Pearson Edexcel

Examiners' Report
June 2019

GCSE Physics 1PH0 1H

ResultsPlus

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus.
Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2019
Publications Code 1PH0_1H_1906_ER

All the material in this publication is copyright
© Pearson Education Ltd 2019

Introduction

This was the second examination of paper 1, at higher level, for the new specification. Questions were set to test candidates' knowledge, application and understanding from the seven topics in the specification:

- Topic 1 – Key concepts of physics
- Topic 2 – Motion and forces
- Topic 3 – Conservation of energy
- Topic 4 – Waves
- Topic 5 – Light and the electromagnetic spectrum
- Topic 6 – Radioactivity
- Topic 7 – Astronomy

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. Within the question paper, a variety of question types were included, such as objective questions, short answer questions worth one or two marks each and longer questions worth three or four marks each. The inclusion of questions designed at targeting candidates' knowledge and understanding of practical work continued. This included assessing their fundamental knowledge of practicals specified in the specification, together with further application, especially where they were asked to propose improvements to a procedure. The two six-mark questions included 9(d) on how radio waves and gamma radiation are produced and the other, 10(b), on the evidence that the universe began at a single point and is expanding. Candidates performed better on the more familiar latter item. Candidates found the former question more demanding; this stretched the most able candidates. Excellent compositions were seen in answer to both these questions.

Candidates coped well with most questions and did particularly well in the questions asking for calculations using equations. Candidates' knowledge of practical work, in contrast, has improved but remains not so secure.

Successful candidates were:

- well-acquainted with the content of the specification
- skilled as a result of having been engaged with practical work during their course
- competent in quantitative work, especially in using equations
- well-focused in their comprehension of the question-at-hand
- willing to apply physics principles to the novel situations presented to them

Less successful candidates:

- had gaps in their conceptual knowledge of the topics of this paper
- had gaps in their procedural knowledge, relating to their practical work
- misread and / or misunderstood the symbols used in equations
- did not focus sufficiently on what the question was asking
- found difficulty in applying their knowledge to new situations

This report will provide exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come from responses which highlight successes and misconceptions, with the aim of aiding future teaching of these topics.

Question 1 (b)

Many candidates did well with this question, but some candidates missed out on the mark lacking the **energy destination** that was required, as reflected in the mark scheme.

(b) Before the car brakes it has kinetic energy.
The kinetic energy decreases as it brakes.

State what happens to the kinetic energy during braking.

(1)

The kinetic energy is released through the brakes. The brakes heat up as the car slows down, transferring the kinetic energy as thermal energy into the environment

ResultsPlus
Examiner Comments

This is a well-focused answer, including the final destination of the energy as thermal energy into the environment.

ResultsPlus
Examiner Tip

It helps to question yourself 'Where does the energy go to?'

The kinetic energy disippates into the surroundings as heat (thermal) energy due to friction in the brakes.

ResultsPlus
Examiner Comments

This is a good response, getting the mark. The addition of the 'due to' explanation was not needed.

ResultsPlus
Examiner Tip

Notice the key command words in the question. Here 'State what happens' means no explanation was needed as to why.

The energy is then transferred to the thermal store of the brakes as they bring the car to a halt.

ResultsPlus
Examiner Comments

Whilst most candidates who scored in this question stated 'thermal energy to the surroundings' this candidate understands that a key destination for the energy is the brakes (brake pads), which get hot. Notice they use the terminology 'thermal energy store'. It is not necessary to use this language; it is very acceptable though.

It is transferred into thermal & sound energy

ResultsPlus
Examiner Comments

This response does not satisfy the mark scheme requirement that a destination for the final energy must be present.

ResultsPlus
Examiner Tip

As stated earlier think 'Where does the energy go to?'

Question 1 (c)

Many candidates achieved success with the graph, and the calculation of 'C', but less of them were able to work out the correct unit for the constant.

(c) The graph in Figure 1 shows how the braking distance, *d*, of a car depends on the velocity, *v*, of the car when the brakes are first applied.

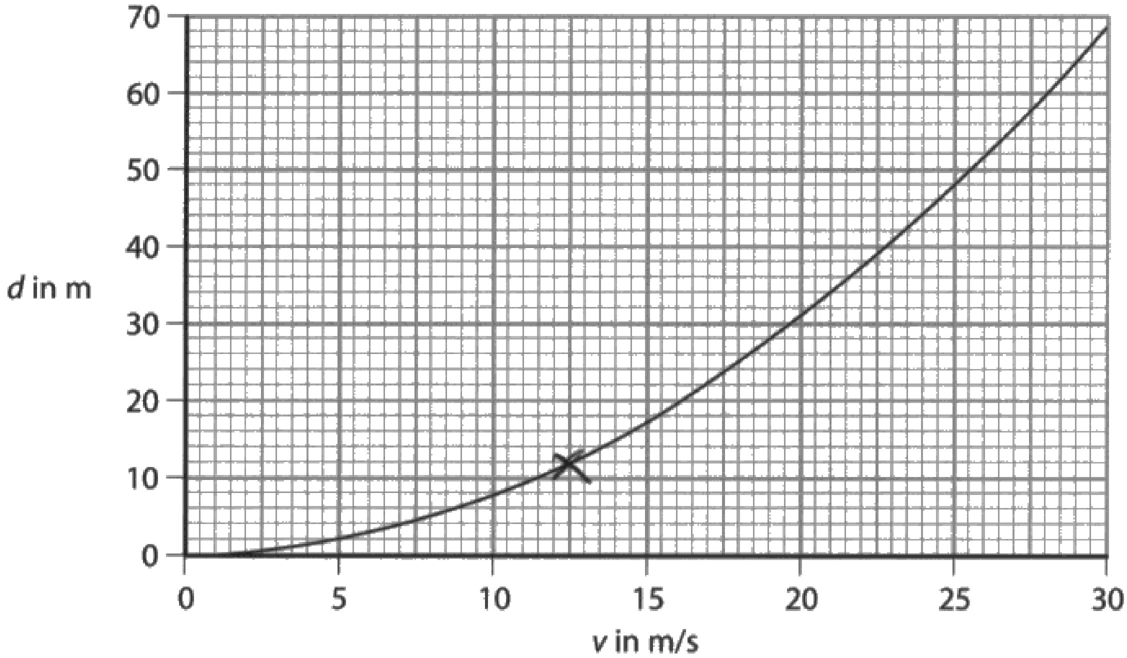


Figure 1

An equation relating braking distance, *d*, to velocity, *v*, is

$$d = \frac{v^2}{C}$$

where *C* is a constant.

Use the equation and data from the graph in Figure 1 to calculate a value for *C*.

Give a unit for *C*.

(4)

$\frac{12.5^2}{c} = 12$

$12c = 12.5^2$

$12.5^2 \div 12 = c$

$c \approx 13$

C = 13 unit Seconds

(Total for Question 1 = 6 marks)

ResultsPlus
Examiner Comments

This candidate chooses a point on the graph, clearly marked with a cross and then substitutes into the equation to get a value for 'C' in the centre of the range that is allowed in the mark scheme. Their only lack is not getting the units correct.

ResultsPlus
Examiner Tip

It is good practice to show working on any graph.

Put units into the equation, with 'C' as the subject, to find out the units of the answer.

(4)

$$C = \frac{v^2}{d}$$

$$= 16^2 \div 20$$

$$= 256 \div 20$$

$$= 12.8$$

C = 12.8 unit m/s^2

ResultsPlus
Examiner Comments

This candidate gets full marks. Clear working is seen on the graph, with an acceptable answer well within the range imposed by the mark scheme. They have additionally obtained the correct units for 'C'.

ResultsPlus
Examiner Tip

Units of 'C' = m^2 s^{-2} divided by m using the equation. This may be done in your head, but you could write it out as well.

$d = \frac{v^2}{c}$

$C = \frac{v^2}{d}$

$= \frac{29^2}{64}$

$= 13.140625\ m/s^2$ C = 13.1 unit m/s^2

ResultsPlus
Examiner Comments

This response shows that it doesn't matter which point is chosen on the graph, an answer within acceptable bounds is still found.

Full marks obtained.

Question 2 (b)

Most candidates were able to state that the infra-red radiation is blocked by the armchair with fewer being able to explain why in terms of the frequency/wavelength of the wave.

The line of sight idea was mentioned by a few candidates, with hardly any referring to diffraction ideas.

(b) Some television remote controls use infrared radiation and other remote controls use radio waves.

Explain why an infrared remote control may not switch on the television from behind an armchair but a radio wave remote control always will.

(2)

radiowaves can travel through solids, they have longer wavelength and lower frequency.

ResultsPlus
Examiner Comments

A succinct explanation getting both mark points.

ResultsPlus
Examiner Tip

'Explain why' answers need to be developed with an eye as to how many marks are being awarded in the question.

An infrared remote control has shorter wavelengths which cannot travel as far as the wavelengths of a radio wave remote control. Radio waves can travel further distances.

ResultsPlus
Examiner Comments

This only gets one mark for the comparison of wavelengths.

'Cannot travel far' misses out the absorption in the armchair key component of an answer that would score both marks.

Infrared radiation can't pass through objects, as it interacts with molecules and gives them energy in the form of heat, but radio waves can, as they don't interact with molecules.

ResultsPlus
Examiner Comments

This answer scores one mark, because although the blocking aspect of the object (armchair) is covered the explanation is insufficient.

This explanation is really restating what absorption is without establishing any key difference between infra-red and radio that lies behind the difference in behaviour.

ResultsPlus
Examiner Tip

Does your answer to an 'explain' question contain enough in answer to 'Why?'

What are the differences between the two types of wave that cause the different behaviours?

Infrared waves can be only be used for short range communication but radiowaves can be used for long-range communication. ~~Inf~~ Consequently, infrared ~~waves~~ remotes cannot communicate with television behind the armchair but radio remotes can as they can travel longer distances.

ResultsPlus
Examiner Comments

This scores 0.

The candidate is not really answering the question, with a lot of their answer restating what the question has already told them.

'Travel longer distances' is not creditable. It doesn't address the question's demand for an explanation and it neglects the role of the intervening object in this.

ResultsPlus
Examiner Tip

Beware of just repeating what's conveyed in the question itself.

Any explanation must get behind what's happening.

Question 2 (c) (i)

A majority of candidates succeeded with this, using the graph effectively, scoring both marks.

Where they failed to get an answer within acceptable bounds they could still get a mark **if** evidence was seen of using the horizontal scale.

(c) Figure 2 is a diagram of a water wave.

A cork is floating on the water.

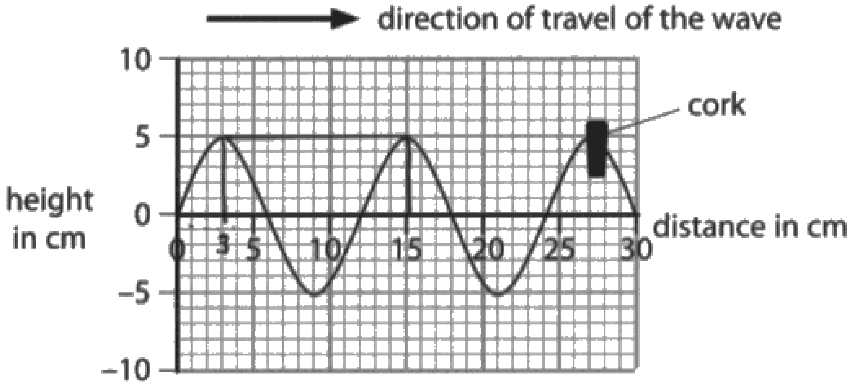


Figure 2

(i) Use the scale on the diagram to measure the wavelength of the wave.

(2)

15 - 3 = 12

wavelength = 12 cm

ResultsPlus
Examiner Comments

Full marks

Working seen on graph and acceptable answer within the bounds specified in the mark scheme.

ResultsPlus
Examiner Tip

Do show working on any graph or diagram. It may earn credit if you slip up with the numerical answer on the way.

(2)

6-0=6
12-6=6

wavelength = 6 cm

ResultsPlus
Examiner Comments

As the mark scheme states an answer of 6 cm gets 1 mark, showing some evidence of using the graph.

The most common mistake was using half a wavelength.

Figure 2

(CORK)
UP, DOWN

(i) Use the scale on the diagram to measure the wavelength of the wave.

(2)

DIRECTION OF WAVE

wavelength = 2·4 cm

ResultsPlus
Examiner Comments

This gets 1 mark as there is clear evidence of use of the horizontal scale, even though it's been misinterpreted.

ResultsPlus
Examiner Tip

To get intermediate marks show all your working, including on graphs such as this.

Question 2 (c) (ii)

This was a high scoring question. It tested a well-tried principle of physics, of which most candidates had knowledge.

It was set in the context of a cork floating on water. Whilst most students knew the definitions some tolerated contradictions in their answers when they said 'it's a transverse wave' but then said 'the cork moves in the direction the wave travels'.

(ii) Describe the motion of the cork.

You should include how the cork moves relative to the direction of travel of the wave.

(2)

The cork moves up and down but doesn't move across the surface of the water. The cork moves perpendicular to the direction of the wave.

ResultsPlus
Examiner Comments

This answer succinctly answers the question. The motion of the cork is described well (mark point 1) with relationship of the cork motion to the direction of the wave spelt out (mark point 2).

ResultsPlus
Examiner Tip

Answer the question directly like this candidate.

Beware of just regurgitating the definitions you have learnt without reference to the particular question at hand.

The cork moves perpendicular to the direction the wave is travelling in, so it will move side to side.

ResultsPlus
Examiner Comments

This student has not imagined the cork moving up and down and so missed the first mark point.

There is a contradiction here; it can't be moving perpendicular, as stated, and sideways at the same time.

If it is transverse then that perpendicular motion must be up and down.

ResultsPlus
Examiner Tip

Imagination helps here.

Imagine the cork bobbing up and down as the wave moves through.

That is the characteristic of a transverse wave.

The cork is moving parallel to the direction of travel of the wave it is moving up and down like the wave is moving.

ResultsPlus
Examiner Comments

The first statement, comparing motion with the direction of travel, is wrong; marking point 2 negated.

However the direct statement about the cork moving up and down is credited - mark point 1.

Question 2 (d)

This was another high-scoring question.

Where a candidate had a problem with units they could score an intermediate mark if they showed the steps in their working clearly.

(d) A different water wave has a wavelength of 0.25 m and a frequency of 1.5 Hz.

Calculate the wave speed.

(2)

wave speed = wavelength × frequency

0.25 × 1.5 = 0.375

wave speed = 0.375 m/s

ResultsPlus
Examiner Comments

Well set out - a commendable practice in case there was a calculator slip, so the intermediate marks may be awarded.

Not necessary in this case where the final evaluation was correct, so the full 2 marks were awarded.

(2)

Wavespeed = frequency x wavelength
= 1.5Hz x 0.25m
= 1.5Hz x 2.5cm
= 3.75

wave speed = 3.75 m/s

ResultsPlus
Examiner Comments

This candidate made a slip with units.

The intermediate (recall and substitute) mark could easily be given because they showed their working clearly.

ResultsPlus
Examiner Tip

Show your working.

Communicate to the examiner how you arrived at your answer to ensure success.

Question 3 (a)

This was a straightforward question testing understanding of nuclear notation.

The vast majority of candidates scored maximum marks with this question.

Question 3 (b) (i)

The answer was 'Geiger Muller' / GM tube. Different spellings were tolerated.

Question 3 (b) (ii)

This was a high-scoring question.

'Background radiation' has particular connotations in this area of the specification - part of topic 6 where the content is sections 6.12 and, especially, 6.13.

(ii) State **two** sources of background radiation.

(2)

1 radon gas

2 soil /rocks

ResultsPlus
Examiner Comments

Radon (gas) and soil/rocks are two major sources.

A very acceptable answer for two marks.

1 can be emmitted from [illegible] rocks.

2 in vegetables & fruits such as bananas.

ResultsPlus
Examiner Comments

This list of acceptable answers in the mark scheme is extensive, including 'named food'.

This was a high-scoring question.

'Background radiation' has particular connotations in this area of the specification - part of topic 6 where the content is sections 6.12 and, especially, 6.13.

1 Mobile phones

2 TV's

ResultsPlus
Examiner Comments

'Background radiation' does not include these sources.

It is easy to see where a confusion arises in a candidate's mind.

ResultsPlus
Examiner Tip

Always bear in mind the context - of the whole question.

Question 3 (c)

Many candidates dealt with the half-life idea effectively with ½ then ¼ then ⅛ calculations i.e. consecutive halvings.

Weaker candidates thought 8 half-lives were involved from an spurious $^{1000000}/_{125000}$ = 8 calculation.

(c) Carbon-14 is radioactive and has a half-life of 5 700 years.

The number of radioactive carbon-14 atoms in a very old piece of wood is found to have decreased from 1 000 000 to 125 000.

Determine the age of the piece of wood.

(2)

1,000,000 ÷ 2 = 500,000

500,000 ÷ 2 = 250,000

250,000 ÷ 2 = 125,000

5700 x 3 = 17100

age of wood = ...17100........ years

ResultsPlus
Examiner Comments

The candidate clearly shows three consecutive halving giving the age of the wood as 3 half-lives long, yielding the correct evaluation.

Full marks for a well communicated answer.

1,000,000 ÷ 125,000 = 8 half lives

5700 x8= 45,600

age of wood = 45600 years

ResultsPlus
Examiner Comments

This shows a weaker candidate's response. Their understanding of the half-life idea is lacking.

Determine the age of the piece of wood. (2)

$\frac{125000}{1000000} = \frac{1}{8}$

5700x2 = 11400

1140x $\frac{1}{8}$ = 142.5

age of wood = 142.5 years

ResultsPlus
Examiner Comments

The mark scheme allows for an attempt using halving, with more than one halving involved, to get a mark.

This is the case here.

(2)

~~1000 000~~ 1000 000 } 1 half life

~~500 000~~ 500 000 } 2 half lives

125 000

×

5700 × 2 = 11400

age of wood = 11400 years

ResultsPlus
Examiner Comments

This is another response scoring 1 mark as a result of 'more than one halving'.

Unfortunately they missed out 250000.

ResultsPlus
Examiner Tip

Although this answer was flawed notice how well the candidate sets out their answer making it very easy to follow, and give some credit for. Compare this with the previous response.

Question 3 (d)

Candidates often made quite a lot of progress with this question. The higher attaining candidates got 2 marks readily and quite a number scored an intermediate 1 mark.

(d) Carbon-14 decays into nitrogen-14.

$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

The symbol for nitrogen-14 is $^{14}_{7}N$

Explain what happens in a carbon-14 nucleus when it decays to a nitrogen-14 nucleus.

(2)

$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$. Carbon-14 has undergone beta minus decay. This is when a neutron becomes a proton in the nucleus and an electron is emitted. This means the atomic number stays the same but the mass number changes.

ResultsPlus
Examiner Comments

Full marks.

The full nuclear equation by itself would score 2 marks.

The rest is also creditworthy apart from the last statement, which is ignored. We do not mark negatively unless a direct contradiction is involved.

ResultsPlus
Examiner Tip

If there are a variety of responses possible it doesn't hurt to include them, provided you don't contradict yourself.

(2)

a neutron in the nucleus decays to form a proton and an electron. The proton stays in the nucleus and the electron is fired out of the nucleus. so the proton number increases but the mass number stays the same

(Total for Question 3 = 9 marks)

ResultsPlus
Examiner Comments

This alternative way of presenting the explanation is just as acceptable. The candidate clearly understands the physics involved, including the 'fired out' comment.

The nucleus loses an electron which is the beta particle. This is a fast moving electron that is produced. The nucleus stabilises as it undergoes decay.

ResultsPlus
Examiner Comments

Mark point 2 of the mark scheme seen - beta particle / fast moving electron.

The neutron -> proton part is missing.

(d) Carbon-14 decays into nitrogen-14.

Beta Plus

The symbol for nitrogen-14 is $^{14}_{7}N$ 14 6

Explain what happens in a carbon-14 nucleus when it decays to a nitrogen-14 nucleus.

(2)

~~Beta plus radiation has occured. A proton is changed into a neutron and a positron~~

Beta minus radiation has occured. A neutron is changed into a proton and electron.

(Total for Question 3 = 9 marks)

proton → neutron & electron   5 rules → net

neutron → proton & electron

ResultsPlus

Examiner Comments

This candidate self-corrects having earlier opting for beta +, but then cancelling that answer.

The two linked parts of the explanation are there:

neutron is changed into a proton (1 mark) with an electron resulting as well (beta-minus radiation gets the mark anyway)

Question 4 (a) (ii)

Many candidates got a mark for $^1/_5$.

To get the second mark the units had to be correctly dealt with.

(ii) The equation that relates the power of a lens to the focal length of the lens is

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

The power of a lens is 5 dioptres.

Use the equation to calculate the focal length of the lens in cm.

(2)

$$5 = \frac{1}{fL}$$

$$fL = \frac{1}{5} = 0 \cdot 2m$$

$$= 20cm$$

focal length = ...20.......... cm

ResultsPlus
Examiner Comments

Well set out and communicated answer.

The candidate appreciates the units involved.

Full marks.

power = $\frac{1}{\text{focal length}}$

$5 = \frac{1}{\text{length}}$ length = $\frac{1}{5}$ = 0.2

focal length = ...0.2...... cm

ResultsPlus

Examiner Comments

1 mark is due for the 1/5.

Then fails to realise that that is in metres and we are asking for cm, so this candidate doesn't get the second mark.

Question 4 (b)

The combined science candidates found this quite challenging. They invariably wrongly choose to let the ray of light enter through the straight side of the semi-circular glass block. This inevitably ended up with one mark. There were examples, however of candidates who had clearly done the investigation and they could talk lucidly about the step involved, also showing an appreciation of what the critical angle is.

(b) Figure 3 shows a semicircular glass block.

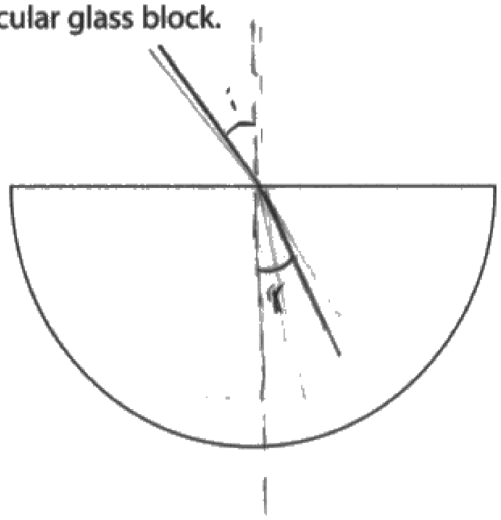


Figure 3

Describe how a student could use the semicircular glass block and other apparatus to determine the critical angle for a glass-air boundary.

You should add to the diagram in Figure 3 to help with your answer.

(4)

~~Use a protractor to determine~~ ~~a normal line~~ - ~~You should then ensure lights are switched off for best ability to see.~~ Place ~~a ray box~~ the glass ~~box towards~~ block on ~~the norma~~ a piece of paper and draw around it, use a protractor to determine a normal line, you should ensure lights are ~~off~~ off. Point a ray box at the normal line and with a pencil draw where it enters and leaves. Remove glass block and join the points - you will be provided with your angle of incidence and refraction, as shown in Figure 3 - which will enable you to calculate the critical angle.

ResultsPlus
Examiner Comments

This was commonly seen.

The critical angle may not be observed nor found if the ray of light is shone into the straight side of the semi-circular glass block.

They get mark point 1 only. This point is emphasised in the final comment in 'Additional Guidance' where it says 'if light enters block at straight edge, maximum 1 mark for MP1'

(b) Figure 3 shows a semicircular glass block.

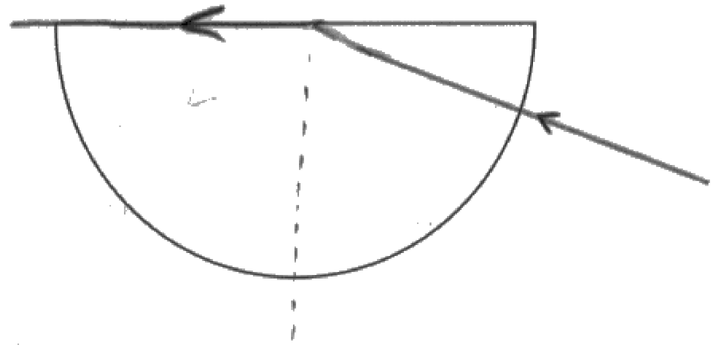


Figure 3

Describe how a student could use the semicircular glass block and other apparatus to determine the critical angle for a glass-air boundary.

You should add to the diagram in Figure 3 to help with your answer.

(4)

Place the semicircular glass block on a plain piece of paper and set up a ray box with one slit. Point the ray to the glass block then adjust until total internal reflection is achieved is which all the ray is refracted perpendicular to the normal. Measure the angle ~~angle used, that is the~~ the ray box was used in, that is the critical angle.

ResultsPlus
Examiner Comments

This student shows a clear understanding of the method involved and, in particular, has shown appreciation of the conditions when the critical angle is just reached.

The marking of the normal line in the diagram helps.

The 'measure the angle' statement at the end could have been more precise, but, with the preceding comments MP 4 was given with some benefit of doubt.

ResultsPlus
Examiner Tip

Clearly expressed language, easy to follow, is seen in this answer. Aim at that. There is no need to be long-winded.

(b) Figure 3 shows a semicircular glass block.

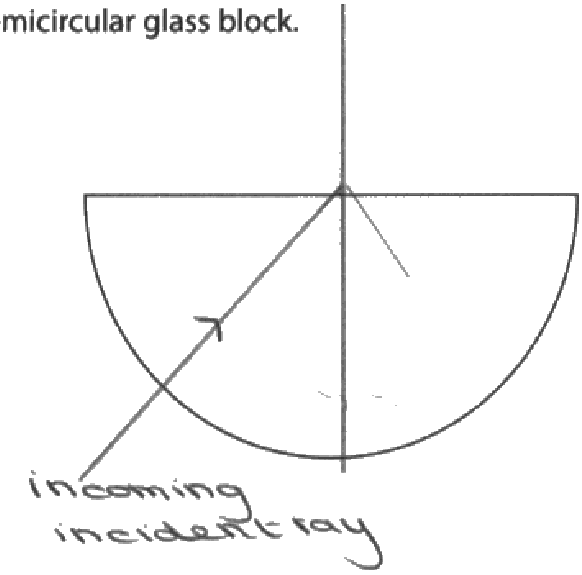


Figure 3

↑ reflection

Describe how a student could use the semicircular glass block and other apparatus to determine the critical angle for a glass-air boundary.

You should add to the diagram in Figure 3 to help with your answer.

(4)

The critical angle can be determined by finding out ~~wherever~~ whether there is any ~~tote~~ total internal reflection ~~An~~ Get an incident ray and ~~find out whether~~ the reflected ray ~~X~~ can be seen, as the ~~ang~~ incident ray crosses the boundary. The angle of incidence is equal

ResultsPlus
Examiner Comments

The student may score both marks awarded just in their diagram.

The marks are awarded for

- Shine a ray of light into the box
- Through the curved face along a radius

Both points are seen in the diagram. Unfortunately what the candidate has written below doesn't add much.

ResultsPlus
Examiner Tip

DIAGRAMS are very important in physics and examiners will credit mark points from a diagrams.

So make them clear and always label as much as you can.

(b) Figure 3 shows a semicircular glass block.

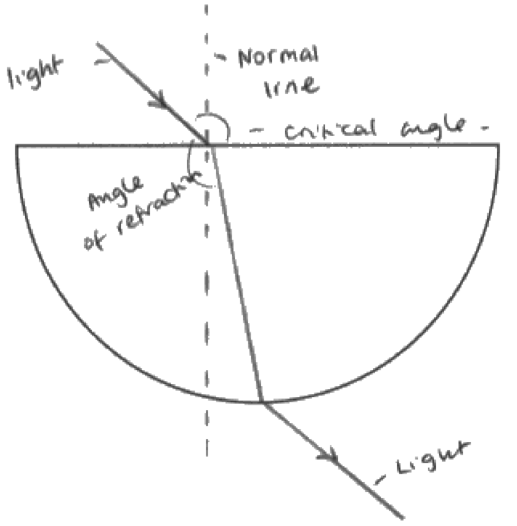


Figure 3

Describe how a student could use the semicircular glass block and other apparatus to determine the critical angle for a glass-air boundary.

You should add to the diagram in Figure 3 to help with your answer.

(4)

In order to determine the critical angle you can use the glass block and a white light. You shine the straight ray of white light into the glass block. Because the block is a denser medium than air the light will slow down and bend towards the normal line (refraction) it will the leave through the other side of the block refracting again back to its original angle. With this you can identify the critical angle and determine it.

ResultsPlus
Examiner Comments

The candidate has put a lot of effort into constructing this effort.

Unfortunately it makes that key error of shining the ray into the straight side of the block and so is limited to one mark maximum.

ResultsPlus
Examiner Tip

You may have some good physics understanding but are you answering the question?

Focus on that first and foremost.

Question 4 (c) (i)

Answers had to be with regard to the Solar System, which was what the question was asking about.

The mark scheme listed 9 possible examples. Others were possible.

(c) (i) A long time ago, scientists believed that the Earth was at the centre of the Solar System.

Evidence has since proved that the Sun is at the centre of the Solar System.

State **one other** idea about the Solar System that **has** changed over time.

(1)

That planets and moons orbit the sun in a perfect circle, we now know that some orbits are elliptical.

ResultsPlus
Examiner Comments

The elliptical nature of planetary orbits was well known by many candidates.

This was one of the commonest correct answers.

Steady state theory + big bang.

(c) (i) A long time ago, scientists believed that the Earth was at the centre of the Solar System.

Evidence has since proved that the Sun is at the centre of the Solar System.

State **one other** idea about the Solar System that has changed over time.

(1)

The steady state theory was the accepted theory about the origins of the universe but the discovery of CMBR disproved this and caused a new theory, The big bang.

ResultsPlus
Examiner Comments

This has nothing to do with the Solar System, so gets zero marks.

ResultsPlus
Examiner Tip

There is no substitute for reading the question.

If you were in the habit of underlining key parts of the question, then you would undoubtedly underline 'Solar System'.

Question 4 (c) (ii)

Most candidates scored well on this question, with almost a half getting full marks.

To get full marks the drawing of a best fit smooth curve was needed.

A number of candidates wrongly went along at 5.2 Earth years thinking (wrongly) that 1 small square = 0.1 years.

(ii) Figure 4 shows data for some of the planets of the Solar System.

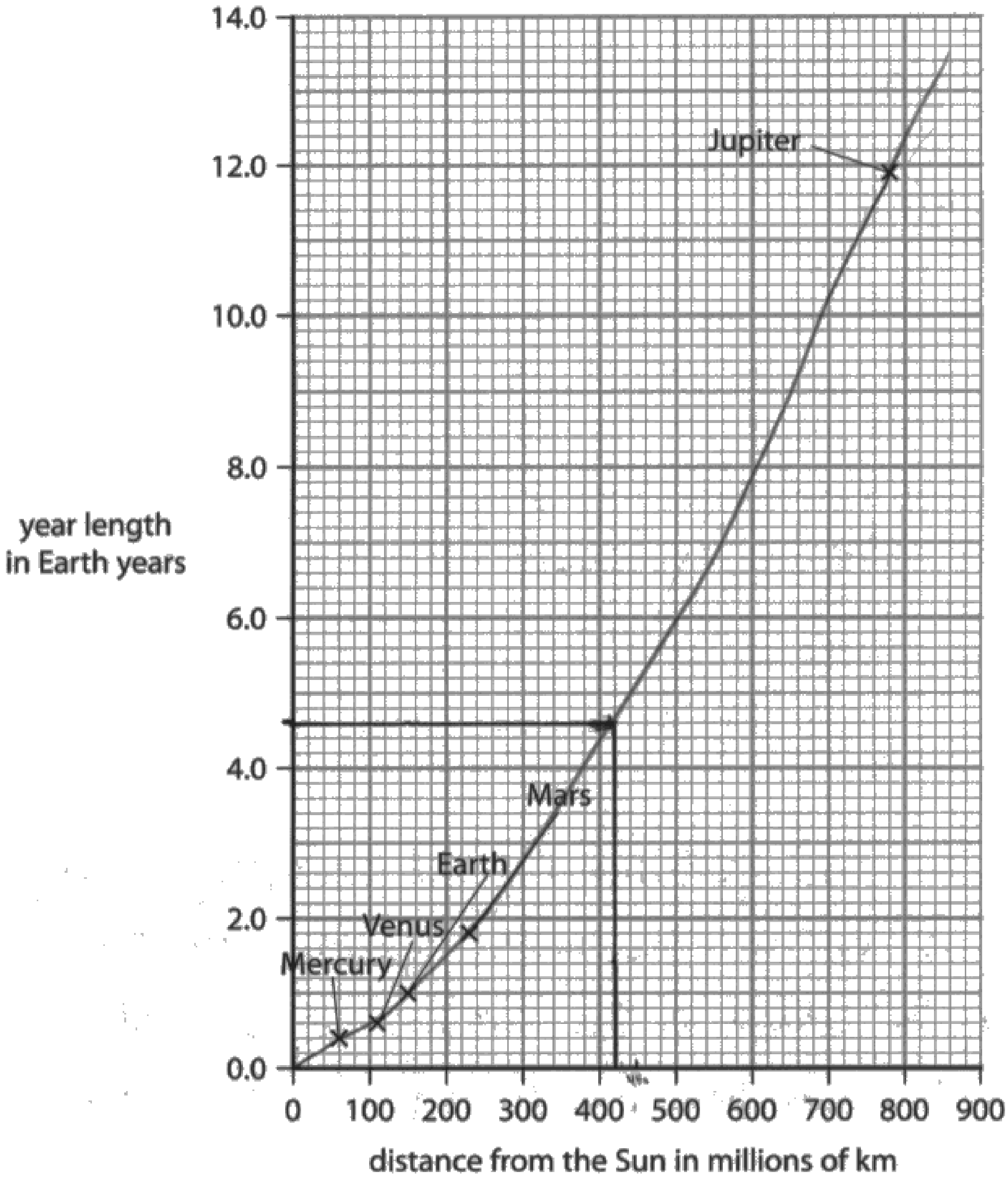


Figure 4

Ceres is an asteroid that orbits the Sun between Mars and Jupiter.
It takes Ceres 4.6 Earth years to make one orbit of the Sun.

Use the graph to estimate the distance of Ceres from the Sun.

Show your working.

(3)

distance of Ceres from the Sun = 420 millions of km

ResultsPlus
Examiner Comments

This answer includes a good best fit curve, a clear horizontal line at 4.6 Earth years and an answer near the centre of the acceptable range.

Full marks obtained.

(ii) Figure 4 shows data for some of the planets of the Solar System.

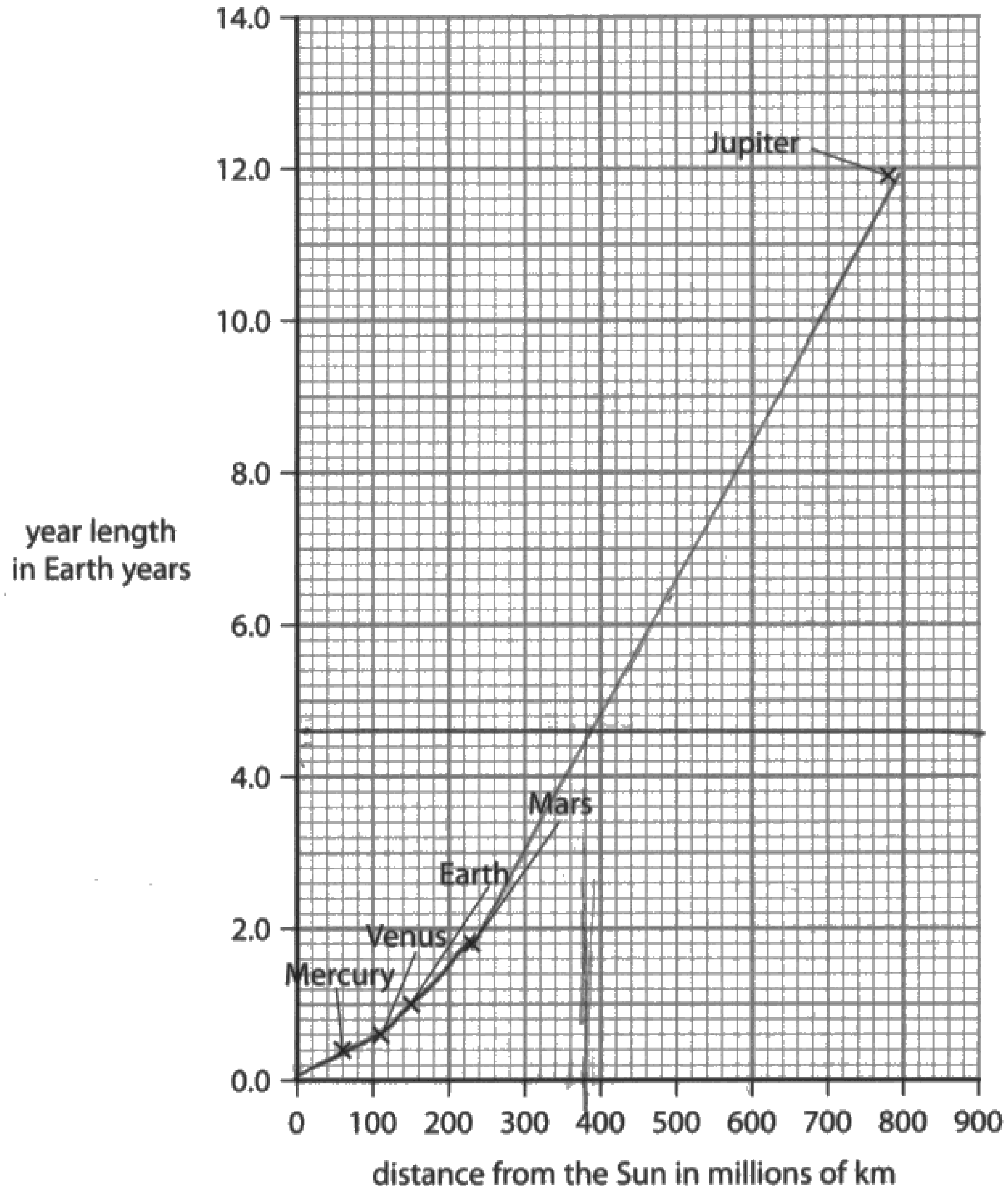


Figure 4

Ceres is an asteroid that orbits the Sun between Mars and Jupiter.
It takes Ceres 4.6 Earth years to make one orbit of the Sun.

Use the graph to estimate the distance of Ceres from the Sun.

Show your working.

(3)

distance of Ceres from the Sun = 380 millions of km

ResultsPlus
Examiner Comments

Full marks given.

A lower curve, followed by a straight line from Earth to Jupiter was accepted for mark point 1.

That often led to a 380 million km answer for the reading from the graph.

It is outside the range seen at the end of the mark scheme but the alternative 'their reading from the line / curve' could be credited.

ResultsPlus
Examiner Tip

The drawing of the intercepting line on the graph is crucial if the mark is to be awarded.

So the onus on the candidate is to make it clear.

(ii) Figure 4 shows data for some of the planets of the Solar System.

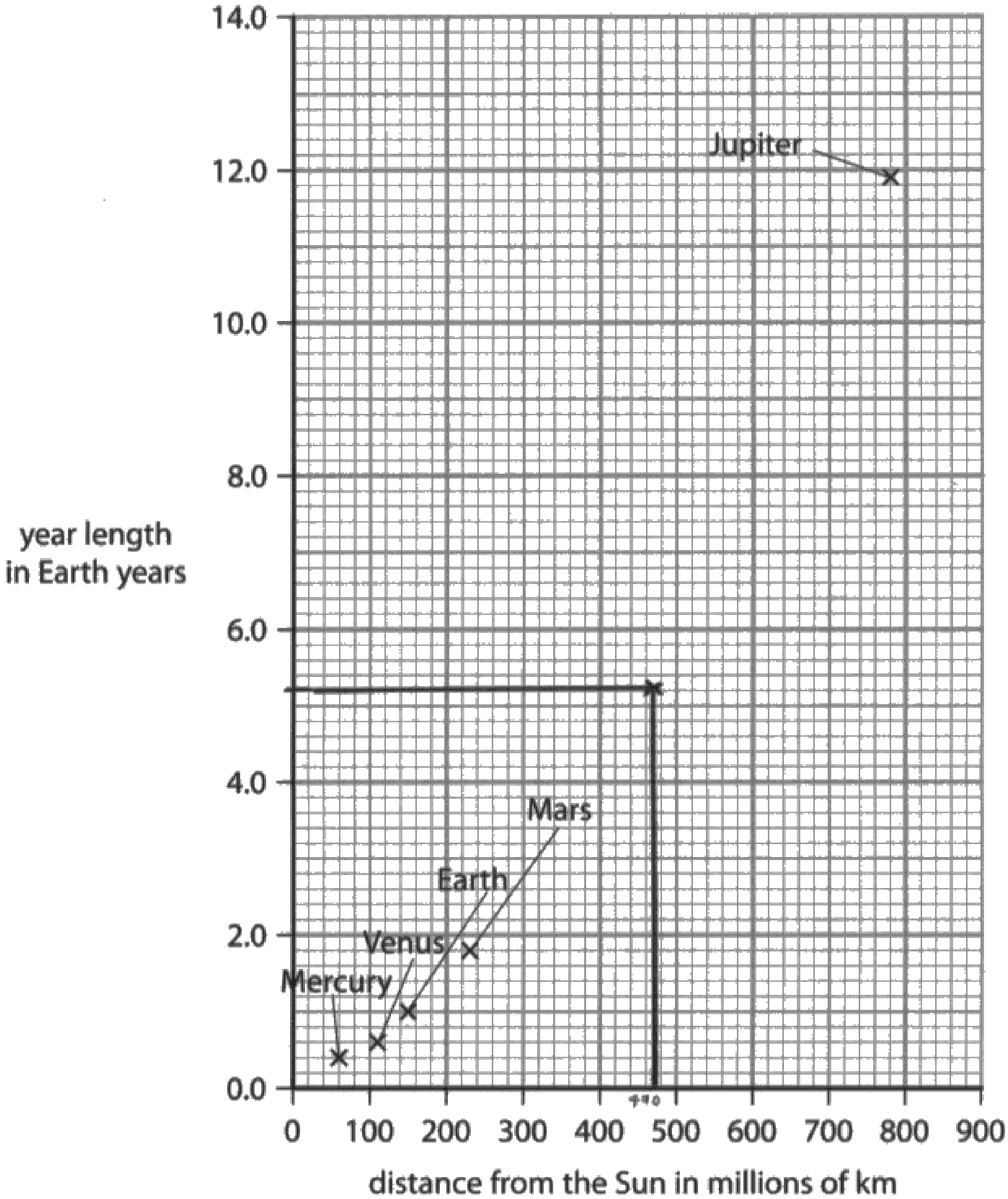


Figure 4

Ceres is an asteroid that orbits the Sun between Mars and Jupiter.
It takes Ceres 4.6 Earth years to make one orbit of the Sun.

Use the graph to estimate the distance of Ceres from the Sun.

Show your working. 4.6 year = 470 millionskm

(3)

distance of Ceres from the Sun = ...470...... millions of km

ResultsPlus
Examiner Comments

With no best fit curve or line drawn no intermediate marks could be awarded.

Mark point 2 cannot be awarded. The mark scheme says horizontal line drawn from 4.6 Earth years **to intercept the drawn line / curve.**

The candidate's answer was also outside the accepted range.

ResultsPlus
Examiner Tip

It's no good just imagining where the intercept is.

Acceptable answers are reliant upon a best fit curve / line.

Question 5 (a)

There was a very broad spread of marks on this question, with ample opportunity, provided the candidate is clear about what is being measured.

For instance the height being measured should not be ambiguous with the height of the ramp itself. Many were not clear on this.

5 Figure 5 shows a way of projecting a small trolley up a sloping track.

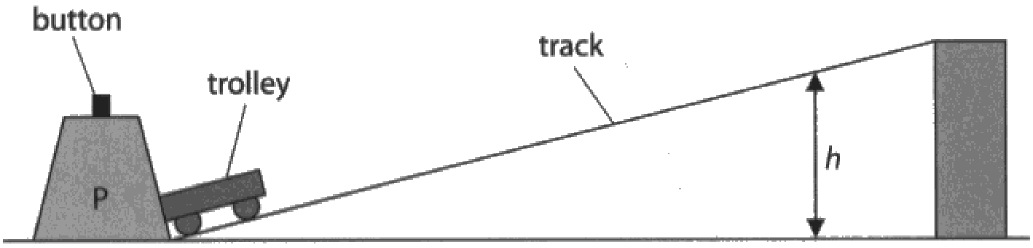


Figure 5

When the button is pressed, a spring is released in P that projects the trolley up the track.

The trolley travels up the track, stops and then rolls back down.

The spring in P always exerts the same force when projecting the trolley.

(a) A student investigates how the mass of the trolley affects the maximum vertical height, *h*, reached by the trolley.

State the measurements the student should make to complete the investigation.

You should make use of the equipment shown in Figure 5 and any other equipment that is needed.

(4)

The Student should measure the mass of the trolley and do this wherever he makes it lighter or heavier using a weighing scale. He should measure the maximum height the trolley reaches each time using a ruler. He should measure the distance the trolley travels on the track using a ruler.

ResultsPlus
Examiner Comments

This candidate spells out clearly that the mass of the trolley is to be measured (1) with an indication that a range of masses is to be used (1).

They then specify measuring the maximum vertical height with a ruler. As the additional guidance stipulates that statement itself is worth 2 marks.

Maximum 4 marks obtained here.

ResultsPlus
Examiner Tip

You must spell out the measurements clearly.

State any measuring instrument to be used. This is an important practical detail with any measurement.

The trolley should be weighed but should measure the mass as weight is affected by gravity. This can be done with a scale. The ~~set~~ angle of the slope should be measured with a protractor and the height of the slope should be measured with a ruler when the trolley is released. The distance of the track should be measured also with a ruler. When mass is added to trolley, it should be measured on the scale again.

ResultsPlus
Examiner Comments

Gains a mark for measuring the mass of the trolley.

Further marks are negated because the candidate talks vaguely about measuring the 'height of the slope'; that is not helpful and does not address the question.

The additional guidance at the end clearly states 'NOT use ruler to measure height of ramp'

ResultsPlus
Examiner Tip

Look at what the question is asking for.

Imagine the scene. The trolley travels up the slope to a certain point, which varies dependent upon the mass of the trolley. It will not always reach the end of the ramp/slope so that would be a fruitless distance to measure.

the student should measure the mass of the trolly in grams and the ~~distance it travels~~ distance each different weight travels in centimeters

ResultsPlus
Examiner Comments

A mark is given for measuring the mass of the trolley.

The distance measurement is inappropriate.

1 mark.

Question 5 (b)

This question needed realisation of the need for m g Dh and the recall of a value for g.

Then the candidate had to apply to two values from the graph.

A compensatory mark was possible where the candidate chose two values from the graph but just put them into m x h.

(b) Figure 6 is a graph of the student's results.

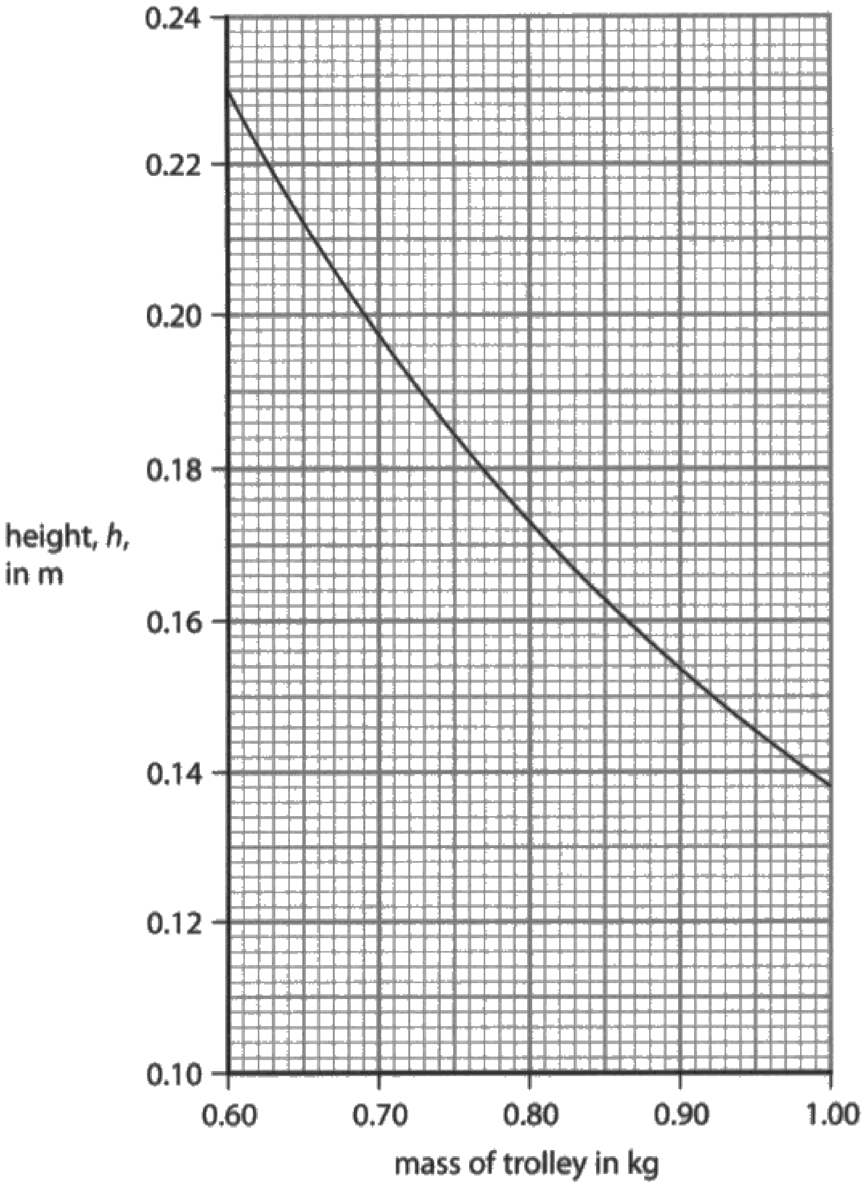


Figure 6

The student states that the energy transferred by the spring is the same each time it is used.

Use data from any two points on the graph in Figure 6 to support this statement.

(3)

When the mass is 0.6kg, ~~a~~ the height is 0.23m, meaning the gravitational potential energy of the trolley at ~~max~~ maximum height is 1.38J - this is the energy the spring transfers. When the mass is 1kg, the height reached is 0.138m meaning the energy ~~over~~ transferred by the ~~ot~~ spring = 0.138 x 1 x 10 = 1.38J, so it is constant.

ResultsPlus
Examiner Comments

Two appropriate values of m g Dh are calculated - 1.38 J in each case. Maximum 3 marks awarded.

The candidate could have made clearer statements but the values calculated match what is expected.

ResultsPlus
Examiner Tip

In case you slip in a calculation it will always benefit you to spell out clearly what you are doing.

Writing down the formula m g Dh would have helped if that were the case.

(b) Figure 6 is a graph of the student's results.

$\frac{1}{2} \times m \times v^2$

$m \times g \times \Delta h$

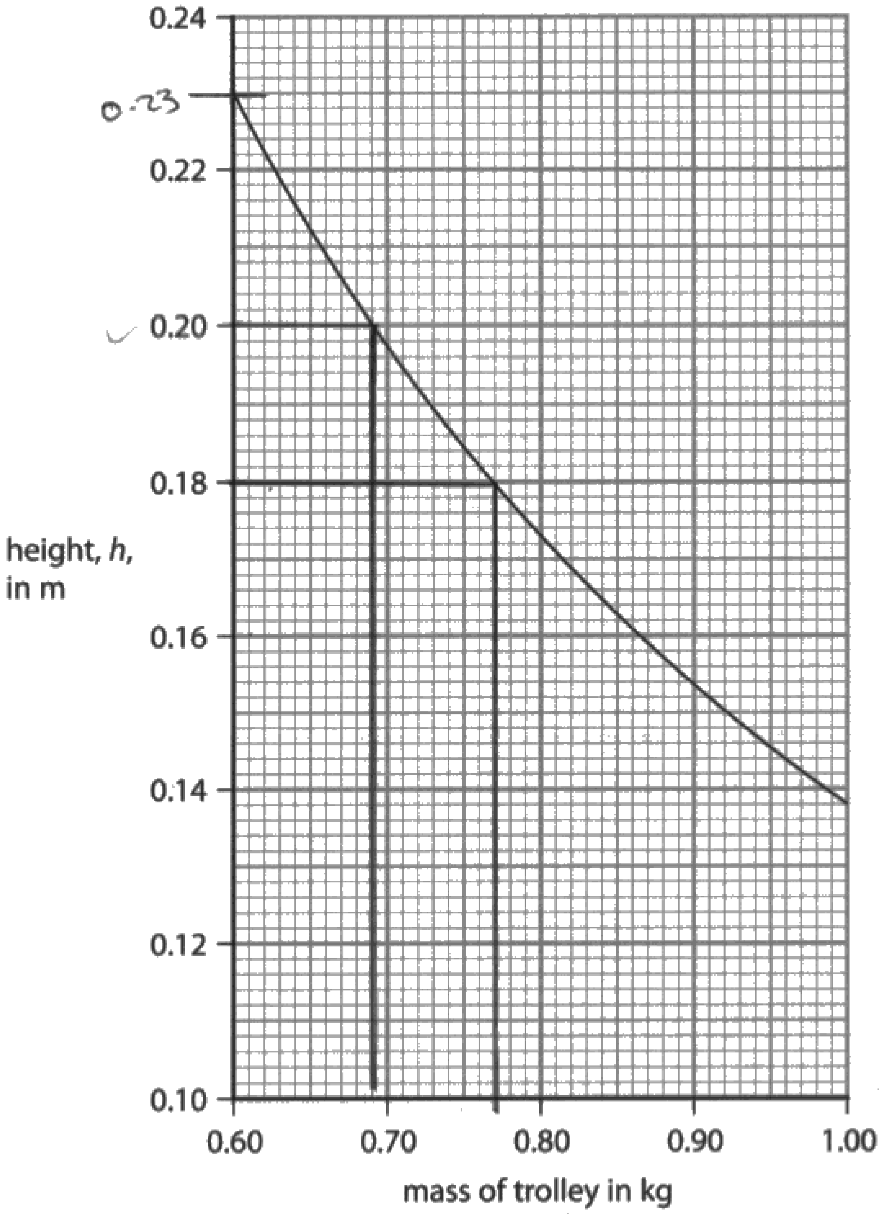


Figure 6

The student states that the energy transferred by the spring is the same each time it is used.

Use data from any two points on the graph in Figure 6 to support this statement.

(3)

0.20 = h g=10 m×g×Δh=GPE

0.69=m 0.69×10×0.2= 1.38 Joules = 1.4 (2sf) joules

0.18 = h g=10 They're the same

0.77 =m 0.77×0.18×10=1.386 = 1.4 (2sf Joules

ResultsPlus
Examiner Comments

This candidate does spell everything out very clearly.

A very commendable answer.

(b) Figure 6 is a graph of the student's results.

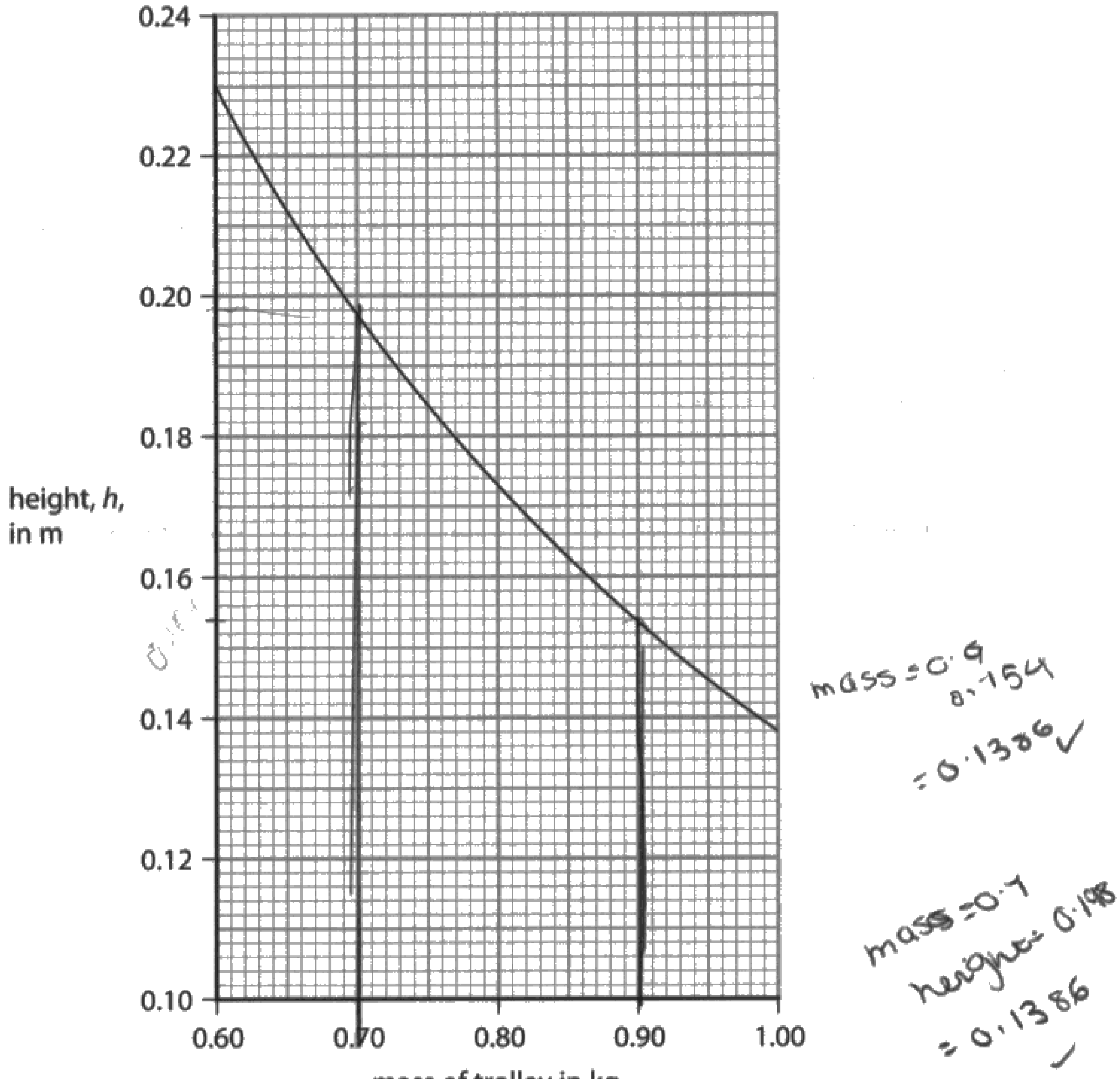


Figure 6

The student states that the energy transferred by the spring is the same each time it is used.

Use data from any two points on the graph in Figure 6 to support this statement.

(3)

When mass = 0.7 kg, height was 0.198 m.

0.7 × 0.198 = 0.1386

mass was 0.9 when height was 0.154. 0.154 × 0.9

= 0.1386. This implies the constant (energy transferred by spring) is always 0.1386

ResultsPlus
Examiner Comments

Just taking and calculating mass x height twice gets 1 mark.

See final piece of 'Additional guidance' in the mark scheme.

(b) Figure 6 is a graph of the student's results.

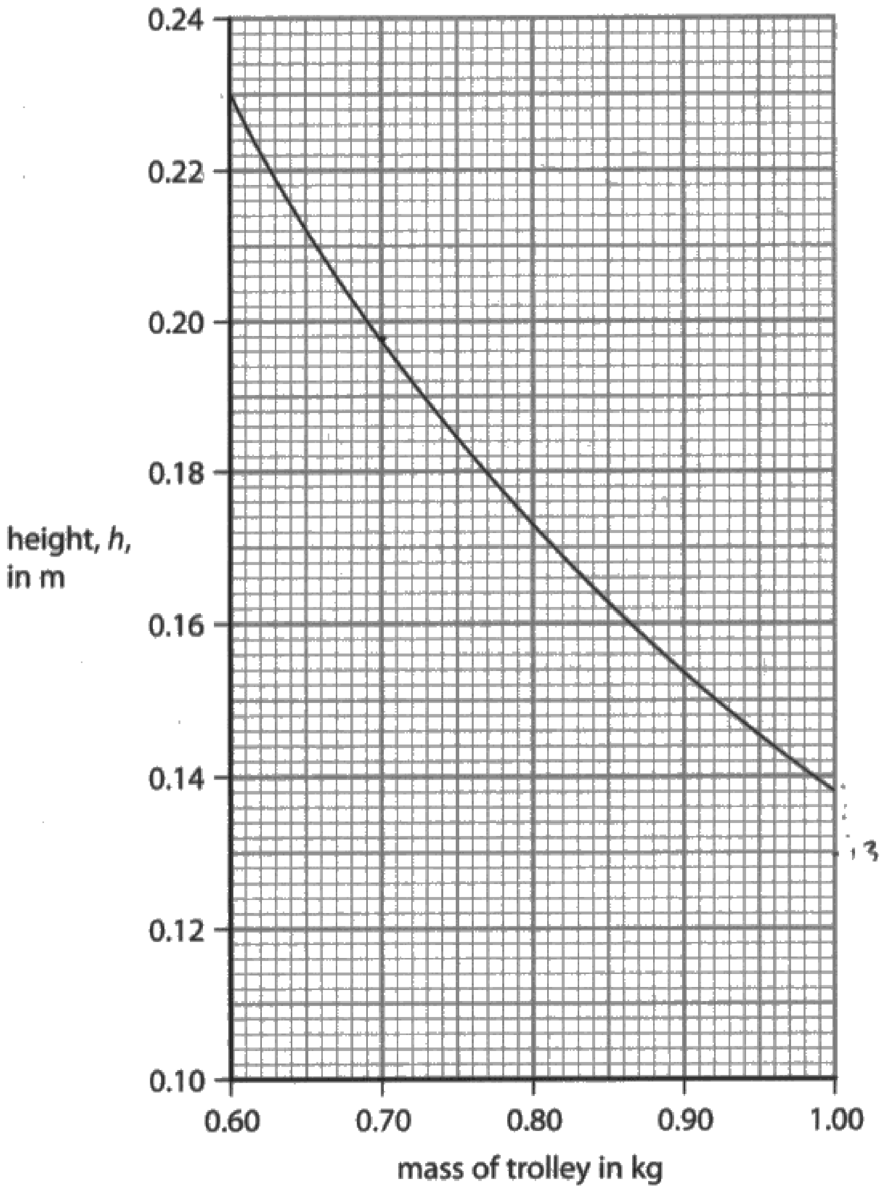


Figure 6

The student states that the energy transferred by the spring is the same each time it is used.

Use data from any two points on the graph in Figure 6 to support this statement.

(3)

The results plot a smooth curve with no outliers. The more the mass is increased the less distance the ~~was~~ trolley travels. For example 1 kg creates a distance ~~of~~ of 0.138 m whereas a weight of 0.7 kg creates a height of 0.198 m, which is more as there is less mass ~~weight~~ dragging the trolley back down at 0.7 kg.

ResultsPlus
Examiner Comments

Unfortunately just taking a pair of values from two points on the graph does not, of itself, score any marks.

Some processing is needed to get marks.

Question 5 (c)

This is a 'Describe how' question requiring the clear communication of practical steps.

A very broad range of marks was obtained in this question.

Lack of clarity over what distance and what time were being proposed often cost candidates marks.

Candidates did often quote the speed = distance / time formula, going on to clearly spell out an appropriate distance and time to measure.

(c) Describe how the student could extend the investigation to determine the average speed of the trolley as it rolls back down the track.

(3)

The student could use a stopwatch to gather information on the time it takes the trolley to roll back down the track from it's highest point reached. The distance should be measured that it travels back from the highest point reached in order to calculate the average speed of the trolley ~~reaches~~ as it rolls back down the track. (using the formula = {speed = $\frac{\text{distance}}{\text{time}}$).

(Total for Question 5 = 10 marks)

ResultsPlus
Examiner Comments

This candidate spells out the appropriate distance to be measured and the corresponding time, with a stopwatch.

Full marks obtained.

ResultsPlus
Examiner Tip

Note the command words 'Describe how'.

This needs practical details.

Aim for clarity and think to yourself 'If someone else read this would they know exactly what to do from my description?'

Find the length of the track. Mark the point the trolley reaches and time how long it takes for it to roll back down from that point. You can then use those values to calculate the speed.

ResultsPlus
Examiner Comments

A mark is scored for measuring an appropriate time.

An appropriate distance to be measured is not spelt out. Examiners cannot do the work / fill in the gaps for candidates.

The candidate fails to spell out the calculation that will be needed to obtain the average speed.

They could use a stopwatch to record the time from when the trolley stops rolling upwards to when it stops rolling back down the track for each weight that is tested.

![ResultsPlus Examiner Comments]

ResultsPlus Examiner Comments

Time aspect only covered so 1 mark is due.

That time is well described.

The student could extend it by inputting a light gate which measures the speed as it goes up the track then another light gate to measure it's final speed.
The student can then calculate a mean from the final and initial speeds (average)

ResultsPlus Examiner Comments

Quite a number of unfeasible practical descriptions using light gates were proposed.

The trolley moves up the slope and then momentarily comes to a stop before rolling back down.

How is any light gate to be placed to match rolling back down from a maximum height reached?

This is an impractical proposal without more detail about exactly how this can be achieved.

0 marks

Question 6 (a)

Higher scoring candidates saw the distance as a key fact from Figure 7 and went on to suggest a longer distance to improve accuracy.

Some talked about the use of technological solutions with precision e.g. talking of the use of microphones coupled to an oscilloscope or data-logger.

They involved the idea of the significance of reaction times when explaining their improvement.

Weaker students tended to talk about the use of technological solutions to the question in a vague way. They used the term 'human error' indiscriminately when explaining their improvement.

6 (a) The diagram in Figure 7 shows two students, P and Q, trying to measure the speed of sound in air.

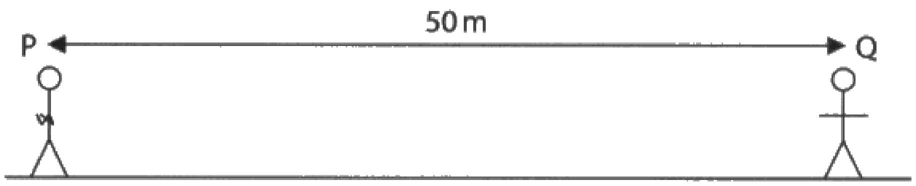


Figure 7

P will clap his hands together.

When Q sees P clap his hands, she will start a timer.

When Q hears the clap, she will stop the timer.

Explain **one** way the students could improve their method.

(2)

They could increase the distance between them so human reaction time of Q will have less of an impact - the results will be more valid.

ResultsPlus
Examiner Comments

This candidate succinctly and coherently gives a complete answer scoring all 2 marks.

ResultsPlus
Examiner Tip

This answer is exemplary; follow its practice in terms of clarity and precision.

The idea of 'will have less of an impact' is very well put.

Stand further apart. This increases the delay between seeing P clap and hearing it. This reduces the impact of Q's reaction times on the result (for starting and stopping the ~~stopwatch~~ timer)

ResultsPlus
Examiner Comments

This is equally well written. The candidate realises it's the reaction time compared with the length of delay that is the key point.

They could extend the distance between them to produce a more accurate measurement on the timer. P could clap repeatedly at the same time in a given period of time (eg. 10 sec) Q should not wait to see P clap, as the time is too close, Q should start ~~as~~ at the same time as P so there is no delay.

ResultsPlus
Examiner Comments

The first mark point - increase the distance- is awarded but there is no significant linked explanation, hence 1 mark only.

(2)

With a microphone synchronised with a camera, so they can slow down the footage and record the precise timings.

ResultsPlus
Examiner Comments

This could be an appropriate viable method. The first mark point alternative is awarded. There was insufficient linked justification to get the second mark.

The candidate has not spelt out in detail any advantage of this method nor have they made it very clear exactly what would be then measured.

Question 6 (b)

The best answers described the particle vibrations that are involved, employing a good use of vocabulary i.e. compressions and rarefactions / longitudinal waves.

Weaker answers talked of sound waves causing vibrations but omitted to mention that **particle** vibrations are involved.

(b) Figure 8 shows a long metal rod and a hammer.
The rod is hit at one end by the hammer.
This causes a sound wave to travel along the inside of the metal rod.

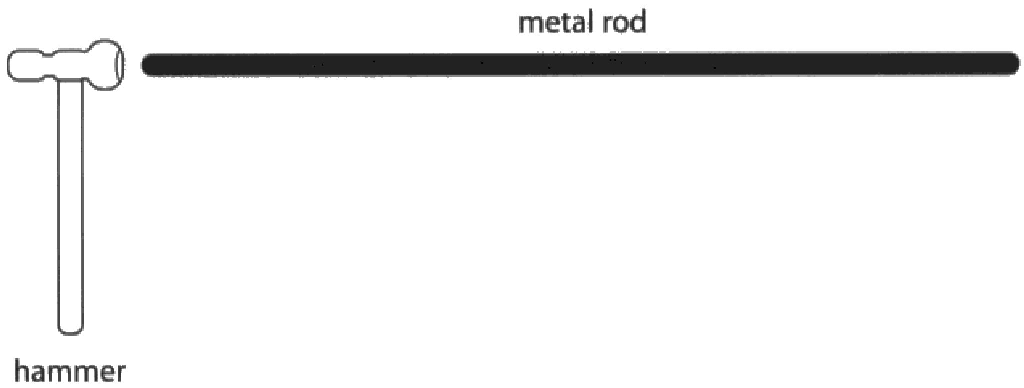


Figure 8

Describe how hitting the rod causes a sound wave to travel along the inside of the rod.

(2)

When the hammer hits the end of the rod, the particles it hits will vibrate. these vibrating particles will hit other particles and cause them to also vibrate, which continues through all the particles in the rod as the longitudinal sound wave passes through.

ResultsPlus
Examiner Comments

This is an excellent description matching both mark points.

The focus on the movement of particle throughout the description was very enabling for this candidate (and for others).

The clear reference to the longitudinal wave would also have scored mark point 2.

ResultsPlus
Examiner Tip

Longitudinal vibrations involve **particles** (atoms / molecules) vibrating.

The hammer causes the rod to vibrate. The vibration then produce longitudinal waves which are sound waves. The vibration travel parallel to the direction that the wave is travelling therefore the wave moves along the inside of the rod.

ResultsPlus
Examiner Comments

The clear apt reference to the involvement of longitudinal waves enabled mark point 2 to be credited.

The lack of mention of **particles** meant that mark point 1 could not be given.

Question 6 (c)

Many candidates drew the ray in the correct quadrant; about half of them then drew the ray bending towards the normal, implicitly recognising the difference between light and sound waves.

(c) Sound travels slower in air than it does in water.

Figure 9 shows the direction of travel of a sound wave approaching a boundary between air and water.

The sound wave refracts at the boundary between air and water.

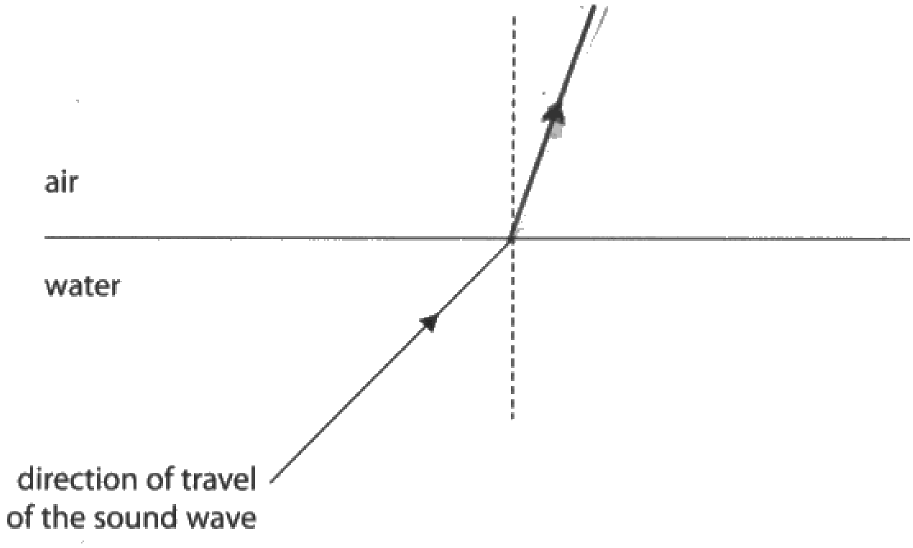


Figure 9

Complete the diagram in Figure 9 to show the direction the sound wave travels in the air.

(2)

ResultsPlus
Examiner Comments

Full marks.

ResultsPlus
Examiner Tip

Sound waves behave the opposite to light going from water to air. They slow down going into the air and so refract towards the normal.

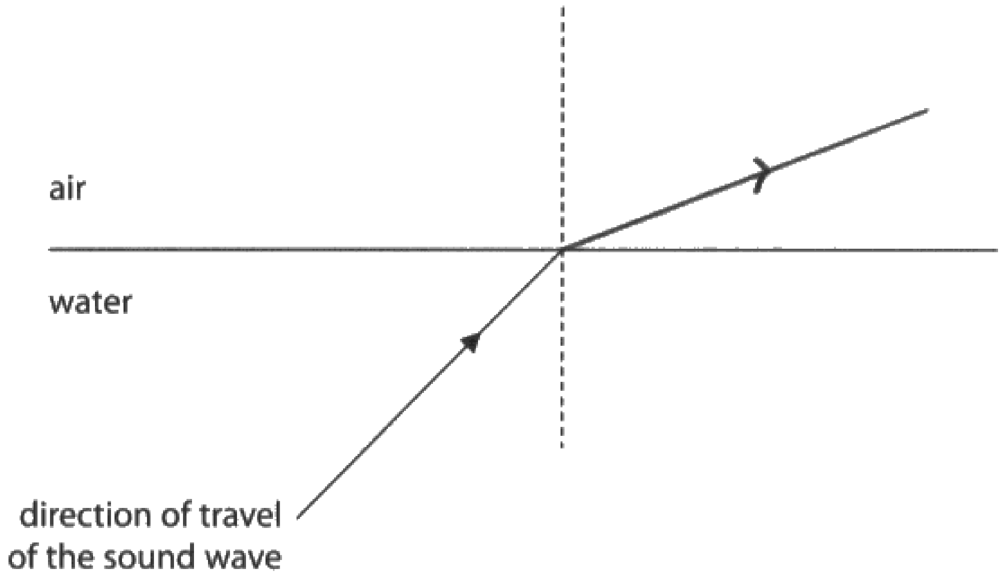


Figure 9

ResultsPlus
Examiner Comments

Mark point 1 awarded. Bends the wrong way so mark point 2 cannot be awarded.

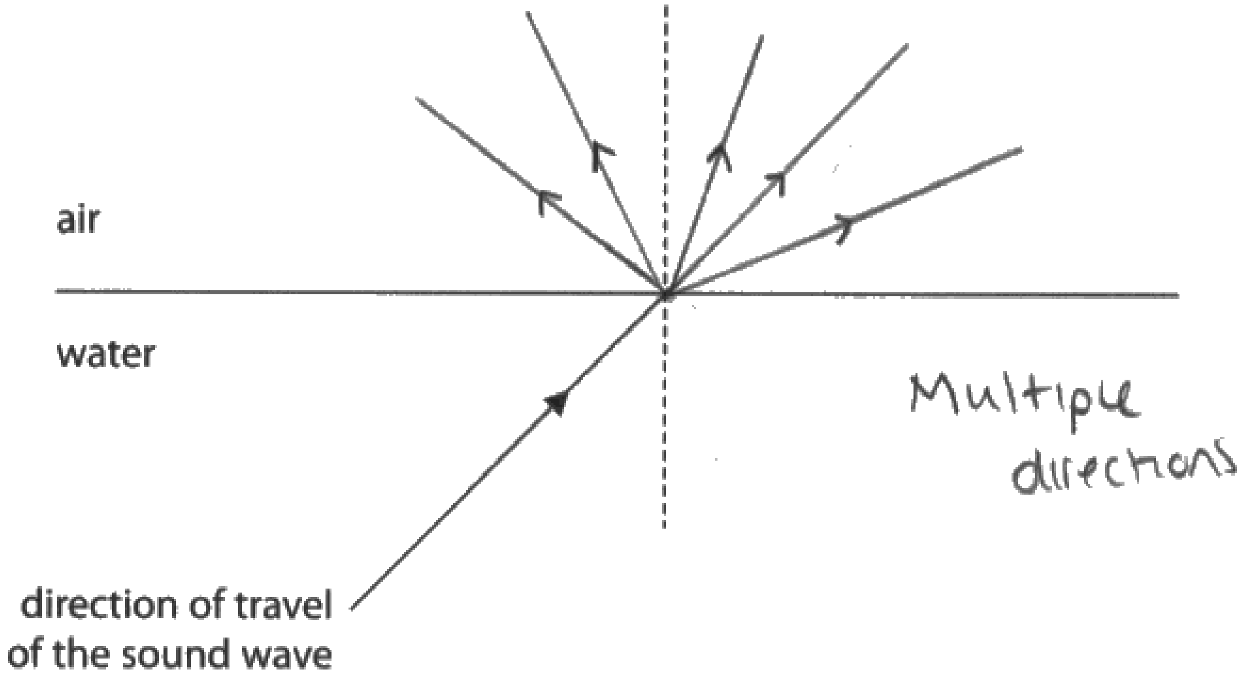


Figure 9

ResultsPlus
Examiner Comments

To score a mark there must be a **single** unambiguous ray in the upper right quadrant.

ResultsPlus
Examiner Tip

If you try and hedge your bets in giving an answer you will not succeed. The onus is upon you, the candidate, to choose your answer. Examiners cannot give credit to multiple answers like this.

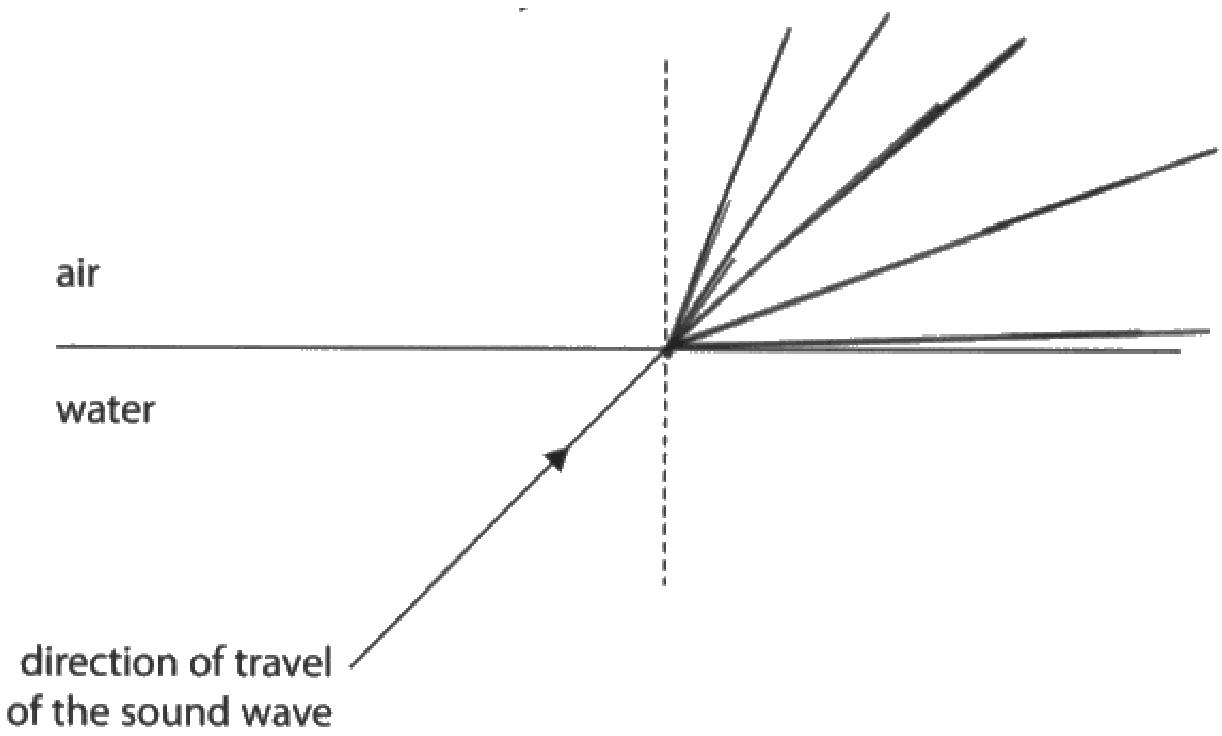


Figure 9

ResultsPlus
Examiner Comments

This is still ambiguous - not as blatant as the previous example you may think.

The same principles apply exactly though. The mark scheme is very clear on this - only one **single** line tolerated.

ResultsPlus
Examiner Tip

This is still ambiguous - not as blatant as the previous example you may think.

The same principles apply.

Question 6 (d)

Many candidates scored highly on this question. A majority obtained 3/3. Some calculations were flawed, in various ways sometimes omitting or getting confused about the square-rooting for example. The final hurdle in evaluating was to only quote an appropriate number of significant figures, consistent with the raw data.

(d) Sound travels slower in cold air than it does in warm air.

The equation relating the speed of sound in air to the density of the air is

$$\text{speed of sound} = \frac{K}{\sqrt{(\text{density})}} \qquad \text{where K is a constant.}$$

The table in Figure 10 gives some data about the speed of sound in air and the density of air.

	speed of sound in m/s	density of air in kg / m³
in cold air	331	1.29
in warm air		1.16

Figure 10

Use the equation and the data in the table in Figure 10 to calculate the speed of sound in warm air.

Give your answer to an appropriate number of significant figures.

(3)

$$331 = \frac{K}{\sqrt{1.29}}$$

$$K = 375.94\ldots$$

$$S = \frac{K}{\sqrt{1.16}}$$

$$S = 349 \text{ (to 3sf)}$$

speed of sound in warm air = 349 m/s

ResultsPlus
Examiner Comments

This is an exemplary text book answer with commendable clarity at every stage.

ResultsPlus
Examiner Tip

The straightforwardness and simplicity seen in the candidate's answer is based upon excellent mathematical and organisational competence.

To be taken as a model answer.

Give your answer to an appropriate number of significant figures.

cold air: $k = 331 \times \sqrt{1.29} = 375.^{(3)}94$

$k = 375.94$

warm air $= \dfrac{375.94}{\sqrt{1.16}} = 349.05$

speed of sound in warm air = 349.05 m/s

ResultsPlus
Examiner Comments

The k calculation is good from the cold data.

The substitution and first evaluation is good.

However the final evaluation has too many significant figures so 2 marks out of 3 are obtained.

ResultsPlus
Examiner Tip

The number of significant figures in the final evaluation should not be greater than the number of significant figures seen in the original data.

Give your answer to an appropriate number of significant figures.

(3)

in cold air: $331 = \frac{k}{\sqrt{1.29}}$ $K = 291.42925$

in warm air: $s = \frac{291.42925}{\sqrt{1.16}}$ $s = 270.5852657 \longrightarrow 271$

speed of sound in warm air = 271 m/s

ResultsPlus
Examiner Comments

The evaluation of k is wrong so mark point 1 is not achieved.

However using their value of k an error carried forward is allowed for mark point 2.

The final answer is evaluated to 3 significant figures so the third mark point is given.

ResultsPlus
Examiner Tip

If you show your working clearly, like this candidate, you can still get marks, even if you slip up on the way.

Give your answer to an appropriate number of significant figures.

(3)

$S = \frac{K}{\sqrt{density}}$

$331 = \frac{K}{\sqrt{1.29}}$

~~K = 331 × 1.29~~
~~= 426.99~~

$K = 331 \times \sqrt{1.29}$
$= 375.94$

$S = \frac{K}{\sqrt{1.6}}$

$= \frac{375.94}{\sqrt{1.6}}$

$S = 297.2$ m/s

= 297 (3 SF)

= 297 m/s (3 sf)

speed of sound in warm air = 297 m/s

ResultsPlus
Examiner Comments

K is evaluated correctly (mark point 1)

Unfortunately the candidate slips up by misreading the density of air in warm air, using a figure of 1.6; it should have been 1.16

This means that mark point 2 may not be awarded.

However mark point 3 is still valid with the final answer given to 3 significant figures.

ResultsPlus
Examiner Tip

Once again we see the value of setting out the working clearly, allowing for easily seen credit where credit is due.

Give your answer to an appropriate number of significant figures.

(3)

$$331 = \frac{K}{1.29}$$

$331 \times 1.29 = K$

$K = 426.99$

$$\frac{426.99}{1.16} = 368.094...$$

$= 368$

speed of sound in warm air = 368 m/s

ResultsPlus
Examiner Comments

This is an example of where someone misses out due to being unable to incorporate / handle the square root aspect.

Nevertheless 1 mark is given for a final answer to 3 significant figures.

Question 7 (b) (i)

The majority of students got this correct, drawing an arrow towards the centre of the circle, acting upon the object, representing a centripetal force.

(b) Figure 11 shows an object moving in a circular path.

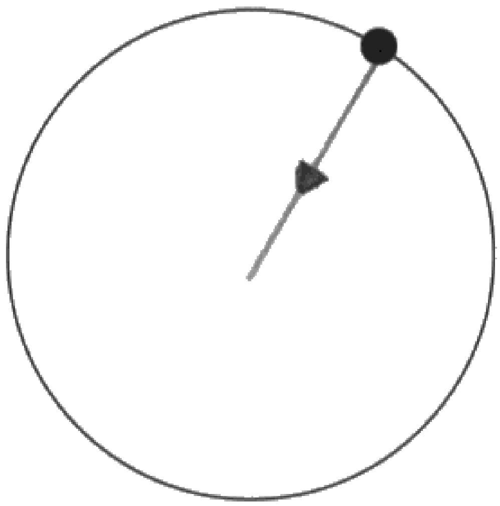


Figure 11

(i) Draw an arrow on Figure 11 to show the direction of the force that keeps the object moving in a circular path.

(1)

ResultsPlus
Examiner Comments

This is the conventional expected answer.

(b) Figure 11 shows an object moving in a circular path.

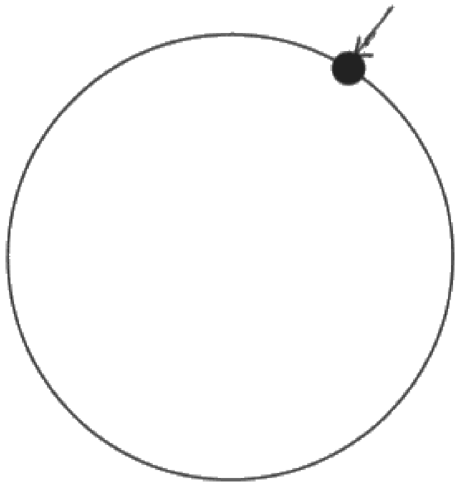


Figure 11

ResultsPlus
Examiner Comments

This matches the mark scheme requirement.

A single arrow towards the centre.

The force is applied to the object; we don't insist upon 'from the object'.

Mark given.

(b) Figure 11 shows an object moving in a circular path.

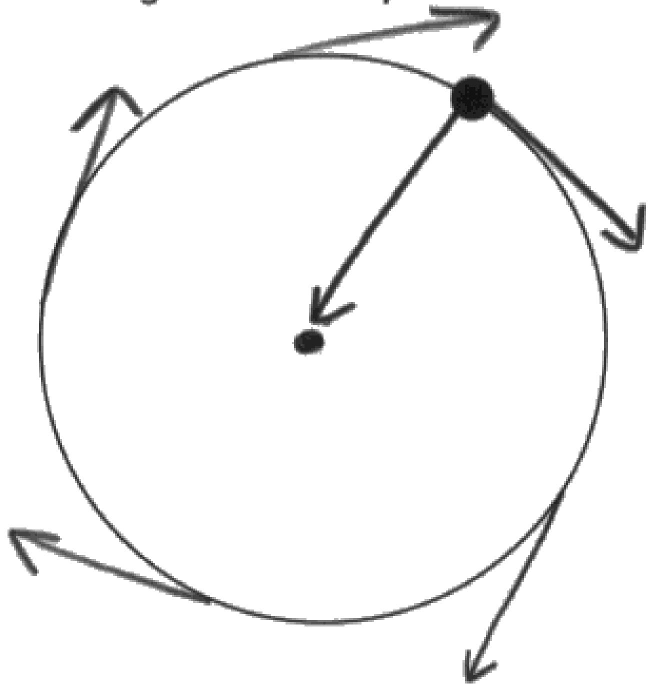


Figure 11

ResultsPlus
Examiner Comments

A **single** arrow is required in order for the mark to be awarded.

The question says draw **an** arrow.

No marks for multiple arrows.

Question 7 (b) (ii)

Most candidates scored 2 marks on this but quite a number only got 1 mark, because of either missing mark point 1 or mark point 2, as the exemplars below demonstrate.

(ii) The object in Figure 11 is moving at constant speed.

Explain why it is not moving with constant velocity.

(2)

Because speed is a scalar quantity so doesn't have direction. The object moves at a constant speed because its speed doesn't change. Velocity is a vector quantity so has direction and magnitude and the object is constantly changing direction so cannot have a constant velocity

ResultsPlus
Examiner Comments

This response is thorough. The last sentence clinches both marks.

It is not moving with constant velocity because velocity requires direction and magnitude and because it is at a constant speed the object is travelling along a fixed path and not accelerating

ResultsPlus
Examiner Comments

First mark point met with velocity as a vector idea clearly expressed.

Hasn't said the direction is changing so can't get the second mark point.

The last comment about fixed path and not accelerating is wrong of course.

The object is constantly changing direction as it moves in a circular path meaning its speed and velocity changes constantly.

ResultsPlus
Examiner Comments

This candidate scores mark point 2, changing direction, but not mark point 1.

The idea that velocity is a vector is not spelt out.

Question 7 (c) (i)

The vast majority of students scored 3/3 on this one.

However there are pitfalls, which the following carefully chosen examples demonstrate.

(c) Figure 12 shows a skier on a slope.

The skier travels down the slope with a constant acceleration.

The speed of the skier is measured at points P and Q.

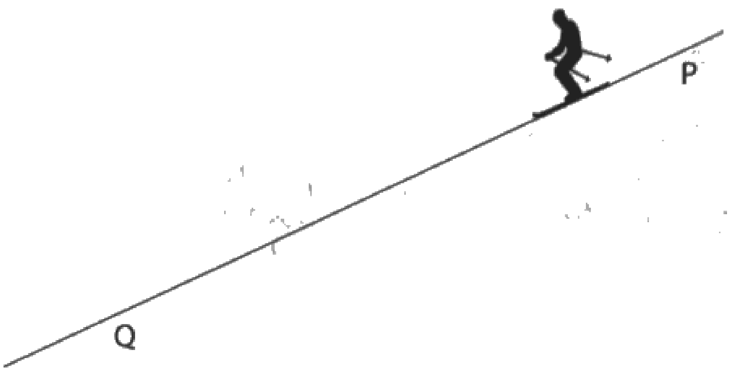


Figure 12

The table in Figure 13 gives some data about the skier making one downhill run.

acceleration	3.0 m/s^2
speed at P	7.6 m/s
speed at Q	24 m/s

Figure 13

(i) Calculate the distance from P to Q.

Use an equation selected from the list of equations at the end of this paper.

(3)

$v^2 - u^2 = 2 \times a \times x$

$(24^2) - (7.6^2) = 2 \times 3.0 \times x$

$\frac{518.24}{6} = \frac{6 \times x}{6}$

$86.37\text{m} = x$

~~(2 s f)~~

(2dp)

distance from P to Q = 86.37 m

ResultsPlus
Examiner Comments

This answer mirrors the mark scheme.

The candidate's reply is well organised.

(c) Figure 12 shows a skier on a slope.

The skier travels down the slope with a constant acceleration.

The speed of the skier is measured at points P and Q.

Figure 12

The table in Figure 13 gives some data about the skier making one downhill run.

acceleration	3.0 m/s²
speed at P	7.6 m/s
speed at Q	24 m/s

Figure 13

(i) Calculate the distance from P to Q.

Use an equation selected from the list of equations at the end of this paper.

(3)

$v^2 - u^2 = 2 \times a \times x$

(final velocity)^2 - (initial velocity)^2 = 2 × acceleration × dist.

$24^2 - 7.6^2 = 2 \times 3.0 \times x$

$\frac{24^2 - 7.6^2}{2 \times 3.0} = x$

$950.64 = x$ ~~or 9.50 × 10²~~

distance = 950.64m

distance from P to Q = 950.64 m

ResultsPlus
Examiner Comments

Mark points 1 and 2 matched.

The only problem here is the final calculator use.

Wrongly evaluated at the end so the candidate loses the last mark.

ResultsPlus
Examiner Tip

Practise this one on your calculator. It should show 86.3733.

(i) Calculate the distance from P to Q.

Use an equation selected from the list of equations at the end of this paper.

(3)

$$v^2 - u^2 = 2 \times a \times x$$

$$\frac{v^2 - u^2}{2 \times a} = \frac{24 - 7.6}{2 \times 3} = \frac{16.4}{6} = 2.7\dot{3}$$

distance from P to Q = 2.73 m

ResultsPlus
Examiner Comments

Only one re-arrangement mark seen here.

Then the candidate fails to square the numerator quantities, so loses subsequent marks.

$$a = \frac{v - u}{t}$$ $7.6 - 3.0 = 4.6$

$(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times a \times x$

$24 - 7.6 = \underline{16.4}$

$2 \times 3.0 = 6$

distance from P to Q = ... m

ResultsPlus
Examiner Comments

Two equations quoted but the candidate doesn't go anywhere with either of them.

No marks

$v^2 - u^2 = 2 \times a \times x$

$24 - 7.6 = 2 \times 3 \times x$

$16.4 = 6x$

$\frac{16.4}{6} = 2.7\dot{3}$

distance from P to Q = 2.73 m

ResultsPlus
Examiner Comments

Once the squares are missed out the rest falls.

ResultsPlus
Examiner Tip

As with $^1/_2\, m\, v^2$ calculations the squares are all important. Don't ignore them.

Question 7 (c) (ii)

A majority of students used v = u + at rearranged for 7 c(ii). These candidates showed great mathematical competency, with accurate calculator use.

Weaker candidates often re-arranged incorrectly or miscalculated. Some took the average speed route, but unfortunately used the wrong average speed.

(ii) Calculate the time taken for the skier to travel from P to Q.

(3)

time = distance / average speed = (7.6+24)/2

= 86.373 / 15.8 = 5.46 =

time from P to Q = 5.5 s

ResultsPlus
Examiner Comments

This shows an average speed route - as in the additional guidance of the mark scheme.

The working is clear and the correct evaluation is seen.

ResultsPlus
Examiner Tip

There isn't just one way of answering this question. Judge for yourself which one you find the easiest to understand. Ask yourself 'Which is the most efficient to use?'

$s = \frac{d}{t}$ $a = \frac{\Delta v}{t}$

$3 = \frac{24 - 7.6}{t}$

$t = 5.5$

time from P to Q = 5.5 s

ResultsPlus
Examiner Comments

This is a well communicated answer.

$\Delta v = v - u$

This candidate chooses the expected route in the main section of the mark scheme.

Generally speaking examiners found that those who re-arrange the equation first then substitute made less mistakes.

ResultsPlus
Examiner Tip

Consider handling the equation, in symbols, re-arranging it and then substitute into it.

As stated earlier examiners find that way less mistakes are made en route.

7.6 m/s

24 m/s

$24 - 7.6 = 16.4$ m/s

$\frac{16.4}{3} = 5.4\dot{6}$

$\frac{86.4 \text{ m}}{5.46} = 15.8$

$\frac{24 - 7.6}{86.4} =$

time from P to Q = 15.8 s

ResultsPlus
Examiner Comments

This is an example of where the candidate makes it difficult for the examiner to credit answers **because the working is not explained**.

The left hand side does contain a v - u calculation which is then divided by the acceleration giving the correct time. Unfortunately the candidate then goes on to work out an average speed and then puts that as their answer.

Benefit of doubt was applied in this case and the left hand side was credited as fulfilling mark points 1 and 2 of the mark scheme.

ResultsPlus
Examiner Tip

Do not risk examiners having to apply benefit of doubt to your working. That would be a dangerous unreliable path.

Instead make your working clear. All equations should have a subject ie **t =** (v - u) / a acceleration = $\frac{\text{change in velocity}}{\text{time}}$

$a = \frac{v - u}{t}$

$3 = \frac{24 - 7.6}{t}$

$t = 3(24 - 7.6)$
$= 49.2$

time from P to Q = 49.2 s

ResultsPlus
Examiner Comments

This gets the recall and substitution first mark.

The re-arrangement is then messed up.

Question 8 (a) (i)

This question differentiated well. Candidates often mentioned half-life; fewer, but still a majority, included the location aspect well. Some dwelt on harm to persons / contamination of the environment, which is not at issue here.

8 (a) Energy from the nuclei of atoms can be used in medical diagnosis and treatment.

(i) Fluorine-18 is a radioactive isotope used in PET scanners for medical diagnosis.

Explain why fluorine-18 must be produced close to the hospital where it is used.

(2)

Fluorine-18 has a very short half life so if it was produced further away, it would decay by the time its needed.

ResultsPlus Examiner Comments

This gains both marks.

The second mark is related to use. To say 'when it is needed' is strong enough in that regard.

As it has a short half-life, so when used it does not harm the patient too much

ResultsPlus Examiner Comments

Short half-life gets the first mark point.

Second not scored. The additional guidance makes it clear that arguments about harm to persons are ignored.

It decays relatively quickly, so it has to be produced nearby or it would lose most of its radioactivity during a PET scan.

ResultsPlus
Examiner Comments

This gains mark point 2 but misses out the short half-life part of the explanation.

Question 8 (a) (ii)

This 4 mark open response item had a wide variation in marks. Almost a half of all candidates were able to get 3 marks, though some fell short of that for one reason or another. Only the highest-attaining candidates said that the alpha source needs to be placed close to the tumour (because of its short range / low penetration)

(ii) Some tumours inside the body can be treated by using either alpha radiation or gamma radiation.

Explain why the source of alpha radiation is usually inside the body but the source of gamma radiation can be outside the body.

(4)

alpha radiation is weakly penetrating as a result it would be injected close to the tumour. However as gamma is highly penetrating it can travel through the skin, as a result it can be found outside the body.

ResultsPlus Examiner Comments

This is a very succinct answer covering all the mark points well.

Note the mark scheme states 'pass through the skin' may be taken as can get into the body from outside in this context.

ResultsPlus Examiner Tip

This answer very neatly puts each property alongside the implication for that radiation. Answers to the point, like this, are to be commended.

Alpha radiation needs to be inside the body because it ~~ionises~~ ~~releases~~ has high ionising power but has low penetrating power which means it can be stopped by some paper or skin. therefore to treat the ~~can~~ ~~to~~ tumours they need to be ~~directly~~ ~~very~~ emitted close to them. However, gamma rays have low ionising power but have high penetrating power which means it can penetrate through the skin and any other types of tissues before reaching the tumor with ~~[illegible]~~ quite small damage as it ~~hasn't~~ ~~got~~ ~~much~~ has low ionising power.

ResultsPlus
Examiner Comments

This also scores full marks. The candidate covers ionising ability and penetrating power well. They clearly understand the physics principles involved and the consequences in this scenario.

Alpha radiation has a lower penetrating power than gamma radiation. In fact, alpha radiation can be stopped by a few cm in air or by the skin. However, gamma radiation can only be stopped by thick lead. Because of ~~this,~~ the low penetrating power of alpha radiation, that type of radiation needs to be inside the body in order to minimise alpha blockages. On the other hand, gamma radiation ~~can~~ doesn't have this sort of problem, so it can enter the patient's body from outside.

ResultsPlus
Examiner Comments

This candidate clearly scores mark points 1, 3 and 4. The answer is very clear and direct. The only thing missing was the need to place the alpha source close to the tumour.

Gamma radiation is very penetrating, so can be used with the source outside the body, however ~~the~~ alpha radiation is not very penetrating, so has to be used with the source inside the body. This is because it cannot penetrate the skin, ~~and~~ tissue, ~~and~~ and possibly bone, surrounding the tumour. Gamma rays are not very ionising so are unlikely to cause damage to other cells, but alpha particles are very ionising so would cause damage to other cells ~~in~~ (i.e skin cells) if used ~~with~~ with the source ~~on~~ outside the body.

ResultsPlus
Examiner Comments

The penetrating power of gamma radiation is recognised by the candidate. Then, however, all they do is repeat the stem of the question without explaining the consequence. The alpha property of not being very penetrating is dealt with as well.

2 marks

Alpha is used inside because it cannot penetrate dense materials such as bone but it can damage the cancer cells and tissues, they're used in tracers to detect the tumour aswell. Gamma is used outside because it could damage your internal bones and penetrate them.

ResultsPlus
Examiner Comments

The mark is awarded for the statement on alpha's penetration.

The comment on gamma is not sufficiently clear on the property of gamma's high penetration.

Question 8 (b) (ii)

A majority of candidates got 3/3 with this question. They made lots of progress with the recall, re-arrangement and substitution, showing good mathematical skills, including finding of the square root at the end.

Some candidates, however, did have problems with re-arranging and a number of problems with powers of ten and calculator use were seen.

(ii) The kinetic energy of one of the particles released in a fission reaction is 1.2×10^{-11} J.

The mass of the particle is 1.4×10^{-25} kg.

Calculate the velocity of the particle. **(3)**

$ke = \frac{1}{2} \times mass \times (velocity)^2$

$1.2 \times 10^{-11} = 1.4 \times 10^{-25} \times \frac{1}{2} \times v^2$

$\frac{1.2 \times 10^{-11}}{1.4 \times 10^{-25} \times \frac{1}{2}} = v^2 = 1.714285714 \times 10^{14}$

$v = 13093073.41$

velocity of the particle = 13 093 073 m/s

ResultsPlus
Examiner Comments

Full marks for this candidate.

The working is easy to follow - recall - substitution - re-arrangement - and the final evaluation.

ResultsPlus
Examiner Tip

The more you show intermediate steps the more chance you have for intermediate marks if things go wrong.

~~1.4×10^{-25}~~

Kenetic energy $= \frac{1}{2} \times m \times v^2$

$1.2 \times 10^{-11} = \frac{1}{2} \times 1.4 \times 10^{-25} \times v^2$

$\frac{1.2 \times 10^{-11}}{\frac{1}{2} \times 1.4 \times 10^{-25}} = v^2$

$v = \sqrt{1.7...}$

$1.7... \times 10^{14} = v^2$

$v = 13093073.41$

velocity of the particle = 1.3×10^7 m/s

ResultsPlus
Examiner Comments

This scores full marks.

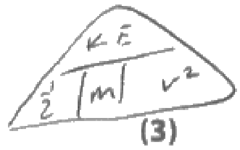
It's easy to follow and benefits from a final answer written in standard form.

ResultsPlus
Examiner Tip

Writing the answer in standard form ie 1.3×10^7, can help eliminate a final error when too many or too few figures may accidentally be written down.

The mass of the particle is 1.4×10^{-25} kg.

Calculate the velocity of the particle.



(3)

$KE = \frac{1}{2} \times m \times v^2$

$1.2 \times 10^{-11} = \frac{1}{2} \times (1.4 \times 10^{-25}) \times v^2$

$v^2 = \dfrac{(1.2 \times 10^{-11})}{\frac{1}{2} \times (1.4 \times 10^{-25})}$

$= 1.7 \times 10^{14}$

velocity of the particle = 1.7×10^{14} m/s

ResultsPlus
Examiner Comments

The candidate gets as far as evaluating v^2 (2 marks) but then forgets to take the square root at the end.

ResultsPlus
Examiner Tip

This is a quite frequent mistake candidates make. It's important to see the calculation through, right to the end.

$1.2 \times 10^{-11} = \frac{1}{2} \times 1.4 \times 10^{-25} \times v^2$

$2.4 \times 10^{-11} = 1.4 \times 10^{-25}$

$KE = \frac{1}{2} \times m \times v^2$

$1.714285714 \times 10^{36} = v^2$

$\sqrt{Ans} =$

velocity of the particle = 1.309×10^{18} m/s

ResultsPlus
Examiner Comments

This candidate gets the recall and substitution mark, and the re-arrangement mark.

They then make a power of ten error on the calculator, missing out on the final evaluation mark.

ResultsPlus
Examiner Tip

Be careful with entering numbers on your calculator. Here it looks as if the student put into their calculator 2.4 x 1011, when they should have put 2.4 x 10-11, making quite a difference in the outcome.

As an added check always ask yourself at the end 'Is this answer reasonable?'

In this case the answer obtained is much bigger that the speed of light, making it impossible. That fact could have alerted the candidate to the fact that they had made a mistake.

(ke = ½ mv²)

(ii) The kinetic energy of one of the particles released in a fission reaction is 1.2×10^{-11} J.

The mass of the particle is 1.4×10^{-25} kg.

Calculate the velocity of the particle.

(3)

$$ke = \frac{1}{2}mv^2$$

$$1.2 \times 10^{-11} = \frac{1}{2} \times 1.4 \times 10^{-25} \times v^2$$

$$1.2 \times 10^{-11} = 7 \times 10^{-26} \times v^2$$

$$\sqrt{1.2 \times 10^{-11} - 7 \times 10^{-26}} = \sqrt{v}$$

$$\sqrt{v} = 3.464101615 \times 10^{-6}$$

velocity of the particle = $3.464101615 \times 10^{-6}$ m/s

ResultsPlus
Examiner Comments

This candidate manages the recall and substitution marks but their re-arrangement is incorrect.

They score the first mark only.

Question 9 (a)

The majority of candidates scored the mark for this. Some were distracted and did not focus on damage / harm to the eye.

9 (a) Some sunglasses have photochromic lenses.

Photochromic lenses are clear when the lenses are indoors but they darken in bright sunlight to reduce the effects of the sunlight.

Photochromic lenses react to ultraviolet light.

Suggest a benefit of making the lenses go dark with ultraviolet light.

(1)

Ultraviolet light can damage the eyes and cause blindness; the dark lenses can protect against this

ResultsPlus
Examiner Comments

The candidate's response matches mark point 1, as spelt out in the additional guidance of the mark scheme.

~~Stop UV~~

will protect the eyes from the sun.

ResultsPlus
Examiner Comments

This answer is too vague and not related sufficiently to the uv aspect.

Question 9 (b)

Most got the ratio (5x) correct and understood that their calculation assumed the constancy of the speed of electromagnetic radiations.

(b) Radio waves from Jupiter take 40 minutes to reach Earth.

Light waves from the Sun take 8 minutes to reach Earth.

Calculate how many times further it is from Earth to Jupiter than from Earth to the Sun.

State the property of electromagnetic radiation that is used in your answer.

(2)

5 times

property all EM waves travel at 3×10^8 (the speed of light)

ResultsPlus
Examiner Comments

Both mark points met.

The property is spelt out with precision.

5 times

property wave speed

ResultsPlus
Examiner Comments

1 mark for 5X.

What about the wave speed? The candidate has not spelt out fully the property - its constancy.

Question 9 (c)

There was a broad range of marks for the open response description asked for here. Higher scoring candidates used scientific ideas such as absorption and transmission with accuracy. They also are much more likely to recognise that it is a focus on the relationship with wavelength. Weaker candidates often only paid attention to relationships with frequency, missing the question focus on the relationship with wavelength.

(c) Ultraviolet waves cover a range of frequencies.

Scientists divide this range into three types, UVA, UVB and UVC.

The table in Figure 14 shows the frequency range for each type.

type	frequency range in Hz
UVA	7.5×10^{14} to 9.4×10^{14}
UVB	9.4×10^{14} to 10×10^{14}
UVC	10×10^{14} to 30×10^{14}

~~lowest~~ lowest frequency = high wave.

= highest frequency = lower wavelength

Figure 14

Figure 15 is a diagram about the effect that the Earth's atmosphere has on three types of ultraviolet radiation.

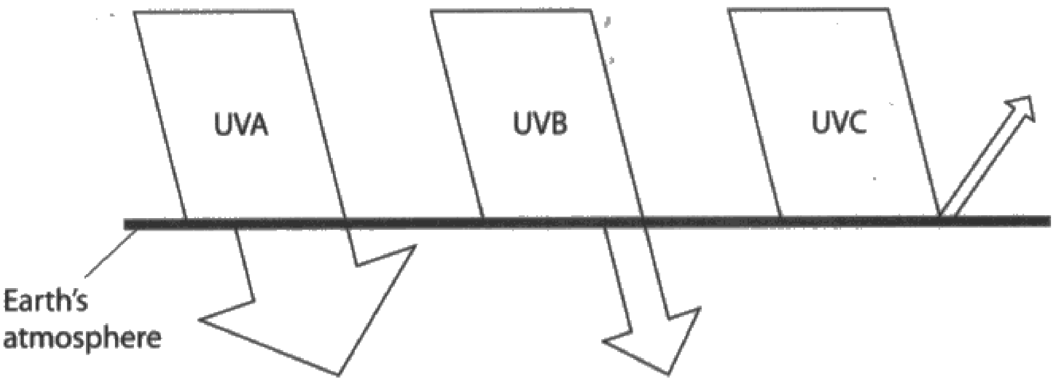


Figure 15

Describe how the effects change with **wavelength**, using information from Figure 14 and Figure 15.

The width of the arrows drawn indicates the amount of radiation that is involved.

Calculations are **not** required.

(4)

As wavelength decreases, less of it is transmitted by the earth's atmosphere. As wavelength increases, more of it passes through the atmosphere. UVC has the highest frequency meaning it has the lowest wavelength of all three of the UV waves and none of it pass through the atmosphere. Most of it are absorbed and some are reflected by the atmosphere. UVA has the longest wavelength of all 3 and most of it passes through the atmosphere. UVB is in the middle and a small amount of it passes through the atmosphere.

ResultsPlus
Examiner Comments

The candidate begins with the overarching relationship statement and then goes on to make very precise and accurate statements about the individual cases for UVC, UVA and UVB in that order.

Full marks obtained.

ResultsPlus
Examiner Tip

Answering a question like this needs a good focus upon what information the diagram offers. Not all saw it as well as this candidate.

There's a lot to be learnt from the way the student composed this answer with rigour and attention to detail.

UVA has most of it's light get through as it has a low frequency so the atmosphere finds it hard to stop. UVB has some of it's light get through as it's ~~wavelength is to~~ frequency is low enough to get some light through. But light in UVC rays are mostly absorbed the atmosphere ~~a~~ apart from a very small amount that is reflected back since it has a very high frequency

ResultsPlus
Examiner Comments

The statements about UVA, UVB and UVC match mark points 1, 2 and 3 well.

All that is missing is an overarching correct relationship concerning the variables.

UVA has the smallest wave length but has the most UVA rays passing through to earth passed the atmosphere. Where as UVC has a large wave length of up to 30×10^{-7}, this means none of its rays can git through earths atmosphere seeing as UVA (7.5×10^{-7}) and UVB (9.4×10^{-7}) have smaller wave lengths they can git through. This clearly shows that the smaller the wave length the more likely it is to pass through.

ResultsPlus
Examiner Comments

This candidate gets the variation with wavelength the wrong way round. UVA has the longest wavelength.

Two marks were awarded for the statements about UVA having the most radiation transmitted and the UVC statement about none of its radiation getting through.

As the fequency increases the amount of radiation absorbed decreases. Therefore, as the wavelength decreases, the amount of absorbtion decreases.
The UVA has the longest wavelength and is absorbed the most, the UVB has a shorter wavelength and is absorbed less.
The UVC is reflected as its wavelength is so short it can't pass through the atmosphere

ResultsPlus
Examiner Comments

The candidate presents muddled arguments, confusing absorption and transmission and getting the overarching relationship wrong therefore. A mark is scored for the UVC can't pass through the atmosphere comment with some benefit of doubt applied since it lies alongside a blasé statement about reflection.

Question 9 (d)

This question is about **the production** of radio and gamma waves.

A good number of candidates knew quite a lot about gamma production, including details from the annihilation process. They were less secure in their knowledge of the production of radio waves but could sometimes make an association with aerials and oscillations (of electrons).

Weaker candidates tended to go off beam and delve into irrelevant details about the properties and uses of the radiations.

*(d) Radio waves and gamma radiation are at opposite ends of the electromagnetic spectrum.

Compare how these two electromagnetic radiations are produced.

(6)

Gamma radiation is produced ~~w~~ when a ~~radioactive isotope give~~ nucleus of a radioactive isotope gives off energy in the form of gamma radiation. This is so the ~~iso~~ nucleus can stabalise its energy levels to what it should be. Radio ~~waves it~~ waves ~~as~~ are produced ~~as~~ when ~~a~~ a machine vibrates the air particles ~~with~~ ~~use~~ using ~~ele~~ electrical ~~energy~~ energy.

ResultsPlus
Examiner Comments

This is a level 2 answer, which tolerates more detailed facts about a radiation compared with the other. The reference to the stability of the nucleus clinches it as a level 2 full 4 marks answer.

*(d) Radio waves and gamma radiation are at opposite ends of the electromagnetic spectrum.

Compare how these two electromagnetic radiations are produced.

(6)

gamma rays are produced when a nucleus decays and emits a gamma ~~particle~~ ray. Microwave radiation ~~is~~ has a lower wave frequency than gamma and is produced differently.

ResultsPlus
Examiner Comments

This is a level 1 answer, with an isolated statement about the production of gamma waves.

Radiowaves are created by oscillations in a ~~a~~ electrical circuit. They have the lowest frequency, longest wavelength and least energy of the whole EM spectrum. They are used for communications as the oscillations that create it travel from antenna to antenna through the air. Gamma rays are created within the nucleus of atoms. They have the highest frequency, shortest wavelength and most energy of the whole EM spectrum. When ~~two~~ an alpha particle collides with an electron, they release gamma radiation in opposite directions.

ResultsPlus
Examiner Comments

This response is a level 2 answer, with some facts about the production of each radiation. It is mostly clear, logical and coherent but goes off slightly at the end with a loss of accuracy in talking about annihilations.

4 marks

Radiowaves are produced by ossilations in an electrical circuit

ResultsPlus
Examiner Comments

Clearly matches level 1 for an isolated fact about one radiation matching indicative content.

• Radio waves are produced by oscillations of electrons in ~~antenna~~ antennaes and sattelites

· this creates a low frequency wave with a longwavelength that is useful in telecommunications

· gamma radiation is produced by the ~~gamma deca~~ decay of particles by gamma radiation

• this creates a high frequency wave with a short wave length that has very few uses, but can be usea to diagnose cancer

· gamma radiation is also produced via the anhilation of an electron and a positron, this process is used in PET scans

ResultsPlus
Examiner Comments

Indicative content is well met by this candidate, both on the production of radio waves, and that of gamma waves. Gamma is cited as being produced in the decay of particles and via annihilations. There is sufficient detail here, on both aspects, to award the full 6 marks at level 3. The comments made match the 'possible candidate responses' for level 3 in the mark scheme. The answer does not have to be perfect to get 6 marks.

ResultsPlus
Examiner Tip

This candidate uses bullet points. That may suit your style; it is acceptable. It's the content that counts. This candidate has focused well on the production aspect and developed a really good answer.

Radio waves	Gamma radiation.
used in day to day objects.	· Used in medical treatment
· ~~doesn't emit~~ does radiation.	· Emits radiation.
· Transverse waves	· Radioactive.
· low frequency	· ~~Fra~~ longitudional waves
· High wavelength	· High frequency
	· low wavelength.

ResultsPlus
Examiner Comments

There is no rewardable content here. The question is about the production of these radiations. This candidate looks at properties and uses at a low level but there is no content about production.

- Gamma rays are produced when an unstable nucleus decays. This can release alpha and beta particles, but it can also release gamma radiation as ionising radiation. Gamma radiation is also produced in nuclear fusion. When 2 hydrogen nuclei fuse together, the heavier nucleus does not weigh as much as the two smaller nuclei added together, showing how huge amounts of gamma radiation is also released.
- Radiowaves can be produced by oscillating charges in a frequency generator. This creates radio waves with large wavelengths and low frequencies in comparison to the short wavelengths and high frequencies in gamma rays.

ResultsPlus
Examiner Comments

Excellent coverage on the production of gamma waves, with more detail than would be expected of a grade 7-9 GCSE Physics student e.g. their knowledge of gamma being emitted during fusion events. The radio wave production is not as detailed. The mark scheme, at level 3, anticipated that where it said 'one radiation may have significantly more detail than the other but both should feature for level 3.'

ResultsPlus
Examiner Tip

This candidate displays excellent communication skills in the way that they composed this answer. Try to emulate that. Think of this as a model answer.

Question 10 (a) (i)

Successful candidates keyed into the complexity of what is being asked for here – about the process **to produce the conditions** . . . Their knowledge included the role of gravity causing nebula collapse and the requirement for very high temperatures and pressures.

10 (a) Stars may originate as a nebula.

(i) Describe the process that then occurs to produce the conditions necessary for nuclear fusion in a new star.

(3)

A nebula is a cloud of dust and gas. The star then contracts due to an imbalance of forces. The gravity force that pulls steller material inwards, is stronger than the outward pressure. The star contracts to form a protostar. Then temperatures rise as gravitational potential energy is converted into kinetic energy (due to contraction). The particles have more kinetic energy which causes the increase in temperature. ~~burning?~~ Nuclear fusion then occurs when the temperature is hot enough and there is enough energy to overcome the electrostatic repulsion of

ResultsPlus
Examiner Comments

This shows a very high level of knowledge and understanding.

All mark points are met, including the energy conversion one, and the candidate appreciates the temperature condition that ensues.

ResultsPlus
Examiner Tip

The answer is well constructed, telling the story of the process with clarity and accuracy concerning the use of technical terms. This is the level to aim for.

Constructing stories about processes helps a lot and aids memory.

The pull of gravity acts inwards and pulls hydrogen and gas and dust together. As the gas contracts the pull of gravity. The Nebula gets hotter as work is being done on it. Eventually it gets hot enough to form a ~~hydrogen~~ helium nuclei. The nuclear fusion allows the helium nuclei to get heavier, increasing the amount of energy. light is then emitted from the star.

ResultsPlus
Examiner Comments

This gets 2 marks for mark point 1 collapses (coming together idea) and mark point 2 'under gravity'.

The third mark point is not given - see additional guidance in the mark scheme where it says reference to 'hot' is insufficient. It needs a reference to high temperatures, which is missing.

ResultsPlus
Examiner Tip

'Conditions' in physics may be quantified - think what variable is involved; here it a temperature condition that is key.

10 (a) Stars may originate as a nebula. – dust+gas

(i) Describe the process that then occurs to produce the conditions necessary for nuclear fusion in a new star.

(3)

Thermal expansion takes place ~~within the protostar~~ which increases the temperature and pressure. Nuclear fusion requires very high temperatures ~~and [illegible]~~ of around 100 million °C and very high pressures.

ResultsPlus
Examiner Comments

The temperature condition is very well spelt out - 1 mark.

The candidate has failed to describe the process that led to this condition being met to get the other marks.

Question 10 (a) (ii)

A majority of candidates dealt with the equation well with a correct evaluation.

A few had powers of ten errors but most coped well with that aspect.

(ii) The energy, *E*, released in nuclear fusion is equivalent to loss in mass, *m*, according to the equation.

$$E = mc^2$$

where *c* is the velocity of light.

$c = 3.00 \times 10^8$ m/s

In 1 second, the energy radiated by the Sun is 3.86×10^{26} J.

Calculate the loss in mass of the Sun in 1 second.

(2)

~~E = m~~

3.86×10^{26} J $= m(3 \times 10^8 \text{ m/s})^2$

$m = \dfrac{3.86 \times 10^{26}}{(3 \times 10^8)^2} = 4288888889$ kg

loss in mass = 4288888889 kg

ResultsPlus
Examiner Comments

Substitutes first, then re-arranges, arriving at a correct evaluation.

Full marks 2/2.

ResultsPlus
Examiner Tip

Consider writing the answer in standard form i.e. 4.29×10^{9} kg

Otherwise there is always the risk of writing one too many or one too few 8s. . . .

(ii) The energy, *E*, released in nuclear fusion is equivalent to loss in mass, *m*, according to the equation.

$$E = mc^2$$

where *c* is the velocity of light.

$c = 3.00 \times 10^8$ m/s

In 1 second, the energy radiated by the Sun is 3.86×10^{26} J.

Calculate the loss in mass of the Sun in 1 second.

(2)

$3{\cdot}86 \times 10^{26} = m \times 3{\cdot}00 \times 10^{8\,2}$ 42888888889

$\frac{3{\cdot}86 \times 10^{26}}{3 \times 10^{8\,2}} =$

loss in mass = 42888888889 kg

ResultsPlus
Examiner Comments

The re-arrangement and substitution has gone well - 1 mark.

However the final evaluation has introduced an error with an extra 8 in there i.e. giving 4.29×10^{10} when it should be 4.29×10^{9}

Examiners do check the powers of ten by counting from the decimal point.

ResultsPlus
Examiner Tip

This mistake can be avoided by using your calculator in scientific mode giving powers of ten directly.

Calculate the loss in mass of the Sun in 1 second.

(2)

$$\frac{E}{m \mid c^2}$$

$$m = \frac{E}{c^2}$$

$$m = \frac{3.86 \times 10^{26}}{(3.00 \times 10^{8})^{2}} = 1.29 \times 10^{10}$$

3×10^{16}

loss in mass = 1.29×10^{10} kg

ResultsPlus
Examiner Comments

Correct rearrangement and substitution - 1 mark.

Then fails in the evaluation, forgetting to square the 3.

ResultsPlus
Examiner Tip

Putting the whole of the denominator in the calculator could have avoided this error.

Simplifying as you go along is OK as long as you don't introduce an error as you do that.

Question 10 (b)

A great majority of candidates performed at a high level 2 or level 3, showing a good understanding of red-shift as evidence for the universe expanding. Whilst they may not have as detailed a knowledge about the CMBR aspect they will, nevertheless associate its release with an initial expansion from the Big Bang.

*(b) The Big Bang theory gives an explanation for the origin of the Universe.

Explain how evidence supports the ideas that

- the Universe is expanding
- the Universe began at a single point.

(6)

The Big Bang theory is that the universe expanded from a tiny particle 13.8 billion years ago and is still expanding Red-Shift is ~~Proof~~ proof that the universe is expanding because objects that are far like galaxies emit light and when detected from Earth the spectra lines are shifted towards the red end of spectrum. The further the object the more shifted it is towards red side. This shows that the universe is currently expanding. ~~Cosm~~ Cosmic microwave background supports the idea that the universe began 13.8 ~~m~~ billion years ago because at the time of the Big Bang lots of radiation was given out everywhere and over time has cooled to around 0°C. ~~E~~ Scientists can see that and date how long ago the radiation was emitted and how long the universe will have left till the universe stops expanding - which is shown that currently we are half way through the cycle.

ResultsPlus
Examiner Comments

This is a clear level 3 response showing extensive knowledge about red-shift and CMBR as the required evidences.

The descriptions relating distance away to degree of red shift, and the cooling down aspect for CMBR both convince that this is worthy of the highest mark.

Indeed it wouldn't have to be this good to still get 6.

ResultsPlus
Examiner Tip

This topic lends itself to the acquisition of knowledge as it engages students so well. You will capitalise on this through your revision of details, like this candidate has, ahead of your exam.

The Big Bang theory states that the universe expaned from a single point around 13.8 billion years ago.
The Cosmic Microwave Background (CMB) radiation provides evidence. This is become traces of it are located in every direction of the universe and are all the same temperature. This can be traced back 13.8 billion years to single dense point.
Red shift also provides evidence for the Big Bang the because the wavelengths can be measured of galaxies and they are shown to be red shifted. This supports that the universe is constantly expanding as red has the highest wavelength on visible light spectrum. The longer a distace galaxies wavelength the faster it is moving away from earth. This shows the universe is constantly expanding, As galaxies are moving away from earth.

ResultsPlus
Examiner Comments

Clear level 3 answer for 6 marks.

Both evidences well dealt with.

The added flourish at the end relating distance to speed that the galaxy moves away further convinces of the high level of this response.

There are two main pieces of evidence to support the Big Bang Theory: cosmic microwave background radiation (CMBR) and red-shift.

The Big Bang theory states that ~~th~~ the world began from an explosion and we are constantly expanding from that point. CMBR supports this. it is radiation that was found in ~~radio~~ radio wave telescopes and can be found everywhere, thus suggesting it is the radiation left over from the Big Bang, ~~[illegible]~~ that has reduced over time into radio waves. Only the Big Bang Theory can explain this.

Red-shift shows that the galaxies are moving further away from each other. This can be shown as the wavelength between us and and ~~other~~ other galaxies elongates. Therefore, it supports the statement that the Universe is constantly expanding. Consequently the Big Bang theory provides more evidence to explain the origin of the Universe in comparison to the Steady State Theory.

ResultsPlus
Examiner Comments

This is a secure level 2 response.

Basic detail is given about the two pieces of evidence.

Neither is explained particularly well or in any depth, but basic detail is there in both cases.

4 marks

Explain how evidence supports the ideas that

- the Universe is expanding → red shift
- the Universe began at a single point. ↗

(6)

The big bang theory states that the universe stated at a point and expanded and that the universe is still expanding.
Evidence which supports this is the idea of red shift. Red shift is when spectral lines from other galaxies move to the red of the spectrum (their frequency decreases) as they move away. This shows the universe is expanding as the galaxies are moving away from us as the universe expands.* This also supports the idea that the universe began at a single point because the ~~expandtion red shift will~~ expandtion will have had to have started at a point.
* The more red shift a galaxy has, the faster it is moving away from us.

ResultsPlus
Examiner Comments

The detail about the red-shift evidence is at a high level.

Level 3, however, requires detail about both pieces of evidence; there is nothing about CMBR here.

Hence a very good level 2 at 4 marks.

Red shift is evidence of the Big Bang theory because is shows that all matter in the Universe is moving away, this proves that the Universe is expanding. If the Universe is constantly expanding it also suggests that it must have started somewhere.

ResultsPlus
Examiner Comments

'Some element of physics' given - red shift with the moving away connection.

Level 1 response.

2 marks

It is mentioned that the Big Bang occured through all the gravity and energy and forces being perfectly right to form a world which become Earth, all the plants and everything occured on its own. Now it is obviously said by scientists that the universe is expanding which is very true. Distances of us from other planets are seeming to get longer apart from the sun. the fact more planets are in this universe that we don't know about already implies anything could be real at this point. This why the Big Bang can be as close to, the only conclusion for the ~~Earth~~ universe beginning, as possible because is there's so much in the universe that we don't know about, the universe must've started at a single point to create this explosion for these planets and stars forming light years away.

ResultsPlus
Examiner Comments

No rewardable content seen here.

Evidence is not discussed at all.

Question 10 (c)

A majority of candidates could take this calculation all the way through to a correct evaluation. They were able to deal with the cube in the expression, the re-arrangement needed and the powers of ten aspect. This work was impressive.

(c) A star has evolved to become a neutron star.

The mass, M, of the neutron star, of radius R, is given by

$$M = \frac{4 \times \pi \times D \times R^3}{3} \qquad \text{where D is a constant}$$

$M = 4 \times 10^{30}$ kg

$D = 6 \times 10^{17}$ kg/m^3

Use the equation to calculate the value for R.

(2)

$$3M = 4 \times \pi \times D \times R^3$$

$$\sqrt[3]{\frac{3M}{4 \times \pi \times D}} = R$$

$$R = \sqrt{\frac{3(4\times10^{30})}{4\times\pi\times 6\times10^{17}}}$$

$$R = 11675.44$$

R = 11675.44 m

ResultsPlus
Examiner Comments

This is handled very competently.

Doing the algebraic manipulation first followed by one lot of substitution and evaluation is commendable practice.

ResultsPlus Examiner Tip

Doing the algebraic manipulation first minimises the chances of a transposition mistake as can occur when you move unwieldy numbers around.

Make sure you can cope with cubes and cube-roots on your calculator.

$$4 \times 10^{30} = \frac{4 \times \pi \times (6 \times 10^{17}) \times R^3}{3}$$

$$\frac{(4 \times 10^{30}) \times 3}{4 \times \pi \times (6 \times 10^{17})} = R^3$$

$$\sqrt[3]{\frac{(4 \times 10^{30}) \times 3}{4 \times \pi \times (6 \times 10^{17})}} = R$$

$$R = 1.67544325 \times 10^{-5}$$

R = $1.67544325 \times 10^{-5}$ m

ResultsPlus Examiner Comments

Re-arrangement and substitution correct.

Calculator use has let this candidate down so they didn't get the final evaluation mark.

$$4 \times 10^{30} = 4 \times \pi \times (6 \times 10^{17}) \times R^3$$

$$R^3 = \frac{4 \times \pi \times (6 \times 10^{17})}{4 \times 10^{30}} \times 3$$

$R^3 = \sqrt{ans}$ $R = \sqrt[3]{\text{ANS[illegible]}}$ $= \downarrow$

$R =$

R = 1.7815874×10^{-4} m

(Total for Question 10 = 13 marks)

ResultsPlus
Examiner Comments

The lack of proper algebraic manipulation has prevented this candidate getting any marks.

The mass appears in the denominator when it should be in the numerator.

Paper Summary

Based on their performance in this paper, candidates are offered the following advice:

- Candidates did well on questions involving some recall of basic physics and they continue to do well on questions involving calculations.
- Candidates did well when it came to conventional graphical interpretations (Qu1(c), 2(c), 4(c)(ii) and 5(b)). However, they did less well when it came to the more complex and demanding question 9(c) on the interaction of UV light with the earth's atmosphere, which employed a less well-known graphic. That was towards the end of the paper where the ramping of demand leads to more challenging questions.
- Candidates' procedural knowledge was again tested. In Qu4(b), a 'describe how' question, which required an experimental description, the responses seen were of variable quality, reflecting their exposure to this experiment in the school laboratory. It also revealed some lack of understanding as to what the critical angle is precisely. The other 'describe how' question was Qu5(c), which was better done, but still involved some implausible or vague instructions that could not be credited.
- The 'state the measurements' Qu5(a) was better done, although a number of candidates did not understand the particular height that was needed, and they were not specific or clear enough concerning their intended measurement of that height.
- In the 'explain improvements' Qu6(a), many failed to see the implication, in the diagram, of using a relatively small distance for such an experiment.
- There were few blank responses seen in the candidates' papers and detailed answers were seen all the way through the paper giving some indication that time was not an issue. Candidates were able to demonstrate their knowledge and understanding, giving many excellent answers. The responses to practically based questions have improved, but candidates could yet progress still more in this area.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.