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IGCSE Physics (0625)
Support for teachers in the Maldives

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24 February 2025

Workshop objectives

Objective: to help improve your teaching of Cambridge IGCSE™ Physics (0625).

To do this we will explore the following areas:

- Syllabus overview – aims, assessment objectives and content
- Using assessment materials to support learners
- Space Physics – Hints and tips
- Q&A

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Agenda

| Session 1	Syllabus Overview
Session 2	Using Assessment Materials to Support Learners
Break	
Session 3	Space Physics and Resources
Q&A	

Session One

Syllabus Overview

Icebreaker and introductions

Introduce yourself in the chat with answers to these questions

1. How much experience do you have of teaching Cambridge IGCSE Physics? Are you new? Have you been teaching it for years?

2. Is there anything that "worries" you? What are your concerns?

There will be Q&A at the end so note any questions as we work our way through.
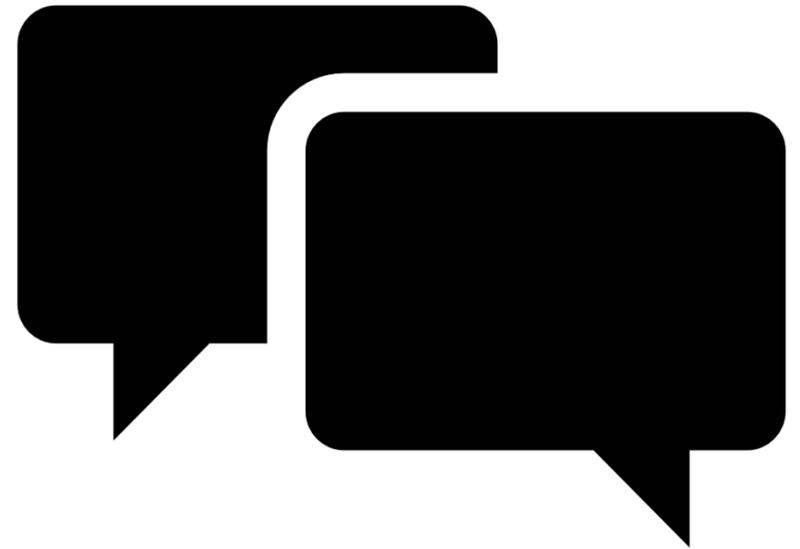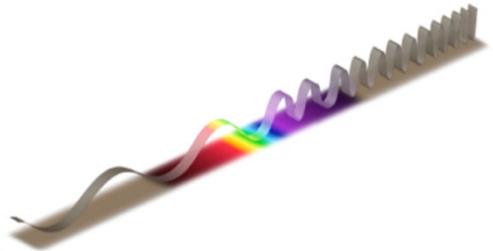
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The syllabus

- contains everything you need to know about Cambridge IGCSE Physics

- it should be the **first** place you go to if you have a question

The syllabus: Aims

The aims of the syllabus are to enable learners to:

- acquire scientific knowledge and understanding of scientific theories and practice

- develop a range of experimental skills, including handling variables and working safely

- use scientific data and evidence to solve problems and discuss the limitations of scientific methods

- communicate effectively and clearly, using scientific terminology, notation and conventions

- understand that the application of scientific knowledge can benefit people and the environment

- enjoy science and develop an informed interest in scientific matters which support further study.

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The syllabus: what to teach

What do you notice about the structure of the syllabus?

1 Motion, forces and energy

1.1 Physical quantities and measurement techniques

Core	Supplement
1 Describe the use of rulers and measuring cylinders to find a length or a volume	
2 Describe how to measure a variety of time intervals using clocks and digital timers	
3 Determine an average value for a small distance and for a short interval of time by measuring multiples (including the period of oscillation of a pendulum)	
	4 Understand that a scalar quantity has magnitude (size) only and that a vector quantity has magnitude and direction

1.5.3 Centre of gravity

1.6 Momentum

Core	Supplement
	1 Define momentum as mass × velocity; recall and use the equation $p = mv$
	2 Define impulse as force × time for which force acts; recall and use the equation $impulse = F\Delta t = \Delta(mv)$
	3 Apply the principle of the conservation of momentum to solve simple problems in one dimension
	4 Define resultant force as the change in momentum per unit time; recall and use the equation $F = \dfrac{\Delta p}{\Delta t}$

Supplement

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Core or Extended?

Core:

- Grades C - G
- Only need to be taught Core material from the syllabus

Extended:

- Grades A* - G
- Need to be taught Core **and** Supplement material from the syllabus

The syllabus: Topics

Learners study the following topics:

1. Motion, forces and energy
2. Thermal physics
3. Waves
4. Electricity and magnetism
5. Nuclear physics
6. Space physics

- What order of teaching do you use?

  Do you follow the order of topics in a particular textbook, or does your school use its own order for teaching?

- Which topics build upon knowledge and understanding that are developed in another topic in the list?

The syllabus: Topics - progression

6.2 Stars and the Universe continued

6.2.3 The Universe

Core

1   Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years

2   Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies

3   Know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth

4   Know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory

Supplement

5   Know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)

6   Explain that the CMBR was produced shortly after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded

7   Know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy's starlight due to redshift

8   Know that the distance d of a far galaxy can be determined using the brightness of a supernova in that galaxy

9   Define the Hubble constant H_0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance from the Earth; recall and use the equation

$$H_0 = \frac{v}{d}$$

- What prior knowledge and skills might learners need to be able to understand this?

The components

Paper 1 (Core) and Paper 2 (Extended) are the multiple-choice papers:

- 45 minutes
- 40 marks   30%
- 40 four-option multiple-choice questions
- Externally assessed

Paper 3 (Core) and Paper 4 (Extended) are the Theory papers.

- 1 hour 15 minutes
- 80 marks   50%
- Short-answer and structured questions
- Externally assessed

The components

Paper 6 is the Alternative to Practical (ATP):

- 1 hour
- 40 marks   20%
- Questions will be based on the experimental skills in Section 4 of the syllabus
- Externally assessed

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The Assessment Objectives

Implications for teaching?

- AO1 Knowledge with understanding
- AO2 Handling information and problem-solving
- AO3 Experimental skills and investigations.

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %		
	Papers 1 and 2	Papers 3 and 4	Papers 5 and 6
AO1 Knowledge with understanding	63	63	0
AO2 Handling information and problem-solving	37	37	0
AO3 Experimental skills and investigations	0	0	100
Total	100	100	100

The Assessment model

1. Please make a note of any observations or questions about the following:

- how the qualification is assessed

- any options/choices available

- the paper combinations for the qualification

- the content of the papers (proportion of each paper assessing each topic or assessment objective, type of questions on each paper)

- the weighting of each paper.

A word about practical work...

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"We don't need to do any practical work because we enter candidates for Paper 6 (Alternative to Practical)"

A Teacher

(ii) Her readings are shown in Table 2.1.

Add units to the column headings in Table 2.1.

Table 2.1

t/	beaker with 200 cm³ of hot water θ/	beaker with 75 cm³ of hot water θ/
0	87.5	85.5
30	85.5	82.0
60	84.0	78.5
90	82.5	75.0
120	81.0	72.0
150	80.0	69.5
180	79.0	67.0

[1]

(c) Write a conclusion stating how the volume of water affects the rate of cooling of the water.

Justify your answer by reference to the results.

....

....

....

.... [2]

3 A student determines the focal length of a converging lens.

Fig. 3.1

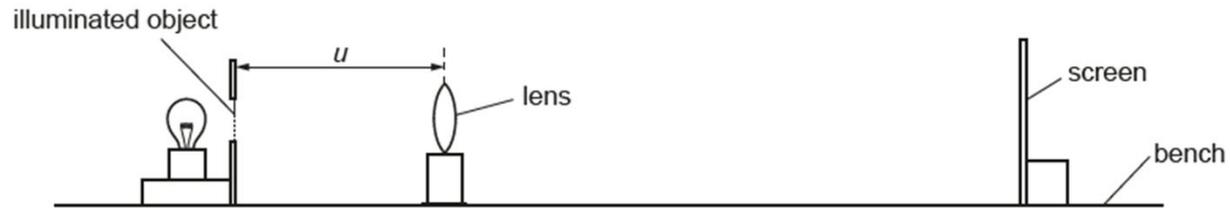**(a)** The student sets up the apparatus as shown in Fig. 3.1.

He sets the distance u between the illuminated object and the lens to 25.0 cm.

He places the screen near the lens and moves the screen until a focused image of the illuminated object is seen on the screen.

Describe a technique for obtaining an image that is as sharp as possible.

....

....

.... [1]

Method 2

(b) Fig. 1.2 shows two wooden blocks and one of the marbles.

Fig. 1.2

Describe how the student uses the two blocks and the marble to determine a new accurate value for the diameter of a marble.
Draw a diagram to show the arrangement.
Describe clearly how the student ensures that the value for the diameter of a marble is as accurate as possible.

....

....

.... [2]

Paper 6

Table 3.1

l/cm	V/V	I/A	R/Ω
20.0			
40.0	1.7	0.47	3.6
60.0	2.2	0.52	4.2
80.0	2.3	0.35	6.6
100.0	2.4	0.29	8.3

(e) Suggest **one** practical reason why students carrying out this experiment may not obtain the same readings as in Table 3.1. Assume that the procedure has been done carefully.

....

....

.... [1]

Paper 6

Candidates will find it very difficult to access the questions on Paper 6 without having been exposed to practical work.

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How to get more marks on paper 6

- Do more practical work!
- Use past Paper 5 questions in lessons as a practical activity
- Practical guidance on pages 52-54 of the syllabus

"We don't have much equipment"

Select suitable activities from old Paper 5

Look at the Confidential Instructions

Find those that use minimal equipment or that use equipment you do have or can easily get

Can you adapt some of the equipment?

Question 1

Items to be supplied by the centre (per set of apparatus, unless otherwise specified)

(i) 12 microscope slides, each of approximate dimensions 7.5 cm × 2.5 cm × 0.1 cm. See Note 1.

(ii) Masking tape. See Note 1.

(iii) A 30 cm ruler with a millimetre scale.

(iv) A card on which the mass and thickness of a single microscope slide is written. See Note 2.

(v) Access to a top-pan balance capable of recording mass to 0.1 g. See Note 3.

Notes

1 The 12 slides must be stacked together. Masking tape must be secured around the edges of the stack so that candidates cannot count the number of slides in the stack. See Fig. 1.1.

masking tape secured around edges

stack of 12 slides

Fig. 1.1

2 The mass m and the thickness t of a **single** microscope slide must be written on a piece of card and the card placed close to the stack of slides.

The mass m must be measured to 0.1 g and the thickness t must be measured to 0.01 cm and displayed on the card as shown in Fig. 1.2.

mass of a single slide m = ... g

thickness of a single slide t = ... cm

Fig. 1.2

3 There must be sufficient top-pan balances available so that candidates do not suffer undue delay when measuring the mass of the stack of microscope slides.

Action at Changeover

Ensure that the information card is placed close to the stack of slides.

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"We don't have much equipment"

Question 1

Items to be supplied by the centre (per set of apparatus unless otherwise specified)

(i) Clamp, boss and stand.

(ii) Pendulum bob attached to approximately 110 cm of inextensible string or thread.

(iii) Metre ruler, graduated in mm.

(iv) Stop-watch or stop-clock with a minimum precision of 0.1 s.

(v) Split cork (or similar device) to hold the thread of the pendulum between the jaws of the clamp.

(vi) Set square.

Notes

1. The pendulum, with a length of approximately 100 cm from the bottom of the split cork (or similar device) to the centre of the bob, must be set up for the candidates. (The boss and clamp should be near the top of the stand and the pendulum must be able to hang freely over the edge of the table.)

2. Candidates must be able to adjust the length of the pendulum easily.

3. The pendulum must be able to swing freely. It may be necessary to increase the stability of the clamp stand (for example, using a G-clamp or by placing a weight on the base).

Action at changeover

Arrange the pendulum as described in Note 1.

"We don't have much equipment"

Question 1

Items to be supplied by the centre (per set of apparatus, unless otherwise specified)

(i) Dry coarse sand (per candidate). See note 1.

(ii) 250 cm^3 measuring cylinder, labelled 'A', with graduations of 2 cm^3. See note 2.

(iii) 100 cm^3 measuring cylinder, labelled 'B', with graduations of 1 cm^3. See note 3.

(iv) Top-pan balance with a minimum resolution of 0.1 g. See note 4.

(v) Supply of cold water. See note 5.

(vi) Paper towels to soak up any water spills.

Notes

1. Each candidate will require a volume of approximately 120 cm^3 of sand.

2. Measuring cylinder A must be dry and clean when presented to each candidate.

3. Another 250 cm^3 measuring cylinder, labelled 'B', with graduations of no larger than 2 cm^3 is an acceptable alternative.

4. This item may be shared but candidates will require easy access during the experiment. The top-pan balance must be capable of measuring the mass of measuring cylinder A and an additional 200 g.

5. Each candidate will require approximately 120 cm^3 of water. The temperature of the water is not important.

Action at changeover

Replace measuring cylinder A, as in (ii), with another clean dry measuring cylinder labelled A.
Supply a dry sample of sand, as in (i).

Session Two

Using Assessment Materials to Support Learners

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How can I use assessment material to support teaching and learning?

In this session we will:

1. explore how to help learners understand the questions
2. explore common errors and misunderstandings and consider how we can address these in our teaching
3. share ways of using past papers in class

What are your main challenges of teaching IGCSE Physics?

Do your learners achieve as well as they could?

Why? Why not?

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School Support Hub – guided tour

- Each syllabus has support documents available on the School Support Hub such as:
  - The **Example Candidate Responses** contain examples of scripts from previous candidates, together with notes on the marks that were achieved.
  - The **Principal Examiner Reports** are produced for each exam series. These report on the strengths and weaknesses of candidate performance over the whole of the cohort of students taking the exam.

- You might also have:
  - The **Learner Guide** has been developed for students taking the qualification. It gives them guidance on the structure of the qualification, how it is assessed and the content.
  - The **Teacher Guide**
  - **Specimen Paper Answers**

https://schoolsupporthub.cambridgeinternational.org/

Question types – multiple choice

11 How is pressure defined?

A area per unit force

B force per unit area

C mass per unit area

D mass per unit volume

23 A pulse of sound is produced at the bottom of a boat. The sound travels through the water and is reflected from the seabed. The reflected sound reaches the boat 1.3s after the sound was produced. The seabed is 1000 m below the boat.

boat

1000 m

seabed
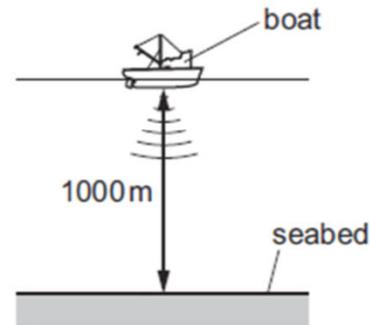
Using this information, what is the speed of sound in the water?

A 770 m/s **B** 1300 m/s **C** 1500 m/s **D** 2600 m/s

Question types – fill in the blank

(b) The teacher demonstrates waves moving from deep water into shallow water.
Fig. 6.1 shows the crests of the waves, viewed from above. The arrows show the direction of wave travel.
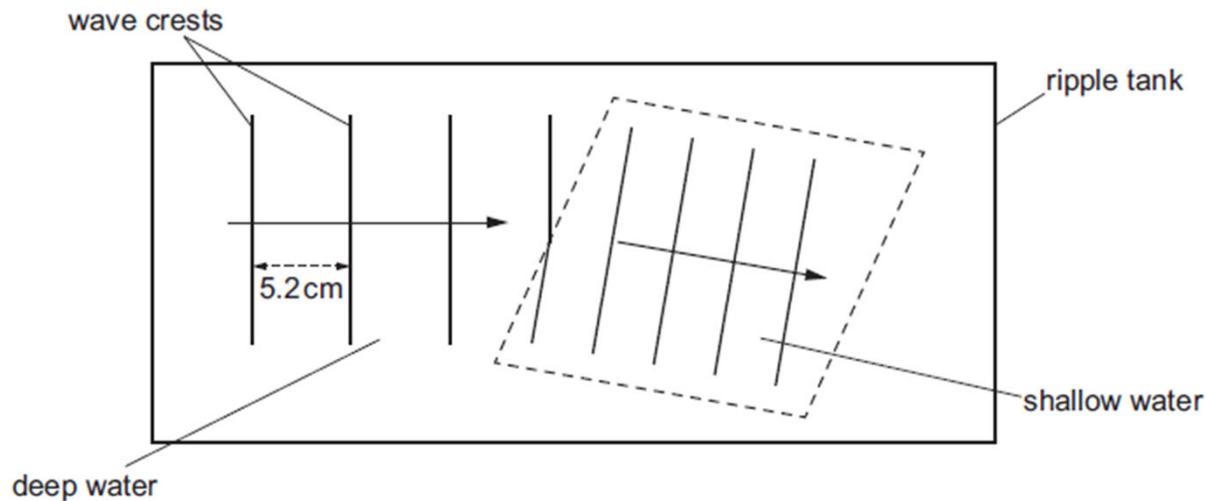
Fig. 6.1

(i) Complete the sentence about the wave property shown in Fig. 6.1.

The change of direction of the wave is called .... [1]

Question types – complete the diagram

Many candidates did not give an answer for the 3 marks in (b).

Why not?

---

7 (a) The direction of vibration in a type of wave is parallel to the direction in which the wave is moving.
State the name of this type of wave.

type of wave .... [1]

6 (a) A sound wave travels through air. Fig. 6.1 shows a pressure–time graph for the air at one place.
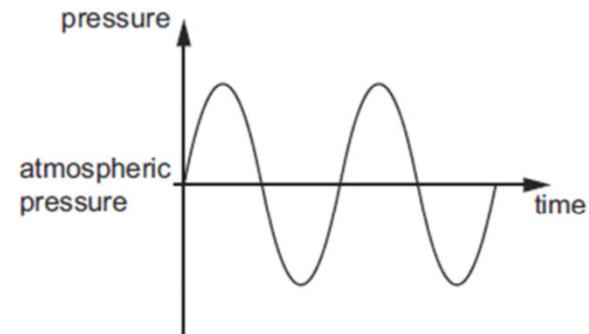
Fig. 6.1

(i) On Fig. 6.1:

- label **one** point C to indicate a compression
- label **one** point R to indicate a rarefaction.

[2]

Question types – short answer

10 (a) (i) Name **three** types of nuclear emission from radioactive sources.

1 ....

2 ....

3 ....

[2]

(ii) State the type of nuclear emission which has a relative charge of +2.

.... [1]

(iii) State the type of nuclear emission which is part of the electromagnetic spectrum.

.... [1]

Question types – long answer

How can we get candidates to maximise their chances of getting 3 marks?

9 (a) A nuclear power station has a reactor where controlled nuclear fission of uranium-235 takes place.

    (i) Explain what is meant by nuclear fission.

    ....

    ....

    ....

    ....

    .... [3]

Question types – calculation

(b) The combined resistance of the three resistors shown in Fig. 9.2 is $4.4\,\Omega$.
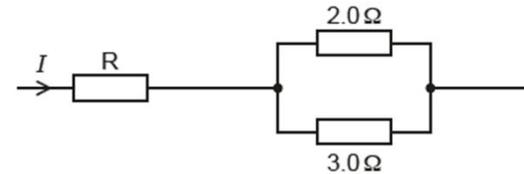
Fig. 9.2

(i) Calculate the resistance of resistor R.

resistance = ... [3]

(ii) The current I in Fig. 9.2 is $0.94\,A$.

Calculate the potential difference (p.d.) across the combination of resistors.

p.d. = ... [2]

[Total: 6]

Question types – practical planning

What problems do your learners have with these?

There are **ALWAYS** 7 marks available on Paper 6 for this.

4   A student investigates the length of time taken for ice cubes to melt when they are placed in water. She uses beakers of water at different temperatures to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

Plan an experiment to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

The following apparatus is available:

thermometer
supply of ice cubes
$250\,cm^3$ beakers
supply of cold water

In your plan, you should:

- write a list of additional apparatus to use

- explain how to carry out the investigation

- state the key variables to keep constant

- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)

- explain how to use the readings to reach a conclusion.

Question types – graphs

What errors do your candidates make?

There are **ALWAYS** 4 marks available on Paper 6 for this.

Table 1.1

P/N	l/mm
0.20	20
0.40	26
0.60	31
0.80	35
1.00	41

Plot a graph of l/mm (y-axis) against P/N (x-axis). Start both axes at the origin (0,0).

[4]
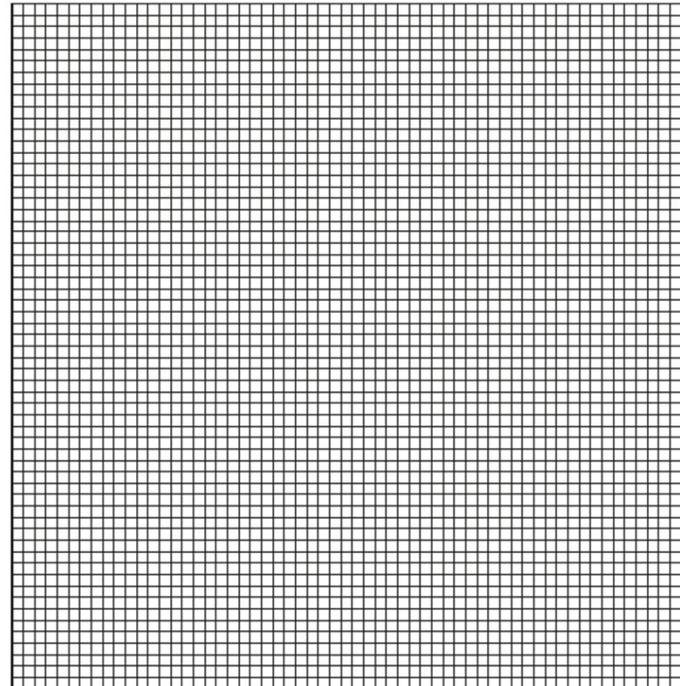
Common mistakes on graphs

(c) Graph:
- axes correctly labelled, right way round and with units
- suitable scales, plots occupying at least half grid in both directions
- all plots correct to within ½ small square
- good best-fit line judgement
- single, thin, continuous line

(c) Plot a graph of θ/°C (y-axis) against t/s (x-axis).

PERFECT!

✓
✓
✓
✓
✓

5/5

[5]
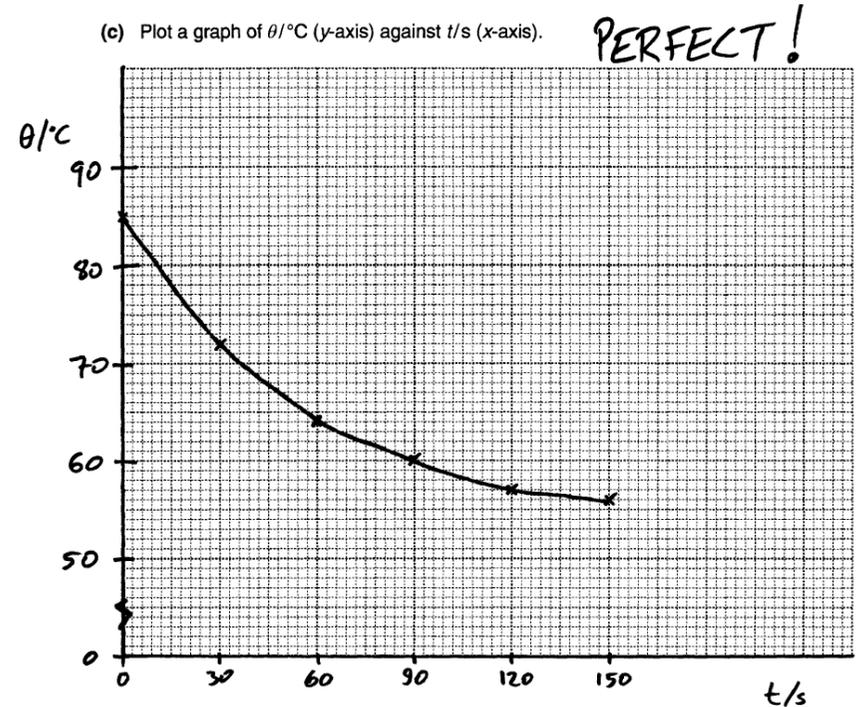
Common mistakes on graphs

What has gone wrong here?

(c) Plot a graph of $\theta/°C$ (*y*-axis) against *t/s* (*x*-axis).

WHOOPS!
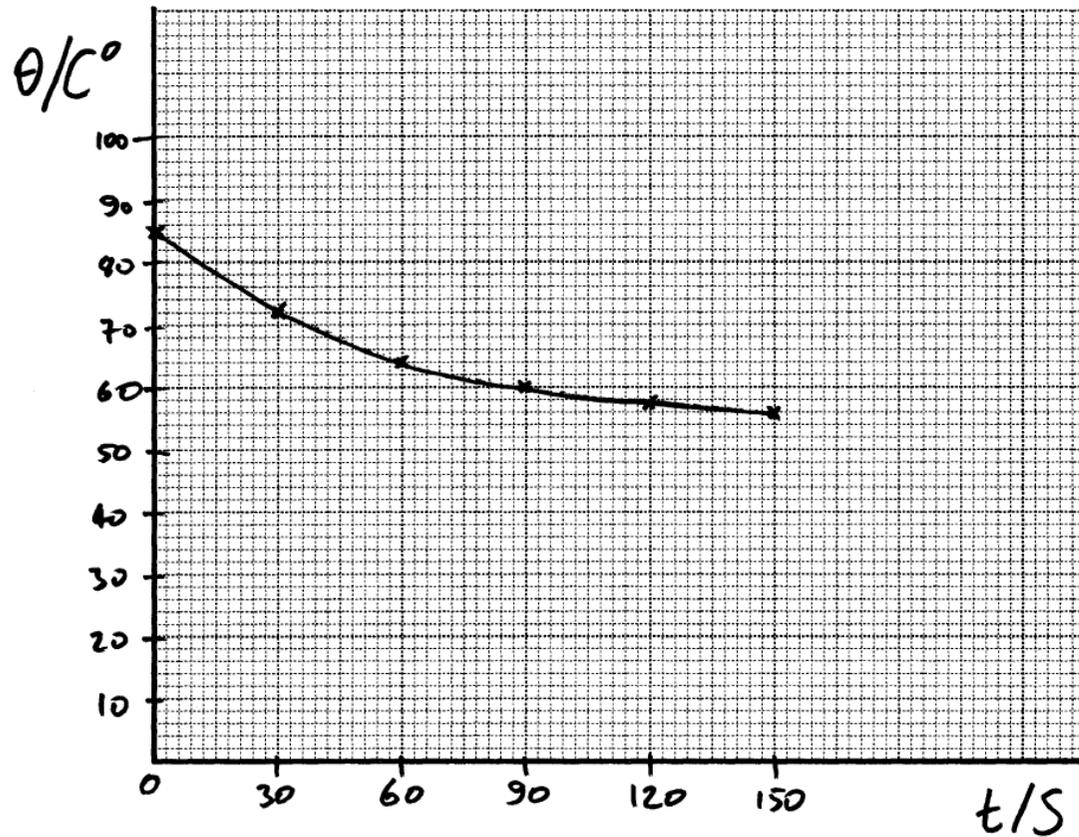
Common mistakes on graphs

Common mistakes on graphs

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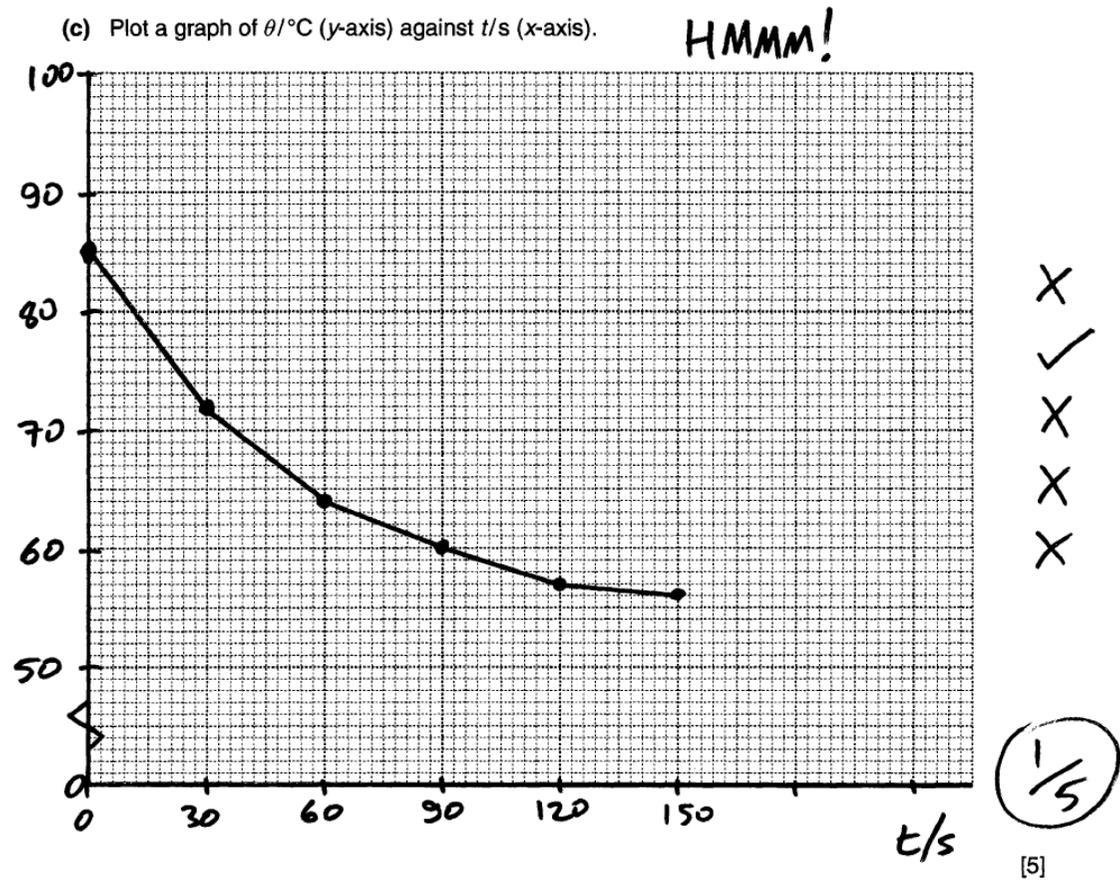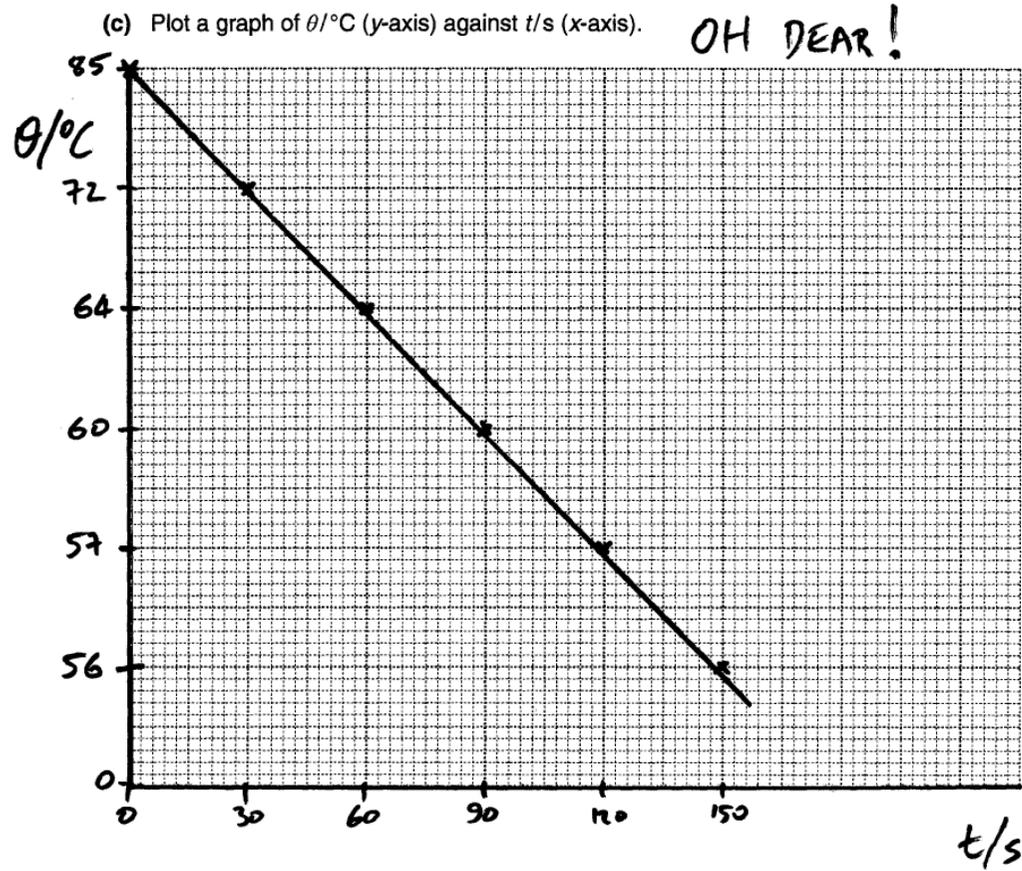
Helping learners to understand the question

Students often do not answer questions as well as they could because they do not fully understand the command word of the question and what they are expected to include in their answer.

(Page 55 of the syllabus)

Command word	What it means
Calculate	work out from given facts, figures or information
Comment	give an informed opinion
Compare	identify/comment on similarities and/or differences
Deduce	conclude from available information
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Determine	establish an answer using the information available
Explain	set out purposes or reasons / make the relationships between things clear / say why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Identify	name/select/recognise
Justify	support a case with evidence/argument
Predict	suggest what may happen based on available information
Sketch	make a simple freehand drawing showing the key features, taking care over proportions
State	express in clear terms
Suggest	apply knowledge and understanding to situations where there are a range of valid responses in order to make proposals / put forward considerations

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Use of past paper questions in lessons

1**. Individually think** about how you have used past papers in your teaching – as a teaching tool rather than as a test.

2. What worked well? Why do you think this was effective?

Use of past paper questions in lessons
"What a good one looks like"

- Look at question 4 – practical planning question

- Read through the question. What would you be looking for in the answer?

Use of past paper questions in lessons
"What a good one looks like"

4   A student investigates the length of time taken for ice cubes to melt when they are placed in water. She uses beakers of water at different temperatures to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.
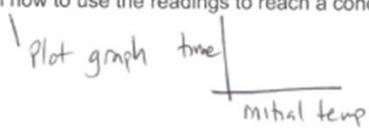
Plan an experiment to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

The following apparatus is available:

thermometer
supply of ice cubes
$250 \, cm^3$ beakers
supply of cold water

In your plan, you should:

- write a list of additional apparatus to use

- explain how to carry out the investigation

- state the key variables to keep constant

- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)

- explain how to use the readings to reach a conclusion.

Use of past paper questions in lessons
"What a good one looks like"

explain how to use the readings to reach a conclusion.

4   A student investigates the length of time taken for ice cubes to melt when they are placed in water. She uses beakers of water at different temperatures to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

Plan an experiment to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

The following apparatus is available:

thermometer
supply of ice cubes
$250\,cm^3$ beakers
supply of cold water

In your plan, you should:

•   write a list of additional apparatus to use

•   explain how to carry out the investigation

•   state the key variables to keep constant

•   draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)

•   explain how to use the readings to reach a conclusion.

Place 1 ice cube in a beaker of water.
Time how long it takes to melt with clock
Change temp of water
Repeat with 2 cubes. Then 3, 4, 5 and 6.
Always use the same amount of water.
Always use 200 cm³ water
To keep it fair I will make sure the
ice cubes are all the same size.

Temp of water	Number of cubes	Time to melt (minutes)

Plot a graph of the results in the table.

Use of past paper questions in lessons
"What a good one looks like"

dependent¹¹ variable

independent variable

4 A student investigates the length of time taken for ice cubes to melt when they are placed in water. She uses beakers of water at different temperatures to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

timer. thermometer.

Plan an experiment to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

The following apparatus is available:

thermometer
supply of ice cubes
250 cm³ beakers
supply of cold water

how to change water temp - Bunsen burner.
Stop clock

In your plan, you should:

1. • write a list of additional apparatus to use

2. • explain how to carry out the investigation

take temp of water (IV)
add cubes — measure time to melt

3. • state the key variables to keep constant

vol of water
number of ice cubes

4. • draw a table, or tables, with column headings, to show how to display the readings (you are not required to enter any readings in the table)

5. • explain how to use the readings to reach a conclusion.

Plot graph time / initial temp

Initial temp of water /°C	Time for ice cubes to melt /s
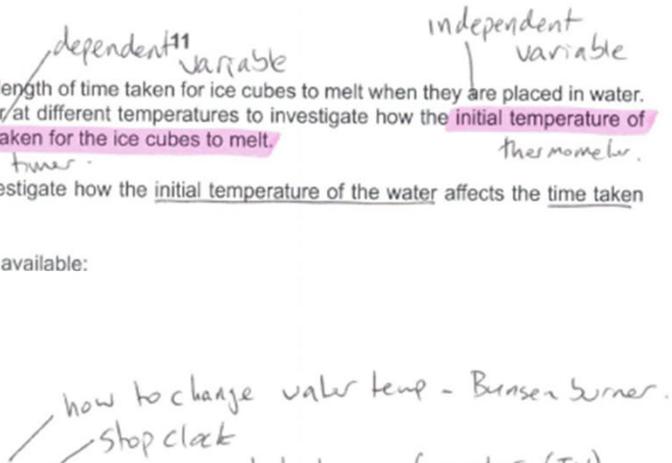
1 — APPARATUS
• Bunsen burner to heat water
• Stop clock

2 — METHOD
• Measure start temp of water - 100 cm³
• Add 5 ice cubes and start timer
• Observe — time how long all ice takes to melt.

3 — KEY VARIABLES
- Volume of water - always 100 cm³
- Always same n° of ice cubes — 5

4 — TABLE
See above

5 — HOW TO USE READINGS
- Plot graph of time against initial temp.

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[Turn over

Use of past paper questions in lessons
"What a good one looks like"

- How might you use this technique with your learners?

- What preparation might you need to do?

- What problems might you have with doing it?

What went wrong?

A ball falling vertically through oil

(c) As the ball falls, its speed v is recorded. Fig. 1.2 is the speed–time graph for the falling ball.
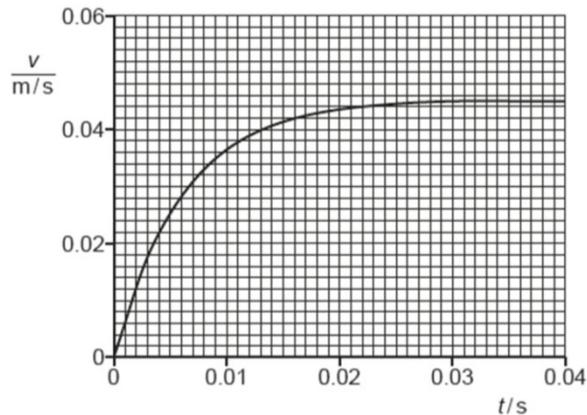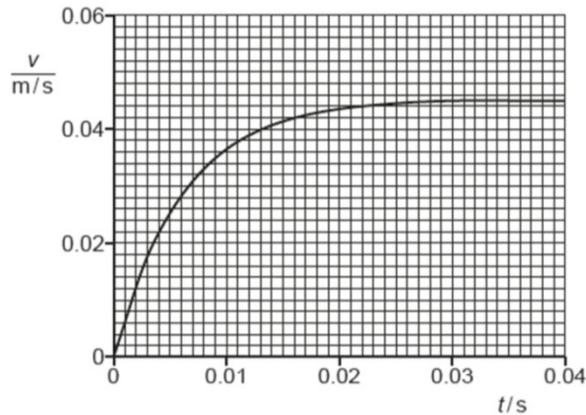

Fig. 1.2

any **four** from:
- (acceleration) decreases
- (acceleration decreases) to zero (at approximately 0.03 s)
- resistive force increases / resistance increases (as speed / velocity increases)
- resultant force (downwards) decreases
- (until) terminal velocity / constant speed (is reached)
- (when) resistive force = weight **OR** resultant force is zero **OR** forces are balanced

(i) Describe what happens to the acceleration between $t = 0$ and $t = 0.040$ s.

Explain why this happens.

The ball falls and gets faster and so the acceleration increases until the ball reaches terminal velocity.

[4]

What went wrong?

A ball falling vertically through oil

(c) As the ball falls, its speed v is recorded. Fig. 1.2 is the speed–time graph for the falling ball.

Fig. 1.2

any **four** from:
- (acceleration) decreases
- (acceleration decreases) to zero (at approximately 0.03 s)
- resistive force increases / resistance increases (as speed / velocity increases)
- resultant force (downwards) decreases
- (until) terminal velocity / constant speed (is reached)
- (when) resistive force = weight **OR** resultant force is zero **OR** forces are balanced

(i) Describe what happens to the acceleration between $t = 0$ and $t = 0.040\,\text{s}$.

Explain why this happens.

Acceleration decreases to zero.
The ball reaches terminal velocity.
Friction increases with speed.
Until weight = friction [4]

What went wrong?

7   A battery, a lamp L, a fixed resistor R and a switch S are connected as shown in Fig. 7.1.
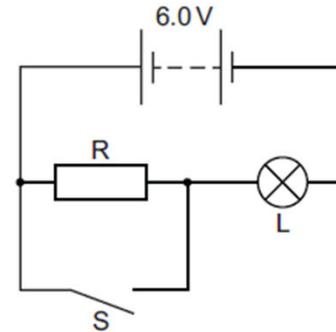
Fig. 7.1

(a)   The potential difference (p.d.) across lamp L is 4.8 V and the current in lamp L is 0.40A.

Calculate the resistance of lamp L.

$$R = V \times I = 4.8 \times 0.40 = 1.92$$

resistance = ... Ω [3]

(b)   State and explain how closing switch S affects the brightness of lamp L.

....

L gets brighter
....

....

.... [3]

[Total: 6]

What went wrong?

12 (a) Fig. 12.1 represents the Earth and the Sun at one point in the Earth's orbit of the Sun.
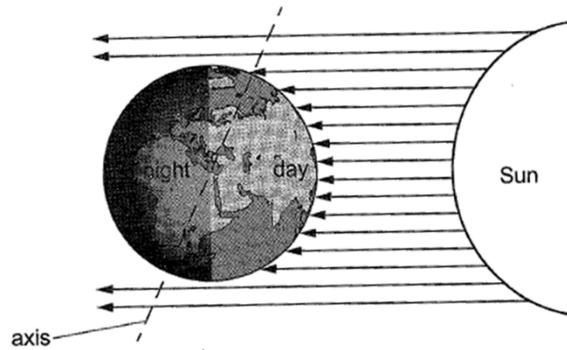
Fig. 12.1 (not to scale)

Explain the apparent daily motion of the Sun across the sky.

The Sun orbits the Earth
This takes 24 hours
[2]

(b) List the four planets closest to the Sun in order of their distance from the Sun. One is done for you.

1 Mercury 2 Venus 3 Earth 4 Moon [2]

(c) The Sun mostly consists of two elements.

State the **two** elements.

1 Hydrogen and Helium

2 Fire energy
[2]

(d) The Sun is a star in a galaxy.

State the name of the galaxy.

Milky Way
[1]

[Total: 7]

What went wrong?

The Principal Examiners' Report to Teachers (PERT) is useful here

Question 12

(a) Many candidates answered this question well, but in other responses there was confusion with the various rotations that were taking place. Many candidates had a clear understanding that the Earth spins on its axis, but fewer stated that this takes 24 hours. Weaker candidates simply described the passage of the Sun across the sky on a typical day. Others were convinced that the motion of the Sun around the Earth was the cause of day and night.

(b) Most candidates gained full credit here but others could not name three planets or thought that Jupiter, Saturn, Neptune and Uranus were closer to the Sun than the Earth is.

(c) This question was answered well by most candidates. However, some candidates did not realise that chemical elements were needed and incorrect answers included "rock", "heat", "energy" or "fire".

(d) The vast majority of candidates answered this correctly. The most common error was to give the Universe as the answer.

What went wrong?

11 A galaxy is approximately 1.2×10^{26} m from the Earth.

(a) Scientists observe light from the distant galaxy.

The wavelength of the observed light is longer than the wavelength of the light emitted from the galaxy.

State the name of this effect.

Redshift

.... [1]

(b) (i) State the current estimate for the Hubble constant H_0.

$$H_0 = 2.2 \times 10^{-18}$$ .... [1]

(ii) Calculate the speed at which the galaxy is moving away from the Earth.

$$H_0 = \frac{v}{d} \qquad v = dH_0 = 1.2 \times 10^{26} \times 2.2 \times 10^{-18}$$

$$= 2.6 \times 10^8$$

speed = 2.6×10^8 .... [2]

(iii) Scientists have measured the speeds at which distant galaxies are moving away from the Earth and their distances from the Earth.

These measurements suggest that all the Universe was once at a single point.

Explain why.

Distant galaxies move faster Universe is expanding and they must have been closer in the past.

.... [2]

[Total: 6]

What went wrong?

The Principal Examiners' Report to Teachers (PERT) is useful here

Question 11

(a)   The majority of candidates who attempted this question stated that redshift is the effect that scientists observe in light from distant galaxies. The most frequent incorrect response was to state "Doppler effect". Many candidates made no attempt at this question.

(b) (i)   Stronger candidates correctly recalled the numerical value of the Hubble constant. However, many did not include the unit in their answer. A wide variety of incorrect values were seen. Many candidates made no attempt at this question.

(ii)   Many candidates gained at least partial credit here by recalling the formula $H_0 = v/d$. Some candidates rearranged the equation and calculated the speed of the galaxy, including the unit with their numerical value to gain full credit. Many candidates made no attempt at this question.

(iii)   The strongest answers to this question stated that scientists' measurements show that the more distant galaxies are moving away faster and that this is evidence of the Universe expanding. Weaker candidates often repeated the question by stating that if distant galaxies are moving away from the Earth now, then in the past they must all have been at a single point. Many candidates made no attempt at this question.

What other common errors are there?

- Wrong formula
- Wrong command word – Describe rather than Explain
- Not writing enough – one mark is usually one correct statement
- Circling/underlining/giving the wrong number of examples, e.g. Name three
- Unable to rearrange equations
- Not showing working out
- Significant figures
- Units

How can we help learners avoid these?

Common errors

How can you use what we have just discussed to help your learners?

- Use past paper questions and the mark schemes in lessons – show learners what the examiner is looking for

- Show the PERT to the learners in lessons

- Show them "What A Good One Looks Like" – WAGOLL

- Model how you would answer questions

- Write a past paper full of errors and ask students to find them

- Pass the Buck – pass an exam question around 3 different people – each tries to improve the answer until it is returned to the original person

Further help – the PERT

- The Principal Examiner Report for Teachers (PERTs) are published after every examination series.

- PERTs are found on the School Support Hub in the Examination Resources section.

- PERTs contain key messages, general comments and specific comments for each paper in every time zone for that series.

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Making sense of the PERT

Read through the PERT extracts for papers 3 and 4.

Think about:

- What theme(s) did you see in the extracts from the PERTs?

- How might this be useful for your teaching?

- What might you do more or less of in your lessons?
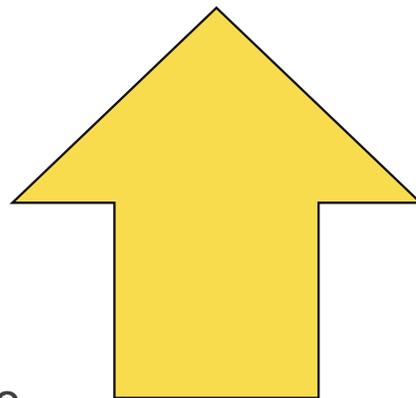
More of
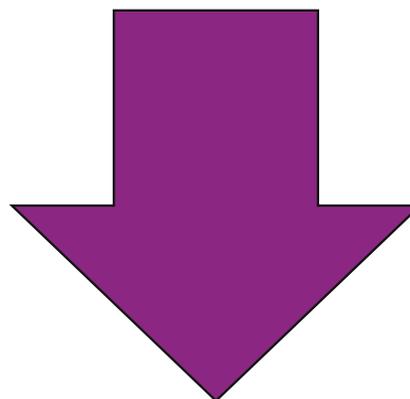
Less of

JK0   I'm sorry but the webinar is too short to do this and get anything meaningful out of it. It would be a great session if we had a longer training.
If you can pick out the themes this would be useful.
Jennie Khan, 2025-02-12T16:22:59.704

IC0 0   I don't want to read a document at them. The PERT highlights are a 2 page (for papers 3 and 4 anyway) document that has picked out al the usual key themes for them. I can send via Zoom chat box live in the session. I would like them to read individually and see if we can get anything back from them.
If we do, great. If not then I will summarise it for them myself.
Though I am all in favour of trying to get them to do something other than listen to me!
Ian C, 2025-02-20T20:53:15.659

JK0 1   Putting the document in the chat may or may not work depending on firewalls (if for example they're on a school computer) or because they're joined on their phone - you may have to share it on the screen if anyone can't open it from the chat.
Jennie Khan, 2025-02-21T16:26:42.632

Session Three

Space Physics and Resources

What depth do we need to teach?

- Look through syllabus and compare statements.

- What do you notice?

- Which areas are most challenging? For teaching. For learning.

- Why?

- Lots of 'know that'. Recall.

- How best to teach recall? Project work and presentations

The Expanding Universe

- Possibly the most complicated part of the Space topic. Why?

6.2.3 The Universe

Core

1. Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years

2. Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies

3. Know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth

4. Know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory

Supplement

5. Know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)

6. Explain that the CMBR was produced shortly after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded

7. Know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy's starlight due to redshift

8. Know that the distance d of a far galaxy can be determined using the brightness of a supernova in that galaxy

9. Define the Hubble constant H_0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance from the Earth; recall and use the equation

$$H_0 = \frac{v}{d}$$

10. Know that the current estimate for H_0 is 2.2×10^{-18} per second

11. Know that the equation

$$\frac{d}{v} = \frac{1}{H_0}$$

represents an estimate for the age of the Universe and that this is evidence for the idea that all the matter in the Universe was present at a single point
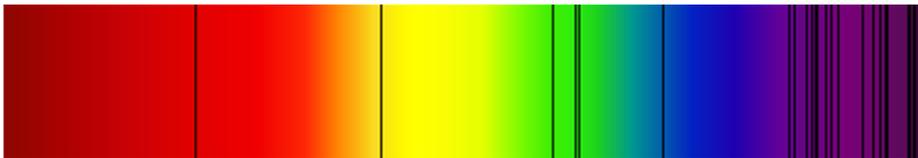
The Expanding Universe

- Needs prior knowledge of:
    - electromagnetic waves
    - wavelength
    - speed
    - stars

  ...and to be able to link it all together.

The Expanding Universe

- Stars emit visible light (among other EM waves)

- Spectra of visible light from nearby galaxies can be analysed
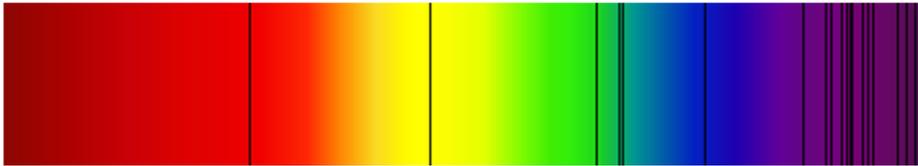
- Black lines are visible – absorption lines
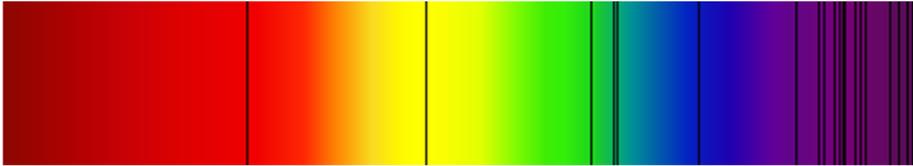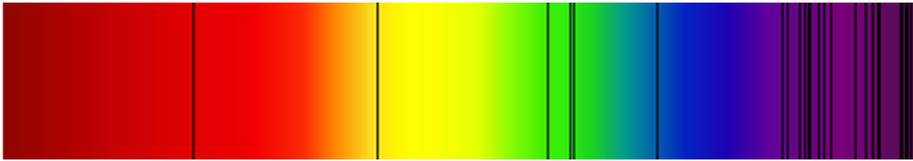
- For distant stars we get this:

- Notice anything?

The Expanding Universe

- It's the same pattern of lines in both spectra

Closer

Further

- The lines in distance galaxies have been shifted towards the red end of the spectrum - REDSHIFTED

The Expanding Universe

- Red light is longer in wavelength so the light from distant galaxies has a longer wavelength than expected.

- Why?

- How can this happen?

- The light must be getting stretched – can only happen if the source is moving away from us

  – Spring demonstration

- All the stars must be moving away from us on the Earth – universe is expanding

  – Balloon demonstration

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Where can we get ideas?

- Scheme of Work and Resource Plus

- Classic Physics demonstrations – very comprehensive! - https://www.physics.upenn.edu/demolab/demolist.html

- NASA Learning Resources - https://www.nasa.gov/learning-resources/

- Institute of Physics – IoP Spark - https://spark.iop.org/

- University of Colorado PhET simulations - https://phet.colorado.edu/

- Good quality YouTube videos – watch all the way through first!

- Materials from Cambridge partner publishers

- Past exam questions

- Does anyone have others to share?

Scheme of Work

- The Scheme of Work from Cambridge gives one possible order of teaching for the topics, along with suggested activities and resources.

- We will explore part of the suggested Scheme of Work in more detail next to help you to become more familiar with it.

- **Individually** think about the following:
    1. Would this activity work for your class?
    2. If not, why not? What changes might you need to make?
    3. What resources would you use?
    4. What other activities do you know that would work well for this topic area?

Scheme of Work

Syllabus ref.	Learning objectives	Suggested teaching activities
		Learners use light gates and datalogger set-ups to measure the initial and final velocities of an interrupt card attached to a moving trolley or toy car and the time between those measurements. Learners then calculate the acceleration. Constant acceleration can be achieved by using a ramp or a mass on a pulley.

Set learners questions to practise calculation of acceleration, change in velocity and time. **(F)**

Extension: Stretch and prepare for A level
Use the definition of acceleration to explain the units for acceleration. Show learners how they can be written as ms^{-2} rather than m/s^2 and explain this mathematically. |
| 1.2.4 Motion

1.2.5 | Sketch, plot and interpret distance–time and speed–time graphs

Determine, qualitatively, from given data or the shape of a distance–time graph or speed-time graph when an object is:

(a) at rest
(b) moving with constant speed
(c) accelerating
(d) decelerating | Learners, in pairs, each sketch a distance–time graph, act the motion shown to their partner, interpret the motion of their partner and draw the distance–time graph for the observed motion of their partner.

Ask learners what the gradient of a distance–time graph represents. Learners may be able to link their understanding of how to calculate the gradient to the definition of speed. Show learners how to find the gradient, and thus the speed or velocity, of a distance–time graph.

Give learners distance–time graphs to match up with the appropriate description. Examples can include an object moving at constant velocity, an object that is accelerating, a stationary object, etc.

==Give learners descriptions to draw as distance-time graphs. This works particularly well on miniature whiteboards as a group interactive task so that learners can compare and discuss what they've drawn. Examples can include someone walking to the bus stop, someone walking backwards, someone sprinting from standstill, etc.==

Learners use motion sensor and datalogger set-ups to investigate the relationship between motion and distance–time graphs. Set learners the challenge of recreating distance–time graphs you give to them – they have to interpret a distance–time graph and act out the motion. Learners investigate how constant speed, acceleration and deceleration appear on the distance–time graph created by a datalogger connected to a motion sensor. |
| 1.2.6 | Calculate speed from the gradient of a straight-line section of a distance–time graph | Learners use ticker tape timers to investigate motion. They measure the distance between dots and, using the time between each dot, plot distance–time graphs.

Learners plot simple distance– or speed–time graphs for their journey to school. They can add more detail by labelling the events that take place on the journey e.g. the school bus stops at traffic lights. |
| 1.2.7 | Calculate the area under a speed-time graph to determine the distance travelled for | Set learners questions that involve interpreting and plotting distance–time graphs. **(F)**

Learners can investigate motion and motion graphs further using The Moving Man simulation that plots motion: **(I)**
https://phet.colorado.edu/en/simulation/legacy/moving-man |

Scheme of Work – useful questions

- When you find an activity….

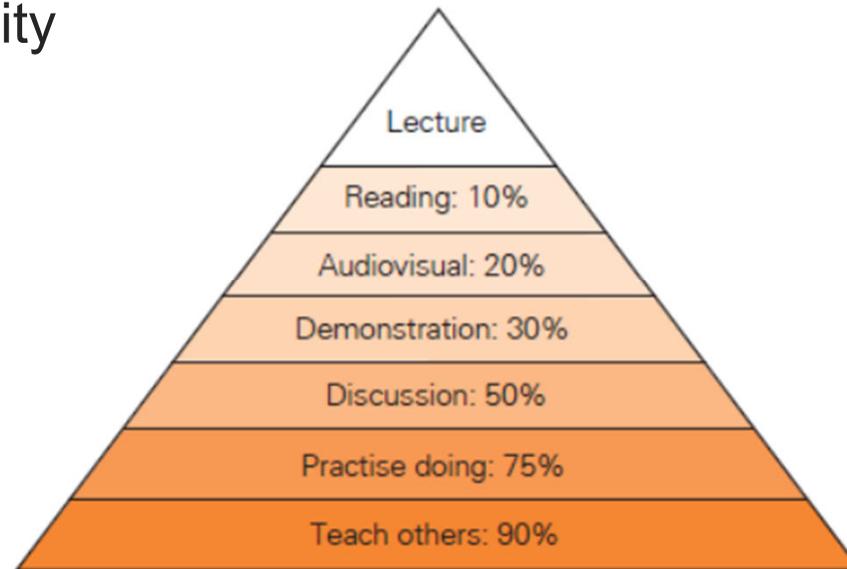- What would you need to **change or adapt** to make it more effective for you and your learners?

You might want to think about:

- the questions you could ask

- how you would introduce an activity

- how you might use the activity

- how you might gauge the understanding of the whole class

Active learning

- Retention rates by activity

- The techniques I have suggested throughout are all active learning – the learners are actively engaging with the materials and not just listening

Active learning - what is it?

True or false?

- Learners should move around the room to be active

- Active Learning cannot be used with a large class

- Active Learning means the teacher loses control of the lesson content

- Active Learning means the teacher is not needed

- Active Learning only works for the stronger learners

"For learners to make sense of new information and ideas, they need to **make links with existing knowledge**, so that they can process and then understand new material. This **sense-making** is an **active process** which can take place during a wide range of learning activities."

Active learning education brief

Teaching and learning activities

- When we plan activities for our learners, it is important that we think about what that activity is good for.

- Look at the teaching activities handout. It contains some activities you may want to use in your classroom and provides links to further reading and ideas.

- Always consider: JK0

- Which topics would your chosen activity work well for? Why?

- Which topics would your chosen activity not work well for? Why not? Could it be adapted?

JK0   Sorry (you get the picture now!) but time probably won't allow for this. Could you give some specific examples instead?
Jennie Khan, 2025-02-12T16:35:29.387
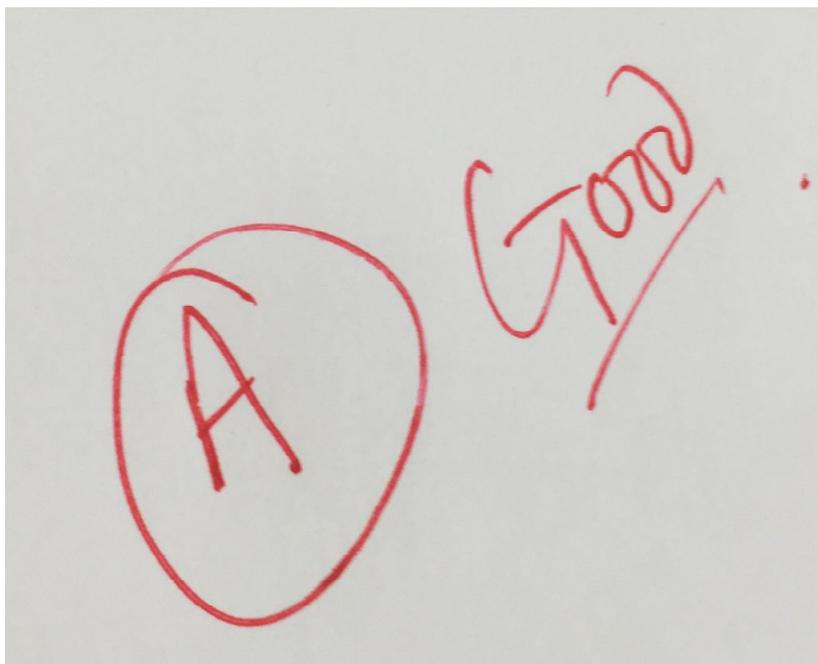
IC0 0   These are on the handout
Ian C, 2025-02-20T23:24:48.327

JK0 1   See comment on slide 60 - please be prepared to share the document on the screen.
Jennie Khan, 2025-02-21T16:56:51.535

Feedback

- What is the problem with this feedback?

Formative feedback

- We are going to focus on one candidate's script to develop some **formative feedback.**

- Think back to the planning questions we looked at.

- What feedback would you give to the lower scoring candidate **to help them improve their work?**

- How would this support their progress?
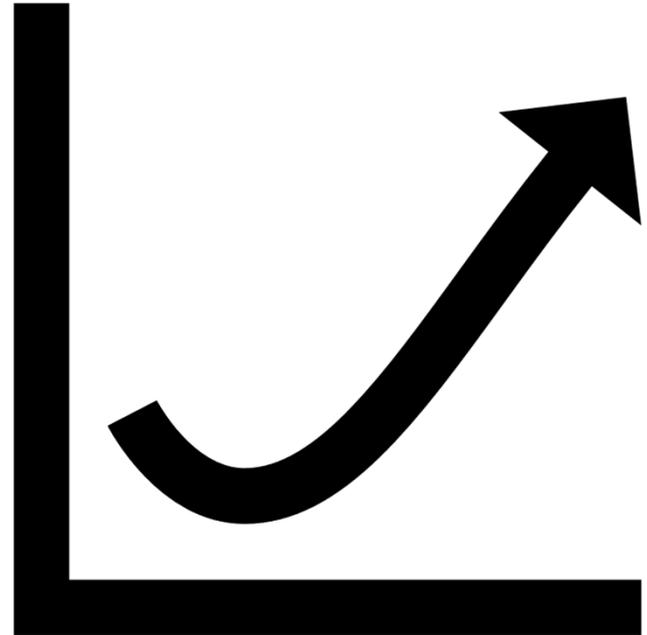
Formative feedback

4 A student investigates the length of time taken for ice cubes to melt when they are placed in water. She uses beakers of water at different temperatures to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

Plan an experiment to investigate how the initial temperature of the water affects the time taken for the ice cubes to melt.

The following apparatus is available:

thermometer
supply of ice cubes
250 cm³ beakers
supply of cold water

In your plan, you should:

- write a list of additional apparatus to use

- explain how to carry out the investigation

- state the key variables to keep constant

- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)

- explain how to use the readings to reach a conclusion.

---

explain how to use the readings to reach a conclusion.

Place 1 ice cube in a beaker of water.
Time how long it takes to melt with clock
Change temp of water
Repeat with 2 cubes. Then 3, 4, 5 and 6.
Always use the same amount of water.
Always use 200 cm³ water
To keep it fair I will make sure the
ice cubes are all the same size.

Temp of water	Number of cubes	Time to melt (minutes)

Plot a graph of the results in the table.

Formative feedback

- What went well
  - Names one piece of equipment needed
  - Clear constant variables

- Even better if
  - Think carefully about what the independent variable is going to be and ONLY change this
  - Set out the work logically – maybe use the bullet points as headings
  - Don't forget units in the table
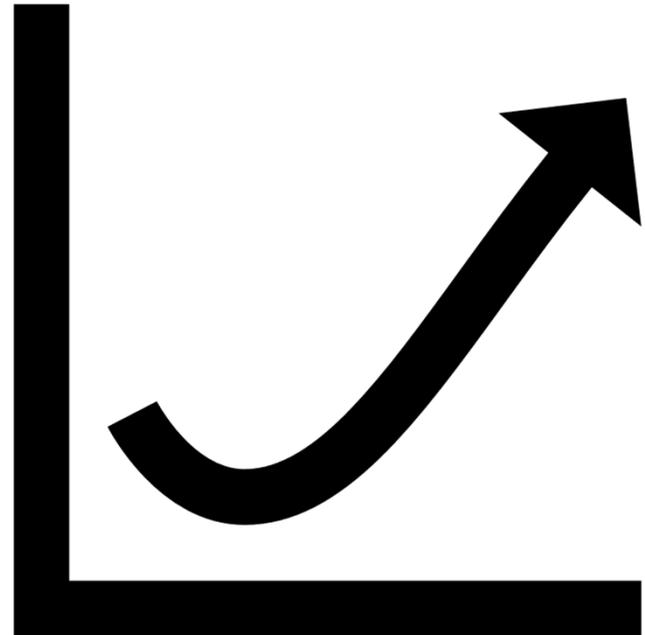
Reflection

1. **Individually** reflect on your top 3 learning points from this session.

2. Consider what impact this session will have on your **teaching**. How might it improve **learning**?

3. **Share** your top learning points in the chat box.

Q&A

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Thank you!

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