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Examiners' Report
June 2022

GCSE Physics 1PH0 1H

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Introduction

Candidates were sitting this examination after two years of disrupted education caused by the covid crisis. The candidates for this examination had a wide range of experiences in their learning and in an attempt to mitigate for this, an Advanced Information Document was distributed to centres to reduce the need for candidates to study the whole of the specification. An additional formulae sheet was also given which gave all the equations used in the specification and included those equations which candidates had previously been required to recall.

Questions were set on the following topics:

- 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.

The questions tested knowledge, understanding and analysis in the context of applications of physics principles. Practical skills were tested using suggested practicals which focused on energy transfer and conservation of momentum. The majority of candidates were able to exhibit mathematical skills by substituting in equations, rearranging and evaluating, however multiples and submultiples of units were often used incorrectly and produced many power of ten errors. Candidates need to appreciate the value of diagrams and graphs in providing information and also to improve their skills in drawing and labelling diagrams to accurately show how apparatus is set up for an experiment. This report exemplifies this and other points which could improve the performance of candidates working on this specification.

Question 1 (b)(i)

The majority of candidates were able to give a value for the magnification of the object, most did this by using the graph paper to obtain the comparable height of image and height of object.

Candidates were given the equation for magnification and a ray diagram showing an object with the image produced using a convex lens.

To obtain the magnification the height of the image and object needed to be taken either measuring with a ruler or by using a comparison of heights taken from the graph paper.

(b) Figure 1 is a ray diagram for a converging lens when used as a magnifying glass.

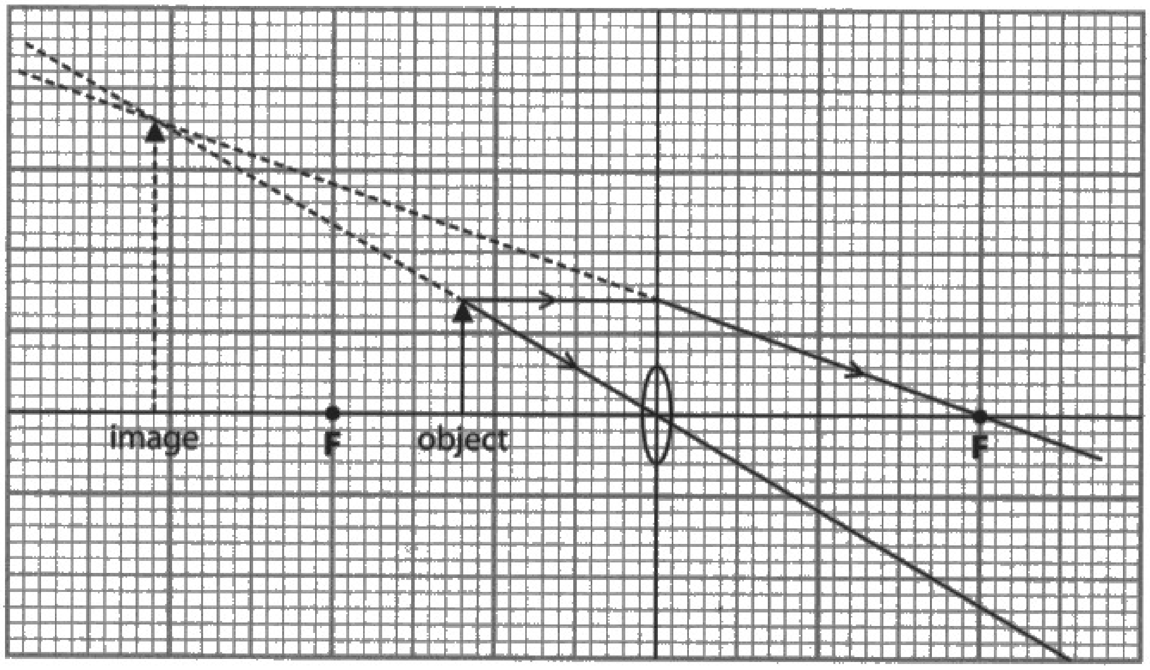


Figure 1

(i) Using information from Figure 1, determine the magnification of the virtual image.

Use the equation

$$\text{magnification} = \frac{\text{height of image}}{\text{height of object}}$$

(2)

$\frac{3.6}{1.4} = 2.5714\ldots$

magnification = 2.6

ResultsPlus
Examiner Comments

Some candidates used a ruler and measured the image to be 3.5 cm and the object 1.4cm.

The accepted evaluation was 2.6 + or – 0.5.

ResultsPlus
Examiner Tip

If measuring with a ruler remember to be directly above or in line with the reading being taken (no parallax).

Graph paper was used as a scale.

(b) Figure 1 is a ray diagram for a converging lens when used as a magnifying glass.

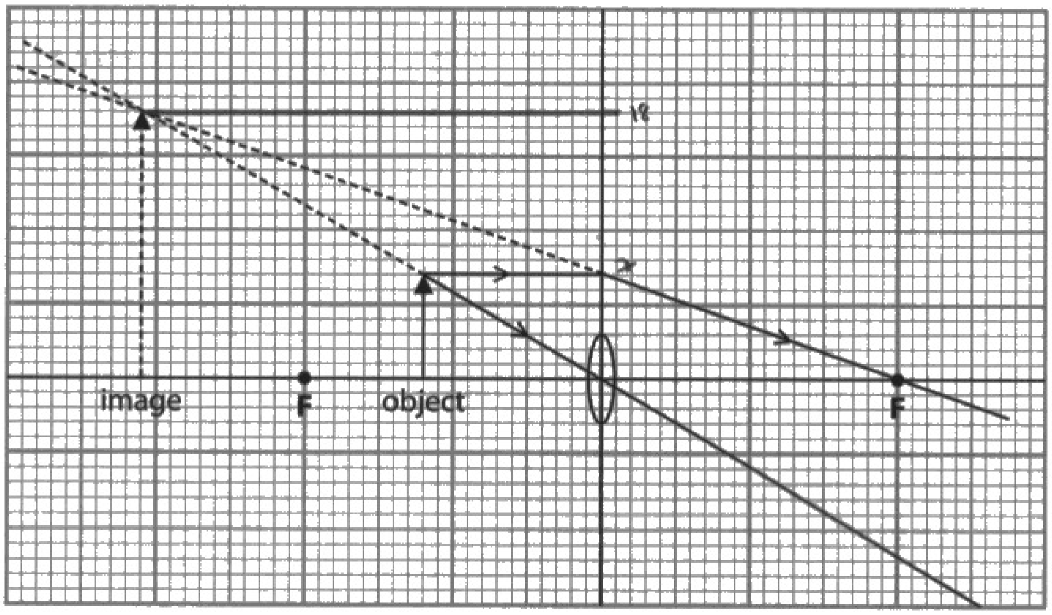


Figure 1

(i) Using information from Figure 1, determine the magnification of the virtual image.

Use the equation

$$\text{magnification} = \frac{\text{height of image}}{\text{height of object}}$$

(2)

$\frac{18}{7} = 2.574...$

$= 2.6$

magnification = ~~2.6~~ 2.6

ResultsPlus
Examiner Comments

The candidates counted small squares. Image 18 small squares. Object 7 small squares.

ResultsPlus
Examiner Tip

When making a comparison remember to keep the same scale for the image and the object.

Question 1 (b)(ii)

Only about half of the candidates were able to gain both marks as they were able to describe how the shape, or the position of the lens could be changed to increase the magnification of the object.

Candidates needed to know how they would change either the shape of the lens or its position with respect to the distance from the lens.

(ii) Describe **one** way the magnification of the image could be increased.

(2)

By using a thicker lens, the light rays will be refracted greater, allowing the magnification to increase.

ResultsPlus
Examiner Comments

The candidate gives that when using a thicker lens then the magnification would be increased. The shape of the lens could be described in various ways including 'fatter', 'shorter focal length' or 'more convex'.

ResultsPlus
Examiner Tip

When describing the lens, 'stronger' is not the best description as it could refer to either a convex or a concave lens, although it was accepted in this response to mean more convex.

This example describes how the lens can be moved to give greater magnification.

(ii) Describe **one** way the magnification of the image could be increased.

(2)

Move the lense futher away from the object to allow the light to spread out more

ResultsPlus
Examiner Comments

The distance between the lens and the object must be increased to give an image which has a greater magnification.

ResultsPlus
Examiner Tip

When describing that there has to be a change in distance between the object and the lens, be careful to specify that it is the distance between the object and the lens that has to be increased or that the object is moved further away from the lens.

Question 1 (c)

More than half of all candidates were able to gain full marks by substituting into the equation and then finding the reciprocal of 1/f.

The value of 1/f was often given in the answer line.

Calculate the focal length, *f*, of the lens.

Use the equation

$$\frac{1}{f} = \frac{a+b}{a \times b}$$

$$\frac{1}{f} = \frac{a+b}{a \times b} = \frac{(20)+(40)}{20 \times 40} = \frac{60}{800}$$

$$= 0.075$$

focal length f = 0.075 cm

ResultsPlus
Examiner Comments

This example shows an incomplete calculation 1/f = 0.075.

ResultsPlus
Examiner Tip

Make sure that you complete the calculation and find the focal length.

The calculation in this example has been completed.

Calculate the focal length, *f*, of the lens.

Use the equation

$$\frac{1}{f} = \frac{a+b}{a \times b}$$

(3)

$$f = \frac{a \times b}{a + b} = \frac{20 \times 40}{20 + 40}$$

$$f = \frac{(20)(40)}{60} = 13.3$$

focal length f = 13.3 cm

ResultsPlus
Examiner Comments

The candidate has inverted the equation at the start of the calculation to find f.

ResultsPlus
Examiner Tip

Check what the question asks for, in this case f focal length, finding 1/f only gets two out of three marks.

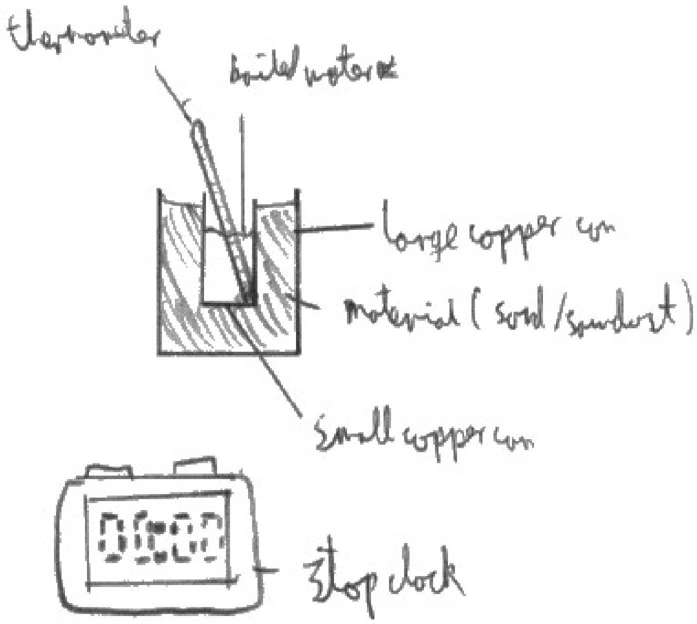
Question 2 (b)(i)

About half of the candidates were able to gain full marks having realised that the thermometer needed to be in the can containing the water for a comparison of transfer of energy to be measured.

Candidates were required to use the apparatus and materials given in the question to draw a labelled diagram and show how the apparatus and materials should be set up to investigate which of the two materials is the better insulator.

(i) Draw a labelled diagram to show how the student should set up the equipment to investigate which material is the better insulator.

(3)



ResultsPlus
Examiner Comments

The diagram gains full marks, not only are the apparatus and materials in the right places but the labelling is also clear and correct.

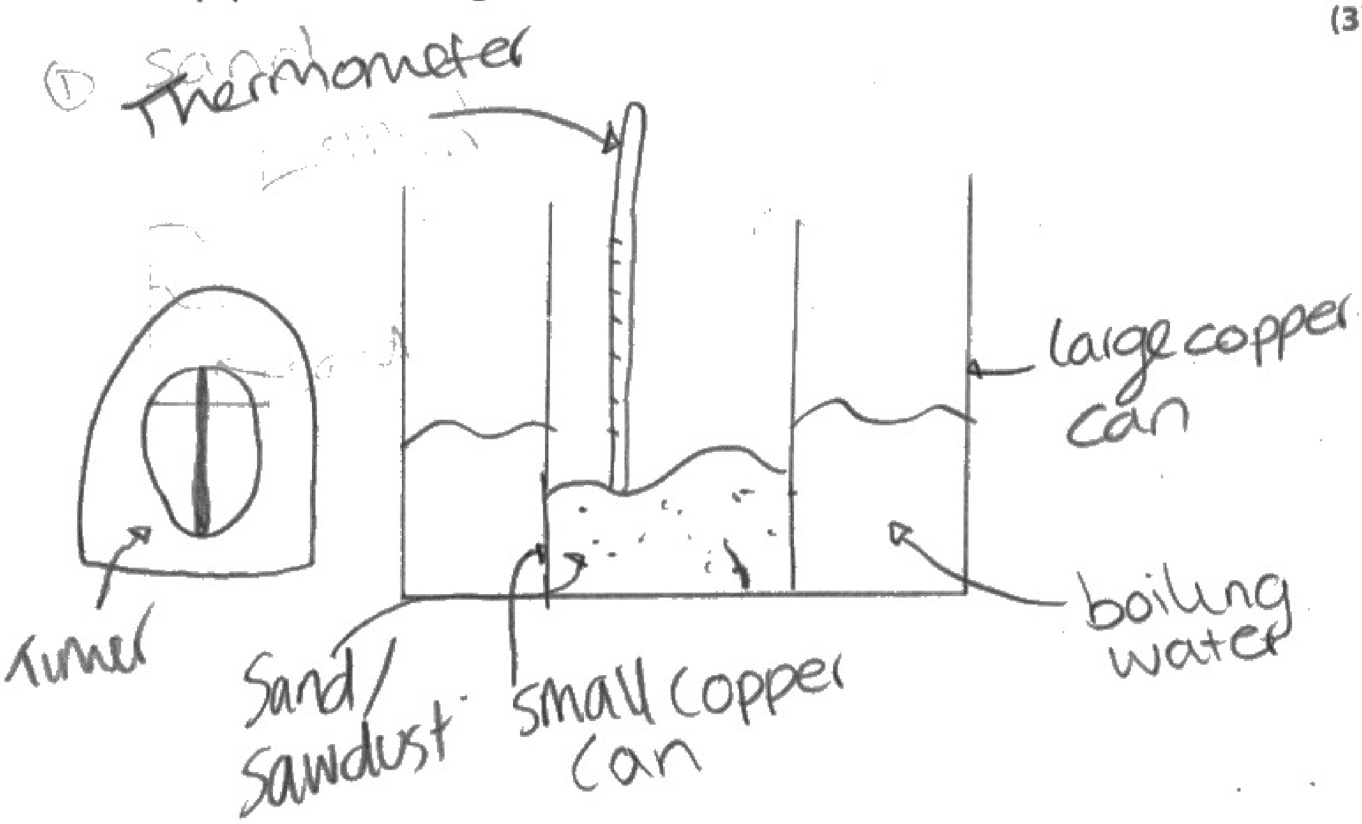
ResultsPlus
Examiner Tip

Make diagrams clear and show which parts are labelled. It often helps to use a ruler.

Reverse position of water and sawdust was acceptable.

(i) **Draw a labelled diagram to show how the student should set up the equipment to investigate which material is the better insulator.**

(3)



ResultsPlus Examiner Comments

Make sure labelling is clear. The sand / sawdust label is pointing to the inside can and this has the thermometer in it. Although the arrangement of cans is correct the thermometer is not in the water so only two out of three marks awarded.

ResultsPlus Examiner Tip

Always draw lines you want to be straight with a ruler and make sure label points are clear.

Question 2 (b)(ii)

The majority of candidates were able to give at least two factors that needed to be controlled for the investigation.

Most candidates chose to keep the volume of water and volume of insulator constant for two marks.

(ii) Give **three** factors that the student must control in this investigation.

(3)

1 volume of water

2 volume of sawdust and sand

3 the ~~thermometer~~ temperature of the water.
initial

ResultsPlus
Examiner Comments

The temperature of the water was not sufficient for a mark as it was necessary to define when the temperature was a control as in the initial or starting temperature.

Many candidates used boiling water and this was sufficient as a specification of starting temperature.

A few candidates specified that the time for the heat transfer must also be controlled.

ResultsPlus
Examiner Tip

The temperature of the room was not considered as a control, as the student may want to account for it but has no control over it.

Question 2 (c)

The majority of candidates gained only one mark for describing how the thermal conductivity of polystyrene changes with the density of polystyrene.

This response gains only one mark for the 'density increases as the thermal conductivity decreases'. This is not a full answer as it does not fully describe the change.

Using the graph in Figure 4, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

(2)

As the density increases, the thermal conductivity of expanded polystyrene decreases. This is shown in figure 5. when tensity is 15, thermal conductivity is 37 whereas at 35 it is 32.

(Total for Question 2 = 9 marks)

ResultsPlus
Examiner Comments

Quoting the values of density and thermal conductivity at two points on the graph does not give the relationship between these points and so the second mark is not awarded.

ResultsPlus
Examiner Tip

The change in the graph has to be described, is it non-linear, gradient decreases or levels off.

The description of how the density changes with the thermal conductivity is complete in this response.

not why

Figure 4

Using the graph in Figure 4, describe how the thermal conductivity of expanded polystyrene changes with the density of expanded polystyrene.

(2)

As the ~~dens~~ density of expanded polystyrene increases, the thermal conductivity of expanded polystyrene. ~~&~~ When the density hits 30 kg/m³ the thermal conductivity stays the same

(Total for Question 2 = 9 marks)

ResultsPlus
Examiner Comments

This is a sensible way of describing the shape of the graph.

ResultsPlus
Examiner Tip

There is no need to try to work out if the graph is exponential or inversely proportional, just describing it as non-linear, ie not a straight line, is sufficient.

Question 3 (a)(i)

Application of knowledge of friction and distance and the difference between wet and dry roads.

Candidates were asked to explain why it was safer to drive more slowly in wet conditions.

(i) The sign tells drivers to drive at a slower speed in wet weather.

Explain why it is safer for drivers to drive at a slower speed in wet weather.

(2)

In wet weather, ie. rain, the roads are wet ~~t&~~ and suppery and act as a lubricant between tyres and the road making it harder to stop (lack of friction). ~~It will take~~ The braking distance would be larger.

ResultsPlus
Examiner Comments

When asked to 'explain', give a reason and then add 'a because' – in this case the braking distance will be larger because the roads are wet and slippery, so a lack of friction.

ResultsPlus
Examiner Tip

Remember it is a physics examination, so you need to relate the answer to the physics that you have learned.

Question 3 (a)(ii)

This question tested the conversion of the units m/s and km/h.

Candidates needed to know that 1000 m were equivalent to 1km and that there were 60x60 = 3600 seconds in an hour.

(ii) Show that a speed of 31 m/s is less than a speed of 130 km/h.

(2)

31 m/s

31 x 60 = 1860 m/m x 60 = 111600 m/h

111~~6~~600 ÷ 1000 = 111.6

111.6 km/h is less than 130 km/h

and 111.6 km/h is equivalent to 31 m/s

ResultsPlus
Examiner Comments

Some candidates worked from 31m/s and converted to m/min then m/hr before dividing by 1000.

ResultsPlus
Examiner Tip

Always show the conversion of units, that will get a mark. Then convert one unit at a time.

Candidates needed to know that 1000 m were equivalent to 1km and that there were 60x60= 3600 seconds in an hour.

(ii) Show that a speed of 31 m/s is less than a speed of 130 km/h.

(2)

130 × 100 = 130000 m

130 000 m/h

÷ (60 x 60)

= 36.1 m/s

31m/s < 36.1 m/s

So 31m/s is less than 130 km/h

ResultsPlus
Examiner Comments

Candidates must learn the multiples of units and be able to use the common knowledge that there are 60 seconds in a minute and 60 minutes in an hour.

ResultsPlus
Examiner Tip

Always show the conversion of units, that will get a mark. Then convert one unit at a time.

For km to m multiply by 1000, for hours to seconds divide the metre answer by 60x60.

Question 3 (a)(iii)

This question tested the use of the equation speed = distance / time, which could be found on the formulae sheet and the use of significant figures.

Although an equation was given and did not need to be recalled the equation did need to be rearranged. Also the answer needed to be given to 2 significant figures to gain full marks.

Calculate the driver's reaction time.

Give your answer to 2 significant figures.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$ **(3)**

$$t = \frac{46}{31} \qquad \text{time} = \frac{\text{distance}}{\text{speed}}$$

$$t = 1.48|387$$

$$\text{to } 2\text{ sf} = 1.48$$

driver's reaction time ....1.48........ s

ResultsPlus
Examiner Comments

Once the equation is rearranged the value obtained for the reaction time is 1.48s.

However it is required that the answer is given to 2 significant figures and should therefore be correctly rounded to 1.5s.

ResultsPlus

Examiner Tip

If rearranging equations is demanding, then write down the equation as it is seen and substitute the values that are given. In many cases a mark is given for correct substitution.

Either the rearrangement or the substitution is incorrect, so one mark is awarded for the evaluation of 0.67.

(iii)

The driver's reaction time is the time between the driver seeing an emergency and starting to brake.

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time.

Give your answer to 2 significant figures.

(3)

$\frac{31}{46} = 0.67\text{s}$

driver's reaction time 0.67 s

ResultsPlus
Examiner Comments

As 0.67 is 0.6739 to two significant figures and 0.67 is given on the answer line, then this gets the significant figure mark as it is independent of the answer obtained.

ResultsPlus
Examiner Tip

When asked for an answer to two significant figures, regardless of the numerical value obtained remember to write this to two significant figures in the answer line.

(iii)

> The driver's reaction time is the time between the driver seeing an emergency and starting to brake.

A car is travelling at a speed of 31 m/s.

The car travels 46 m between the driver seeing an emergency and starting to brake.

Calculate the driver's reaction time.

Give your answer to 2 significant figures.

(3)

31 m/s

travelled 46 m

46 ÷ 31 = 1.48387 = 1.5

driver's reaction time ....1.5........ s

ResultsPlus
Examiner Comments

This shows the correct selection of equation, substitution and answer to 2 sig.fig.

This is completely correct.

ResultsPlus
Examiner Tip

The answer should be given to 2 sig.fig.

Question 4 (a)(ii)

This question tested the understanding of radioactive half-life in a practical situation.

This question had two parts relating to the use of an isotope which had a half-life of about 6 hours being used for a kidney scan.

The first part of the question asked why an isotope having a half-life of 6 mins would not be suitable for this scan.

The second part of the question asked why an isotope with a half-life of six days would be equally unsuitable.

Answers such as it would decay too quickly or too slowly were not credited as they did not relate to the situation in which the radioactive isotope was being used.

(ii) During the scan, a technician needs to take readings for about 30 minutes.

The half-life of the isotope used is about 6 hours.

1. State why an isotope with a half-life of about 6 minutes is **not** suitable.

(1)

As it would decay to quickly

2. State why an isotope with a half-life of about 6 days is **not** suitable.

(1)

It would stay in the patients body for too long

ResultsPlus
Examiner Comments

The answer 'it would decay to quickly' needs to add so the technician would not be able to take a reading (in 30 mins).

The second answer gains a mark because it gives a reason related to the fact that the radioactive isotope is injected into the patient.

ResultsPlus
Examiner Tip

Relate your answer to the situation in which the question is placed.

Each answer is just one mark and does not require a long explanation.

(ii) During the scan, a technician needs to take readings for about 30 minutes.

The half-life of the isotope used is about 6 hours.

1. State why an isotope with a half-life of about 6 minutes is **not** suitable.

(1)

It wont Stay reactive long enough for the technician to get a reading

2. State why an isotope with a half-life of about 6 days is **not** suitable.

(1)

It will Stay in the blood Stream for too long and it can cause harm to the person

ResultsPlus
Examiner Comments

Both answers relate to the situation in which the radioactive isotope is being used.

ResultsPlus
Examiner Tip

Look at the marks which are awarded to each part of a question to judge how detailed your answer should be.

Question 4 (a)(iii)

The majority of candidates could gain at least one mark for being familiar with the use of lead aprons or protective clothing and many were able to gain a second mark for shielding or limiting exposure time.

The two answers both gained a mark. The question asked for two ways of reducing the radiation risk to the technician doing the kidney scan, so no explanation was required.

(iii) State **two** ways of reducing the radiation risks to the technician.

(2)

1 Sheilds against radiation e.g. aluminium, lead

2 Reduce expousure time as much as possible.

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Examiner Comments

As lead was included, aluminium was ignored.

ResultsPlus
Examiner Tip

Only short answers are required as one mark is awarded for each correct answer.

Both answers are correct but only score one mark.

(iii) State **two** ways of reducing the radiation risks to the technician.

(2)

1 Wearing gloves, so technician won't be contaminated / irradiated.

2 Wearing a mask – so the technician doesn't breathe radiation in.

ResultsPlus
Examiner Comments

Gloves and masks are all part of protective clothing and are therefore in the same mark point.

ResultsPlus
Examiner Tip

Make different points not those that are related to be sure of getting both marks.

Question 4 (b)(i)

This question tests candidates understanding of the purpose of the control rods in a nuclear reactor.

The majority of candidates found this question demanding and did not appreciate that the control rods absorbed the neutrons produced in the fuel rods.

This candidate understands that it is neutrons that are absorbed by the control rods and therefore there are less neutrons available for fission reactions.

(i) Explain how pushing the control rods further into the reactor slows down the nuclear chain reaction.

(2)

control rod
The ~~reactor~~ absorbs neutrons causing less neutrons to start a chain reaction, meaning less nuclear fission.

ResultsPlus
Examiner Comments

Learn the difference between the purpose of the control rods and the moderator in a nuclear reactor.

ResultsPlus
Examiner Tip

Think of a reason for the nuclear chain reaction slowing down, do not use the wording in the stem of the question.

Question 4 (b)(ii)

This question uses information about the average speed of fast and slow neutrons to calculate the average speed of the slow neutrons as a percentage of the speed of the fast neutrons.

The candidate was able to use the values correctly to find the percentage.

(ii) The moderator in a nuclear reactor slows down the neutrons so that the neutrons are more likely to start other fission reactions.

In a nuclear reactor,

- the average speed of the fast neutrons is 3.0×10^7 m/s
- the average speed of the slow neutrons is 4.0×10^3 m/s

Calculate the average speed of the slow neutrons as a percentage of the average speed of the fast neutrons.

(2)

$$\frac{4.0 \times 10^3}{3.0 \times 10^7} \times 100 = 0.01\dot{3}$$

$0.01\dot{3}$ %

ResultsPlus
Examiner Comments

More than half of all candidates were able to complete this calculation successfully. The errors came from not reading the question properly and trying to find the average speed of the fast neutrons as a percentage of the average speed of the slow neutrons and incorrect use of standard form.

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Examiner Tip

Learn how to find percentages and practice using standard form.

Question 4 (b)(iii)

Candidates were asked to describe how energy is transferred from the nuclear reactor to the next stage in the process of generating electricity.

This was found to be challenging with few candidates gaining both marks.

Very few candidates gained the first marking point. It was rare to find the energy from the nuclear reactor described as kinetic energy of the fission fragments of nuclear energy, but the second marking point was seen as thermal energy of the coolant.

(iii) The nuclear reaction is the first stage in the process of generating electricity.

Describe how energy is transferred from the nuclear reaction to the next stage in the process.

(2)

The nuclear reaction generates alot of thermal energy and that is used to heat up water which will turn into steam and will turn a turbine creating kinetic energy which is turned into electrical energy.

ResultsPlus Examiner Comments

Two marks could be achieved if it was recognised that steam transfers thermal energy from the reactor to kinetic energy of the turbine.

ResultsPlus Examiner Tip

The question asks for a description of how energy is transferred and therefore the answer should include energy stores and transfers to gain marks.

A rare completely correct response.

(iii) The nuclear reaction is the first stage in the process of generating electricity.

Describe how energy is transferred from the nuclear reaction to the next stage in the process. *

(2)

The kinetic energy created by fission in the nuclear reaction, is transferred into thermal energy in a coolant which then creates steam, which is needed to turn a turbine.

ResultsPlus
Examiner Comments

The response starts by giving the kinetic energy of the fission fragments in the nuclear reactor and the transfer to thermal energy in the coolant.

ResultsPlus
Examiner Tip

Revise the energy transfers throughout the process of generating electricity starting with the kinetic energy/nuclear energy from the reactor.

Question 5 (a)(i)

This question tested mathematical skills in the use of equation of motion to determine acceleration.

The question gave an approximate answer and candidates were asked to 'show that' the value given was about correct.

This type of question allows candidates access to the second part of a question if they are unable to get an answer for the first part.

The candidate has selected the correct equation and shown the substitution and correct evaluation.

5 (a) (i) An aircraft starts from rest and accelerates along the runway for 36 s to reach take-off velocity.

Take-off velocity for this aircraft is 82 m/s.

Show that the acceleration of the aircraft along the runway is about 2 m/s².

Assume the acceleration is constant.

(2)

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

$$a = \frac{82 - 0}{36}$$

$$a = \frac{82}{36}$$

$$a = 2.28$$

(to 3 sf).

ResultsPlus
Examiner Comments

Setting the calculation out clearly allows intermediate marks to be awarded even if the evaluation is incorrect.

ResultsPlus
Examiner Tip

For a 'show that' question always take the answer given to at least one more decimal place than the 'show that' answer.

Question 5 (a)(ii)

The equation to be used was given but candidates needed to know what each of the symbols used meant and also to realise that the initial velocity u was zero, as at the start of the question it is stated that the 'aircraft started from rest'. This coupled with the need to rearrange the equation to make x the subject made the question quite demanding.

This example shows a correct substitution, rearrangement and evaluation.

(ii) Calculate the distance the aircraft travels along the runway before take-off.

Use the equation

$$v^2 - u^2 = 2ax$$

(3)

$v^2 - u^2 = 2ax$

$\cancel{0 - 82}$

$82^2 - 0^2 = 2 \times 2.3 \times x$

$\dfrac{82^2}{2 \times 2.3} = x$

$x = 1461.74$

distance = 1461.7 m

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Examiner Comments

The initial velocity u has been given the value zero, the final velocity v has been squared and the distance used was taken from the value calculated in part (i) of the question.

ResultsPlus
Examiner Tip

Always show the values inserted into the equation given and remember to show values that are squared correctly.

This example shows an incorrect substitution.

(ii) **Calculate the distance the aircraft travels along the runway before take-off.**

Use the equation

$$v^2 - u^2 = 2ax$$

(3)

$82 - 0 = 2 \times 2 \times ?$

$\frac{82}{4} = 20.5$

$82 = 4 \times ?$

$82 = 4 \times 20.5$

distance = 20.5 m

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Examiner Comments

The candidate has used the 2m/s^2 for the acceleration rather than any value that they might have calculated in part (i) this then allows for a correct evaluation in part (ii). Unfortunately this candidate has forgotten to square the value of velocity and their evaluation is incorrect.

ResultsPlus
Examiner Tip

Rewrite the equation before substituting to note the square for the velocity.

Question 5 (a)(iii)

Having calculated the distance that the aircraft would use to take off, candidates were asked to give a reason for the runway used being much longer than that calculated.

Any sensible reason for having the runway longer than the calculated distance was acceptable.

(iii) Suggest **one** reason why the length of the runway used is always much longer than the calculated distance that the aircraft travels along the runway before take-off.

(1)

The aircraft could take longer to accelerate on ocassions, such as colder or wetter weather

ResultsPlus
Examiner Comments

Just suggesting that the aircraft might take longer to accelerate would be sufficient but the candidate added due to weather conditions.

ResultsPlus
Examiner Tip

As the previous part of the question asked for a calculation on acceleration it is sensible to relate the answer to the rest of the question.

Question 5 (b)(i)

The majority of candidates were able to complete this calculation as the equation for kinetic energy was given on the additional formulae sheet.

The example shows a correct calculation.

(b) (i) The aircraft lands with a velocity of 71 m/s.

The mass of the aircraft is 3.6×10^5 kg.

Calculate the kinetic energy of the aircraft as it lands.

(2)

$\frac{1}{2} \times \text{mass} \times (\text{speed})^2$

$\frac{1}{2} \times (3.6 \times 10^5) \times (71)^2$

kinetic energy of aircraft = 907380000 J

ResultsPlus Examiner Comments

The part equation is written and substitution made with the velocity squared.

ResultsPlus Examiner Tip

Write out the equation to remind yourself of the square for velocity.

This example shows the complete equation.

(b) (i) The aircraft lands with a velocity of 71 m/s.

The mass of the aircraft is 3.6×10^5 kg.

Calculate the kinetic energy of the aircraft as it lands.

(2)

$$ke = \frac{1}{2} m v^2$$

$$ke = \frac{1}{2}(3.6 \times 10^5)(71^2)$$

$$ke = 907380000$$

kinetic energy of aircraft = 9.0738×10^8 J

ResultsPlus
Examiner Comments

The final answer is given in standard form which is preferable.

ResultsPlus
Examiner Tip

If standard form is not used make sure you count the number of zeros in the answer on the answer line.

Question 5 (b)(ii)

This question tests the understanding of energy transfer and the majority of candidates were able to gain one mark knowing that the energy was transferred mechanically or thermally or transferred to the thermal store.

This example gives a way that the kinetic energy of the aircraft on landing has been transferred to the surroundings.

(ii) When the aircraft has come to a stop, all the kinetic energy has been transferred to the surroundings.

Give **one** way that the energy has been transferred to the surroundings.

(1)

The friction between brakepad and wheels to stop creates thermal energy

ResultsPlus
Examiner Comments

Friction or air resistance would have been sufficient to gain this mark.

ResultsPlus
Examiner Tip

Learn the ways that energy can be transferred. Mechanically or thermally are two possible examples in this case.

Question 6 (b)(i)

This question tested knowledge and understanding of red shift using a diagram to show how the red shift increases when a line spectrum of light for hydrogen from a distant galaxy is compared with the same line spectrum viewed using a hydrogen source on Earth. The question was a 'show that' so that a value could be used for part (ii) if the calculation in part (i) was completed incorrectly.

This example shows a correct substitution into the equation given but incorrect use of standard form.

(i) Show that the red shift for the light from the distant galaxy is about 0.025

(2)

$$z = \left(\frac{(6.72 \times 10^{-7}) - (6.56 \times 10^{-7})}{6.56 \times 10^{-7}}\right)$$

$$Z = \frac{1.6 \times 10^{-8}}{6.56 \times 10^{-7}} = 2.43902439 \times 10^{-16}$$

ResultsPlus Examiner Comments

The candidate knows how to subtract values in standard form but forgets that dividing by 10^{-7} is the same as multiplying by 10^{7}.

ResultsPlus Examiner Tip

Practise using standard form.

The candidate has converted standard form to numerical values.

(i) **Show that the red shift for the light from the distant galaxy is about 0.025**

(2)

$$\frac{0.000000672 - 0.000000656}{0.000000656}$$

$$= 0.02439 \approx 0.025$$

ResultsPlus
Examiner Comments

It is better to learn how to use standard form. There is less chance of getting too many or too few zeros.

ResultsPlus
Examiner Tip

It is good practice to give your answer and then compare it with the 'show that' answer. If your answer is not approximately the same as the 'show that' do not repeat your calculation, carry on the calculation with the 'show that' answer given.

Question 6 (b)(ii)

In the first part of the question, z the red shift was calculated. This value of z was then used in part (ii) to calculate the recession velocity v.

If z was calculated incorrectly the 'show that' value given in part (i) should have been used.

This question produced a range of answers depending on whether candidates used their calculated value for z or the 'show that' value given.

(ii) The galaxy is moving away from the Earth at velocity, *v* (recession velocity).

The velocity of light, $c = 3.00 \times 10^8$ m/s

The recession velocity is given by the equation.

$$v = z \times c$$

Calculate the recession velocity of the distant galaxy.

(2)

$V = 0.024 \times 3 \times 10^8$

$V = 7200000$

recession velocity = 7200000 m/s

ResultsPlus
Examiner Comments

The candidate shows substitution into the equation, converts to numerical form and gives the correct answer.

ResultsPlus
Examiner Tip

Better to use either standard form or numerical form and not a mixture of both.

Question 6 (b)(iii)

The majority of candidates were able to gain one mark on this question because they noted that the spectral line X for the more distant galaxy had a longer wavelength than the line X indicated in Figure 7. However, explaining why this provided evidence for the Universe expanding was more problematic.

This response shows that the candidates understands that as the wavelength is increasing the red shift is increasing and so is the recession velocity.

(iii) The wavelength of the spectral line X measured for a more distant galaxy was 6.92×10^{-7} m.

Explain how this provides evidence that the Universe is expanding.

(2)

When galaxies get further the ~~wave length~~ wavelength is increasing which shows that the further galaxies are ~~moving~~ travelling faster and that the Universe is expanding

ResultsPlus
Examiner Comments

The candidates notes that the galaxies that are further away are travelling faster and therefore the Universe is expanding.

ResultsPlus
Examiner Tip

This is the third part of the question and therefore is related to parts (i) and (ii). The calculations provide the reasoning for the Universe expanding.

Question 6 (c)

This question referred to observations of the Universe using telescopes on Earth and to explain why some telescopes are located on satellites.

The candidate noted that telescopes on satellites were in space which gave the first marking point.

(c) Observations of the Universe can be made using telescopes on Earth.

Explain why some telescopes are located on satellites that orbit the Earth.

(2)

Some types of electromagnetic radiation is absorbed by the Earths atmosphere, so they can't be detected at ground ~~levl~~ level. In space, there won't be any ~~obsta~~ obstacles to block the EM radiation.

ResultsPlus
Examiner Comments

This candidate gave the absorption of some wavelengths of radiation by the Earth's atmosphere as the reason for using telescopes on satellites, another reason which was given was distortion of light by the Earth's atmosphere, clouds, dust and pollution.

ResultsPlus
Examiner Tip

You need to state that the telescopes on satellites are in space and then explain why they are there.

Question 7 (b)(i)

This question tested practical skills using an investigation with trolleys on a slope to test conservation of momentum.

Candidates found it difficult to describe the investigation, although a diagram showing both trolleys on a slope with sticky pads labelled was given.

Candidates were also given the option of adding to the diagram of the apparatus, some candidates took advantage of this and added light gates.

In this example the candidate has added to the diagram to show the position of light gates and realised the importance of the sticky pads in joining the trolleys together, so that the momentum of the trolleys after the collision can be compared with the momentum of trolley A before the collision.

(i) Describe an investigation the students could carry out to show that momentum is conserved when these two trolleys collide.

You may add to the diagram to help with your answer.

(4)

First add a card to trolley B. Next install a set of light gates after each trolley. Record the masses of each trolley, then let Trolley A go down the slope & record the velocity using the acceleration. ~~Record similarly the velocity & mass of trolley B, and plug the values into equations for momentum before and after the crash.~~ As the trolleys become stuck ~~together~~ when they collide, their mass increase should correspond to the decrease in velocity of trolley ab. Plug into conservation of M equation to show MU=MV

ResultsPlus
Examiner Comments

The experiment is described in a logical order and when the candidate realises that trolley B is stationary at the start of the investigation and that the description is incorrect, it is crossed out and the correct version included.

ResultsPlus
Examiner Tip

Use the diagram to help with your description.

The candidate has used what they know about momentum, added it to the diagram and gained half the marks.

(i) **Describe an investigation the students could carry out to show that momentum is conserved when these two trolleys collide.**

You may add to the diagram to help with your answer.

(4)

you could find out both of the trolleys mass and ~~[illegible]~~ velocity then when the trolleys collide find out the velocity afterwards of trolley B to see how much force has been transfered.

ResultsPlus
Examiner Comments

The candidate has seen an experiment with trolleys, cannot remember the detail but uses the knowledge to gain some marks.

ResultsPlus
Examiner Tip

Use what you know, even if it is not all correct. The fact that momentum is mass x velocity gives a start with the measurement of mass and velocity.

Question 7 (b)(ii)

The question asked for experimental detail about the runway being put at a slope.

Very few candidates were able to give the correct answer which is 'to compensate for friction'.

The trolley is given a slight push to start and the slope ensures that it maintains a constant velocity before the collision and that the velocity of the trolley is not reduced due to friction with the runway.

One of the very few correct responses.

(ii) Give a reason for the runway being at a slope.

(1)

So that it can compensate for the friction.

ResultsPlus
Examiner Comments

Trolley maintains a constant velocity would also have been correct.

ResultsPlus
Examiner Tip

Note experimental detail when an investigation is written up as this will help in looking for inconsistencies in results.

Question 7 (c)(i)

This question tested mathematical ability and the idea that velocity is a vector quantity and therefore has both magnitude and direction.

The candidate substituted into the equation given and noted that the time had to be converted into seconds from milliseconds and that the ball had changed direction. This change in direction is noted with a second minus in the substitution, so adding the momentum before and after the collision to find the change in momentum.

(i) Calculate the average force exerted by the ball on the racket.

Use the equation

$$F = \frac{mv - mu}{t}$$

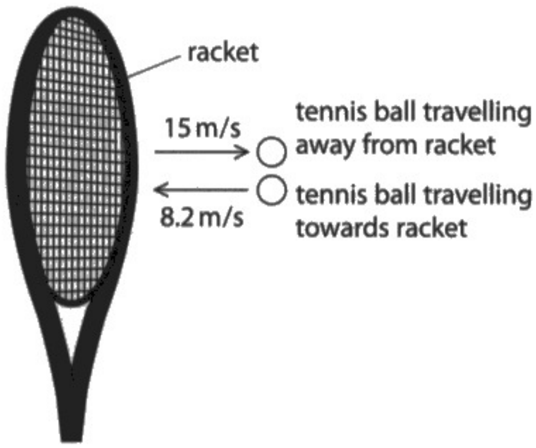


Figure 9

(3)

~~F = 15 - -8.2~~

~~$F = \frac{0.075(15 - -8.2)}{0.012} =$~~

$12 \times 10^{-3} = 0.012\text{s}$

$$F = \frac{0.075(15 - -8.2)}{0.012} = 145$$

force = 145 N

ResultsPlus
Examiner Comments

The candidate shows the change in time from milliseconds to seconds (ms to s) and remembers the change in direction of the ball with the additional minus.

ResultsPlus
Examiner Tip

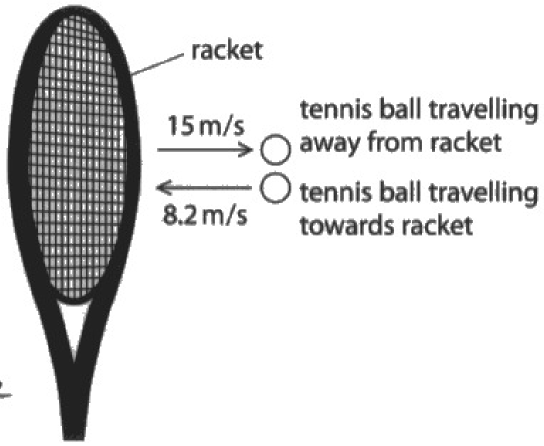
Note that ms is milliseconds.

This example shows the most common error. The two moments are subtracted.

(i) Calculate the average force exerted by the ball on the racket.

Use the equation

$$F = \frac{mv - mu}{t}$$



$\frac{12}{1000} = 0.012$

Figure 9

$F = \frac{mv - mu}{t}$

$12ms = 0.012\ s$

(3)

$F = \frac{(0.075)(15) - (0.075)(8.2)}{(0.012)}$

$F = \frac{0.51}{0.012}$

$F = 42.5$

force = 42.5 N

ResultsPlus
Examiner Comments

The time is changed but the fact that velocity is a vector quantity has not been recognised.

ResultsPlus
Examiner Tip

Get information from the diagram, this makes the change in direction clear.

Question 7 (c)(ii)

Knowledge of Newton's Third Law of Motion was tested in this question. A majority of candidates were able to score both marks, knowing that the forces were equal and opposite.

Those candidates that quoted the Third Law – that action and reaction are equal and opposite, but did not relate this to the collision between the racket and the ball, could still gain a mark.

Newton's Third Law is related to the force acting on the racket and the ball.

(ii) Describe how Newton's Third Law of Motion applies to the collision between the racket and the ball.

(2)

~~Th~~ The force of the racket on the tennis ball will be equal to the force of the tennis ball on the racket. However these forces will be opposite

ResultsPlus
Examiner Comments

Some candidates also noted that the forces act on different bodies and the forces are of the same type (contact forces).

ResultsPlus
Examiner Tip

Learn Newton's Laws of Motion.

Question 8 (a)

The question tested mathematical understanding as no equation was given as a guide, candidates had to use standard form and submultiples of distance, nanometres to metres (nm to m).

Many candidates found this challenging.

A correct calculation using standard form.

Estimate how many gold atoms would fit across this thickness of gold foil.

(2)

$$\frac{4 \times 10^{-7}}{1.5 \times 10^{-16}}$$

number of atoms = 2667

ResultsPlus
Examiner Comments

The conversion of 0.15nm to 1.5 x 10^{-10} m was difficult and was not often completed correctly.

ResultsPlus
Examiner Tip

Learn submultiples and practice using standard form.

Question 8 (b)(i)

Candidates were asked to take information from a graph, which showed the number of particles scattered at different angles in the Rutherford alpha particle scattering experiment.

The y-axis of the graph was the labelled number of scattered particles and the scale was in powers of ten. The x axis was the angle of scattering between 0 and 180 degrees.

Candidates had to identify the number of alpha particles scattered at 5 degrees and at 100 degrees and give the ratio of these numbers.

Estimate the ratio of the number of particles scattered through 5° to the number of particles scattered through 100°.

(2)

$5^\circ = 10^{6.73}$

$100^\circ = 10^2$

ResultsPlus
Examiner Comments

Any value between 10^6 and 10^7 was acceptable for 5 degrees but only 10^2 was acceptable at 100 degrees.

Many candidates were able to identify the values correctly but were unable to express these in the form of a ratio to gain the second mark.

ResultsPlus
Examiner Tip

Learn how to show ratios and how to compare values written in standard form.

A typically correct answer with the ratio given numerically.

(i) The number of particles detected at each angle in a given time is shown on the graph in Figure 11.

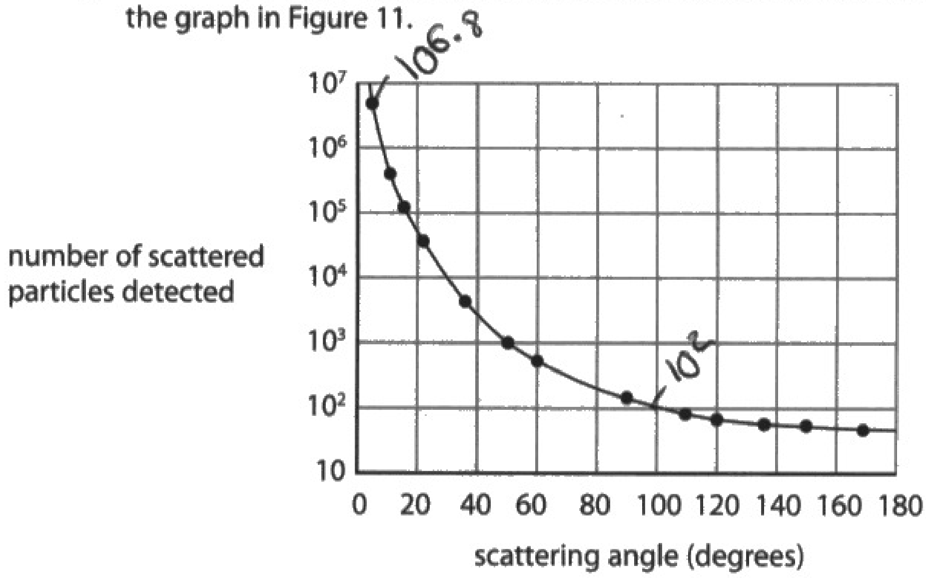


Figure 11

Use information from the graph.

Estimate the ratio of the number of particles scattered through 5° to the number of particles scattered through 100°.

(2)

$10^2 = 100$

$10^7 = 10000000$

100000 : 1

ratio = 100000 : 1

ResultsPlus
Examiner Comments

Ratio could have been left as 10^7:10^2 as the simplest form of the ratio was not required.

ResultsPlus

Examiner Tip

Do not change standard form to numerical value as this increases the possibility of errors.

Question 8 (b)(ii)

Candidates found this question challenging as they were often uncertain of the current model of the structure of the atom with respect to alpha particle scattering, although the question asks for the explanation of the number of particles scattered at different angles and this is shown in the graph and there is a diagram showing alpha particle scattering.

The response includes the main points of observations and conclusions given in the mark scheme.

(ii) Explain how the difference in the number of particles scattered at different angles gives evidence for the current model of the structure of the atom.

(4)

Most particles ~~[illegible]~~ went straight through or were only refracted slightly showing the atom is mostly empty space. The particles that were slightly refracted show that there are ~~[illegible]~~ negative electrons around in shells as Alpha particles are positive. ~~[illegible]~~ Finally a very small amount were reflected back showing there is a tiny very dence nucleus in the middle.

ResultsPlus
Examiner Comments

Candidates should know that most alpha particles go straight through the gold film and therefore the gold atoms are mainly empty space.

The second point is that a few alpha particles are reflected (scattered through 180 degrees) and this shows there must be a dense, small nucleus in the atom.

The mention of electrons from the Bohr theory is ignored as these have no effect on the scattering of alpha particles.

ResultsPlus Examiner Tip

Learn to relate the structure of the atom to Rutherford's alpha particle scattering experiment.

Question 8 (c)(i)

A model which can be used to demonstrate alpha particle scattering was shown as a diagram. The sheet of paper is a representation of the atom and the weight in the centre represents the nucleus.

The marble which is rolled down the slope is a representation of the alpha particle as it approaches an atom of gold at various distances from the nucleus. The candidates were also told that the apparatus included a protractor. This could be used to measure the angle at which the marble was scattered when the slope was moved along the edge of the paper.

The candidate describes how the apparatus can be used to demonstrate the scattering of the alpha particle, comparing those that go straight through the atom and those that are scattered through 180 degrees by the nucleus.

(i) Describe how the students could use the apparatus to model the scattering of alpha particles.

(2)

Dropping a marble down the slope at every cm interval and measuring the angle it bounces off at if at all - should show 0° until opposite the weight, when they will start to bounce in different directions

ResultsPlus
Examiner Comments

The candidate is able to understand how the model works.

ResultsPlus
Examiner Tip

Look back at the rest of the question and relate the model to the experiment.

Question 8 (c)(ii)

Some candidates were able to give the limitations of the model. The main reasons given were that the model was not to scale, there was no charge on the marble or weight in the centre, it was only 2-dimensional.

One of the limitations given.

(ii) Give **one** limitation of this model.

(1)

It doesn't represent the charges of the particles

ResultsPlus
Examiner Comments

This shows that the candidate has a good understanding of alpha particle scattering.

ResultsPlus
Examiner Tip

Look for the differences between the model and the actual experiment.

Question 9 (b)(i)

This question was introduced as being about waves in the electromagnetic spectrum.

The majority of candidates were able to make a substitution into the correct equation. The equation relating velocity of a wave to frequency and wavelength was available on the additional formulae sheet so it did not have to be recalled.

The main pitfalls were in rearranging the equation correctly and changing gigahertz to hertz.

In this example no attempt was made to change gigahertz to hertz. The substitution and rearrangement were correct giving two marks.

(b) (i) A microwave oven uses waves of frequency 2.45 GHz.

Calculate the wavelength of the microwaves.

The velocity of light is 3.00×10^8 m/s.

(3)

wave speed = frequency x wave length

Frequencey = 2.45 GHZ

~~wave~~ $\frac{3.00 \times 10^8}{2.45\,\text{GHZ} \rightarrow 2450}$ = wave length

122449

wavelength = 122449 m

ResultsPlus
Examiner Comments

It would be more sensible to substitute in the original equation to be sure of getting a mark for this. The correct power of 10 for frequency is not required.

ResultsPlus
Examiner Tip

Learn the multiples of units to be able to use correct powers of 10.

A correct calculation.

(b) (i) A microwave oven uses waves of frequency 2.45 GHz.

Calculate the wavelength of the microwaves.

The velocity of light is 3.00×10^8 m/s.

(3)

$v = f \times \lambda$

$3 \times 10^8 = 2.45 \times 10^9 \times \lambda$

$\frac{3 \times 10^8}{2.45 \times 10^9} = 0.1224\text{m}$

wavelength = 0.122 m

ResultsPlus
Examiner Comments

The equation is shown, the values are substituted then rearranged giving a correct evaluation.

ResultsPlus
Examiner Tip

Complete calculations one step at a time.

Question 9 (b)(ii)

More than half of the candidates were able to calculate the energy supplied to the oven correctly.

The equation for efficiency could be found in the additional formulae sheet and most candidates used 55% efficiency as 0.55 in the equation.

The equation had to be rearranged but as candidates were expecting to find a larger answer for the total energy supplied, there were less errors in rearrangement.

A typical error of using 55% then ignoring the 100.

(ii) The microwave oven is 55% efficient and transfers 42 000 J of energy to some food when it is heated.

Calculate the total amount of energy that must be supplied to the oven.

(3)

$$\text{efficieny} = \frac{\text{useful}}{\text{total}}$$

total = useful / efficieny

= 42 000 / 55

= 763.63

energy supplied to oven = 763.63 J

ResultsPlus
Examiner Comments

Equation is correctly rearranged with power of 10 error and used 55% not 0.55.

ResultsPlus
Examiner Tip

Look at the answer, does it make sense?

In this case, the total energy has been calculated as less than the energy given to the food, which is obviously wrong and probably needs a second look.

Question 9 (c)

This was an extended response question and candidates were asked to compare X-rays and radio waves being radiations at different ends of the electromagnetic spectrum.

Candidates were generally able to give at least one use of X-rays and radio waves and many were able to correctly compare frequency or wavelength.

However, comparing the ways that electrons are involved in the production of X-rays and the production of radio waves was more challenging and tended to produce responses that were in the stem of the question. Some candidates did know that when electrons change energy levels, that energy was emitted from the atom in the form of X-rays. However very few candidates knew that the oscillation of electrons in circuit was the source of radio waves.

A level 1 response, 2 marks.

*(c) X-rays and radio waves are part of the electromagnetic spectrum and have different uses.

These radiations are produced in different ways.

X-rays are emitted when electrons within an atom go through energy changes.

Radiowaves are produced by electrons in circuits.

Compare X-rays with radio waves.

Your answer should refer to

- the uses of both types of radiation
- the different ways that electrons are involved in producing X-rays and radio waves.

(6)

X-rays are used to create images of peoples bones in hospitals since they can go through skin and tissues but are stopped by bones since they're thick. Radiowaves are used to send signals through audio, for example, ~~around~~ and can travel through air for long distances. ~~Electrons~~

ResultsPlus
Examiner Comments

The candidate has just compared the uses of X-rays and radio waves, there is no attempt to compare frequency or wavelength or to compare the way that the radiations are produced.

ResultsPlus
Examiner Tip

Always give the information that you know, even if it does not completely answer the question.

A level 2 response, 4 marks.

*(c) X-rays and radio waves are part of the electromagnetic spectrum and have different uses.

These radiations are produced in different ways.

X-rays are emitted when electrons within an atom go through energy changes.

Radiowaves are produced by electrons in circuits.

Compare X-rays with radio waves.

Your answer should refer to

- the uses of both types of radiation
- the different ways that electrons are involved in producing X-rays and radio waves.

(6)

X rays and radio waves are different as radiowaves have a long wavelength and ~~short~~ low frequency. ~~Radiowaves~~ X-rays have a short wavelength and high frequency. Radiowaves have low penetration but X-rays have high penetration. Therefore they're used in medical equipment and can pass through skin and tissue. They could cause cancer. Radiowaves are used in communications as their long wavelength means they can travel far. Similarities are that they're both eletromagnetic waves and are transverse.

ResultsPlus
Examiner Comments

The candidate has correctly compared frequency and wavelength for X-rays and radio waves and briefly given a description of a use of both.

No attempt has been made at comparing the involvement of electrons in the production of these radiations.

ResultsPlus
Examiner Tip

Comparison of quantitative factors makes this answer a level 2 response.

A level 3 response, 6 marks.

*(c) X-rays and radio waves are part of the electromagnetic spectrum and have different uses.

These radiations are produced in different ways.

X-rays are emitted when electrons within an atom go through energy changes.

Radiowaves are produced by electrons in circuits. → oscillations alternating current

Compare X-rays with radio waves.

Your answer should refer to

- the uses of both types of radiation
- the different ways that electrons are involved in producing X-rays and radio waves.

(6)

X-rays emitted when electrons in an atom go through energy changes. When an electron is hit with right ~~level~~ amount of energy and wavelength it gets excited, move to a more outer electron shell before moving back down to original shell emitting same amount of energy that entered. X rays used for creating images inside the body.

Radio waves produced by electrons in circuits. when an alternating current oscillates radio waves ~~emit~~ emitted. Radio waves used for long distance communication, through satellite and shorter distance via bluetooth.

ResultsPlus
Examiner Comments

The candidate has mentioned a use of X-rays and radio waves and has described the way that the change in energy levels of electrons in atoms allows X-rays to be produced. There is also an understanding that electrons in circuits oscillate to produce radio waves.

ResultsPlus
Examiner Tip

Learn the uses of radiations in the electromagnetic spectrum and how changes in energy level of the electrons can produce a range of radiations which are part of the electromagnetic spectrum.

Question 10 (a)(ii)

Some candidates were unable to give any reason for the limit to the frequencies that the human ear can detect quite often, because frequency was confused with amplitude and they referred to the damage that loud sounds can do to the ear.

There were a wide variety of correct answers to this question and most answers relating to size, sensitivity or common usage were awarded a mark.

(ii) Suggest **two** reasons why there are limits to the frequencies that a human ear can detect.

(2)

1 We have no use for hearing sounds with frequences of below 20Hz and above 20,000Hz so we're not adapted to do so

2 Our ears aren't sensitive enough to detect frequencies of below 20Hz and above 20,000Hz

ResultsPlus
Examiner Comments

The example given refers to the frequencies which human ears find most useful and the sensitivity of our ears.

ResultsPlus
Examiner Tip

Learn the difference between frequency and loudness of a sound.

Question 10 (b)(i)

Candidates found this question challenging as the use of ultrasound signals to determine cracks in metal bars seemed unfamiliar to them.

This question is comparable to a sonar signal being used to find a school of fish but seemed to present much greater difficulty.

In this example the candidate understands that the signal emitted is reflected. In Figure 13a the signal is reflected from the bottom of the metal bar and the time taken to receive the signal is shown on the chart.

In Figure 13b the signal comes back quicker because the crack reflects the signal and the signal covers a much shorter distance.

(i) Explain how the signals in Figure 13a and Figure 13b show that there is a crack in the metal bar in Figure 13b.

(2)

The signal is received back quicker as ~~the~~ some of ultrasound waves bounces of the crack and back to the reciever.

ResultsPlus
Examiner Comments

It is necessary to use the diagrams as they show the distance the signal has travelled and the time it takes to return to the receiver.

ResultsPlus
Examiner Tip

Use the information given in the diagrams.

The candidate has realised that the signal is being reflected and used the chart to see the time difference.

(i) **Explain how the signals in Figure 13a and Figure 13b show that there is a crack in the metal bar in Figure 13b.**

(2)

Shorter reflection time in 13b Showing that the ultrasound waves has not reached the bottom of the metal. So instead are being reflected at a crack

ResultsPlus
Examiner Comments

The candidate has used the information provide in Figure 13a and Figure 13b.

ResultsPlus
Examiner Tip

Use the diagrams – they both show reflection of the signal.

Question 10 (b)(ii)

This question tested an understanding of the system and the meaning of amplitude.

Many candidates did not understand that amplitude is a measure of the energy that a wave or signal has.

It is necessary to understand the meaning of amplitude to answer this question.

(ii) Suggest **one** reason why the amplitude of signal R in Figure 13b is smaller than the amplitude of signal P shown in Figure 13a.

(1)

Some of the signal was already returned from the crack so there's less for R

ResultsPlus
Examiner Comments

There is no mention of energy absorbed but it noted that less of the pulse is reflected from the base because some has already been reflected at the crack.

ResultsPlus
Examiner Tip

Learn that the amplitude of a wave represents the energy the wave has.

Question 10 (c)

This question tested the ability of candidates to analyse and interpret information.

Information was given about the seismic P and S waves which travel through the Earth when there is an earthquake. A diagram showed the path of these waves through the Earth and where over the surface of the Earth the waves could be detected.

Candidates were then asked to use the information given to explain what the diagram showed about the density of the Earth and the nature of the Earth's core.

A level 3 response, 6 marks.

Explain what the diagram in Figure 15 shows about the density of the Earth and the nature of the Earth's core.

Use information from the table in Figure 14 and the diagram in Figure 15 in your answer.

(6)

- Both P and S waves reached A because they can both pass through the ~~liquid~~ solid mantle but they were continuously refracted because ~~$~~ as you go deeper in the mantle, it becomes denser
- Only P waves reached C because the S waves could not pass through the liquid outer core
- No waves reached B because the S waves were blocked by the ~~sol~~ liquid outer core and the P waves were refracted by the ~~denser~~ less dense outer core
- P waves that entered the inner core were also refracted by the dense, solid core

ResultsPlus
Examiner Comments

The candidate uses the information from the table and diagram and notes that both S and P waves pass through the mantle therefore it must be solid. The candidate also gives conclusions about the density of the Earth in that the density must change because the waves are refracted.

ResultsPlus
Examiner Tip

Remember to draw conclusions from your analysis of information.

A level 1 response, 2 marks.

Explain what the diagram in Figure 15 shows about the density of the Earth and the nature of the Earth's core.

Use information from the table in Figure 14 and the diagram in Figure 15 in your answer.

(6)

We can ~~[illegible]~~ learn that there is a change of state when waves reach the ~~go~~ Earth's core, No S waves are detected on the other side of the core and the P waves that have travelled through changed direction once they hit the ~~ore~~ core.

ResultsPlus
Examiner Comments

The candidate uses some of the information that is given in the diagram and notes that 'no S waves are detected on the other side of the core' – this is level 1.

If the conclusion that therefore, the core must be liquid was added to this response, it would be at level 2.

Similarly it is noted that 'P waves have travelled through and changed direction' – this is a level 1 observation.

If a conclusion, such as therefore the density of the core must change, was added this would take the response to level 2.

ResultsPlus
Examiner Tip

Use the information in the table and diagram, then analyse the information to give a conclusion.

Paper Summary

Based on their performance on this paper, candidates should:

- learn multiples and submultiples of units.
- practice the use of standard form and significant figures.
- know the meaning of all the symbols used in equations.
- always substitute into the given equation then rearrange if necessary.
- take full advantage of the information given in diagrams, graphs and tables.
- learn to describe the shape of graphs as well as the relationship.
- write up investigations with diagrams and experimental detail.

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