



Examiners' Report

June 2024

GCSE Physics 1PH0 1H

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Introduction

The majority of candidates were not affected by any disruption to their learning and preparation for this examination. A full range of practical investigations including the core practicals indicated in the specification should have been completed to support candidates in their learning experience. An Equation booklet giving all the equations from the specification was issued to candidates with the question paper. The following topics were tested in the examination.

Topic 1 Key concepts in 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

Generally, candidates were able to cope well with mathematical concepts, however rearranging equations and the use of standard form still causes problems. Although the majority of candidates can now determine half-life of a radioactive source from a graph many lack detailed knowledge of the uses and effects of radioactive sources. A significant number of candidates also found relating their knowledge of vectors and scalars to a situation involving both momentum and energy was not straightforward. Candidates should also be prepared to add to diagrams or draw their own diagrams to help with explanations. There needs to be more practical work with mirrors and lenses to include the conventions used for naming angles and describing images.

Question 1 (b)

The question tests the use of standard form using the nuclear fission reaction. Only just over half of candidates were able to score three marks. The mass of four protons at the start of the reaction is given as is the mass of the helium nucleus formed. The missing mass is converted into energy. The candidate has to calculate the percentage of the original mass of the protons that was converted into energy.

The mass of the helium nucleus is subtracted from the original mass of four protons and the difference in mass, which has become energy is expressed as a percentage of the original mass.

(b) In the Sun, four protons start the process of nuclear fusion.

These protons combine and finally produce a helium nucleus.

The helium nucleus has a smaller mass than the four protons.

This difference in mass is converted to energy.

Four protons have a total mass of 6.69×10^{-27} kg.

A helium nucleus has a mass of 6.64×10^{-27} kg.

Calculate the percentage of the original mass that has been converted to energy.

(3)

$$\frac{\text{difference}}{\text{original}} \times 100$$

$$\frac{5 \times 10^{-29}}{6.69 \times 10^{-27}} \times 100$$

$$\frac{5 \times 10^{-29}}{6.69 \times 10^{-27}} \times 100$$

$$= 0.7473841555$$

percentage of mass converted to energy 0.747 %



The candidate has set out their calculation so that each stage can be clearly seen, and the answer has been given to three significant figures. This is the appropriate number of significant figures as three significant figures have been used in the values given.



Learn the use of standard form. It is essential where the values used are very small or very large and the use of decimal points or zeros is not practicable.

There is some merit in calculating a relevant percentage.

(b) In the Sun, four protons start the process of nuclear fusion.

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A helium nucleus has a mass of 6.64×10^{-27} kg.

Calculate the percentage of the original mass that has been converted to energy.

(3)

$$\frac{6.64 \times 10^{-27}}{6.69 \times 10^{-27}} \times 100 = 99.25261584$$

99%

percentage of mass converted to energy 99 %



ResultsPlus
Examiner Comments

This candidate either did not understand the question or could not subtract values in standard form. However the percentage calculated for the values given is correct and is credit worthy.



ResultsPlus
Examiner Tip

Show what you have done to get your answer if it is relevant as this example shows it can gain a mark.

Question 1 (c)(i)

The majority of candidates were able to arrive at an answer within the range allowed. The question shows the wavelength of light in the spectrum of an element at different distances from the Earth. A line P is marked on the spectrum of the element on Earth and the line P is marked on the spectrum of the element from a distant galaxy. Candidates are required to estimate the wavelength difference between the two lines marked P using the wavelength scale on the diagram.

The question requires an estimate of wavelength therefore a range between 50 and 70nm was allowed for the answer. The distance between two known wavelengths is needed and this is to be compared with the distance between the two P lines.

- (c) Figure 1 shows the spectrum of an element detected in the light from a distant galaxy, from a nearby galaxy and from a source on Earth.

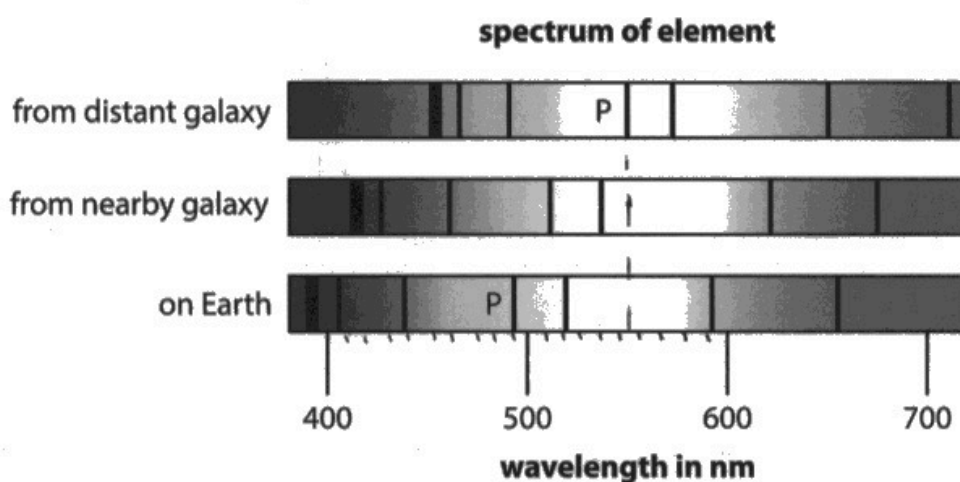


Figure 1

- (i) Estimate the difference between the wavelength of line P in the spectrum from the distant galaxy and the wavelength of line P in the spectrum on Earth. (1)

$$550 - 490 = 60$$

difference in wavelength =60..... nm



Many candidates put a line on the diagram to make measuring the distance easier. This candidate also added a scale from which the wavelength difference can be seen to be 60 nm.



Remember to bring a ruler to the examination. It is one of the things you are told to have.

Question 1 (c)(ii)

Almost half the candidates scored just one mark for this question because they knew that red shift meant that galaxies were moving away from the Earth. Although the diagram did show that more distant galaxies have a bigger red shift. This was not often included in the answers given. Many students showed that they understood redshift and the Doppler effect but did not answer the question as to how this supports the idea that the universe is expanding. Very few candidates scored the third marking point as they did not consider more distant galaxies moving away faster.

The explanation should include not only that red shift indicates that the galaxies are moving away from the Earth but should also consider that the red shift is greater for more distant galaxies and the distant galaxies are moving faster supporting the idea of an expanding universe.

- (ii) Scientists have discovered that light from almost all distant galaxies has spectral lines shifted towards the red end of the spectrum.

Explain how red shift in light, received from galaxies at different distances from the Earth, supports the idea that the Universe is expanding.

(3)

red shift shows objects moving away (galaxies) from earth showing that it is still expanding. galaxies further away are moving faster supporting idea of big bang. Galaxies closer to us are moving slower so have less red shift. The fact everything is moving away from earth shows expansion.

(Total for Question 1 = 8 marks)



ResultsPlus
Examiner Comments

The example scores 3 marks.

The first marking point for 'the red shift' shows objects moving away (galaxies) from the Earth'

The third marking point; galaxies further away are moving faster'

The reverse argument for the second marking point 'galaxies closer to the Earth have less red shift'.



ResultsPlus
Examiner Tip

Note that this is the second part of a question and therefore follows from the first part which is a diagram. The diagram shows that red shift is greater for more distant galaxies.

The majority of candidates scored either no marks or 1 mark for this question as only light from distant galaxies was considered, and not that more distant galaxies have a bigger red shift.

- (ii) Scientists have discovered that light from almost all distant galaxies has spectral lines shifted towards the red end of the spectrum.

Explain how red shift in light, received from galaxies at different distances from the Earth, supports the idea that the Universe is expanding.

(3)

Red light waves have the longest range out of all visible light. The red shift shows that the waves are getting longer and have a larger wavelength meaning they are getting stretched out. This shows galaxies are moving away from us meaning the universe is expanding. ~~because~~



ResultsPlus
Examiner Comments

The example only scores 1 mark for 'red shift ...shows galaxies are moving away from us'.



ResultsPlus
Examiner Tip

Read the question carefully, it states 'different distances' so your answer should refer to the difference in red shift at different distances from the Earth.

Question 2 (a)

The majority of candidates were able to score both marks for this calculation. The question asked for the height of a ramp that was being used by a skateboarder that loses gravitational potential energy of 980J as they go from top to bottom of the slope, a height h . The equation is given in the question as is the gravitational field strength $g=10\text{N/k}$. The first mark is awarded for substitution into or rearrangement of the equation and the second mark for evaluation of the height.

Almost all candidates completed the substitution but there was an occasional error in rearranging the equation to find the height.

2 Figure 2 shows a person on a skateboard at the top of a ramp.

At P, the person is not moving.

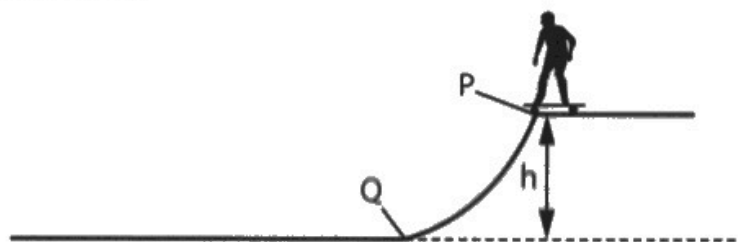


Figure 2

(a) The person rides the skateboard down the ramp from P to Q.

The gravitational potential energy of the person decreases by 980 J.

The mass of the person is 35 kg.

Calculate h, the height of the ramp.

Use $g = 10 \text{ N/kg}$.

Use the equation

$$\text{change in gravitational potential energy} = m \times g \times h$$

(2)

$$980 = 35 \times 10 \times h$$

$$980 = 350 \times h$$

$$\div 350 \quad \div 350$$

$$2.8 = h$$

$$h = \underline{2.8} \dots \dots \dots \text{ m}$$



ResultsPlus
Examiner Comments

The example shows that the candidate has underlined the relevant information, substituted the values correctly into the equation and calculated the height.



Make sure you write out your working clearly so that if the evaluation is incorrect a mark may be given for correct working.

Substitution and rearrangement can be completed in either order.

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At P, the person is not moving.

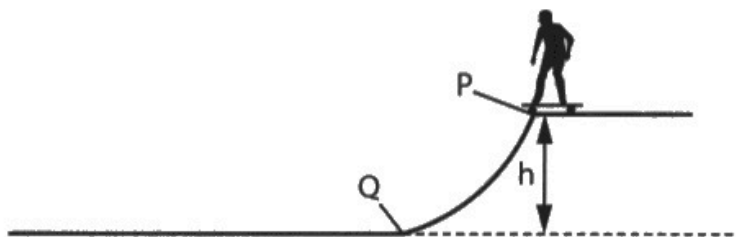


Figure 2

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The gravitational potential energy of the person decreases by 980 J.

The mass of the person is 35 kg.

Calculate h, the height of the ramp.

Use $g = 10 \text{ N/kg}$.

Use the equation

$$\text{change in gravitational potential energy} = m \times g \times h$$

(2)

$$\text{Height} = \frac{m \times g}{\text{GPE}}$$

$$\frac{35 \times 10}{980} = \frac{5}{14} = 0.36$$

$$h = 0.36 \text{ m}$$



ResultsPlus
Examiner Comments

The equation has been rearranged wrongly but it is clear that the substituted values are correctly inserted into the algebraically wrong equation, and this gets the mark for substitution.



Always show clearly your working out.

Question 2 (b)

This is a three mark calculation to find the velocity the skateboarder achieves at the bottom of the slope, given that the kinetic energy of the skateboarder at the bottom of the slope is 950 J. The equation for velocity squared is given in the question. The first marking point was for substitution into the equation, the second for calculation of velocity squared and the third marking point was for finding the square root of the velocity squared to give the final velocity. For those candidates that did not arrive at the correct answer the error was usually attempting to convert the mass in kilograms to grams. Not remembering that the SI unit for mass is kilograms.

The example shows correct substitution, calculation of velocity squared and then taking the square root to calculate the velocity.

(b) The kinetic energy, KE, of the person at Q is 950 J.

The mass of the person is 35 kg.

Calculate the velocity of the person at Q.

Use the equation

$$v^2 = \frac{2 \times KE}{m} \quad (3)$$

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

$$v^2 = \frac{2 \times 950}{35}$$

$$v^2 = \frac{1900}{35}$$

$$\text{velocity} = 7.368 \text{ m/s}$$

$$v^2 = 54.28571429$$

$$v = \sqrt{54.2857...}$$

$$v = 7.367883976$$



ResultsPlus
Examiner Comments

Correct calculation of v , the additional decimal places are ignored as it is not required to give the answer to the appropriate number of significant figures.



ResultsPlus
Examiner Tip

Write out the calculation showing one step at a time, keeping the equality signs beneath each other. Each step can be followed not only by the examiner but also by the candidate so there is less likelihood of making errors.

Question 2 (c)(i)

Part (c) of Question 2 considers the energy changes that occur between the top and bottom of the skateboarding ramp. Most candidates were able to give X as thermal energy or energy dissipated.

Candidates needed to note the difference between the value of gravitational energy and kinetic energy and what X represented.

(c) Figure 3 is a diagram that represents energy changes from P to Q.

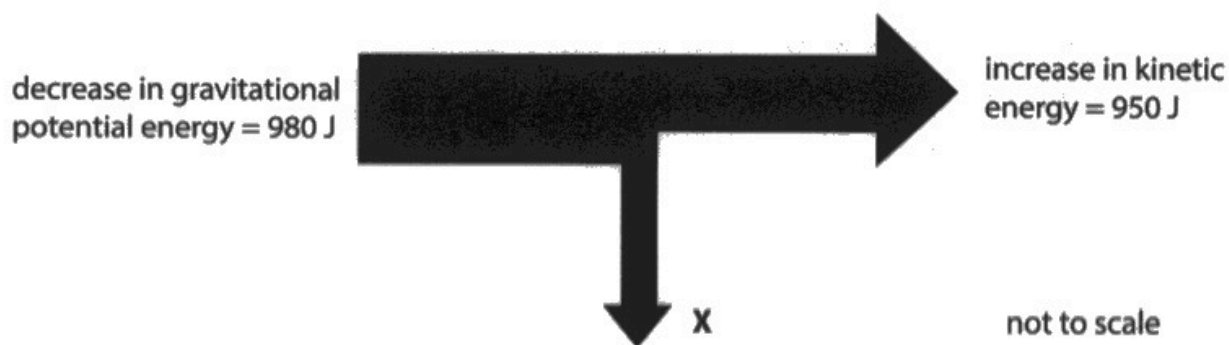


Figure 3

(i) State what is represented by X.

(1)

thermal energy / wasted energy



ResultsPlus
Examiner Comments

The energy change must be related to the situation given in the first part of the question. That is the skateboarder coming down a slope.



ResultsPlus
Examiner Tip

Remember when anything moves some energy will be transferred to the thermal store/transferred to the surroundings/dissipated.

Question 2 (c)(ii)

Using the diagram for 2(c)(i) almost all candidates were able to subtract the increase in kinetic energy from the decrease in gravitational energy to get X to be 30J.

Question 2 (c)(iii)

Most candidates were able to calculate the efficiency of the system, although the equation for efficiency was not given in the question but could be found in the equation booklet. Some candidates chose to give efficiency as a ratio having no units and others as a percentage. This made no difference to the mark awarded, provided the percentage % sign was used correctly.

Efficiency calculated as a percentage.

(iii) Calculate the efficiency of the system represented in Figure 3.

(2)

$$\frac{950}{980} \times 100 = 96.9387\dots$$

efficiency = 96.9 %



ResultsPlus
Examiner Comments

The equation used is not shown but substitution is correct and the correct percentage given as the efficiency.



ResultsPlus
Examiner Tip

Note the answer line does not have a percentage sign therefore this must be added if a percentage is calculated.

Efficiency calculated as a ratio.

(iii) Calculate the efficiency of the system represented in Figure 3.

(2)

$$\begin{aligned} \text{Eff} &= \frac{\text{Useful}}{\text{Total}} \\ &= \frac{950}{980} \\ &= 0.9693877551 \\ &= \underline{0.97} \end{aligned}$$

efficiency = 0.97



ResultsPlus
Examiner Comments

The calculation is set out well and is easy to follow. The final answer has been sensibly given to two significant figures, as two significant figures are used in the question.



ResultsPlus
Examiner Tip

Remember efficiency is never more than 1 as a ratio or 100%.

Question 3 (a)(i)

The majority of candidates were able to read correctly from the graph, the point at which the lines on the graph cross. This was awarded a mark for answers in the range 64m to 68m.

The candidate has noted the correct point of intersection with a cross on the graph.

3 (a) Two people, L and M, have a 100m race.

L starts running before M.

Figure 4 shows a distance/time graph of the race.

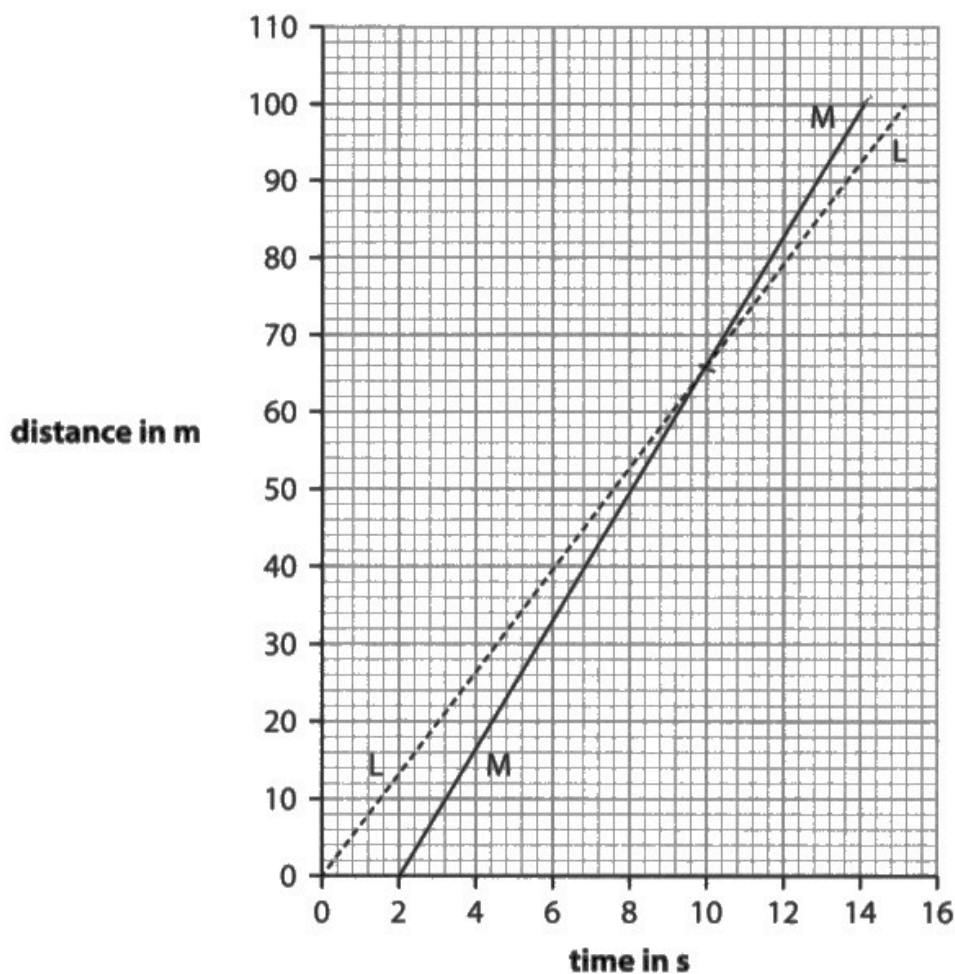


Figure 4

(i) State the **distance** that L has run when M overtakes.

(1)

distance = 64 m



Although the point of intersection of the lines has been marked the distance scale has been read incorrectly as 64m not 66m. This does get the mark as it is within the range allowed.



Note the scale on a graph to give correct readings.

Question 3 (a)(ii)

Almost three quarters of candidates were able to obtain the correct value for the velocity of L. The equation for velocity was not given but could be found in the equation booklet and distance and time then had to be identified from the graph. If compatible values for distance and time were taken from the graph this gave the value of velocity.

The correct equation has been selected with values taken from the graph.

(ii) Calculate the velocity of L when running the 100 m race.

(2)

$$s = \frac{100}{14.6} = 6.85 \text{ m/s}$$

velocity = 6.85 m/s



It is clear that the candidate has taken values from the graph, so the first mark is awarded. However, the reading of time for the distance of 100m for L has been incorrectly read from the time scale. The correct reading is 15.2s which gives a value for velocity of 6.6 m/s.

Using 14.6s the value for velocity is 6.85 m/s which is outside the range of acceptable answers, so no evaluation mark is awarded.



Note the scales used on each axis of the graph to give correct readings.

Question 3 (b)(i)

Almost all candidates were able to score both marks for this question. The equation was given in the question in the rearranged form requiring only a correct substitution of the change in velocity and acceleration to evaluate time taken.

This shows incorrect substitution giving an incorrect evaluation.

(b) A motorcycle is travelling at a velocity of 6.2 m/s.

The motorcycle accelerates at 2.5 m/s² until its velocity is 10 m/s.

(i) Calculate the time taken for this acceleration.

Use the equation

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}} \quad (2)$$

$$\frac{10 - 6}{2.5} = 1.6$$

time taken = 1.6 s



ResultsPlus
Examiner Comments

The candidate has been careless in reading the information in the question. No mark can be awarded for the substitution and the evaluation is also incorrect.

The correct change in velocity is $10 - 6.2 = 3.8$ m/s giving a time for acceleration of 1.5s.



ResultsPlus
Examiner Tip

Read the question, particularly numerical values carefully and at least get the substitution correct.

Question 3 (b)(ii)

Candidates found this part of the question more difficult than 3(b)(i). The equation was given but some candidates were unable to identify the values to substitute for v , u and a . The final velocity being zero because the motorcycle had stopped, deceleration being represented by a , the velocity needing to be squared and the equation rearranged to find x were all difficulties that could lead to an incorrect evaluation. Quite frequently the deceleration was made positive, and this gave a negative value for distance. In this case the negative value was ignored.

This candidate shows correct substitution into the given equation. It shows correct rearrangement and evaluation.

(ii) The motor cycle now decelerates (slows down) from 10 m/s to a stop.

The deceleration is at a constant rate of 4.4 m/s².

Calculate the distance the motorcycle travels as it slows down to a stop.

Use the equation

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

(2)

$$\begin{array}{l} 0^2 - 10^2 \\ 10^2 \end{array} = 2 \times -4.4 \times x$$

$$x = \frac{0^2 - 10^2}{2 \times -4.4} = 11.36$$

distance = 11.36 m



The candidate has recognised that **a** is the deceleration and therefore has a negative value.

u is the initial velocity of 10m/s and **v** the final velocity is zero because the motorcycle has stopped.

The rearrangement is correct giving a correct evaluation of distance.



Remember that deceleration is negative acceleration, and that **u** is initial velocity and **v** is final velocity.

Question 3 (c)

Many candidates were able to give a factor apart from the time for the collision that would affect the force exerted on a car during a collision. They were also able to link this to a relevant equation which had to include force, which could be found in the equation booklet. Those that only scored the first marking point linked increase in speed to distance over time or increase in momentum to $p=mv$ instead of choosing an equation such as $F=mv-\mu t$.

The example shows a correct factor being named but being linked to the wrong equation.

(c) A car collides with a barrier on a road.

The time of the collision is very short.

Explain **one** factor, other than the time of the collision, that would affect the force on the car in the collision.

Your explanation should refer to an equation in the Equation Booklet.

The ~~mass~~^{mass} of the car when it hits the barrier would also affect the force on the car in the collision. This is because kinetic energy (KE) is directly proportional to half the mass ($KE = \frac{1}{2}m \times v^2$). (2)



Mass is a factor that affects the force in a collision but it must be linked to an equation using force. Only the first marking point was awarded.



Read the question carefully and note that the link must be force.

Question 4 (b)(i)

Most candidates did not understand how the scan obtained from a PET scanner is used to detect a cancerous tumour. Very few candidates were able to score all three marks. One mark was the mark most frequently awarded and this was for the 'detection by radiation detectors', as the practice that was detected was ignored and many candidates thought that positrons were detected. Positron-electron annihilation was only given by a few candidates and most of these candidates knew that gamma rays were emitted in opposite directions, and this was enough for three marks. There was the occasional mention of triangulation without any further detail, but time difference was rarely seen.

A logical response which shows good knowledge of the process used in PET scanning.

(i) Explain how the scan can give the location of the tumour.

(3)

-A positron is linked with a glucose and absorbed into the body, cancer cells will likely absorb it as it has high metabolic rate.
-The positron comes into contact with the electrons in the organs and annihilates, producing a gamma ray, multiple gamma rays, especially up to 3 (triangular) is detected by radiation detectors. Therefore the area where the gamma rays intersect is likely the location of tumour.



The first sentence is not relevant to this question but shows the candidate understands the process.

The first mark is awarded for positron-electron annihilation, 'producing gamma rays' gives the second marking point, 'in opposite directions' is the third marking point, 'detected by radiation detectors' is the fourth marking point.

There is also an attempt to explain triangulation for the sixth marking point.



Learn how a PET scanner works and practice writing a concise accurate description of the process.

Question 4 (b)(ii)

This is the second part of the question about the PET scanner, and the injection of a radioactive isotope into a patient is given in the stem of the question. About half of the candidates were able to score two marks for this question. Candidates realised that the half-life of the isotope was short but then often did not link this to the need to use the radioactive isotope before the activity of the isotope decreased too much. Therefore, it had to be used a short time after it was produced and therefore must be produced near the place where it is to be used.

This shows recognition that the half-life of the radioactive isotope is short and therefore must be used a short time after it is produced.

(ii) Explain why the radioactive isotope injected into the patient must be produced near to the place where it is to be used.

(2)

The radioactive isotope has a short half life so it will not stay in the patients body. This means it has to be given to the patient just before it decays.



ResultsPlus
Examiner Comments

This response scored both marks.

The second marking point is for 'a short half-life'.

The third marking point is for 'given to patient before it decays'.



ResultsPlus
Examiner Tip

The question asks for an explanation that gives a response and then explains why, but in a 'because' form.

'It must be given to the patient before it decays because it has a short half-life'.

Question 4 (c)

Many candidates found this question difficult, with only a few being able to score both marks. The question asked for two differences between irradiation and contamination. Most candidates gave one distinguishing factor for irradiation and then the opposite for contamination. This was only one difference. The most frequent answer was that irradiation is from outside the object and contamination is from in, or about the object being irradiated. This is one difference and scored one mark.

A response which gives two differences between irradiation and contamination.

(c) Radiotherapy can involve irradiation of patients.

Radioactive tracers can involve contamination of patients.

State **two** differences between irradiation and radioactive contamination.

(2)

1. An Irradiated object is not radioactive itself, whereas radioactive contamination causes the object to emit radiation.
2. Contamination requires contact with a radioactive substance, whereas irradiation can occur through EM waves.



ResultsPlus
Examiner Comments

The first difference that irradiation does not make an object radioactive is the first marking point.

The second difference is the third marking point 'contamination requires contact with a radioactive source'.



ResultsPlus
Examiner Tip

Learn the differences between irradiation and contamination, and when two differences are required for any process then just explaining one difference by referring to both processes is not sufficient.

Question 4 (d)(i)

Candidates had to determine the half-life of an isotope from a graph showing the decay in activity of two isotopes. The initial activity shown on the graph was 100 Bq so the half-life can be determined as the time it takes for the activity to fall to half of its original value, that is 50 Bq. A horizontal line from about 50 Bq would score the first mark. However, the majority of candidates were able to score both marks by giving an answer within the range allowed in the answer line.

This response shows a correct method but gives an incorrect answer.

(d) Figure 6 shows the decay curves of two different isotopes, Q and P.

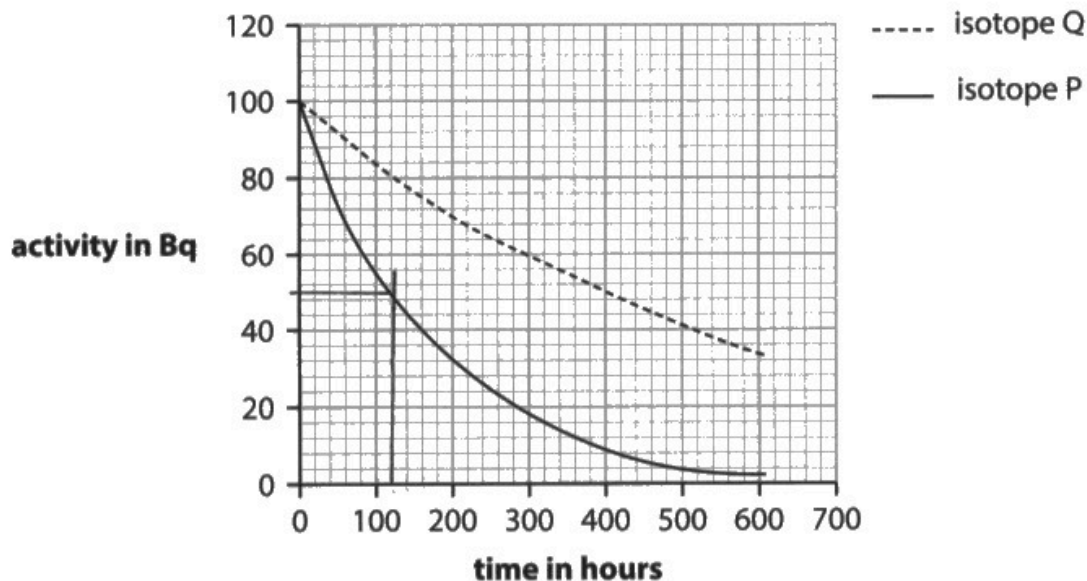


Figure 6

(i) Use the graph in Figure 6 to determine the half-life of isotope P.

(2)

half-life of isotope P =140..... hours



The candidate has drawn the horizontal line at 50Bq, across to the line for isotope P.

The vertical line is also correct but the value obtained from the time axis is outside of the range allowed because the scale on the graph has been read incorrectly. The answer given is 140 hours, but the graph shows the correct answer of 120 hours.

Only one mark is awarded as the answer in the answer line is incorrect.



Take care when reading the scales on graphs.

Question 4 (d)(ii)

This is the second part of 4(d) and uses information from the graph. The question asks candidates to suggest a reason why isotope Q could be more dangerous to humans than isotope P.

Most candidates were able to score the one mark in response to this and the most common answer was because Q has a longer half-life or takes longer to decay.

Question 5 (a)(i)

This question referred to a table containing information about UVA, UVB and UVC. The wavelength range of each type of UV and the % of the energy of the radiation absorbed by the Earth's atmosphere was given in the table. Candidates were required to explain why UVC which is potentially the most dangerous radiation does not cause harm to people. More than half of candidates were able to score both marks noting that UVC has the smallest wavelength or is the most ionising but does not harm people because it is all absorbed by the Earth's atmosphere.

The response considers the wavelength but is not careful enough about how the energy is absorbed.

5 Ultraviolet (UV) waves from the Sun travel towards the Earth.

Ultraviolet waves can be grouped by wavelength.

The three groups of wavelengths are UVA, UVB and UVC.

Figure 7 shows, for each group,

- the wavelength range
- the effect of the Earth's atmosphere on each type of UV wave.

micro $\times 10^{-6}$
nano $\times 10^{-9}$

	UVA	UVB	UVC
wavelength range	400 nm to 315 nm	314 nm to 280 nm	279 nm to 100 nm
% energy absorbed by the Earth's atmosphere	5%	95%	100%

Figure 7

(a) (i) Explain why UVC is potentially the most dangerous ultraviolet radiation but does not cause harm to people.

(2)

It has the smallest wavelengths - meaning it's higher frequency - and is more likely to ionize cells causing mutations however since it's ^{completely} absorbed by the earth, it can't cause harm.



The first marking point is awarded for the 'smallest wavelength'. The second marking point is not awarded because the candidate refers to the UVC being absorbed by the Earth instead of the Earth's atmosphere. Being absorbed by the Earth's atmosphere would mean the UVC would not reach the surface of the Earth.



Make sure your answer actually says what you mean it to say.

This response has the wavelength from the table read wrongly.

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Ultraviolet waves can be grouped by wavelength.

The three groups of wavelengths are UVA, UVB and UVC.

Figure 7 shows, for each group,

- the wavelength range
- the effect of the Earth's atmosphere on each type of UV wave.

	UVA	UVB	UVC
wavelength range	400 nm to 315 nm	314 nm to 280 nm	279 nm to 100 nm
% energy absorbed by the Earth's atmosphere	5%	95%	100%

Figure 7

(a) (i) Explain why UVC is potentially the most dangerous ultraviolet radiation but does not cause harm to people.

(2)

It has a ^{longer} ~~shorter~~ wavelength, which means it is more radioactive. But does not cause harm it is absorbed all by earth's atmosphere so humans do not come into contact.



ResultsPlus
Examiner Comments

The first mark is not awarded as the wavelength is shorter not longer.

However, the second mark can be awarded for 'absorbed all by the Earth's atmosphere'.



ResultsPlus
Examiner Tip

Read the information carefully and relate it to the correct type of UV.

Question 5 (a)(ii)

The equation needed was not given in the question, it had to be selected or recalled and then rearranged to calculate frequency. Also, the correct wavelength had to be selected and then converted from nanometres to metres to be used in the equation. About half the candidates were able to score two marks for this three mark question. The problem being the conversion of nanometres to metres and a consequent power of ten error in the answer.


This response gives a completely correct calculation.

- (ii) The speed of electromagnetic radiation is 3.00×10^8 m/s.

Calculate the frequency of the shortest wavelength of UVB radiation.

(3)

$v = f \times \lambda$



~~frequency~~
frequency = $\frac{\text{Speed}}{\text{wavelength}}$

$$\frac{3 \times 10^8}{280 \times 10^{-9}} = 1.0714 \dots \times 10^{15}$$
$$\sim 1.071 \times 10^{15}$$

frequency = 1.07×10^{15} Hz



ResultsPlus
Examiner Comments

The first mark is for selecting the shortest wavelength for UVB. This is 280nm.

Correct substitution and rearrangement of the correctly selected equation gives the second mark.

The third mark is for the correct evaluation which converts nm to m.



ResultsPlus
Examiner Tip

Learn to convert all lengths into metres for use in equations.

Question 5 (b)

This question was a practical example of the use of UV radiation in the detection of forged bank notes. The candidates found this explanation difficult with just under half the candidates either making no attempt to answer or there was no rewardable material given. A labelled diagram of the energy levels in an atom with UV going to an electron, the electron changing to a higher energy shell, then moving back to a lower energy shell with the emission of a light wave could score. This shows marking points 1, 2, 4 and 5.

A concise answer which gives the main points in explaining why the marks on banknotes can be seen under UV light.

(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

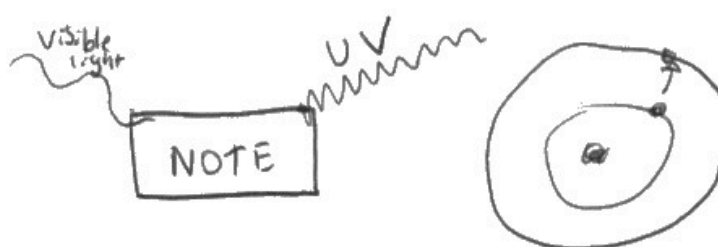
In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.

(4)



UV radiation has a shorter wavelength than visible light as well as more ionising energy. This energy causes electrons to move up shells and then emit light as they lose energy and move back down. This means that light can be seen when shining UV on a bank note.



The diagram does not get credit as it shows UV going into a bank note not an atom and visible light coming out.

However the text gives the main points in the process.

The first marking point is not awarded. There is no indication that the energy of the UV is absorbed by electrons.

The 'energy causes electrons to move up shells' scores the second marking point.

'emit light' is the fifth marking point.

'as they lose energy and move back down' is the fourth marking point.

Three marks scored.



Learn the process and practice writing a concise accurate explanation.

A complete concise answer which also includes correct labelled diagrams

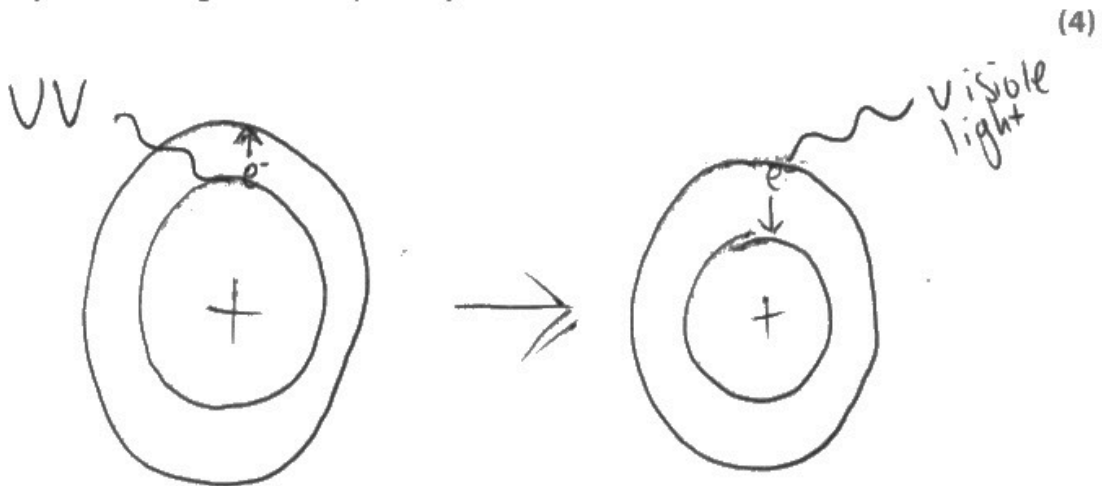
(b) UV radiation of wavelength 365 nm is used to detect forged banknotes.

In a genuine banknote there are marks that **cannot** be seen using visible light. These marks **can** be seen using UV radiation.

Explain why the marks can be seen when the UV radiation shines on the banknote.

Your answer should refer to the energy of electrons in atoms.

You may draw a diagram to help with your answer.



When UV radiation shines on the banknote, it provides energy to electrons, causing them to move to the next shell. This makes them unstable, and they return to their original position. This causes energy to be released in the form of visible light.



4 marks are awarded.

The first marking point that energy is absorbed by electrons is in the text.

Electrons change shells is in the diagram and the text for second marking point.

Electrons return to their original position score the fourth marking point.

The emission of visible light is shown on the diagram and given in the text and scores the fifth marking point.



Restrict your answer to the main features you are describing.

Question 6 (a)(ii)

Candidates found it difficult to describe in sufficient detail a way of showing that, using a mirror and light from a ray box, the angle of incidence is equal to the angle of reflection. Part of the problem being that a significant number of candidates identified the glancing angles and not the angles of incidence and reflection.

Many candidates did not add to the diagram and their description of the angles of incidence and reflection were not detailed enough to award the third marking point. The angle must be identified as between the ray of light and the normal. The most frequently awarded mark was the fourth marking point, for the use of a protractor to measure the angles.

This example shows how the diagram can be used to give marks.

- (ii) A student uses a mirror to demonstrate that the angle of incidence is equal to the angle of reflection.

Figure 8 shows the apparatus the student uses.

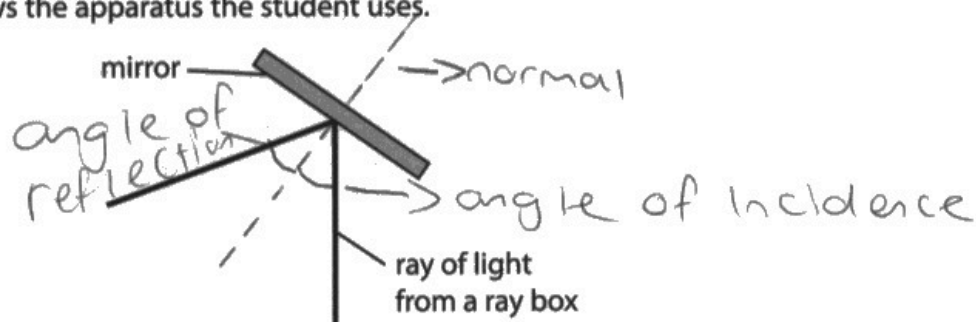


Figure 8

Describe the procedure the student should use with the ray and mirror in the position shown in Figure 8.

You should include any extra equipment needed.

You may add to Figure 8 to help your answer.

(3)

draw a line in the normal this is a line 90° degrees to the surface of the mirror then use a protractor placing the 0 on the (normal) line this will tell you the two angles of incidence and reflection if correct both will be same



This response is awarded all three marks. The normal is shown, the angles of incidence and reflection are correctly labelled, and a protractor is used to measure the angles.



Additions to a diagram are a good way to score marks.

This example shows additions to the diagram that are incorrect.

- (ii) A student uses a mirror to demonstrate that the angle of incidence is equal to the angle of reflection.

Figure 8 shows the apparatus the student uses.

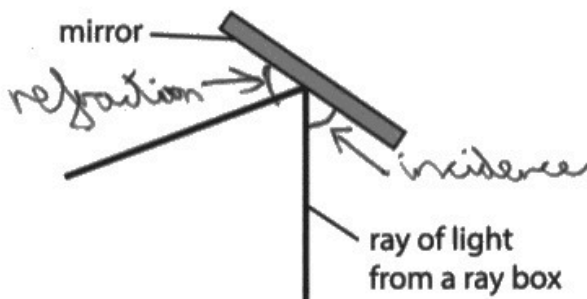


Figure 8

Describe the procedure the student should use with the ray and mirror in the position shown in Figure 8.

You should include any extra equipment needed.

You may add to Figure 8 to help your answer.

(3)

The student should place the mirror on a blank piece of paper and draw it on along with the light ray. The student should then use a protractor to measure the angle of incidence and angle of reflection. The student should repeat this to prove his theory.



The candidate scores 2 marks, the first and fourth marking points with no marks awarded for the information on the diagram.

First marking point for putting the apparatus on a sheet of paper and the fourth marking point for using a protractor to measure the angles.

The angles shown on the diagram are the glancing angles between the ray of light and the mirror.



Learn that all angles are measured between the normal and the ray of light.

Question 6 (b)(i)

The information to answer this question can only be obtained from the diagram.

- (b) Figure 9 shows a ray of light from a ray box passing through a semi-circular glass block.

A student uses the apparatus in Figure 9 to determine the critical angle for glass.

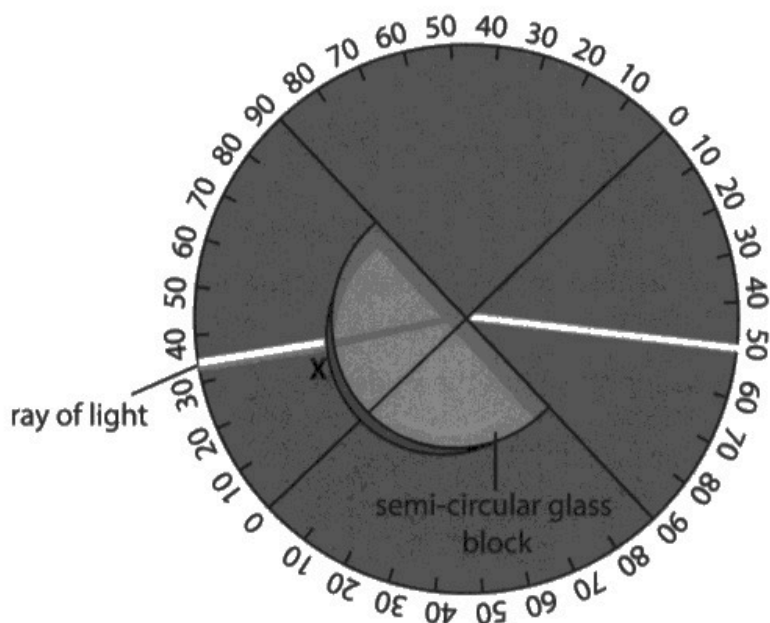


Figure 9

- (i) State why the ray of light does not change direction as it enters the glass block at X.

ray of light enter glass block at 90° angle. (1)



ResultsPlus
Examiner Comments

As the ray of light continues to the centre of the semi-circular block it must be along a radius and strike the block perpendicular to the curved surface of the glass block.



ResultsPlus
Examiner Tip

Diagrams contain important information.

Question 6 (b)(ii)

Candidates found it difficult to describe how the critical angle for the glass could be found using the apparatus shown in the diagram in 6(b)(i). In many cases it was obvious the practical had been carried out because there was a description of the beam along the straight edge of the semi-circular glass block or just getting total internal reflection. However, many candidates did not know how this was achieved, or which angle was the critical angle. Answers often lacked accuracy and detail in the description.

This example gives a good description of the experiment but does not describe how the critical angle is found.

(ii) Describe how the critical angle for glass can be determined using the apparatus shown in Figure 9.

(3)

The critical angle is the point where the light exits the block along the boundary. By gradually increasing the angle of incidence, eventually the point will be found where the glass light exits along the boundary. Increase by 2 degrees each time in a trial and error format.



This response scores 2 marks.

First marking point for increasing the angle of incidence and the second marking point for the light exiting along the boundary.

The description does not include the measurement of the critical angle.



Read the question carefully and make sure you actually answer the question.

The response shows a concise accurate and correct answer.

(ii) Describe how the critical angle for glass can be determined using the apparatus shown in Figure 9.

(3)

increase the angle of incidence until the angle of refraction is at 90° at the flat side of the glass block. once it reaches it measure the angle of incidence that will be the critical angle.



ResultsPlus
Examiner Comments

This response scores all the marks.

First marking point for increasing the angle of incidence.

Second marking point the refraction is at 90 degrees at the flat side of the glass block.

Third marking point the angle of incidence is the critical angle.



ResultsPlus
Examiner Tip

Keep your answers concise and accurate.

Question 6 (c)

Less than a third of candidates were able to give the meaning of the term virtual image. Many candidates just stated that the image was not real, which was not credit worthy. The most common correct answer was that 'the image could not be projected on to a screen' or the image is on the same side of the lens as the object.

Question 7 (a)(i)

Most candidates showed that they could read the graph correctly and gave the time of constant velocity between 22s and 45s.

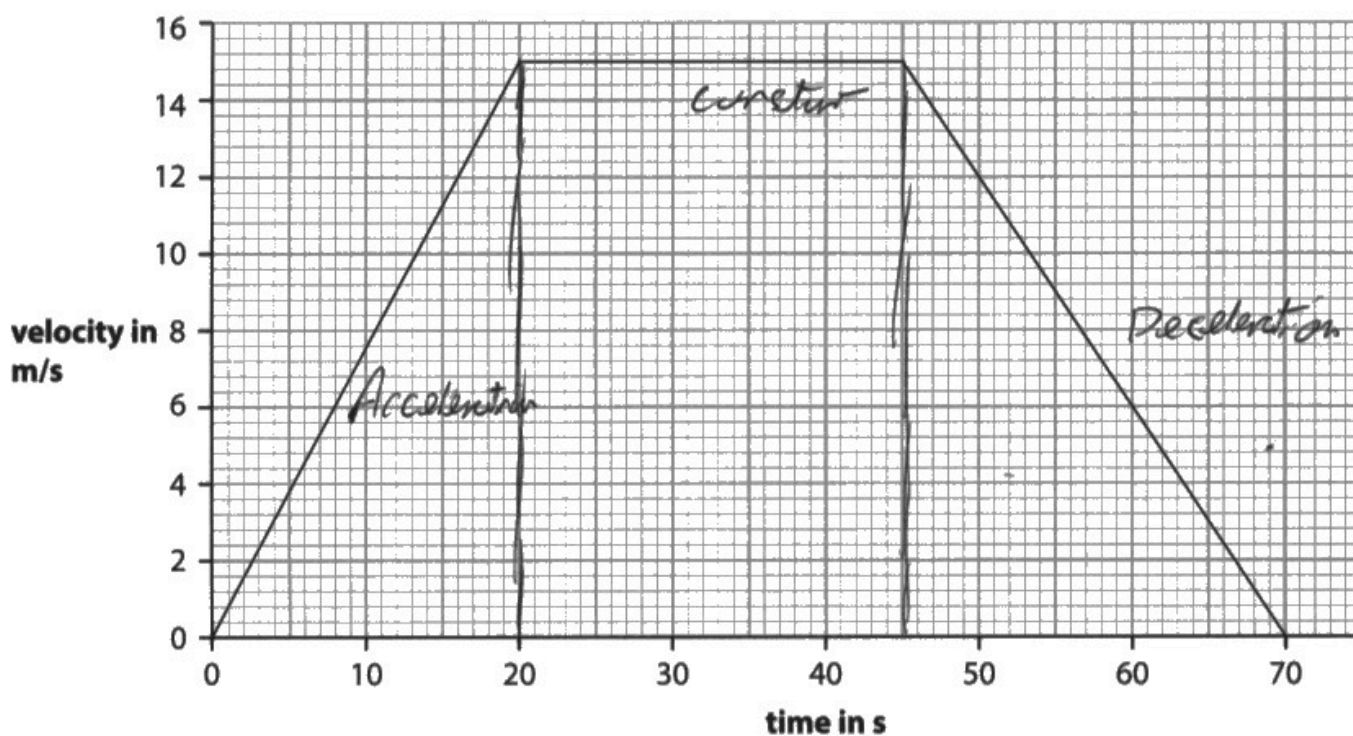
Question 7 (a)(ii)-(iii)

About 80% of candidates were able to calculate the total distance travelled from the area underneath the graph to score 3 marks for 7(a)(ii). Most candidates used two triangles and a rectangle to calculate the area. A few used the area of a trapezium. The first two marking points were used to calculate the area and the third mark was for the evaluation.

The majority then went on to use their value, or the value given in the question to calculate correctly the average speed of the car for the total distance travelled. No equation was given for this calculation and the correct evaluation scored one mark.

This response is an example of the candidate reading the velocity scale wrongly and taking the velocity to be 14.5m/s instead of 15m/s.

7 (a) A car starts from rest and then travels for 70s as shown on the graph in Figure 11.



- (ii) Use data from the graph in Figure 11 to show that the car travels a total distance of about 710 m in 70 s.

(3)

$$\frac{20 \times 14.5}{2} = 145 \text{ m}$$

$$145 + 362.5 + 181.25$$

$$= 688.75 \text{ m}$$

$$25 \times 14.5 = 362.5 \text{ m}$$

$$\frac{25 \times 14.5}{2} = 181.25$$

- (iii) Calculate the average speed of the car for the total distance travelled.

(1)

$$d = us \times \text{time}$$

$$\frac{d}{s \times t}$$

$$\frac{688.75}{70} = s$$

$$s = 9.8392 \dots$$

$$\text{average speed} = 9.84 \text{ m/s}$$



ResultsPlus
Examiner Comments

Two marks are awarded for 7(a)(i) and 1 mark for 7(a)(ii).

The process used to calculate the total distance travelled is correct but using 14.5 instead of 15 gives an incorrect evaluation so only two marks are awarded.

The candidate goes on to use their evaluation of total distance travelled to calculate average speed. This is an error carried forward. The calculation of average speed is correct for the value used and scores one mark.



Set out your working so that it can be clearly followed. Just giving the answer 688.75 without any working would not have scored any marks for 7(a)(i).

Question 7 (b)

The question asked for initial mass rather than just mass. However, many candidates were able to select the equation $F = m \times a$ and complete the calculation of mass correctly. The most frequent error was an attempt to convert kilograms to grams, although kg is clearly written at the end of the answer line.

- (b) The **inertial** mass of an object is a measure of how difficult it is to change the velocity of the object.

A force of 450 N acts on a car to give the car an acceleration of 0.35 m/s^2 .

Calculate the **inertial** mass of the car.

$$\begin{aligned} F &= ma \\ 450 &= m \times 0.35 \\ \frac{450}{0.35} &= m \\ m &= 1285.71 \end{aligned}$$

$$\begin{aligned} F &= ma \\ \frac{450}{0.35} &= m \\ m &= 1285.7 \\ &\approx 1285.7 \text{ kg} \end{aligned} \quad (2)$$

inertial mass of car 1285.7 kg



ResultsPlus
Examiner Comments

This is a correct example of the rearrangement of the correct equation to evaluate mass.



ResultsPlus
Examiner Tip

The example scored both marks.

The first mark was given for substitution into the correctly identified equation.

The second was given for rearrangement and evaluation.

Example showing an attempt at a unit conversion, which was unnecessary and incorrect.

- (b) The **inertial** mass of an object is a measure of how difficult it is to change the velocity of the object.

A force of 450 N acts on a car to give the car an acceleration of 0.35 m/s².

Calculate the **inertial** mass of the car.

(2)

$$f = m \times a$$
$$450 = m \times 0.35$$
$$\frac{1285.7}{1000} = m$$
$$1.2857$$

inertial mass of car 1.2857 kg



ResultsPlus
Examiner Comments

One mark was scored. The correct equation is selected, and the substitution is correct, which scores 1 mark.

The rearrangement is also correct and so is the initial evaluation. However this evaluation is divided by 1000 and the answer on the answer line is incorrect, so the second mark cannot be scored.



ResultsPlus
Examiner Tip

Remember that the standard unit of mass is the kilograms and the unit for the answer will be written at the end of the answer line.

Question 7 (c)(i)

The next three parts of this question refer to the graph line shown as an example for Q7(c)(i). The graph is a straight line which can be represented by the equation $y=mx+c$.

Q7(c)(i) asked for the quantities that x and y represented. About a third of candidates were unable to score a mark for this.

The example shows the graph used in this question.

(c) Figure 12 shows a different velocity/time graph.

This straight line graph can be represented by the equation

$$y = mx + c$$

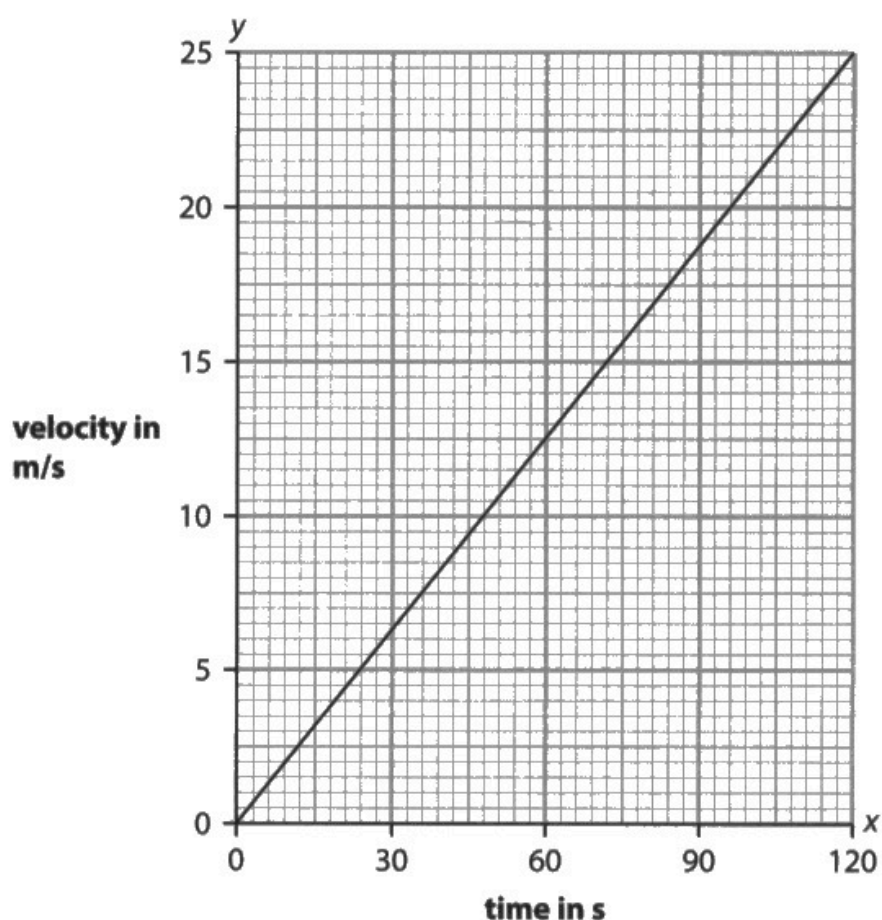


Figure 12

(i) Give the quantities that x and y represent in the equation.

(1)

x represents Time
y represents velocity



Both answers are correct and score one mark.



Learn what each of the symbols in the equation represents.

Question 7 (c)(ii)

Using the same graph, candidates were asked to determine the value of m . About a quarter of candidates were unable to score a mark for this question, probably because they did not recognise that m is the gradient of the graph. Of those that tried to find the gradient, most obtained a value within the range given.

Example of a correct calculation of m , the gradient of the graph.

(ii) Calculate the value of m from the graph in Figure 12.

$$\frac{\Delta y}{\Delta x} \quad C_1 = (0, 0) \quad (2)$$
$$C_2 = (120, 25)$$

$$\frac{25}{120} = \frac{5}{24}$$

$$\frac{5}{120} = \frac{25}{120} = \frac{5}{24} = 0.2083 \text{ m/s}^2 \approx 0.21$$

$$m = \underline{0.21} \text{ m/s}^2$$



ResultsPlus
Examiner Comments

Two marks were awarded.

The first mark was for the use of distance and time values taken from the graph.

The second mark was for evaluation of a gradient within the tolerance allowed.



ResultsPlus
Examiner Tip

It is important to convert fractions obtained for the gradient to decimals. Fractions on the answer line are not awarded a mark for evaluation.

Question 7 (c)(iii)

Q7(c)(ii) asked for the value of c in the equation $y=mx+c$. Many candidates realised $c=0$ because the straight line goes through the origin of the graph.

Question 8 (b)

Only about a third of candidates were able to give the answer that ionising means the loss or gain of electrons, and score a mark.

An acceptable version of loss or gain of electrons.

(b) Alpha, beta and gamma are all **ionising** radiations.

Give the meaning of the term **ionising**.

(1)

Radiation that is able to knock electron off
an atom



'able to knock an electron off an atom' was accepted as a description of ionisation.



Be able to explain the meaning of commonly used terms.

Question 8 (c)

Many candidates recognised that a Geiger-Muller tube was used to determine background radiation. The detail of how this was to be carried out eluded them. Many candidates realised that the count rate was needed but did not get the mark because the count was not associated with a particular time. Removing radioactive sources in the vicinity was seen quite frequently repeating the reading to get an average value was only seen occasionally.

This response shows a logically ordered response.

(c) A teacher determines the background radiation count rate in a laboratory.

Explain how to determine a value for the background radiation count rate.

(3)

A GM tube should be placed in the laboratory with no radioactive sources near it. It should then be allowed to count (measure) for a set period of time giving a measure for the amount of background radiation. This process should be repeated 3 times and then a mean should be found to give an accurate count rate.



3 marks are scored.

The first mark is awarded for knowing that the G-M tube is used.

Knowing that there must not be any radioactive sources near the G-M tube when the readings are taken scores the second mark.

Taking the count for a set period of time scores the third mark.



Learn the detail of how this process is carried out.

Question 8 (d)(i)

The majority of candidates were able to produce a labelled diagram of the apparatus used to investigate the absorption of beta radiation in the correct order to carry out the experiment to score both marks.

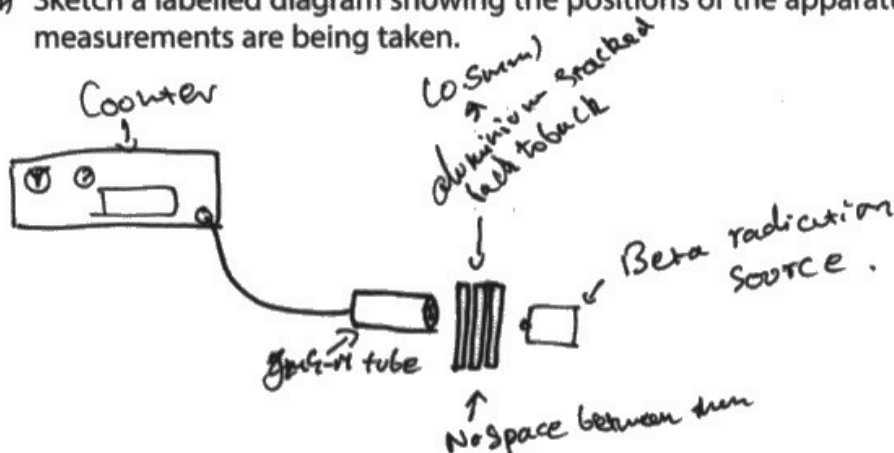
A response showing a neat correctly labelled diagram.

(d) The teacher now investigates the absorption of beta radiation by different thicknesses of aluminium.

The apparatus available is

- a source of beta radiation
- a Geiger-Müller (G-M) tube and counter
- 10 pieces of aluminium, each 0.5 mm thick
- a metre rule.

(i) Sketch a labelled diagram showing the positions of the apparatus when the measurements are being taken.



The diagram shows the apparatus with the aluminium pieces between the beta source and the Geiger-Muller tube all correctly labelled. It was not essential to include the ruler in the diagram.



Make labelled diagrams of experiments that you have seen to help you to remember detail.

Question 8 (d)(ii)

Only just over half of candidates were able to correctly give the independent variable as the number of pieces of aluminium or the thickness of aluminium. This is the variable that when changed affects the results of the experiment. When the aluminium is made thicker less beta radiation reaches the G-M tube, so the reading is less. G-M tube reading is the dependent variable.

Question 8 (d)(iii)

Less than half of candidates were able to name the quantity that must be kept constant during the experiment. The quantity to keep constant is the distance between the beta source and the G-M tube as it is the G-M tube with the counter that counts the amount of beta radiation that gets through the aluminium pieces. If the beta source is moved further away from the G-M tube with nothing between them the reading on the G-M tube will reduce. Therefore, the beta source and the G-M tube must be placed at a set distance then the only change is the number of pieces of aluminium placed between them.

Question 8 (d)(iv)

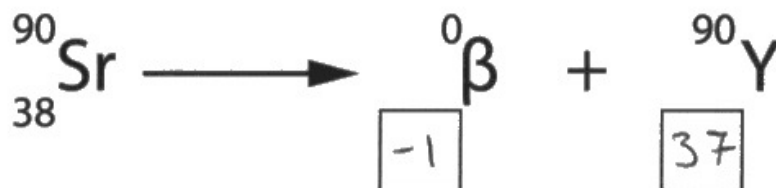
Candidates had to know that beta minus has a charge of minus one (-1) in order to fill in the first box and then correctly balance the equation to give 39 in the second box. $-1 + 39 = 38$.

This response shows the most common error in attempting to balance the equation.

(iv) Strontium-90 is the source of beta minus radiation in this investigation.

Complete the nuclear equation for this emission of beta minus radiation.

(2)



ResultsPlus
Examiner Comments

The first mark is awarded for knowing that beta is an electron and has a charge of -1.

The equation is not balanced correctly. $-1 + 37$ is not 38 so the second mark is not awarded.



ResultsPlus
Examiner Tip

Learn the mass numbers and atomic numbers that are used for alpha, beta and gamma radiation.

Question 9 (a)(ii)

A large number of candidates were able to gain the mark for this question by stating that the ball moving in a circle at constant speed has a constantly changing velocity because it is continuously changing direction.

Question 9 (b)

At least half of the candidates could score two marks for this calculation. The equation was given and there was a mark for substitution or rearrangement, and a mark for evaluation. The final mark of this 3 mark question was to give the answer to the appropriate number of significant figures. As all the values in the question are given to 2 significant figures, then the answer should have been given to two significant figures. That is 0.061s. The zero after the decimal point is a place holder and does not count as a significant figure.

This example shows a correct calculation given to two significant figures.

(b) Figure 14 shows a gymnast landing on a mat and coming to rest.

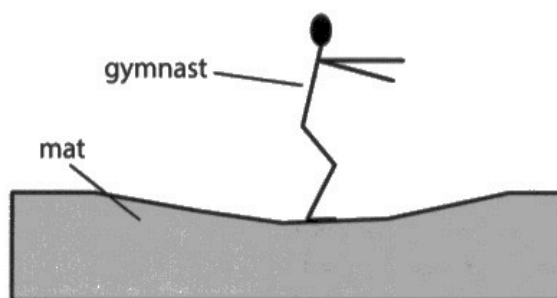


Figure 14

The gymnast has a mass of 53 kg.

The gymnast lands on the mat with a velocity of 4.0 m/s.

The average force exerted by the mat on the gymnast is 3500 N.

Calculate the time taken for the gymnast to come to rest.

Give your answer to an appropriate number of significant figures.

Use the equation

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

$$\text{Momentum} = \text{Mass} \times \text{velocity}$$

$$212$$

(3)

$$3500 = \frac{212}{T}$$

$$\frac{212}{3500}$$

$$\text{time} = 0.061 \dots \text{ s}$$



This response is awarded three marks.

The substitution and rearrangement are completed for the first mark. The change in momentum is calculated and substituted into the equation which is correctly rearranged as $212/3500$.

The evaluation is then taken to two significant figures, which scores the second and third mark.



Look at the significant figures given for the values used in the equation and keep your answer to the same number of significant figures.

Question 9 (c)

This question showed, in a diagram two trolleys of equal mass travelling in opposite directions at the same speed. The trolleys collide, stick together and come to a stop. The candidates were asked to explain how both momentum and energy were conserved in the collision. A common error was to try to explain conservation of momentum in terms of forces.

Level 1 was achieved by describing conservation of momentum as being the same before and after a collision and stating that energy cannot be created or destroyed. About half of the candidates achieved Level 1.

To achieve Level 2 some candidates explained how there was conservation of energy with little mention of momentum. A few gave very good explanation of momentum being zero before collision due to equal and opposite momentum and zero after collision because the trolleys had stopped, but then did not mention energy.

To achieve Level 3, the momentum being zero before and after the collision, it had to be explained together with the conservation of energy.

This is an example of a Level 1 response.

*(c) Figure 15 shows two trolleys, P and Q, moving at the same speed, v , directly towards each other.

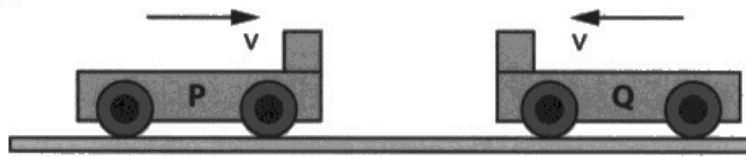


Figure 15

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

- Momentum is mass multiplied by velocity.
- Both trolleys have the same momentum and so will exert equal forces on each other.
- This causes them to stop, instead of one continuing, meaning momentum is conserved.
- Energy cannot be created or destroyed, only transferred.
- As the two trolleys collide, the energy is spread equally over both of them, as well as unused into energy into the environment.
- This as well, causes them to go stationary, meaning the energy used is conserved.



Level 1 2 marks

The first paragraph gives the equation for momentum, but the explanation is incorrect as the trolleys do not have the same momentum. The mention of force is not credit worthy and the fact that the trolleys stop is given in the stem of the question.

The second paragraph says that 'energy cannot be created or destroyed' and 'unused energy into the environment', but the kinetic energy in the moving trolleys is not mentioned. This would be needed to take the response to Level 2.



Name the energy stores, and remember momentum is a vector quantity.

This response achieves Level 2.

*c) Figure 15 shows two trolleys, P and Q, moving at the same speed, v , directly towards each other.

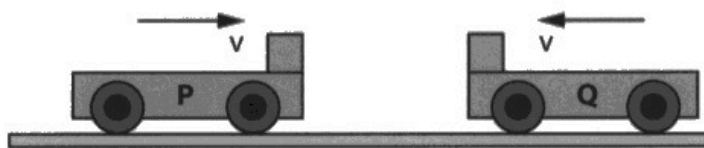


Figure 15

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

Energy is conserved in the collision as it travels to different stores. When the trolleys are moving, energy is in the kinetic energy store of both trolleys. When they collide the energy ~~move~~ is transferred to the surrounding by heat and sound. Some energy is mechanically transferred also to heat thermally ~~transf~~ transferred into friction to make both the trolleys stop (heat is given off) This is how energy is conserved as energy cannot be created or destroyed.

~~As~~ As it's not a closed system, momentum could be transferred to the surrounding. ~~As~~ Momentum cannot be created or destroyed, either so has to be transferred. As both trolleys have the same mass and velocity, they will also have the same momentum. This means that one cannot force the other to move as they're the same



This is Level 2 4 marks.

In the first paragraph the candidate has given a good explanation of conservation of energy.

However, the statement that 'both trolleys have the same momentum' shows that the candidate does not understand that momentum is a vector quantity, therefore is unable to explain how momentum is conserved.



Remember momentum is a vector quantity.

This example achieves Level 3.

*(c) Figure 15 shows two trolleys, P and Q, moving at the same speed, v , directly towards each other.

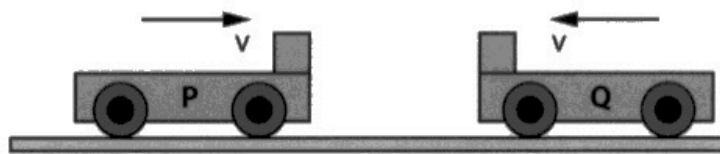


Figure 15

The trolleys have the same mass.

When the trolleys collide, they stick together and stop.

Explain how momentum and energy are both conserved in this collision.

(6)

Momentum is conserved due to ~~the fact~~ the fact that the momentum of both carts is equal and opposite. This is because mass of P (m_p) is equal to mass of Q (m_q) and they are at the same speeds towards each other, in opposite directions $v_p = -v_q$, therefore the momentum of Q is a negative of P's momentum, and when they collide their momentums are added. This results in the momentums canceling out, resulting in 0 momentum both before and after this collision.

Energy is conserved as when the two carts collide, energy is dissipated in the form of heat to the environment through, for example, friction in the axle, wheels, elasticity of the carts, or sound. This means energy was not lost, instead converted from KE to other forms.



Level 3 6 marks

The first paragraph gives an excellent explanation of the momentum before and after the collision stating it is zero and therefore momentum is conserved.

The second paragraph considers conservation of energy and names the energies before and after the collision.



Keep your explanations logical and concise.

Question 10 (b)(i)

Candidates needed to get information from the diagram in order to calculate the amount of energy transmitted through a sound insulating board.

The candidate uses the information from the diagram to understand the process and complete the calculation.

- (b) Figure 16 is an energy diagram for a sound wave incident on a sound-insulating board.

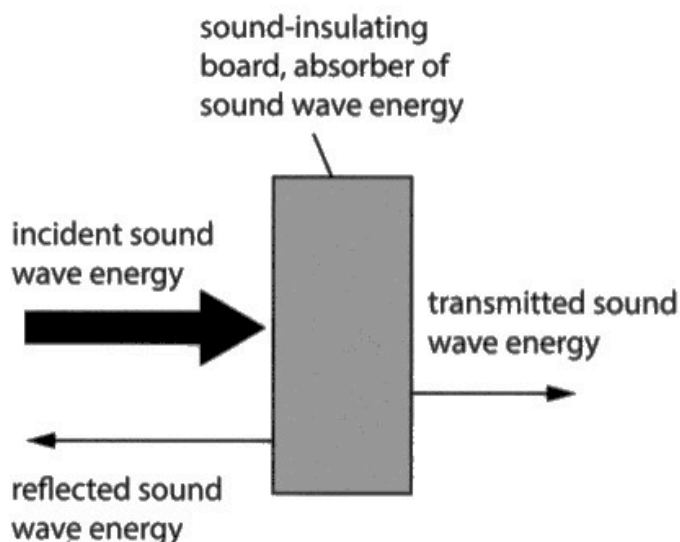


Figure 16

- (i) The incident energy is 0.25 J.

The absorbed energy is 67% of the incident energy.

The reflected energy is 15% of the incident energy.

Calculate the amount of the transmitted energy.

(2)

$$0.67 + 0.15 = 0.82$$

$$0.18 \text{ left}$$

$$0.25 \times 0.67 = 0.1675$$

$$0.25 \times 0.15 = 0.0375$$

$$0.25 \times 0.18 = 0.045$$

$$\text{transmitted energy} = \underline{0.045} \text{ J}$$



2 marks awarded.

The response shows that the % of absorbed and reflected energy was added and then subtracted from 100%.

This gives 18% as the transmitted energy. This % of the total energy is then calculated.



Look at the diagram for information.

Question 10 (b)(ii)

About three quarters of candidates gave the way of reducing the percentage of energy transmitted through the sound insulating board as increasing the thickness of the board.

Question 10 (c)

Candidates needed to use the information on the coefficient of absorption of sound of the various materials to explain why rooms with carpets and curtains were less noisy than rooms without carpets and curtains. The majority of candidates realised that carpets and curtains absorbed more sound, but far fewer realised it was less noisy because less sound was reflected back into the room.

This example considers absorption and reflection of sound.

- (c) The ratio of the absorbed energy E_a to incident energy E_i is the coefficient of absorption of sound α .

$$\alpha = \frac{E_a}{E_i}$$

The table in Figure 17 gives the coefficient of absorption for various materials.

material	$\alpha = \frac{E_a}{E_i}$
curtains	0.55
painted walls	0.02
wood floors	0.10
carpeted floors	0.60

Figure 17

Explain why rooms with carpets and curtains are less noisy than rooms without them.

Use the information given in Figure 17 in your answer.

because carpets and curtains⁽²⁾ have a higher coefficient of absorption of sound meaning sound is not reflected



2 marks scored.

The first marking point is scored for the 'higher coefficient of absorption of sound'.

The second marking point for 'sound is not reflected'.



The explanation gained two marks; two points must be made to score both marks.

Question 10 (d)

This question required candidates to explain how the depth of the ocean beneath a boat can be determined using sound waves. About half of the candidates could generally explain the process. However far fewer included detail such as the need for an ultrasonic pulse to be used to determine the time of travel of the ultrasound.

This response achieved at Level 1.

***(d) Explain how sound waves can be used to determine the depth of the ocean directly underneath a boat.**

You may draw a diagram to help with your answer.

(6)

- Firstly, the sound wave is transmitted into the ocean.

- This will ~~begin~~ to cause the ocean to start vibrating leading to the wave being reflected back.

- Once they have been reflected this will cause an image to build up which is ~~what~~ is known as Sonar.



Level 1 2 marks.

In the first paragraph 'A sound wave is transmitted into the ocean' is a Level 1 statement.

In the second paragraph 'the wave is reflected back' is another Level 1 statement.

In the third paragraph there is the mention of 'sonar'.

Without the time of travel of the wave or the equation to determine distance travelled, this response is Level 1.



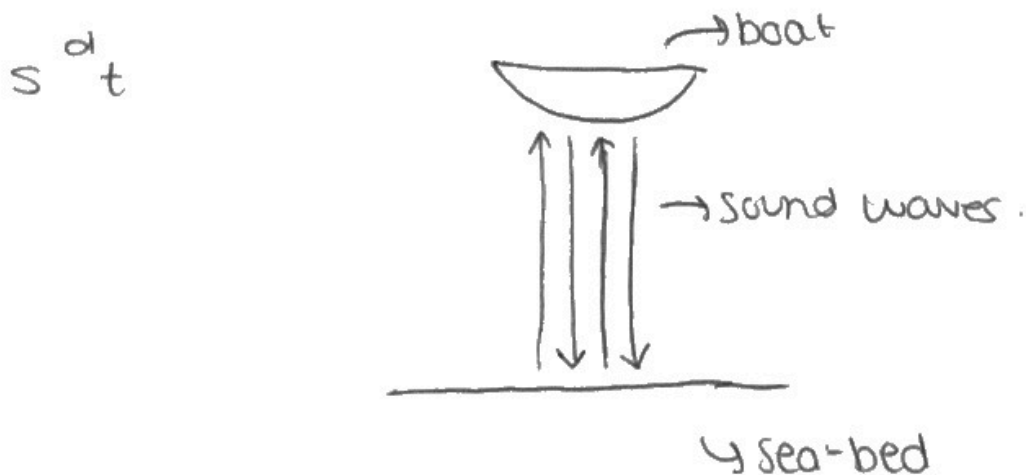
Draw a labelled diagram. This will help to clarify your thoughts on the process to be explained.

This response has sufficient in the explanation to achieve Level 2.

***d) Explain** how sound waves can be used to determine the depth of the ocean directly underneath a boat.

You may draw a diagram to help with your answer.

(6)



The boat emits sound waves from the bottom. Then someone on the boat can use a stop watch to determine how long it took for the sound to travel to the bottom of sea (sea-bed) and back to the boat. As we know the speed of light we can use the equation $\text{Speed} \times \text{time} = \text{distance}$ to find the distance the sound travelled. Once the distance has been found it needs to be halve as the distance calculated is the distance the sound has travelled there and back. So halving it finds the distance it travel from the boat to the seabed.



Level 2 4 marks.

The process described using sound waves rather than an ultrasound pulse, but the process is explained in a logical order. The diagram shows waves reflected from the seabed, although reflection off the seabed is not given in the text. There is also an error in quoting the speed of light rather than the speed of sound. However, the correct equation is quoted and the reason for halving the distance found is explained, achieving Level 2.



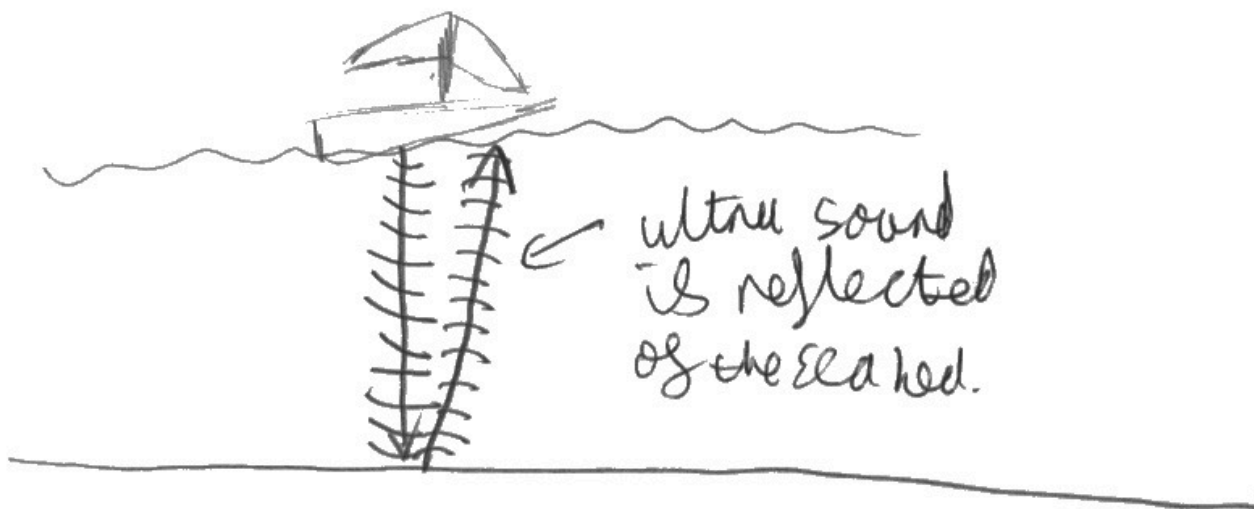
Keep explanations in a logical order.

This response is concise and accurate, achieving Level 3.

*(d) Explain how sound waves can be used to determine the depth of the ocean directly underneath a boat.

You may draw a diagram to help with your answer.

(6)



Boats use sonar technology to measure the depth of the ocean. The sonar uses the ultra sound frequency to measure this. They release a pulse of ultra sound and measure the time it takes to for the pulse to come back because they know the speed of the pulse and they measure the time it takes to return they can use $S = \frac{D}{T}$ to find the distance. By rearranging it to $S \times T = D$. However they must divide the time taken by 2 as the pulse must travel to the bottom of the sea bed and back.



Level 3 6 marks.

The response has a labelled diagram showing the ultrasound wave being reflected from the seabed. The third line refers to the release of a (ultrasound) pulse to measure the time of travel. The correct equation is given for the calculation of distance and the reason for the dividing the time measured by two is given.

The speed of sound which needs to be known has not been mentioned but there is sufficient accurate detail to give Level 3 6 marks.



Learn the detail of a process and explain it in a logical order.

Paper Summary

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

- bring a ruler to the examination
- use diagrams for information
- draw diagrams or add to diagrams to help with explanations
- learn to use standard form
- learn how to give answers to the appropriate number of significant figures
- learn how to determine the independent and dependent variable in an experiment
- do not give answers in the form of fractions
- record and learn experimental processes.

Grade boundaries

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

<https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html>

