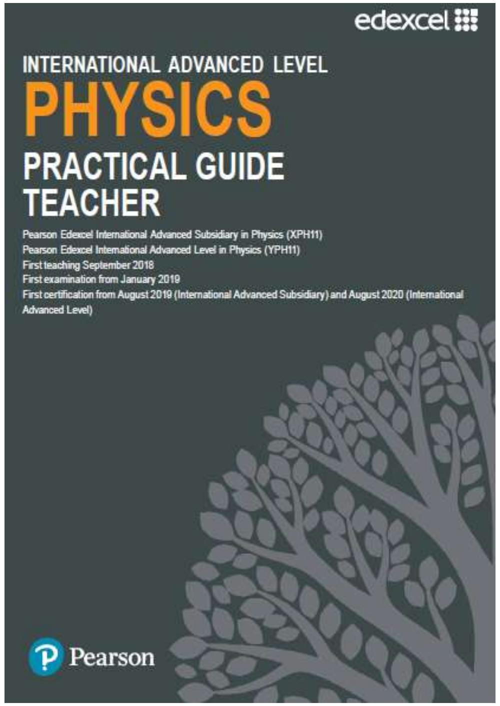
Experiments should cover a range of different topic areas and require the use of a variety of practical techniques.



How do the core practicals cover practical skills?

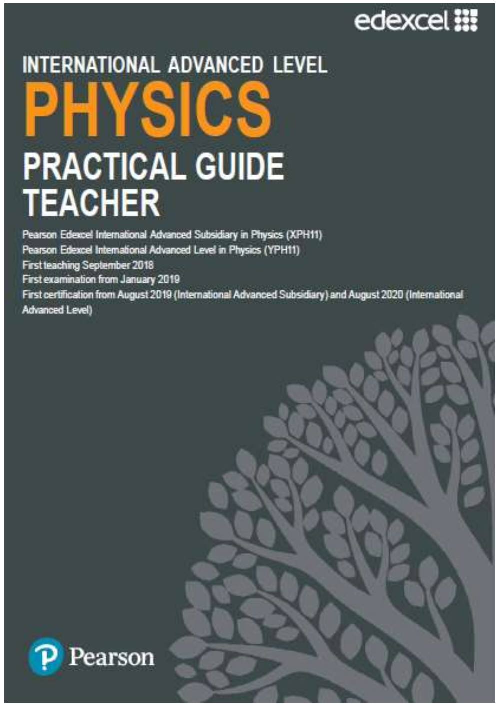
- As long as you follow the programme of core practicals, you will automatically cover all of the standard techniques and apparatus the students are expected to know and reproduce in their examinations.

- However, students who do well in Units 3 and 6 are often those that have carried out a range of practicals so you should aim to complete *more* than just the core practicals.



How do the core practicals cover practical skills?

- The core practicals are part of the specification and the students are expected to know them for the examinations.
- Students can use different methods and techniques to those stated – but they will still need to know and understand the methods stated in the core practicals.
- We'd recommend that you did other practical work as well as the practicals specified.
- These need not include expensive pieces of apparatus. Any practical work that your students attempt – not just the core practicals – will develop their practical competency.



Teaching practical skills

What our examiners have noticed: Units 1 and 2

- Many candidates showed a good progression from GCSE to A Level, with prior knowledge extended and new concepts taught and understood well.

- Candidates found the length of some of the calculations to be challenging, often missing out key steps, therefore only scoring 1 or 2 marks for interim steps.

- The new regions of the specification were answered as expected, if not better.

What our examiners have noticed: Units 1 and 2

- It was the problem-solving nature of some of the questions as well as the requirement for explanations in an unstructured setting that many found to be challenging.
- The main challenges were on questions requiring more application.
- Candidates who had a sound understanding of the physics involved did not always demonstrate this in their responses due to a lack of precision of the language and terminology used. Some missed exactly what the question was actually asking.
- While the mathematical ability seen was strong, application to the context was not as expected.

What our examiners have noticed: Unit 3

- For this paper, the topics included materials, waves and particle nature of light. As *understanding* of the core practicals is assessed by the Unit 1 and 2 papers, the practical context met in the Unit 3 paper may be less familiar. However, *it is the skills rather than the details of the practical that we are assessing*.

- There were many questions that would be familiar for candidates but there are some questions where performances would suggest they were unfamiliar with the practical skills.

- Understanding of keywords (such as resolution) and command words (such as describe how) proved a challenge to candidates at the lower end of the ability range.

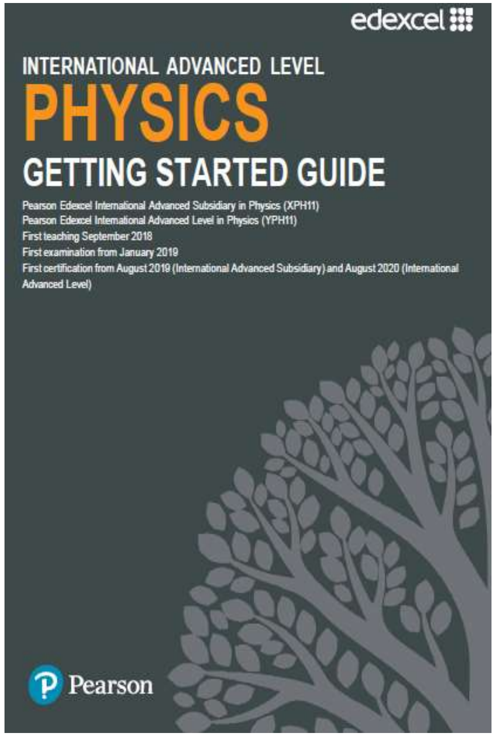
- At all ability levels, there were some questions where candidates answered in generic terms, rather than being specific to the particular practical described in the question.

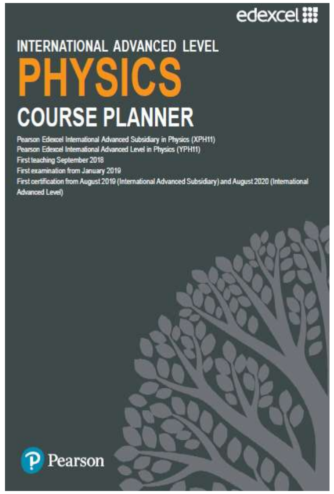
What are the implications for teaching and learning arising from the feedback from the examiners' reports?

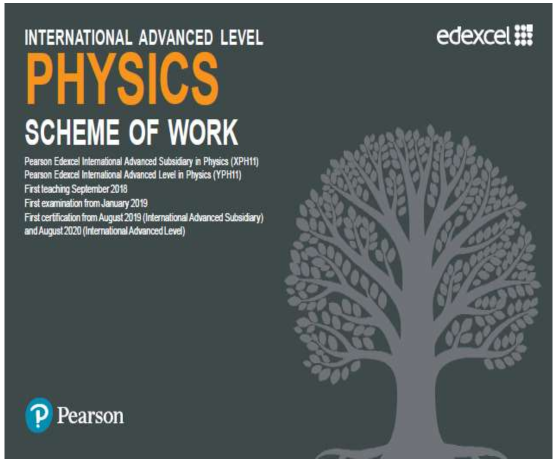
Content Overview

How do I make sure I cover all the content?

- Specification
- Lesson plans
- Schemes of work
- Year planners







Week	Prior Learning	Content of Lessons	Teaching Suggestions	Spec Reference
1	International GCSE/GCSE mechanics – describing motion	SI base and derived units. Measurement & techniques. Sig. figs., scientific notation, standard form and prefixes. Distance, displacement, speed, velocity and acceleration.	The work on SI base and derived units, Sig. figs., standard form and prefixes is required for all topics and needs to be revisited regularly.	
2	describing motion graphically	Displacement/time and velocity/time graphs and their interpretation, for motion with uniform and non-uniform acceleration.	Displacement/time graph for a trolley on a runway with a motion sensor. Mathematical requirement: graph plotting and measuring gradients	2, 3
3	International GCSE/GCSE mechanics – equations for speed and acceleration	Derive equations of motion: $s = \frac{(u+v)t}{2}$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ Practise problems in one dimension. Measurement of the acceleration of free fall. *CORE PRACTICAL 1:* Determine the acceleration of a freely falling object.	Examples to include positive and negative values of the variables. Mathematical requirement: manipulate of equations. Investigate the motion of a bouncing ball. All students should carry out this experiment.	1, 11

How do you plan your lessons in physics? Do you, for example, have a common lesson structure as a starting point? Are there any ways you might need to adapt your method(s) of lesson planning to deliver this specification?

Assessment Overview

How is the content assessed?

Unit 1: Mechanics and Materials	Unit 2: Waves and Electricity	Unit 3: Practical Skills in Physics I
Externally assessed Written exam: 1h 30m 80 marks 40% of IAS 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1h 30m 80 marks 40% of IAS 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1h 20m 50 marks 20% of IAS 10% of IAL This unit will assess students' knowledge and understanding of experimental procedures and techniques developed in Units 1 and 2. The paper may include short-open, open-response, calculations and extended-writing questions.

How is the content assessed?

Unit 4: Further Mechanics, Fields and Particles	Unit 5: Thermodynamics, Radiation, Oscillations and Cosmology	Unit 6: Practical Skills in Physics II
Externally assessed Written exam: 1h 45m 90 marks 40% of IA2 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1h 45m 90 marks 40% of IA2 20% of IAL The paper may include multiple-choice, short open, open-response, calculations and extended-writing questions.	Externally assessed Written exam: 1h 20m 50 marks 20% of IA2 10% of IAL This unit will assess students' knowledge and understanding of experimental procedures and techniques developed in Units 4 and 5. The paper may include short-open, open-response, calculations and extended-writing questions.

What are the Assessment Objectives?

		% in IAS	% in IA2	% in IAL
AO1	Demonstrate knowledge and understanding of science.	34–36	29–31	32–34
AO2	(a) Application of knowledge and understanding of science in familiar and unfamiliar contexts.	34–36	33–36	34–36
	(b) Analysis and evaluation of scientific information to make judgements and reach conclusions.	9–11	14–16	11-14
AO3	Experimental skills in science, including analysis and evaluation of data and methods.	20	20	20

Relationship of assessment objectives to units for the International Advanced Subsidiary qualification

Unit number	Assessment objective (%)			
	AO1	AO2(a)	AO2(b)	AO3
Unit 1	17–18	17–18	4.5–5.5	0.0
Unit 2	17–18	17–18	4.5–5.5	0.0
Unit 3	0.0	0.0	0.0	20
Total for International Advanced Subsidiary	34–36	34–36	9–11	20

Relationship of assessment objectives to units for the International Advanced Level qualification

Unit number	Assessment objective (%)			
	AO1	AO2(a)	AO2(b)	AO3
Unit 1	8.5–9.0	8.5–9.0	2.25–2.75	0
Unit 2	8.5–9.0	8.5–9.0	2.25–2.75	0
Unit 3	0	0	0	10
Unit 4	7.3–7.8	8.4–8.9	3.6–4.0	0
Unit 5	7.3–7.8	8.4–8.9	3.6–4.0	0
Unit 6	0	0	0	10
Total for International Advanced Level	32–34	34-36	11-14	20

Question Types

What types of questions are asked?

Papers on the content units (1, 2, 4 and 5) will include a mixture of different question styles, including:

- multiple-choice questions
- short open questions
- calculations
- open response questions
- extended writing questions.

Papers on the practical skills units 3 and 6 have all of these question styles *except* multiple choice.

Multiple-choice questions

A car is travelling at a velocity v. The driver applies the brakes and the car decelerates until it comes to rest. The work done by the brakes on the car is W.

Which of the following expressions is correct?

☐ **A** $W \propto v$

☐ **B** $W \propto v^2$

☐ **C** $W \propto \frac{1}{v}$

☐ **D** $W \propto \frac{1}{v^2}$

Short open questions

A light dependent resistor (LDR) has a resistance of 6100 Ω when illuminated with indoor lighting.

(a) Explain how the resistance of an LDR changes with illumination. Your answer should include reference to conduction electrons.

(2)

....

....

....

....

....

Calculation questions

Zinc has a work function of 4.3 eV. Calculate the maximum wavelength of light that will produce the photoelectric effect with zinc.

(3)

....

....

....

....

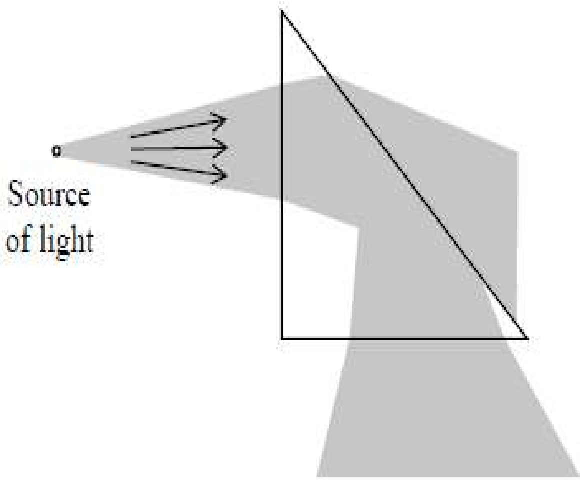
....

....

Maximum wavelength = ...

Open response questions

The diagram shows the path of a beam of light travelling from a light source in air through a 45° glass prism. The path taken by the beam of light is shaded. The critical angle for glass is 41°.

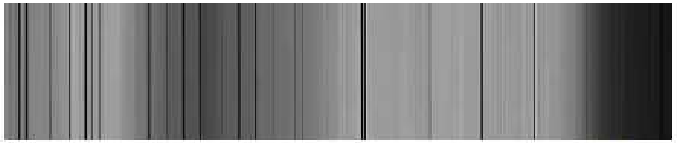


Explain the path of the beam of light.

(4)

Extended writing

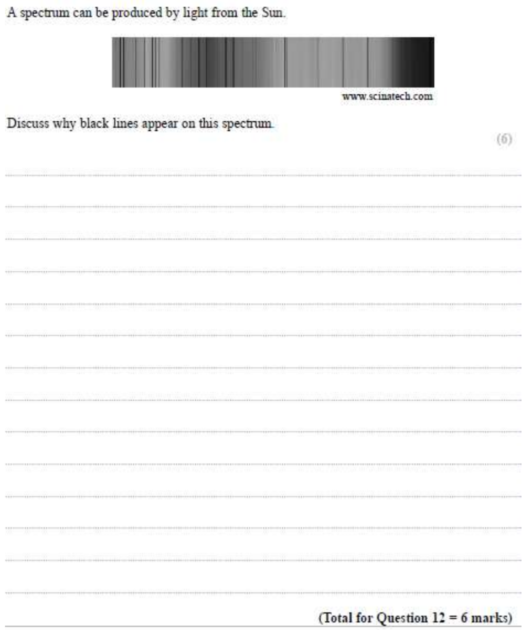
A spectrum can be produced by light from the Sun.



www.scinatech.com

Discuss why black lines appear on this spectrum.

A screenshot of the full page with this question at the top shows that a fair amount of space – a whole side of A4 – is provided for a candidate to respond to this 6-mark question.



A spectrum can be produced by light from the Sun.

www.scinatech.com

Discuss why black lines appear on this spectrum.

(6)

(Total for Question 12 = 6 marks)

Mark Schemes

Mark schemes and examiner reports

Pearson Edexcel

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH11)
Paper 01
Unit 1: Mechanics and Materials

Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2023

Pearson Edexcel International Advanced Subsidiary Level In Physics (WPH13)
Paper 01: Practical Skills in Physics I

Pearson Edexcel

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH12)
Paper 01
Unit 2: Waves and Electricity

Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2023

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH12)
Paper 01: Waves and Electricity

What are mark schemes?

- These are the ‘answers’ to the questions.
- They often give a number of alternative answers students might give.
- They can show indicative content to guide the markers.
- They also advise a marker of common errors and what to credit and not credit.
- Examiners are encouraged to use the mark scheme positively and to look to reward marks for what is there rather than penalise students for what isn’t.

What is in the mark schemes?

Question Number	Answer		Mark
13a	Use of $V=W/Q$ $W = 7.92 \times 10^5$ J **<u>Example of calculation</u>** $W = V \times Q = 22 \times 36{,}000 = 792{,}000$ J	(1) (1)	(2)
13bi	Use of speed = distance/time Time = 0.45 s (Accept 7.5×10^{-3} minutes or 1.25×10^{-4} hours) **<u>Example of calculation</u>** 16 km hr^{-1} = 16,000 m/ 3,600 s= 4.4 m s^{-1} Time = distance / speed = 2.0 m / 4.4 m s^{-1} = 0.45 seconds.	(1) (1)	(2)
13bii	Use of $I = Q / t$ Calculates total charge used in 2.00 m Number of electrons = 4.2×10^{19} (e.c.f. from (i)) **OR** Use of speed = distance / time Calculates total charge used in 2.00m Number of electrons = 4.2×10^{19} (no e.c.f. required from (i) for this method) **<u>Example of calculation</u>** $I = Q / t$ = 36,000 C / (40 x 60) s = 15 A Total charge used in 2.00m = I × t = 15 A x 0.45 s = 6.75 C number of electrons = 6.75 C / 1.6×10^{-19} C = 4.2×10^{19}	(1) (1) (1) (1) (1) (1)	(3)
	Total for question 13		**7**

What is in the mark schemes?

Question Number	Answer	Mark
*14a	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.	

Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points
6	4
5–4	3
3–2	2
1	1
0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

- When temperature is higher, greater energy to electrons (in thermistor)
- When temperature is higher, more conduction/free electrons
- When temperature is higher, lower resistance in thermistor
- Decreased p.d. across thermistor / YZ
  Or current in circuit/thermistor increases
- Increased p.d. across fixed resistor **Or** increased p.d. across XY
- So for the air conditioning application, secondary circuit should be across XY

(6)

(Allow converse statements for IC 1,2, 3 and 4)
(Do not allow contradicting statements for IC4 e.g. lower V so lower I)

General marking guidance

- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.

- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme.

- When examiners are in doubt regarding the application of the mark scheme to a candidate’s response, the team leader must be consulted.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Consider…

Which Assessment Objectives are being assessed in this part of an exam question?

AO1	Demonstrate knowledge and understanding of science.
AO2	(a) Application of knowledge and understanding of science in familiar and unfamiliar contexts. (b) Analysis and evaluation of scientific information to make judgements and reach conclusions.
AO3	Experimental skills in science, including analysis and evaluation of data and methods.

A student carried out an experiment to determine the resistivity of a metal in the form of a wire. She made the following measurements:

length of wire = 0.20 m
resistance of wire = 50 mΩ
diameter of wire = 0.36 mm

Determine the metal of the wire using information from the table below.

Metal	Resistivity / Ωm
aluminium	2.7×10^{-8}
tungsten	5.6×10^{-8}
iron	1.0×10^{-7}

(3)

Activity

How can we encourage students to develop confidence in tackling questions (such as this one) where the context is different from that in which the concept was initially learned?

The photograph shows a machine used for surveying the seabed. A communications cable connects the machine to a ship on the surface.

communications cable

Source from: http://www2.dupont.com/Personal_Protection/en_GB/assets/PDF/OandG/Nexans%20Case%20Study.pdf

The material used in the outer casing of the communications cable must withstand the large pressures at the seabed, yet be light enough to lift out of the water.

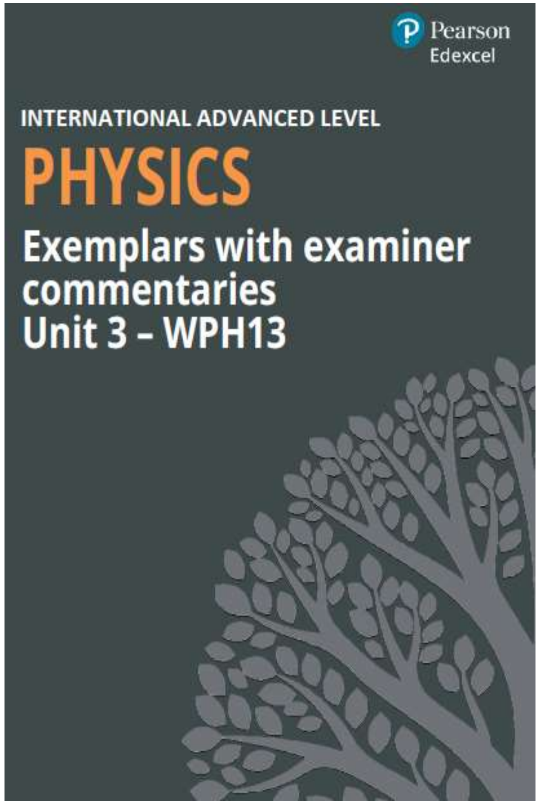
density of Kevlar = 1400 kg m^{-3}

density of steel = 7800 kg m^{-3}

(i) Deduce whether steel or Kevlar is more suitable to use in the outer casing of a communications cable at the seabed.

(4)

Exemplars



Exemplar response A

(a) Describe what the student should do to obtain the data to plot the force-extension graph.
(4)

Measure the mass of the load using an electronic balance and repeat for same mass. Multiply with gravitational accelaration to get F. Use a meter-rule ~~f~~ and set square to place the meter rule parallel to the spring and measure the initial ~~mass~~ length. Hang ~~an~~ loads of varying masses and measure the final length of the spring for each mass. Substract initial length to find extension for each of value of F. ~~Plot the graph~~, Repeat measurements of each mass and its corresponding extension.

Examiner's comments:

This response was given 4 marks.

The first marking point is clear in the first 3 lines of this response.

There is a clear reference to the calculation of extension by subtracting the initial length from the final length in the 7th and 8th lines, so achieving the second marking point.

Although the response does not refer to parallax, it does make a credit worthy attempt at the third marking point, using the set square and ensuring the ruler is parallel to the spring.

Note – this mark was awarded rarely, as many candidates did not include ideas of accuracy when giving an account of what should be done to obtain the data.

The final marking point is awarded for responses that explain how the multiple pairs of force/mass and extension needed to plot a graph are achieved. Here, "hang loads of varying masses" is enough for the final marking point.

Exemplar activity

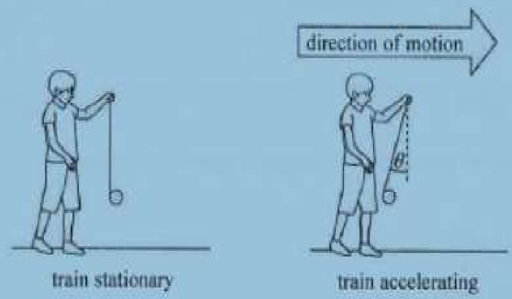
Here is an example, from an IAS ‘Exemplars’ document, of a part-question requiring a force diagram and the related mark scheme below.

Answer		Mark
• Weight/*W*/*mg* labelled	(1)	2
• Tension/*T*	(1)	

A yo-yo is a toy that consists of two connected discs on a piece of string.

© homydesign/Shutterstock

A child stands in a stationary train holding a yo-yo. The train accelerates and the string moves into the position shown, at an angle θ to the vertical.



(a) Draw the free-body force diagram for the yo-yo when the train is accelerating.

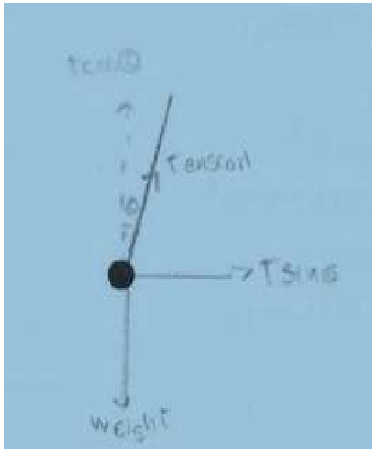
(2)

Exemplars

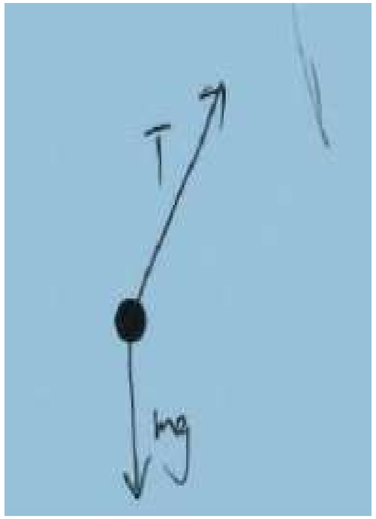
What mark would you give?

Answer		Mark
• Weight/*W*/*mg* labelled	(1)	2
• Tension/*T*	(1)	

A



B



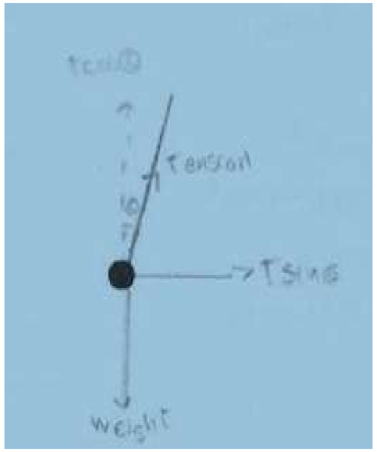
Exemplars

The examiner's decision

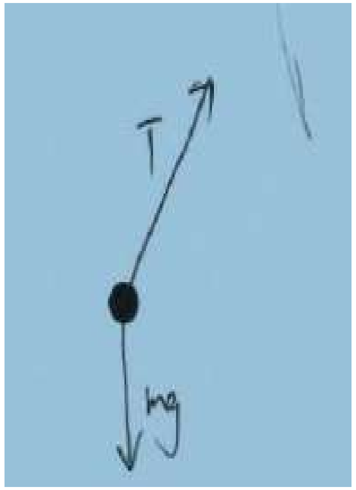
Exemplar A: 1 mark
This candidate has drawn both of the forces expected to score the 2 marks, but has added in the components of tension in both the horizontal and vertical planes. This might have been acceptable if both of the components of T drawn had been dotted lines. In this case the Tsinθ is drawn as a solid line, so this candidate scores just 1 mark.

Exemplar B: 2 marks
Ideally, lines of force would be drawn using a ruler. However, this candidate has scored both marks even though the lines are not completely straight. This is because it is completely clear which directions the weight and tension are acting. There are no additional forces drawn so all is correct.

A



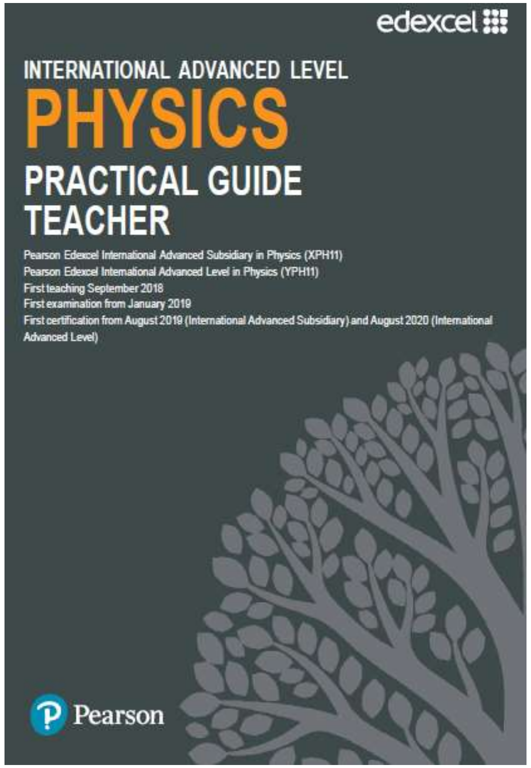
B



Assessment of practical work and exam techniques

Assessment of practical work

- As mentioned earlier, all of the assessment of practical work is in the final written exams on units 3 and 6 (about 20% of the total marks) – there is no practical exam, nor ‘assessed practicals’ in this course.
- This increases the need (over what may have happened in some older specifications) for learning during practical lessons to be planned carefully so that students develop the skills necessary to tackle those exam questions.
- The Practical Guide (Teacher) is an invaluable tool to aid this area of learning.



Practical Guide - Teachers

The practical guide for teachers includes:

- practical assessment – the whole picture
- assessment of practical skills
- using core practicals to teach skills
- mapping core practicals for mathematics skills development
- teaching approaches to core practicals
- answers to Student Guide questions
- answers to core practical questions.

Practical Guide - Teachers

Student records

Possible formats for students to keep records of their practical work include:

- a lab book. This has some advantages, mostly in being a 'working document' where students can write notes on procedures, as well as take down data, sketch rough graphs and so on
- a folder of practical work, having the advantage of being able to store worksheets and other stimulus material alongside the practical notes
- integrating practical notes into student's main folder.

Whichever format you decide works best, it is important that the method of collecting and recording the practical work that students do meets the following requirements:

- be a useful revision aid for students at the end of their course
- allow students to record evidence in a variety of formats, such as diagrams/drawings, tables, graphs and so on. This would also include space for any data analysis or evaluation.

5. Investigate the effects of length, tension and mass per unit length on the frequency of a vibrating string or wire

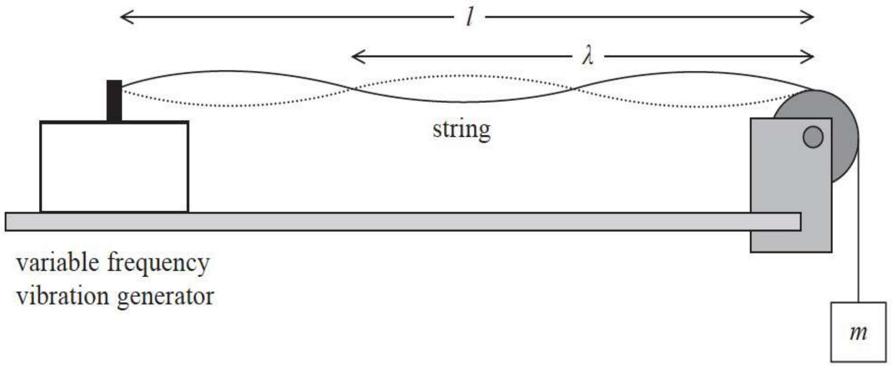
This experiment has 3 variables to test and so is another that makes a very good investigation and the sheets in the guide take this approach. The students might write a plan out of class and come to the lesson ready to carry it out so clearly the theory will have to be done thoroughly first. Because it is more open ended than some of these practicals students will need to keep a complete record of all that they do from the plan onwards.

It is unlikely that centres will have enough vibration transducers for a class set so if all students are to do this at the same time a vertical alternative is possible. A wire is hung vertically with slotted masses at the bottom, an alternating current is passed down the wire, leads attached with crocodile clips, an a magnetic field is placed at the centre – either a horseshoe magnet or pole faced magnets on a yoke. This removes frequency as a variable since it is 50 Hz, unless frequency generators are available. This makes a good alternative and students can still make measurements of standing waves by varying the mass on the wire. There will be no variable to control but students could still plan for frequency as a variable.

Safety should feature in all reports but this one has it as a feature since there are wires under tension and hanging masses. The data can be processed using ICT as there is a non-linear relation in the variables.

Example question on practical skills

A student carried out an experiment to determine the mass per unit length μ of a string, using a standing wave. The standing wave produced is shown in the diagram.



The student recorded the following data.

Length of string l	1.25 m
Frequency f	105 Hz
Mass m	0.25 kg

(a) Calculate μ given the equation below.

$$\sqrt{\frac{mg}{\mu}} = f\lambda$$

(3)

Example question on practical skills – mark scheme for part (a):

Question Number	Answer		Mark
4(a)	• Use of $\sqrt{\frac{mg}{\mu}} = f\lambda$	(1)	
	• Use of $l = 1.5 \times \lambda$	(1)	
	• $\mu = 3.2 \times 10^{-4}$ kg m^{-1}	(1)	3
	Example of calculation $1.5 \times \lambda = 1.25$ m $\lambda = 0.833$ m $\mu = (0.25\text{ kg} \times 9.81\text{ m s}^{-2}) / (105^2\text{ Hz}^2 \times 0.833^2\text{ m}^2)$ $\mu = 3.21 \times 10^{-4}$ kg m^{-1}		

Example question on practical skills (continued):

(b) (i) Identify two significant sources of uncertainty in the student's measurements.

(2)

(ii) For each of these sources of uncertainty, describe an experimental technique the student could have used to obtain an accurate measurement.

(4)

… and the accompanying mark scheme for part b(i):

4(b)(i)	Mark 4(b)(i) and (b)(ii) holistically **Max 2 from** *Frequency* • Uncertainty in identifying when nodes form (1) • Uncertainty in identifying maximum amplitude (1) *Length* • Parallax error when measuring length (1) • Uncertainty in measuring length to top of pulley **Or** uncertainty in measuring length as string is not straight (1) *Mass* • Zero error on mass balance (1)	**2**

...and for part b(ii):

4(b)(ii)	**Max 4 (from only 2 pairs)** **For each source from (b)(i)** Description of experimental technique (1) Additional detail (1) *<u>Examples</u>* *Frequency* • Repeat and calculate the mean frequency (1) • Vary frequency from above and below resonance to find two values for the frequency when the standing wave forms (1) *Length* • Use a set square to reduce parallax error in length **Or** hold ruler in contact with the wire to reduce parallax error in length **Or** ensure ruler and string are at eye-level (1) • Switch off vibrator **Or** ensure string is straight (1) *Mass* • Zero balance before each measurement (1) • To remove systematic error **Or** idea that this error is not reduced by repeating (1)	**4**

In the light of those sections of the specification which describe what students will be assessed on in the practical units (and the example question we have just looked at) what are the implications for teaching and learning when students are engaged in experiments and investigations?

Exam Technique

The exam paper

Instructions

- Use **black** ink or **black** ball-point pen.
- Answer the questions in the spaces provided – *there may be more space than you need*.
- **Show all your working in calculations and include units where appropriate.**

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Exam technique

Preparation

- Effective exam techniques need to be practised by students using past papers or part-papers; perhaps ‘home-made’ papers using Exam Wizard tailored to suit the exercise or focused on the particular technique being practised.
- Give students such a paper to practise how to access it.
- Give students mark schemes so they can learn what is expected.
- Having a ‘go to’ strategy, a starting point, builds confidence and reduces the stress of ‘what do I do first’.

Exam strategy – one way to tackle a paper

- Look through the whole paper first, underlining (or, better, highlighting) the command words in each question.
- Decide which question to do first – start with the question(s) you feel most confident with, which is not necessarily question 1.
- Read the question carefully – don't repeat the stem in your answer.
- Don't give up on a whole question if you find one section of the question difficult – move on to the next part.
- The same strategy holds for whole questions you find difficult – move on.
- Come back to missed questions and parts of questions when you have picked off all the 'low-hanging fruit'.

Activity question

What strategies do you share with your students that you find effective?

Walking-talking mocks

- Students sit in the same exam room where they will do their exam, preferably in the same seats (it can be done in the classroom, but not always as effective in building confidence in exam conditions).
- Students are given an exam paper which is as close to being like the real thing as possible (i.e. exam writing booklet if relevant).
- Students are literally walked through every question on the paper – the person leading the session talks them through the smallest steps, such as underlining key words, how to plan, things to remember, etc.
- You might focus on a particular area – such as mathematical questions, or questions based on devising a practical investigation.
- Students then write their responses in timed conditions.

Exam Insights 2024

Aims and objectives

1. Receive feedback on the performance of candidates in the June 2024 exam series

2. Consider the variation of candidates' performance on different questions and explore why performance varies

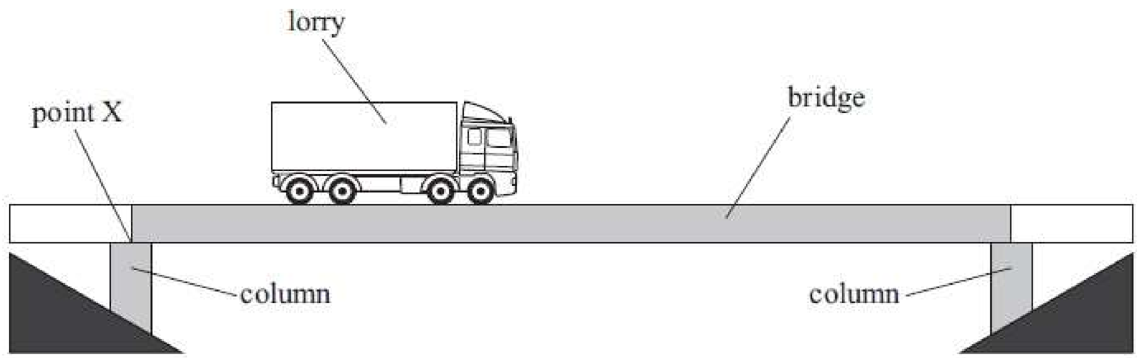
3. Discuss the Examiner's Report

4. Address common issues and FAQs.

Examples of Student Responses: Feedback strand 1: unstructured calculations

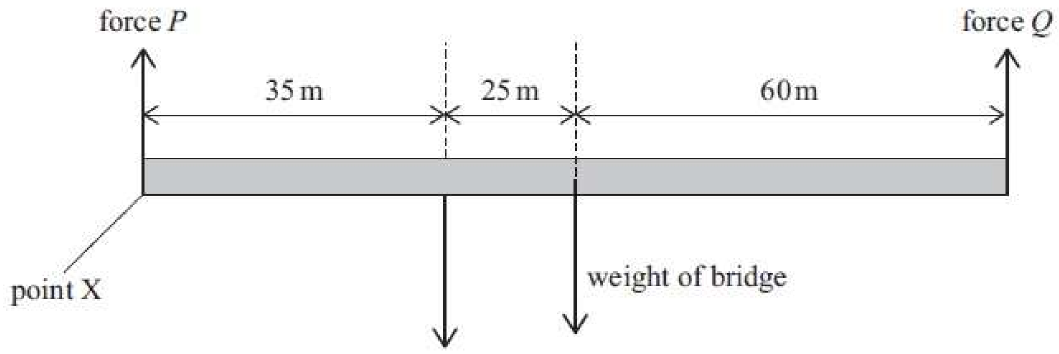
WPH11, Q18a

18 A lorry is crossing a bridge. The bridge is supported by two columns, as shown.



Forces P and Q act on the bridge from the columns. The centre of gravity of the bridge is at its centre. At a particular time the lorry is 35 m from point X.

A simplified diagram showing the positions of the forces on the bridge is shown below.



(a) Calculate the magnitudes of the forces P and Q.

You should take moments about point X.

force from lorry = 4.2×10^5 N
weight of bridge = 9.8×10^5 N

(5)

WPH11, Q18a MS

18(a)	Use of moment of a force = Fx	(1)	
	Use of principle of moments	(1)	
	Use of Newton's first law **Or** Second use of principle of moments	(1)	
	$P = 7.9 \times 10^5$ N	(1)	
	$Q = 6.1 \times 10^5$ N	(1)	5
	Maximum 4 marks if incorrect / no unit with answers. <u>Example of calculation</u> Total clockwise moment $= 4.2 \times 10^5 \text{ N} \times 35 \text{ m} + 9.8 \times 10^5 \text{ N} \times 60 \text{ m}$ $= 7.35 \times 10^7$ N m Total anticlockwise moment $= Q \times 120$ m $Q \times 120 \text{ m} = 7.35 \times 10^7$ N m $Q = \dfrac{7.35 \times 10^7 \text{ N m}}{120 \text{ m}} = 6.12 \times 10^5 \text{ N}$ $P = 4.2 \times 10^5 \text{ N} + 9.8 \times 10^5 \text{ N} - 6.12 \times 10^5 \text{ N} = 7.88 \times 10^5 \text{ N}$		

WPH11, Q18a – example 1

(a) Calculate the magnitudes of the forces P and Q.

You should take moments about point X.

force from lorry = 4.2×10^5 N
weight of bridge = 9.8×10^5 N

(5)

the unit: clockwise ~~momentum~~ moment is $60m \times 9.8 \times 10^5 N + 4.2 \times 10^5 N \times 85m$

$= \cancel{945 \times}\ 9.45 \times 10^7 N \cdot m.$

$P \cdot (35m + 25m + 60m) = 9.45 \times 10^7 N \cdot m$

$\Rightarrow P = 7.875 \times 10^5 N$

The clockwise moment is $35m \times 4.2 \times 10^5 N + \cancel{25m}\,(25m + 35m) \times 9.8 \times 10^5 N$

$= 7.35 \times 10^7 N \cdot m$

The force $Q = \frac{\cancel{mom}\ moment}{(35m + 25m + 60m)}$

$= 6.125 \times 10^5 N$

$P =$ $7.875 \times 10^5 N$

$Q =$ $6.125 \times 10^5 N$.

WPH11, Q18a – example 2

(a) Calculate the magnitudes of the forces P and Q.

You should take moments about point X.

force from lorry = 4.2×10^5 N
weight of bridge = 9.8×10^5 N

(5)

⇒ For force P

$F_1 d_1 = F_2 d_2$

$4.2 \times 10^5 \times 35 = F_2 \times 25$

$1.47 \times 10^7 = F_2 \times 25$

$F_2 = \frac{1.47 \times 10^7}{25} = 5.88 \times 10^5$

⇒ For force Q

$F_1 d_1 = F_2 d_2$

$4.2 \times 10^5 \times 25 = F_2 \times 60$

$1.05 \times 10^7 = F_2 \times 60$

$F_2 = \frac{1.05 \times 10^7}{60} = 1.75 \times 10^5$

$\therefore \quad m = \frac{W}{g} = \frac{9.8 \times 10^5}{9.81} = 9.99 \times 10^4$

Force P = $5.88 \times 10^5 - 9.99 \times 10^4$

$= 4.88 \times 10^5$ N

For force Q = $1.75 \times 10^5 - 9.99 \times 10^4$

$= 7.51 \times 10^4$ N

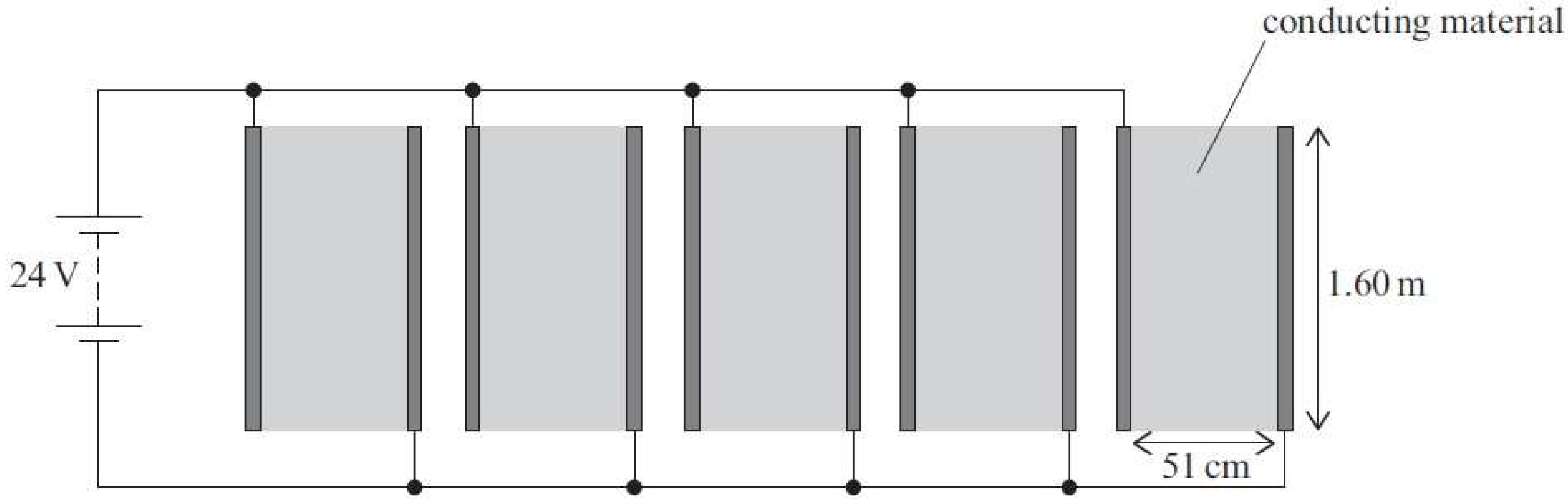
P = 4.9×10^5 N

Q = 7.5×10^4 N

Examples of Student Responses: Feedback strand 2: deduction questions

WPH12, Q14d

(d) A student designs a heating system using five heating panels, as shown.



To be safe, the maximum power of the student's heating system should be less than 350 W.

Deduce whether the student's heating system is safe.

resistivity of conducting material = $6.4 \times 10^{-3}\,\Omega\,m$
thickness of conducting material = 0.48 mm

(5)

WPH12, Q14d

Question Number	Answer		Mark
14(d)	Calculate area using 1.60 × thickness	(1)	
	Use of $R = \frac{\rho l}{A}$	(1)	
	Use of resistors in parallel formula	(1)	
	Use of $P = \frac{V^2}{R}$	(1)	
	680 W is greater than 350 W so the system is not safe	(1)	
	OR		
	Calculate area using 1.60 × thickness	(1)	
	Use of $R = \frac{\rho l}{A}$	(1)	
	Use of $P = \frac{V^2}{R}$	(1)	
	Multiplies calculated power x 5	(1)	
	680 W is greater than 350 W so the system is not safe	(1)	5
	<u>Example of calculation</u> $A = 1.60\ \text{m} \times 0.48 \times 10^{-3}\ \text{m} = 7.68 \times 10^{-4}\ \text{m}^2$ $R = \frac{6.4 \times 10^{-3}\ \Omega\ \text{m} \times 0.51\ \text{m}}{7.68 \times 10^{-4}\ \text{m}^2} = 4.25\ \Omega$ $R_{\text{total}} = \frac{4.25\ \Omega}{5} = 0.85\ \Omega$ $P = \frac{(24\ \text{V})^2}{0.85\ \Omega} = 678\ \text{W}$		

WPH12, Q14d – example 1

Deduce whether the student's heating system is safe.

resistivity of conducting material = $6.4 \times 10^{-3}\,\Omega\,m$
thickness of conducting material = 0.48 mm

(5)

$R = \frac{\rho L}{A}$

$R = \frac{6.4 \times 10^{-3}\,(1.60)}{4.8 \times 10^{-4}\,\left(\frac{5}{100}\right)}$

$R = 41.63\,\Omega$

$P = 5\left(\frac{V^2}{R}\right)$

$P = 5\left(\frac{24^2}{41.63}\right)$

$P = 68.9\,W$

Yes so the heating system is safe.

WPH12, Q14d – example 2

Deduce whether the student's heating system is safe.

resistivity of conducting material = $6.4 \times 10^{-3}\,\Omega\text{m}$
thickness of conducting material = 0.48 mm

(5)

$\cancel{R = \frac{\rho l}{A}}$

$\cancel{R = \frac{6.4\times10^{-3} \times 1.60}{1.60 \times 0.51 \times 0.48\times10^{-3}}}$

$\cancel{R = 28.44}$

$\cancel{P = \frac{V^2}{R}}$ $\cancel{P = \frac{24^2}{28.44}}$

51cm → 0.51

$R = \frac{\rho L}{A}$

$R = \frac{6.4\times10^{-3} \times 0.51}{1.60 \times 5 \times 0.48\times10^{-3}}$

$R = 0.85\,\Omega$

$P = \frac{V^2}{R}$

$P = \frac{24^2}{0.85}$

$P = 677.6\,W$

the student heating system is not safe

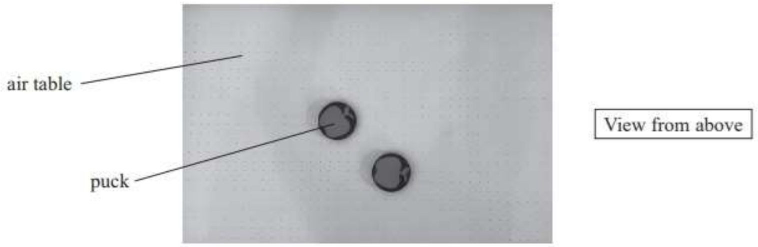
677.6 > 350 w

(Total for Question 14 = 14 marks)

WPH14, Q15bi

15 An air table has a surface with many small holes. Air is blown through the holes. Plastic pucks can move freely over the table on a cushion of air.

The photograph shows the surface of an air table with two pucks on it.

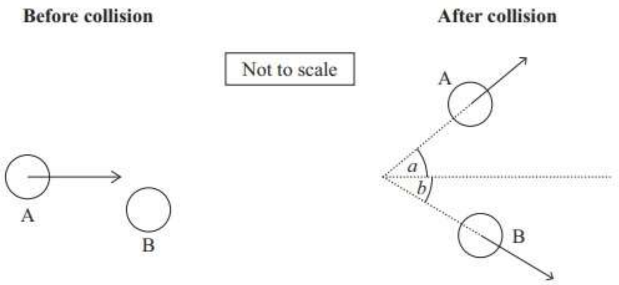


Some students used the air table to investigate conservation of momentum.

(b) The students observed several collisions between two identical pucks, A and B. One puck was stationary before each collision.

They noticed that after each collision the two pucks seemed to follow paths at 90° to each other.

The diagram shows one of the collisions.



The students recorded the following data for this collision.

initial momentum of A	$0.046\,\mathrm{kg\,m\,s^{-1}}$
angle a	33°
final momentum of A	$0.039\,\mathrm{kg\,m\,s^{-1}}$

(i) Deduce whether the angle between the paths of the pucks after the collision was 90°.

You should use the principle of conservation of momentum.

(5)

WPH14, Q15bi MS

15(b)(i)	Use of trigonometrical function for x component of A momentum after collision **Or** Use of trigonometrical function for y component of A momentum after collision Applies conservation of momentum Applies trigonometry to calculate final angle for B Angle between A and B = 91(°) Comparison between calculated angle and 90° including conclusion in words <u>Example of calculation</u> x component of A after = 0.039 kg m s^{-1} × cos 33° = 0.0327 kg m s^{-1} y component of A after = 0.039 kg m s^{-1} × sin 33° = 0.0212 kg m s^{-1} x component of B after = 0.046 kg m s^{-1} – 0.0327 kg m s^{-1} = 0.0133 kg m s^{-1} y component of B after = 0.0212 kg m s^{-1} tan θ = 0.0212 kg m s^{-1} ÷ 0.0133 kg m s^{-1} = 1.59 θ = 57.9° 58° + 33° = 91° which is about 90°	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**

WPH14, Q15bi – example 1

(i) Deduce whether the angle between the paths of the pucks after the collision was 90°.

You should use the principle of conservation of momentum.

(5)

Horizontally (⟷)

$P_{Ab} = mv = 0.046 \text{ kg m s}^{-1}$

~~= 0.046 k~~

$P_{AaH} = P_{Aa} \cdot \cos a$

$= 0.039 \cdot \cos 33^\circ$

$= 0.033 \text{ kg m s}^{-1}$

$P_{Ab} - P_{AaH} = P_{BaH} = 0.013 \text{ kg m s}^{-1}$

Vertically (↕)

$P_{AaV} = P_{Aa} \cdot \sin a$

$= 0.039 \cdot \sin 33^\circ$

$P_{AaV} = 0.021 \text{ kg m s}^{-1}$

$P_{BaV} = P_{AaV} = 0.021 \text{ kg m s}^{-1}$

$P_{Ba}{}^2 = P_{BaV}{}^2 + P_{BaH}{}^2$

$P_{Ba}{}^2 = 0.013^2 + 0.021^2$

$P_{Ba} = 0.025 \text{ kg m s}^{-1}$

$\tan b = \frac{P_{BaV}}{P_{BaH}} = \frac{0.025}{0.013}$

$\tan b = 1.923$

$b = 62.5^\circ$

$a + b = 95.5^\circ$

$95.5^\circ \neq 90^\circ$, it's ~~not~~ not 90°.

WPH14, Q15bi – example 2

(i) Deduce whether the angle between the paths of the pucks after the collision was 90°.

You should use the principle of conservation of momentum.

(5)

$0.039 \times \cos 33° = 0.0327$ ~~ms~~ $kg\,m\,s^{-1}$

$0.046 - 0.0327 = 0.0133\ kg\,m\,s^{-1}$

$0.039 \times \sin 33° = 0.0212\ kg\,m\,s^{-1}$

~~$\tan^{-1}\left(\frac{0.0212}{0.0133}\right) = 86.4°$~~

~~$86.4 < 90°$~~

$\sqrt{0.0133^2 + 0.0212^2} = 0.025\ kg\,m\,s^{-1}$

$\tan^{-1}\left(\frac{0.0212}{0.0133}\right) = 57.9°$

$57.9° + 33° = 90.9°$

$90.9°$ ~~≈ 90~~

WPH15, Q15b with MS

15(b)	Surface area of top of ice floe calculated [453 m^2]	**(1)**	
	Intensity at sea level calculated using 56% [767 W m^{-2}]	**(1)**	
	Use of $I = \frac{P}{A}$	**(1)**	
	Use of $P = \frac{\Delta W}{\Delta t}$	**(1)**	
	t = 4.4 days [4.3 days if "show that" value used] (ecf from (a)) **Or** $E = 2.10 \times 10^{11}$ J for 7 days	**(1)**	
	4.4 days is less than 7 days so claim is not correct **Or** 1.32×10^{11} J < 2.10×10^{11} J so claim is not correct **Or** Correct conclusion based on comparison of candidate's calculated values	**(1)**	**6**
	Example of calculation $P = 0.56 \times 1370 \text{ W m}^{-2} \times 453 \text{ m}^2 = 3.48 \times 10^5 \text{ W}$ $t = \frac{1.32 \times 10^{11} \text{ J}}{3.48 \times 10^5 \text{ J s}^{-1}} = 3.79 \times 10^5 \text{ s}$ $t = \frac{3.79 \times 10^5 \text{ s}}{8.64 \times 10^4 \text{ s day}^{-1}} = 4.39 \text{ days}$		

15 The photograph shows a large area of ice floating in the sea. This is called an ice floe.

(Source: © elmvilla/Getty Images)

Energy from the Sun melts the ice floe.

(a) An ice floe has a mass of 3.53×10^5 kg.

Show that the energy required to melt this ice floe is about 1.3×10^{11} J.

(b) At the top of the atmosphere, the intensity of radiation from the Sun is 1370 W m^{-2}. As radiation passes through the atmosphere, 44% is absorbed or reflected by the atmosphere.

A scientist claims that, even with continuous sunshine, the time taken for the ice floe to melt completely would be greater than 7 days.

Deduce whether this claim is correct.

average thickness of ice floe = 0.85 m
volume of ice floe = 385 m^3
1 day = 8.64×10^4 s

(6)

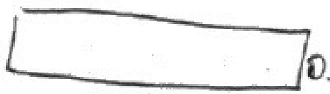
WPH15, Q15b – ex 1

(b) At the top of the atmosphere, the intensity of radiation from the Sun is $1370\,\mathrm{W\,m^{-2}}$. As radiation passes through the atmosphere, 44% is absorbed or reflected by the atmosphere.

A scientist claims that, even with continuous sunshine, the time taken for the ice floe to melt completely would be greater than 7 days.

$V = 385$

Deduce whether this claim is correct.



average thickness of ice floe = 0.85 m
volume of ice floe = $385\,\mathrm{m^3}$
1 day = $8.64 \times 10^4\,\mathrm{s}$

(6)

$I = 1370 \cdot (1 - 0.44) = 767\,\mathrm{W\,m^{-2}}$

$A = \frac{380}{0.85} = 447\,\mathrm{m^2}$

$P = 767 \cdot 447 = 3.43 \cdot 10^5\,\mathrm{W}$

$\frac{1.32 \cdot 10^{11}}{3.43 \cdot 10^5} = 3.85 \cdot 10^5\,\mathrm{s}$

$\frac{3.85 \cdot 10^5}{8.64 \cdot 10^4} = 4.45$ days

∴ The claim is wrong as the ice melts in 4.45 days

(Total for Question 15 = 9 marks)

WPH15, Q15b – example 2

(b) At the top of the atmosphere, the intensity of radiation from the Sun is $1370\ \mathrm{W\,m^{-2}}$. I
As radiation passes through the atmosphere, 44% is absorbed or reflected by the atmosphere.

A scientist claims that, even with continuous sunshine, the time taken for the ice floe to melt completely would be greater than 7 days.

Deduce whether this claim is correct.

average thickness of ice floe = 0.85 m
volume of ice floe = $385\ \mathrm{m^3}$
1 day = 8.64×10^4 s

(6)

$\text{Area } A = \frac{385}{0.85} = \cancel{453\,\mathrm{m}}\ 453\,\mathrm{m^2}$

$P = I \cdot A = 1370 \times 44\% \times 453 = 2.73 \times 10^5\ \mathrm{W}$

$W = Pt = 2.73 \times 10^5 \times 8.64 \times 10^4 \times 7 = 1.65 \times 10^{11}\ \mathrm{J}$

$1.65 \times 10^{11}\ \mathrm{J} > 1.32 \times 10^{11}\ \mathrm{J}$

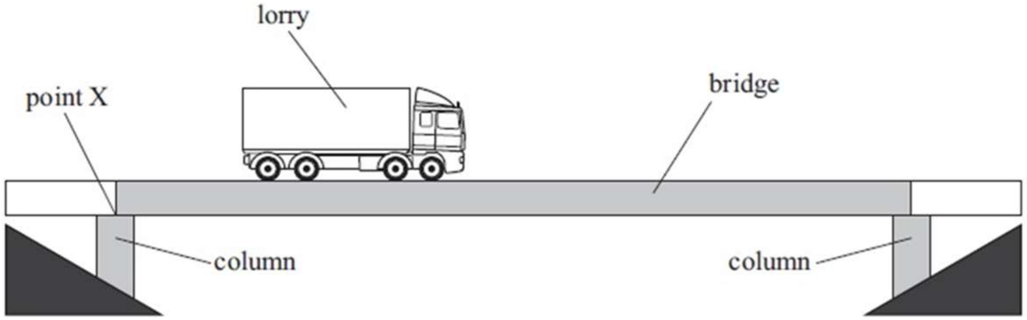
~~The~~ The time taken is less than 7 days so the claim is incorrect.

Examples of Student Responses: Feedback strand 3: explanation questions

WPH11, Q18b with MS

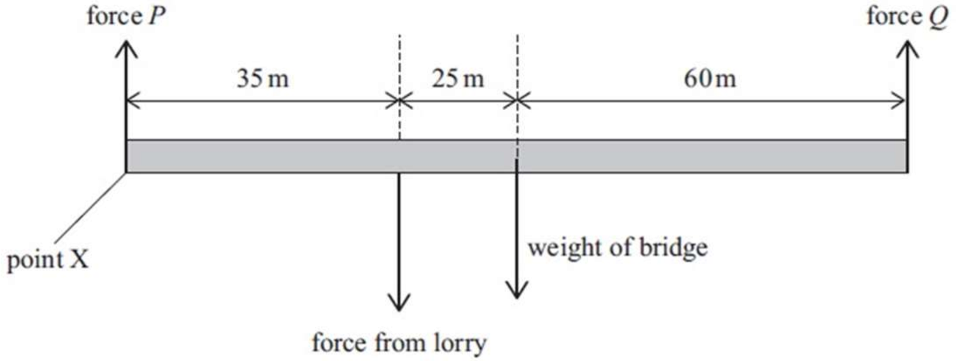
18(b)	Allow P for X throughout Allow Q for Y throughout	
	EITHER	
	Distance from X to (centre of gravity of) lorry increases	**(1)**
	(So) moment (about X) due to (force from) lorry increases	**(1)**
	Sum of moments remains zero (for equilibrium)	**(1)**
	So moment (about X) due to Q increases	**(1)**
	Distance from X to Q remains the same therefore Q increases	**(1)**
	OR	
	Distance from other end of bridge (Y) to (centre of gravity of) lorry decreases	**(1)**
	(So) moment about Y due to (force from) lorry decreases	**(1)**
	Sum of moments remains zero (for equilibrium)	**(1)**
	So moment about Y due to P decreases, and P must decrease	**(1)**
	And (at equilibrium) the sum of P and Q remains the same therefore Q increases	**(1)**

18 A lorry is crossing a bridge. The bridge is supported by two columns, as shown.



Forces P and Q act on the bridge from the columns. The centre of gravity of the bridge is at its centre. At a particular time the lorry is 35 m from point X.

A simplified diagram showing the positions of the forces on the bridge is shown below.



(b) Explain why force Q increases as the lorry moves across the bridge.

(5)

WPH11, Q18b – example 1

(b) Explain why force Q increases as the lorry moves across the bridge.

(5)

-As the lorry moves across the bridge, past halfway it is not acting on the center of mass of the bridge ∴ weight is not evenly distributed. The lorry would be causing a 'turning force' clockwise which Force Q, the collum has to counter and produce a greater anti-clockwise moment to ensure the bridge is stable. The lorry produces a clockwise moment about the centre of gravity, and any other point of the bridge since M = Fd, the further away the lorry gets the greater the turning force produced. This resulltant force needs to be countered.

WPH11, Q18b – example 2

(b) Explain why force Q increases as the lorry moves across the bridge.

(5)

Take P as the pivot. Let the distance between P and the lorry be x.

Moment clockwise = $W_L x + 60W$, and W_L and W are constant

Moment anticlockwise = $F_a \times 120$

Since it is in equilibrium, the resultant moment is zero.

$120 F_a$ ~~$W_L x + 60W$~~ $= W_L x + 60W$

Then when x increases, F_a would increase.

WPH15, Q18bii with MS

(b) Luminosity measurements suggest that our galaxy has a mass equal to 8.0×10^{11} solar masses.

(i) A star in one of the outer arms of the galaxy is orbiting the centre of the galaxy. The star is 5.7×10^{20} m from the centre of the galaxy.

Show that the orbital period of the star should be about 8×10^{15} s.

(ii) The orbital period of the star is actually $6.0 \times 10'$ s.

The two values for the orbital period of the star do not agree.

Deduce what this tells us about our galaxy.

Assume that the value for the distance of the star from the centre of our galaxy is correct.

18(b)(ii)	The actual period is (much) smaller than the calculated value	**(1)**	
	So the mass of the galaxy must be greater than 8.0×10^{11} solar masses [accept the given mass for the numerical value] **Or** the gravitational force on the star must be bigger (than assumed)	**(1)**	
	There must be matter that does not emit em-radiation **Or** There must be matter that we cannot detect via em-radiation [Accept "there must be matter that we cannot see"]	**(1)**	
	(This suggests that) there is dark matter	**(1)**	**4**

WPH15, Q18bii Example 1

(ii) The orbital period of the star is actually 6.0×10^7 s.

The two values for the orbital period of the star do not agree.

Deduce what this tells us about our galaxy.

Assume that the value for the distance of the star from the centre of our galaxy is correct.

(4)

The actual orbital period of the star is much smaller compared to the calculated value. This indicates that the mass of the galaxy must be much greater than the mass taken from Luminosity measurements. This concludes that there must be matter in our galaxy that doesn't emit electromagnetic radiation, also known as dark matter. ∴ this tells that our galaxy contains dark matter which we can't detect which means we won't know its actual mass from its Luminosity.

WPH15, Q18bii Example 2

(ii) The orbital period of the star is actually 6.0×10^7 s.

The two values for the orbital period of the star do not agree.

Deduce what this tells us about our galaxy.

Assume that the value for the distance of the star from the centre of our galaxy is correct.

(4)

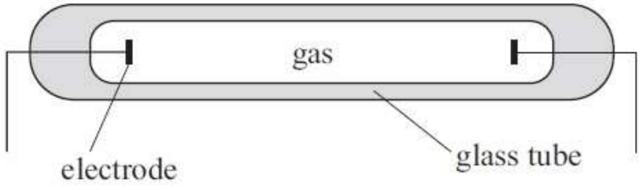
The actual orbital period is much smaller than the one calculated. This means that the velocity of the star ($v = \frac{2\pi r}{T}$ where r is correct) is a lot larger than it should be. $v \propto \frac{1}{T}$ The gravitational pull of the galaxy is not large enough to keep this star with such a speed in orbit, so we conclude that there must be some kind of matter holding the galaxy together, that we call dark matter, providing this extra gravitational force needed

Examples of Student Responses: Feedback strand 4: linkage questions

WPH12, Q17aii with MS

17 In the second half of the 19th century, scientists began to investigate interactions between photons and electrons.

(a) A discharge tube is a glass tube containing gas, as shown.



When the discharge tube is connected into an electrical circuit, the gas atoms emit photons. The photons have specific frequencies.

*(ii) The electrical circuit applies a large potential difference (p.d.) across the discharge tube.

Explain how the p.d. across the discharge tube causes photons to be emitted by the gas atoms.

(6)

IC1 The potential difference causes a current in the gas / tube
IC2 So energy is transferred to the gas atoms
IC3 Electron/atom gains (sufficient) energy to move up energy levels
IC4 An (excited) electron (is unstable and) falls back down emitting a photon
IC5 With a wavelength/frequency corresponding to the difference in the energy levels Or reference to $E = hf$ or $E \propto f$
IC6 Electrons/atoms exist in discrete/fixed/certain energy levels so only certain frequencies / wavelengths are emitted

WPH12, Q17aii – example 1

Explain how the p.d. across the discharge tube causes photons to be emitted by the gas atoms.

(6)

Higher voltage means that ~~a higher~~ the current across the discharge tube ~~in~~ is higher. The release of ~~electrons~~ ~~photons~~ Photoelectrons from an atom is instantaneous. So when the intensity increases, the ~~rate~~ rate of ~~photon~~ photoelectrons released ~~increses~~ increases as one ~~one~~ photon interacts with one electron. The increase in current supply increases the photon energy absorbed by the hydrogen atoms. If this energy is higher than the work function, photoelectrons will be released. Depending on the energy of the photon, the frequency will also varry. ~~Th~~ If this frequency is higher than the threshold frequency, then photonelectrons will be released ~~Photon~~ as ~~phot~~ the photon energy is relative to the frequency.

WPH12, Q17aii – example 2

Explain how the p.d. across the discharge tube causes photons to be emitted by the gas atoms.

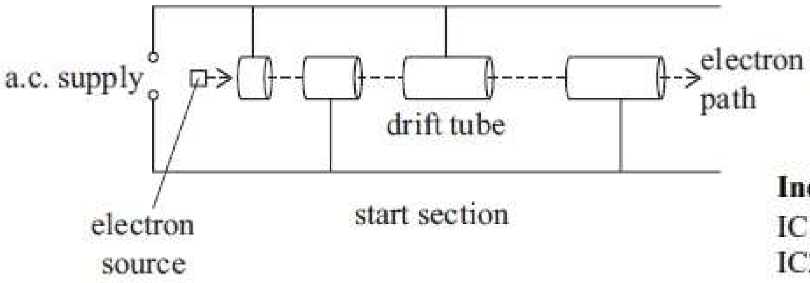
(6)

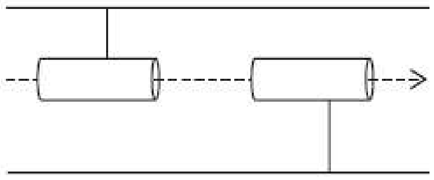
gas atoms absorb ~~photons~~ electrons. since $E = VQ$ larger the potential difference more the energy. when the energy of the ~~photon~~ electron is greater

$E = hf = \phi + \frac{1}{2}mv^2$ the electrons gain energy and move to a higher energy level where they are exited. when the electrons get de-excited they move to lower energy level emitting a photon. energy levels are discreet and the difference in energy levels is the energy of the photon. energy is directly proportional to the frequeny. electrons require minimum threshold frequency to be emitted.

WPH14, Q16b with MS

*(b) The diagram shows the start section of a linac and the end section of a linac.





Explain how a linac produces high energy electrons.

You should refer to the a.c. supply and to the length of the drift tubes in each section.

(6)

Indicative content

IC1 The electrons are accelerated by an <u>electric field</u> between the drift tubes

IC2 The (a.c) polarity changes (when the electrons are in the tubes) so the (electric) field is in the same direction when the particle is in the gaps
Or The (a.c.) polarity changes so it is always accelerating the particles

IC3 The a.c. frequency is constant

IC4 The length of the drift tubes increases (along the Linac) so the electrons spend the same time in the tubes / gaps
Or The length of the gaps increases (along the Linac) so the electrons spend the same time in the tubes / gaps

IC5 The tubes have constant length at the end

IC6 As the electrons approach (but do not achieve) the speed of light their speed no longer increases

WPH14, Q16b – example 1

Explain how the p.d. across the discharge tube causes photons to be emitted by the gas atoms.

(6)

Higher voltage means that ~~a higher~~ the current across the discharge tube ~~in~~ is higher. The release of ~~electrons~~ ~~photons~~ photoelectrons from an atom is instantaneous. So when the intensity increases, the ~~rate~~ rate of ~~photon~~ photoelectrons released ~~increses~~ increases as ~~the~~ one photon interacts with one electron. The increase in current supply increases the photon energy absorbed by the hydrogen atoms. If this energy is higher than the work function, photoelectrons will be released. Depending on the energy of the photon, the frequency will also varry. ~~Th~~ If this frequency is higher than the threshold frequency, then photon electrons will be released ~~Photon~~ as ~~phot~~ the photon energy is relative to the frequency.

WPH14, Q16b – example 2

when an electron is produced by the source, it is accelerated by an electric field produced by a.c current to the first tube. Then just before leaving the first tube, the electric field changes direction so that it is accelerated towards the next tube. The change in field direction is done by constant frequency of a.c supply which produces alternating magnetic field. As the ~~part~~ electron accelerates, its speed increases. To keep the frequency of ac supply constant, the tubes are elongated one after another, so that the electron spend the same time in each tube, according to $s = vt$. However, when near the end sections, the speed of the electrons are so high, ~~th~~ it reaches relativistic speed. So speed stop increasing and mass starts increasing. Thus, the tubes also stop increasing in length near the end section.

Examples of Student Responses: Feedback strand 5: experimental skills

WPH13, Q3b with MS

3(b)	Calculates time t = number of divisions × time per division Use of $v = \frac{s}{t}$ Uses $2 \times s$ **Or** Uses $\frac{1}{2} \times t$ $v = 331$ (m s^{-1}) <u>Example of calculation</u> $t = 6$ divisions × 0.5 ms per division = 3 ms $v = \frac{s}{t} = \frac{2 \times 0.497\ \text{m}}{3 \times 10^{-3}\ \text{s}} = 331.3\ \text{m s}^{-1}$	**(1)** **(1)** **(1)** **(1)**	**4**

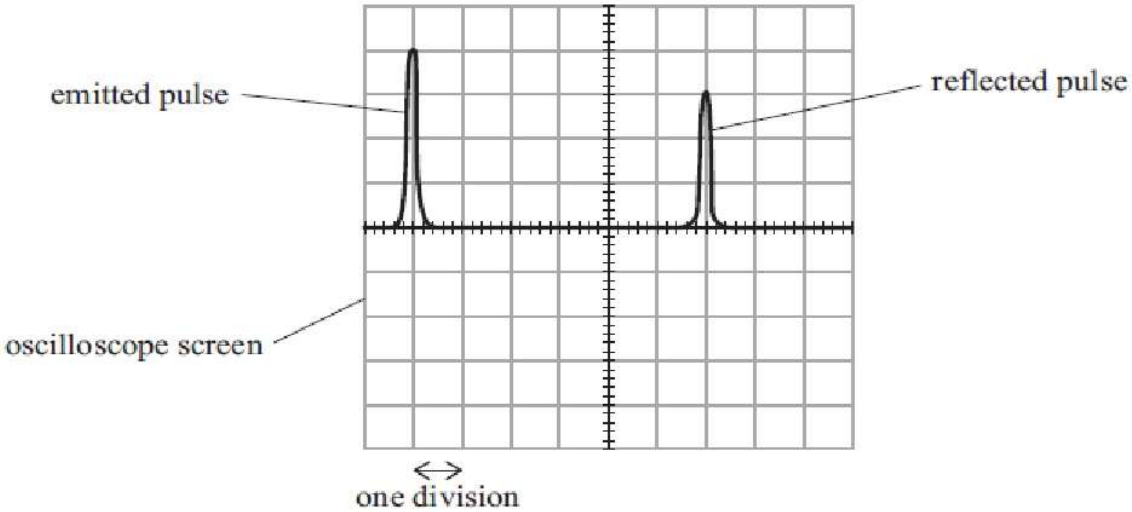
3 A student determined the speed of ultrasound in air using an ultrasound transducer.

(b) The ultrasonic transducer emitted pulses of ultrasound.

The emitted pulses were reflected at the water surface and then detected when they returned to the ultrasonic transducer.

The student connected an oscilloscope to the transducer, to determine the time between an emitted pulse and the reflected pulse.

The oscilloscope screen is shown below.



The horizontal axis represents time.

The time scale was set to 0.5 ms per division.

Show that, for this example, the speed v of ultrasound in air was about 330 m s^{-1}.

length of air column s = 49.7 cm

WPH13, Q3b – example 1

Show that, for this example, the speed v of ultrasound in air was about $330\,\text{m}\,\text{s}^{-1}$.

length of air column $s = 49.7\,\text{cm}$

(4)

$v = \frac{s}{t}$

$v = \frac{2 \times (49.7 \times 10^{-2})}{0.5 \times 6 \times 10^{-3}} = 331.3\ \text{m/s} \simeq 330\ \text{m/s}$

time $= 6 \times (0.5 \times 10^{-3})$

distance $= 2 \times s$ (inorder to traveland be reflected back)

WPH13, Q3b – example 2

Show that, for this example, the speed v of ultrasound in air was about $330\,\mathrm{m\,s^{-1}}$.

length of air column $s = 49.7\,\mathrm{cm}$

(4)

~~0.5ms x10 = 5ms~~ $\frac{49.7\,\mathrm{cm}}{100} = 0.497\,\mathrm{m}$ $\frac{0.5\,\mathrm{ms}}{1000} = 5\times10^{-4}\,\mathrm{s}$

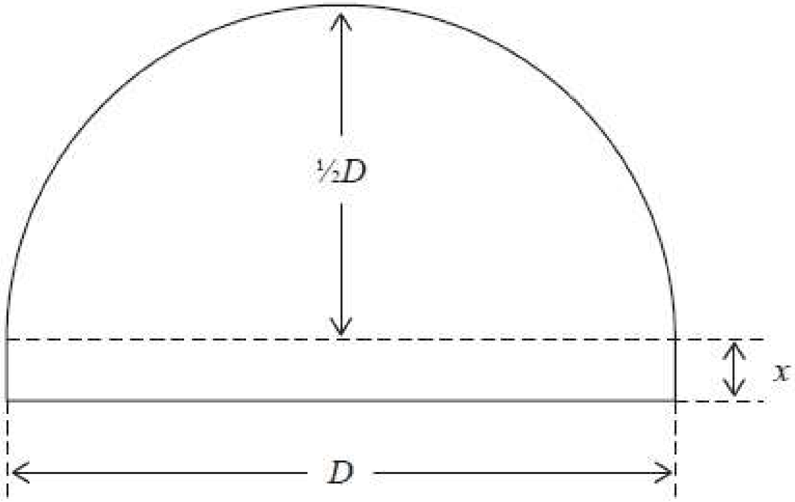
$5\times10^{-4}\,\mathrm{s} \times 10 = 5\times10^{-3}\,\mathrm{s}$ $2s = 0.994\,\mathrm{m}$ $\therefore \frac{0.994}{2.5\times10^{-3}} = 397.6\,\mathrm{ms^{-1}}$

$5\times10^{-3}\times\frac{1}{2}$ since time should be halved since wave is reflected.

length is doubled since the wave is reflected.

WPH16, Q4b

(b) The student determined the volume V of the plastic protractor from the measurements shown.



The student recorded the following measurements.

$D = 10.10\,\text{cm} \pm 0.05\,\text{cm}$
$x = 4.5\,\text{mm} \pm 0.1\,\text{mm}$
$t = 1.40\,\text{mm} \pm 0.02\,\text{mm}$

(i) Show that V is about $6.2\,\text{cm}^3$.

(2)

(ii) Show that the uncertainty in V is about $0.2\,\text{cm}^3$.

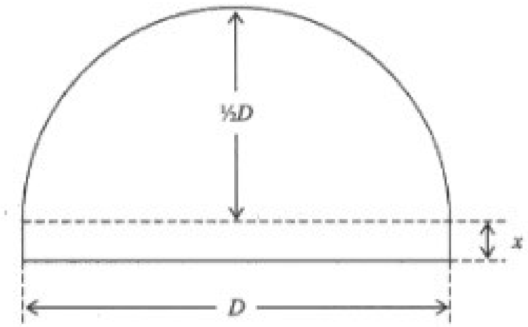
(4)

WPH16, Q4b MS

4(b)(i)	Uses V = (area of semicircle + area of rectangle) × thickness	**(1)**	
	$V = 6.24$ (cm^3)	**(1)**	**2**
	Example of calculation Volume of semicircle $= \frac{\pi D^2 t}{8} = \frac{\pi \times (10.1\text{cm})^2 \times 0.14 \text{ cm}}{8} = 5.608 \text{ cm}^3$ Volume of rectangle $= 10.1 \text{ cm} \times 0.45 \text{ cm} \times 0.14 \text{ cm} = 0.636 \text{ cm}^3$ $V = 5.608 \text{ cm}^3 + 0.636 \text{ cm}^3 = 6.24 \text{ cm}^3$		
4(b)(ii)	**EITHER**		
	Doubles %U in D — Accept doubles $\frac{\Delta D}{D}$	**(1)**	
	Correct calculation of %U in $\frac{\pi D^2 t}{8}$ **Or** Correct calculation of %U in Dxt	**(1)**	
	Calculation of U in $\frac{\pi D^2 t}{8}$ **and** U in Dxt	**(1)**	
	U = 0.16 (cm^3)	**(1)**	
	Example of calculation %U in D = 0.5% %U in x = 2.2% %U in t = = 1.4% %U in $\frac{\pi D^2 t}{8}$ = (2 × 0.5%) + 1.4 % = 2.4 % %U in Dxt = 0.5 % + 2.2 % + 1.4 % = 4.1 % U in V = (5.61 cm^3 × 2.4 %) + (0.64 cm^3 × 4.1%) = 0.135 cm^3 + 0.026 cm^3 = 0.16 (cm^3)		
	OR		
	Uses maximum values to calculate maximum V **Or** Uses minimum values to calculate minimum V	**(1)** **(1)**	
	Maximum V = 6.40 (cm^3) **Or** minimum V = 6.08 (cm^3)	**(1)**	
	Correct calculation of half range	**(1)**	**4**
	U = 0.16 (cm^3)		
	Example of calculation Maximum $V = \frac{\pi \times (10.15\text{cm})^2 \times 0.142\text{cm}}{8} + 10.15\text{cm} \times 0.46\text{cm} \times 0.142\text{cm}$ = 5.74 cm^3+ 0.66 cm^3= 6.40 (cm^3) Minimum $V = \frac{\pi \times (10.05\text{cm})^2 \times 0.138\text{cm}}{8} + 10.05\text{cm} \times 0.44\text{cm} \times 0.138\text{cm}$ = 5.47 cm^3 + 0.61 cm^3 = 6.08 (cm^3) U in $V = \frac{(6.40 - 6.08)\text{cm}^3}{2}$ = 0.16 (cm^3)		

WPH16, Q4b – example 1

(b) The student determined the volume V of the plastic protractor from the measurements shown.



The student recorded the following measurements.

$D = 10.10\,\text{cm} \pm 0.05\,\text{cm}$
$x = 4.5\,\text{mm} \pm 0.1\,\text{mm}$
$t = 1.40\,\text{mm} \pm 0.02\,\text{mm}$

(i) Show that V is about $6.2\,\text{cm}^3$.

(2)

$4.5 \div 10 = 0.45\,\text{cm}$ $\quad 1.4 \div 10 = 0.14\,\text{cm}$ $\quad 10.10 \div 2 = 5.05\,\text{cm}$

$V = 0.5 \times \pi \times (5.05)^2 \times 0.14 + 0.45 \times 10.10 \times 0.14 = \boxed{6.24\,\text{cm}^3}$

(ii) Show that the uncertainty in V is about $0.2\,\text{cm}^3$.

(4)

$V = \frac{1}{8}\pi D^2 t + Dxt$

$\frac{0.05}{10.10} \times 100 = 0.495\%$ $\quad \frac{0.02}{1.4} \times 100 = 1.4\%$

$2 \times 0.495 + 1.4 = \underline{2.42\%}$ $\quad \cancel{0.242 \times 0.25 \times \pi \times 10.10^2 =}$

$\cancel{0.0242 \times 0.5 \times \pi \times (5.05)^2 \times 0.14 = 0.135}$

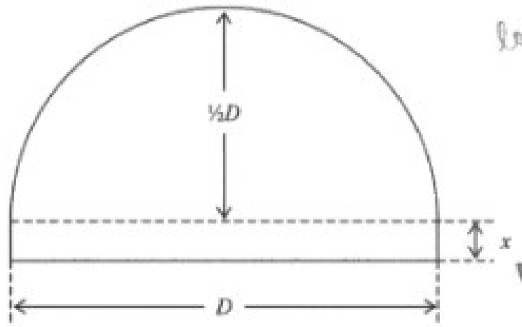
$0.0242 \times \frac{1}{8} \times \pi \times (10.10)^2 \times 0.14 = \underline{0.136}$ $\quad \frac{0.1}{4.5} \times 100 = 2.22\%$

$2.22 + 1.4 + 0.495 = 4.15\%.$ $\quad 0.0415 \times 0.45 \times 10.10 \times 0.14 = 0.02638$

$0.02638 + 0.136 = \boxed{0.16\,\text{cm}^3}$

WPH16, Q4b – example 2

(b) The student determined the volume V of the plastic protractor from the measurements shown.



lower limit = 6.09 cm³

A = 44.122 cm²

πr² 39.7 cm²

Dx = 4.422 cm²

10.05

0.138

0.44

The student recorded the following measurements.

$D = 10.10\,\text{cm} \pm 0.05\,\text{cm}$
$x = 4.5\,\text{mm} \pm 0.1\,\text{mm}$
$t = 1.40\,\text{mm} \pm 0.02\,\text{mm}$

(i) Show that V is about $6.2\,\text{cm}^3$.

(2)

$A = \pi r^2 = \pi \times (5.05)^2 \times 0.5 = 40.06\,\text{cm}^2$ } 44.605 cm²

$A = D \times x = 10.1\,\text{cm} \times 0.45\,\text{cm} = 4.545\,\text{cm}^2$

$V = 44.605\,\text{cm}^2 \times 0.14\,\text{cm} = 6.2447 = 6.2\,\text{cm}^3$

(ii) Show that the uncertainty in V is about $0.2\,\text{cm}^3$.

(4)

upper limit = D=10.15 cm t=0.142 cm

x=0.46 cm

$\frac{1}{2}\pi r^2 = 40.5$ $Dx = 4.669$ $A = 45.169\,\text{cm}^2$

$45.169\,\text{cm}^2 \times 0.46\,\text{cm} = 6.414\,\text{cm}^3$

lower limit = D=10.05 cm t=0.138 cm   uncertainity = 0.16 cm³

x=0.44 cm

$\frac{1}{2}\pi r^2 = \cancel{44.122\,\text{cm}^2}$ 39.7 cm² $Dx = 4.422\,\text{cm}^2$ $A = 44.122\,\text{cm}^2$

$44.122\,\text{cm}^2 \times 0.\cancel{138}\,\text{cm} = 6.09\,\text{cm}^3$ $\frac{6.414 - 6.09}{2} = 0.16\,\text{cm}^3$

Common mistakes
(and how to avoid them)

Common mistakes

1. When answering an AO2b question candidates sometimes forget to make a conclusion.
2. Some candidates do not pay sufficient attention to the command words used in the question.
3. Some candidates miss out on a final answer mark in a question because they omit units.
4. Some responses just repeat previous mark scheme answers.
5. The conclusion must include a comparison of the calculated answer and a value given in the question.
6. Candidates should learn the difference between ’describe’ and 'explain’ so the correct level of detail is included.
7. Units are required for all calculated final answers (including AO3 questions) unless it is a ‘show that’ question.
8. A ‘standard’ answer (as seen in a previous MS) is only fine if it is iven in response to a standard question.

Common mistakes

9. Some responses to unstructured calculations are poorly set out.
10. If candidates set their work out haphazardly, they may miss out on full marks for their response as it may not be clear what method they have used.
11. Definition and derivation questions are often poorly answered.
12. Linkage questions tend to miss out on essential detail required for indicative content credit to be given.
13. Candidates should set out their work so that the logic of the solution can be seen. It may help to divide the answer space into two columns so that candidates do not run out of space.
14. Candidates should be encouraged to learn standard definitions and derivations.
15. Candidates should be encouraged to plan the key points that they want to make before they start to write in the answer space.

Support

Types of support available

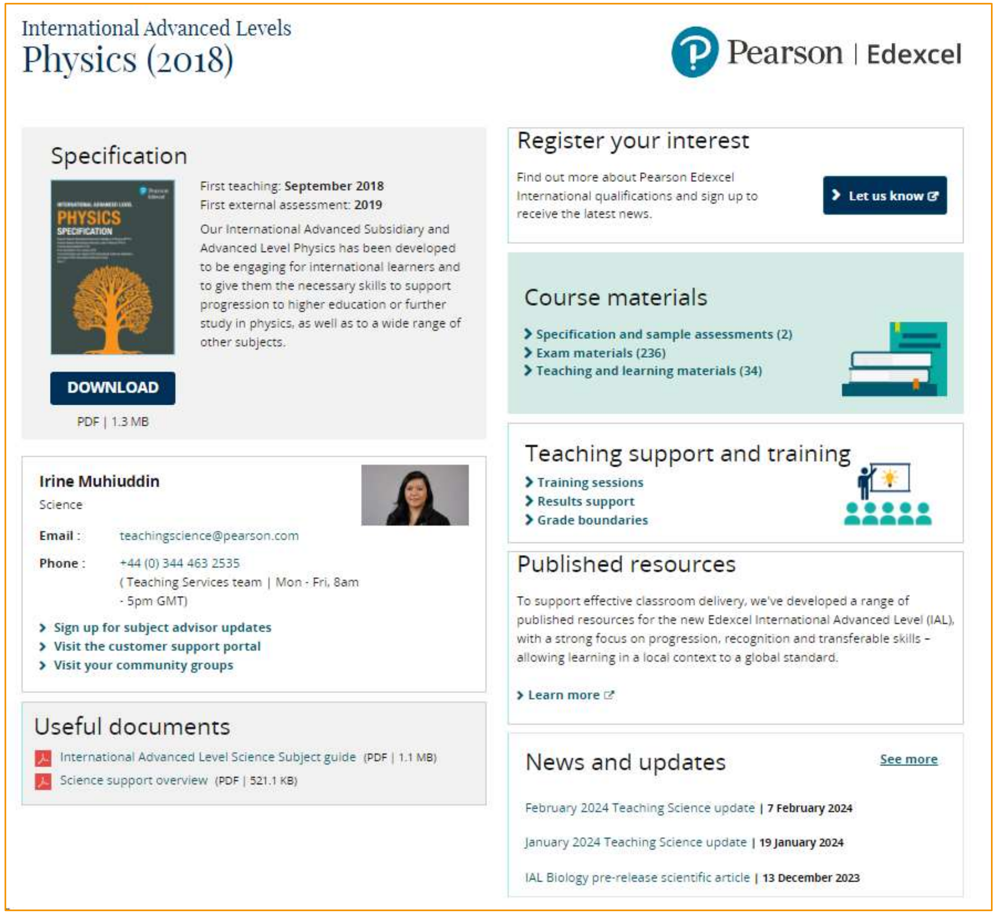
Online support:

- Teaching and Learning Materials.
- Past Papers, Mark Schemes & Examiners' Reports.
- Teacher Resource Packs.

Published resources:

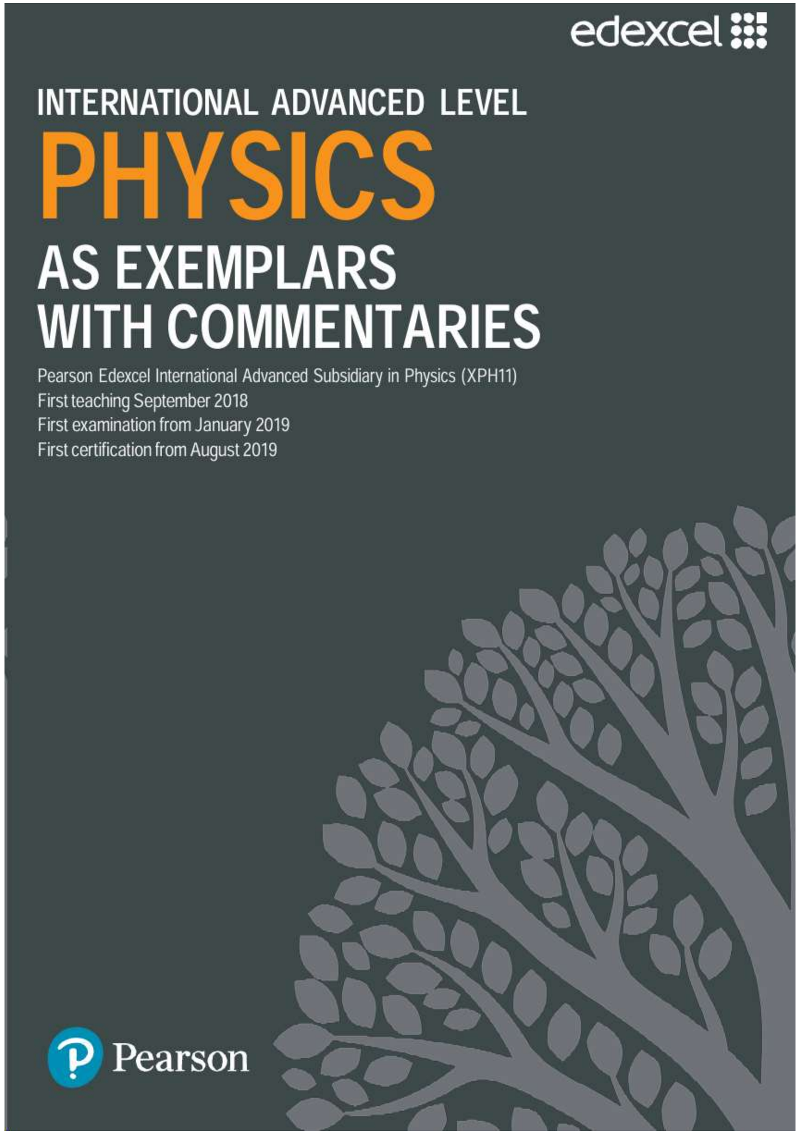
- Student Books.
- Lab Books.

Teaching and learning materials



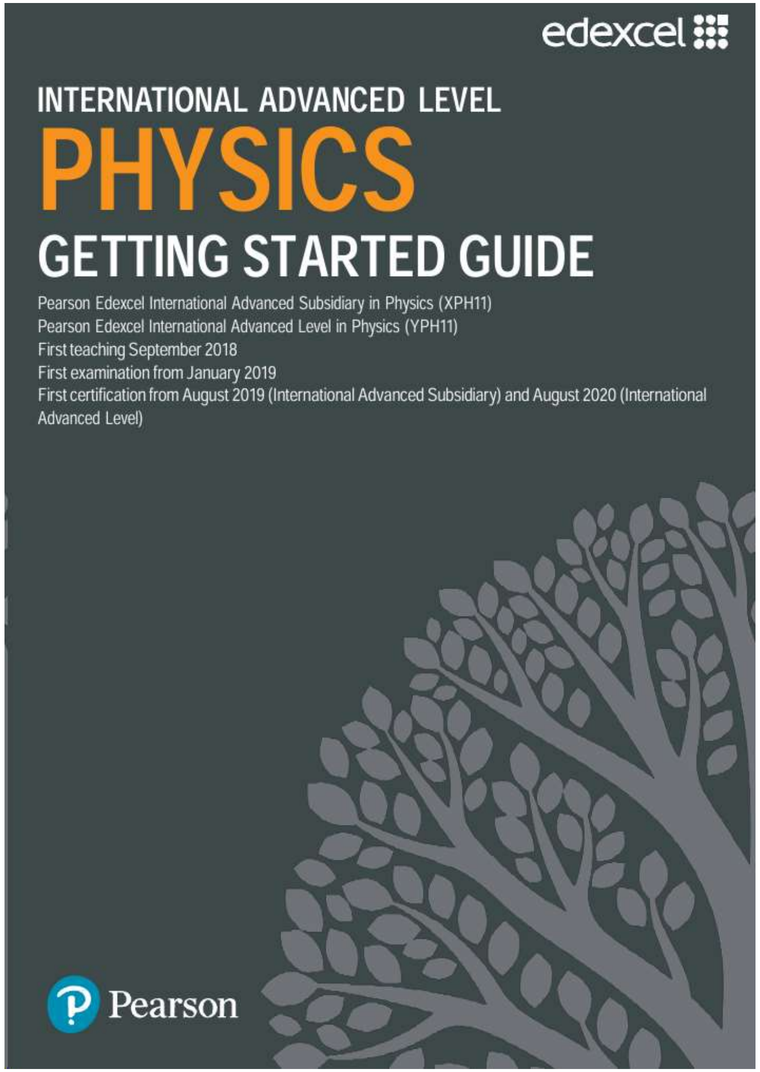
Exemplar material

- Marked exemplars with examiner commentaries.
- Available for both IAS & IAL.



Getting Started Guide

The Getting Started Guide provides an overview of the new Edexcel IAL in Chemistry (2018), provides information about the content and assessment, and gives you a better understanding of what these mean for you and your students.

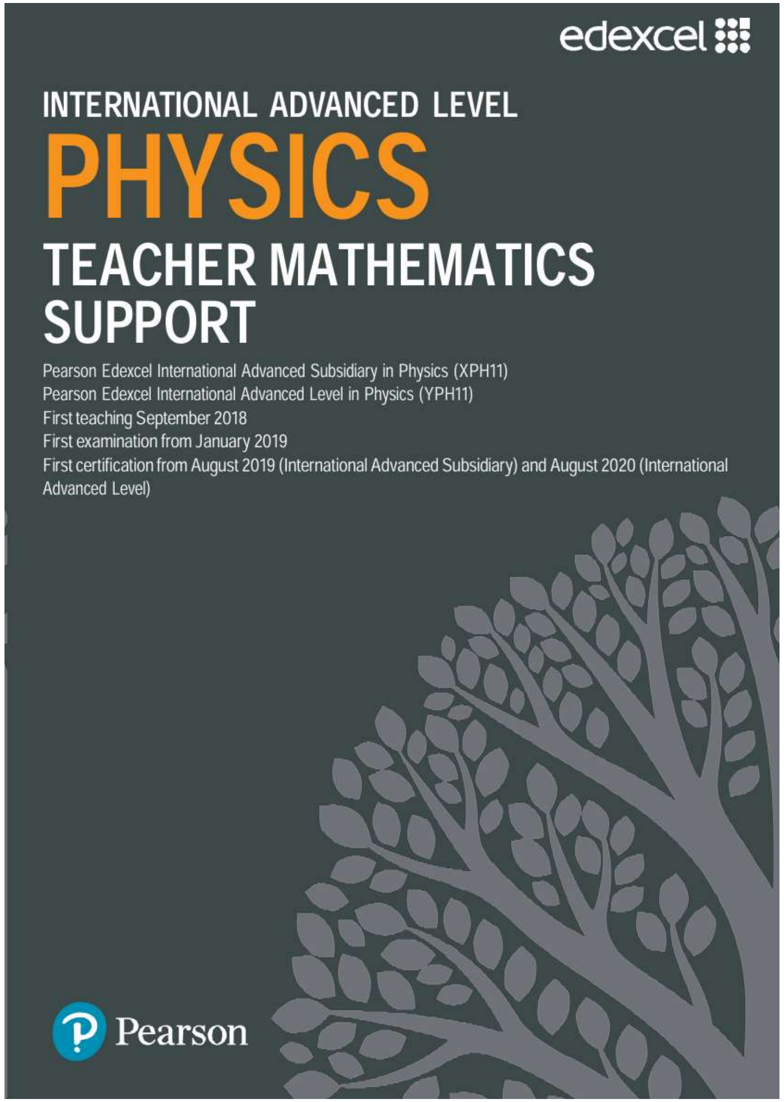


Teacher Mathematics Support

This covers selected topics that students find difficult.

These are:

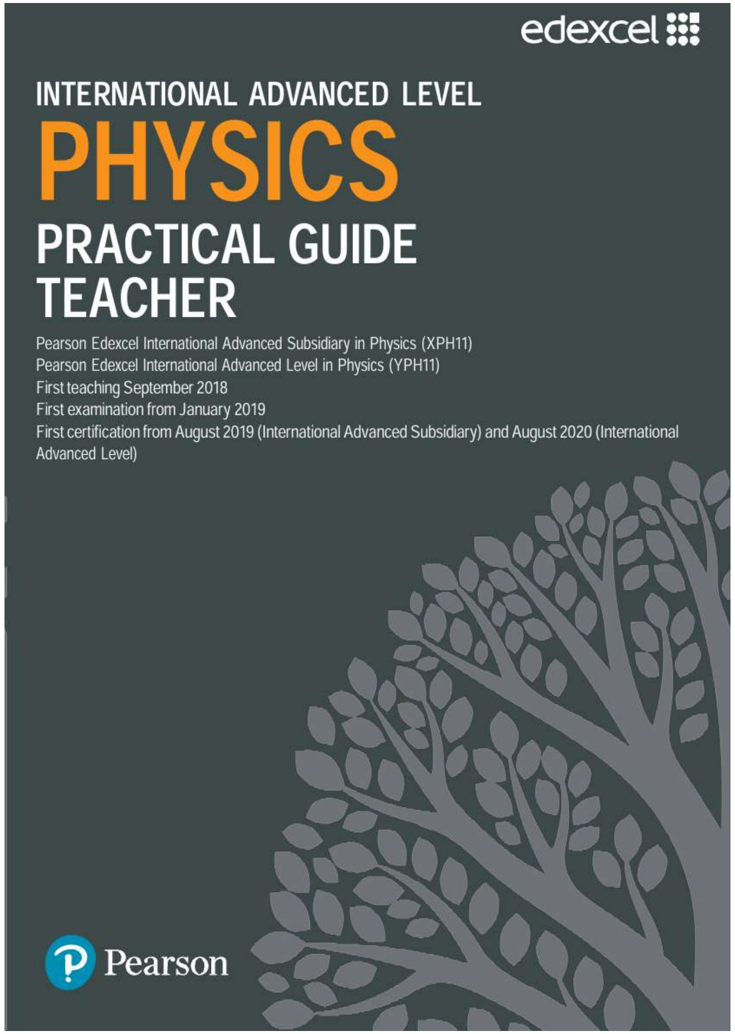
- Mole calculations.
- Enthalpy changes.
- Reaction rates.
- Equilibrium calculations.
- Acid base equilibria and pH calculations.
- Electrode potentials.



Teacher Practical Guide

This guide is designed to:

- support you and your students through all elements of practical work in the new International AS and A Level specification
- explain how the new requirements for practical skills can be developed throughout the course using both core practicals and other specification content.

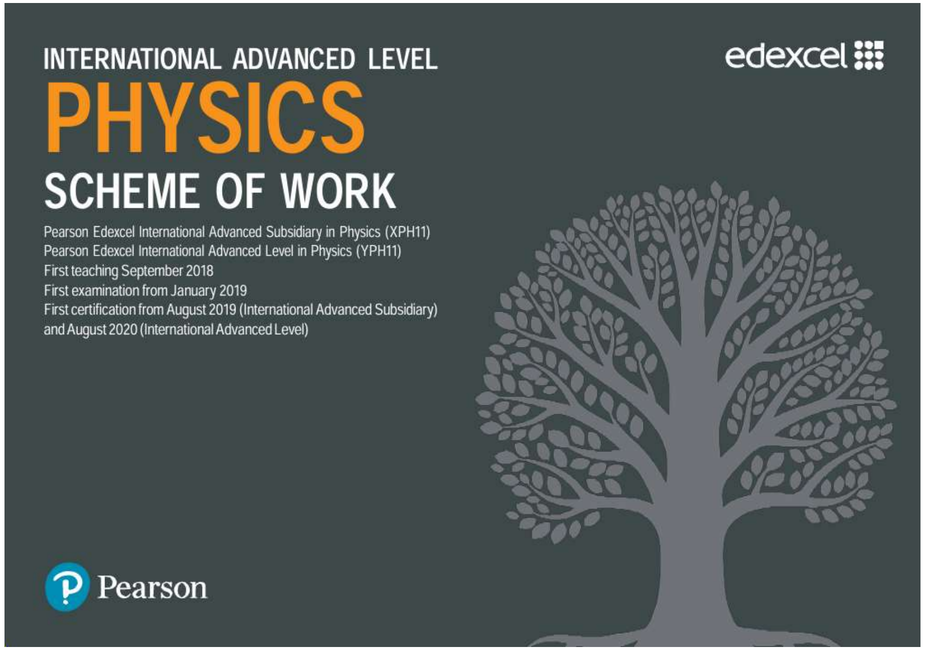


Scheme of Work

The scheme of work is broken up into units and topics, so that there is greater flexibility for moving topics around to meet planning needs.

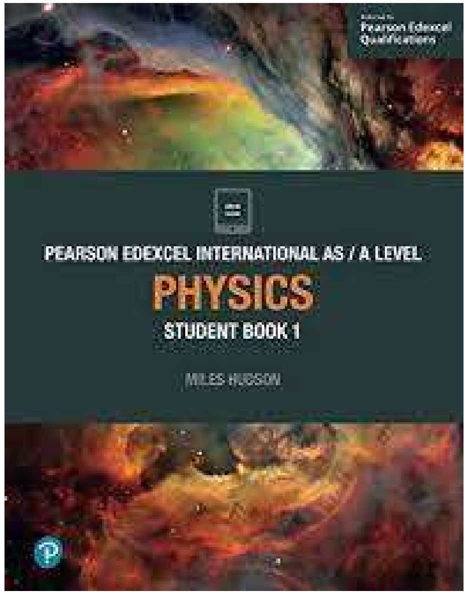
It includes:

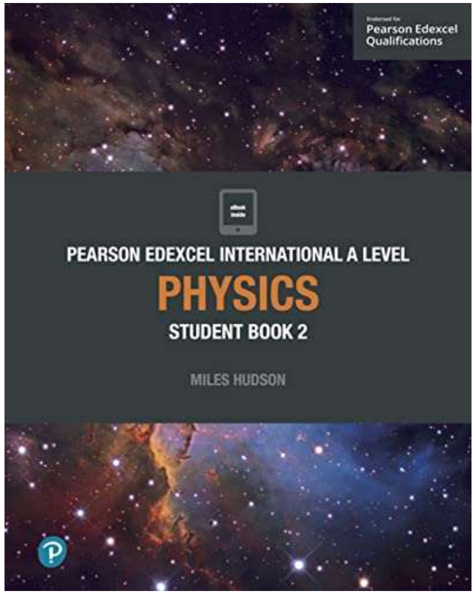
- Recommended teaching time for topics, though of course this is adaptable according to individual teaching needs.
- Classroom activities, teaching points and suggested teaching resources.
- Objectives for students at the end of the topic area and examples of integrated transferable skills.



Published resources

Pearson have published two student books to cover the IAS and IAL courses

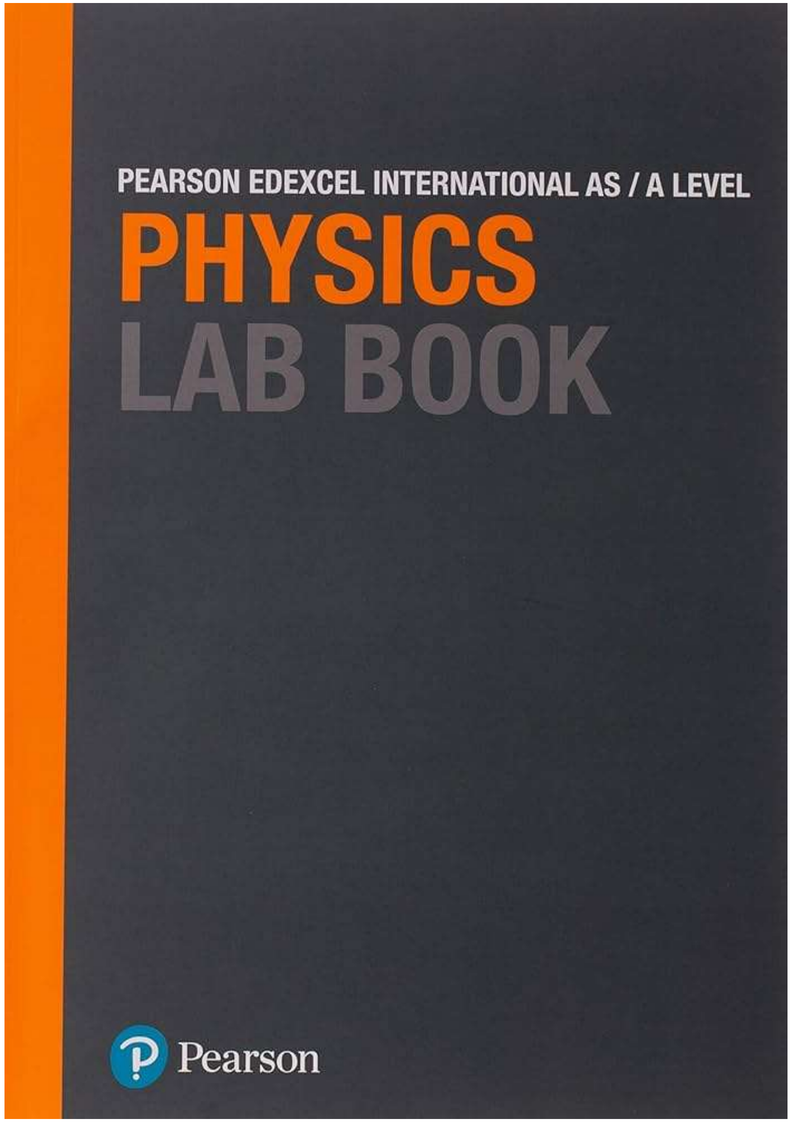




SB1 covers IAS content SB2 covers IAL content

Published resources

Pearson have also published a Lab Book that covers all of the Core Practicals



Subject advisor

Tim Lawrence

Email: teachingscience@pearson.com

Phone: +44 (0) 344 463 2535

Questions