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Examiners' Report
June 2022

International GCSE Physics 4PH1 1P

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Introduction

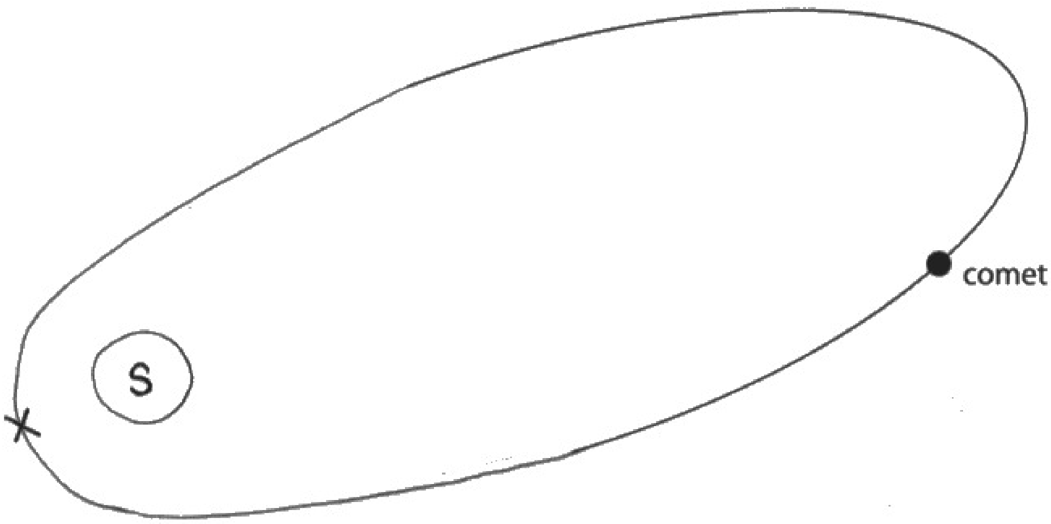
The examination was written to assess the full range of grades from 1 to 9. Consequently, some questions were written to be challenging whilst others were designed to be more straightforward and accessible. A range of different question types were included in the examination such as objective and multiple choice, calculations, and both short and long written responses. Approximately 20% of the marks available in the examination were for candidates' demonstrations of experimental skills and understanding. Candidates were provided with advance information about which sub-topics from the specification would form the main focus of the examination. In addition, candidates were provided with a full list of the formulae to be used.

Successful candidates were well-acquainted with the content of the specification and could recall facts whilst applying their understanding to new and complex situations. They were competent in performing quantitative work and could rearrange and substitute data into given formulae to obtain the correct answer. Successful candidates also showed evidence of undertaking all the required practicals themselves and could produce detailed, coherent methods whilst recalling the relevant results of these experiments.

Less successful candidates showed gaps in their knowledge of topics and either had limited experience or could not recall information from the required practical tasks. These candidates often did not address the demands of the question and overlooked the importance of the command words being used.

Question 1 (a)

Most candidates were awarded the mark in Q01(a)(i) due to their understanding that the star should not be at the centre of the elliptical orbit. These candidates also scored at least 1 mark for their completion of the orbital path in Q01(a)(ii). However, only a minority of candidates were awarded the second mark as the length/quality of their ellipse was insufficient. Q01(a)(iii) proved to be the most challenging aspect of this question and many candidates did not make the link between the speed of the comet and its distance from the Sun.



(a) (i) Add an S to the diagram to show the position of the Sun.

(1)

(ii) Complete the diagram to show the orbit of the comet.

(2)

(iii) Add an X to the diagram to show the position where the comet is moving fastest.

(1)

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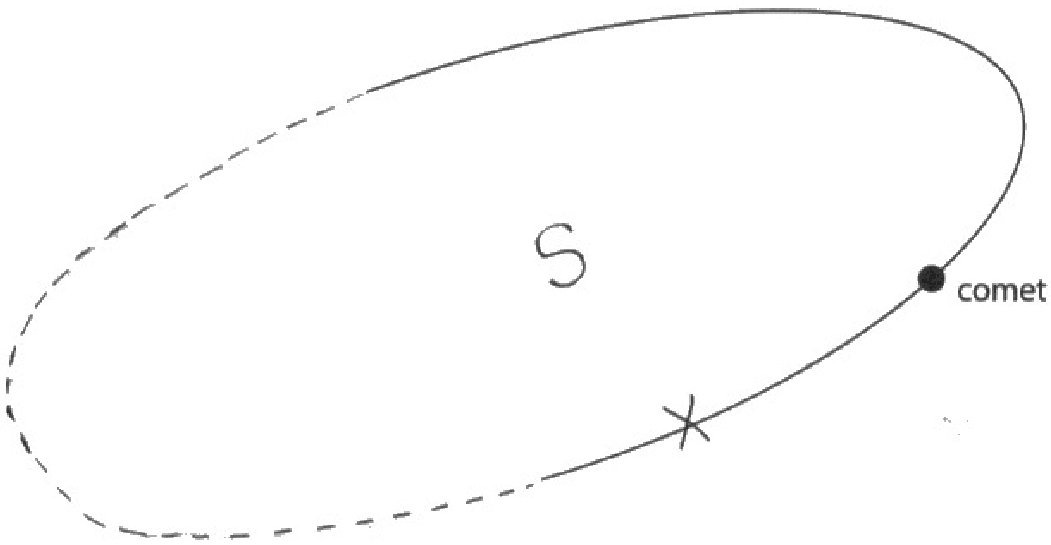
Examiner Comments

This candidate's response was awarded full marks. Their diagram has been drawn very carefully.



(a) (i) Add an S to the diagram to show the position of the Sun.

(1)

(ii) Complete the diagram to show the orbit of the comet.

(2)

(iii) Add an X to the diagram to show the position where the comet is moving fastest.

(1)

ResultsPlus Examiner Comments

The position of the Sun in this candidate's diagram is incorrect as it is not far enough from the centre of the orbit. However, the orbital path is correct and the X is marked at the position where the comet would have its maximum speed if the Sun were in the position marked by the candidate.

Question 1 (b)

Most candidates were able to score at least 1 mark in Q01(b). However, often clear comparisons were not made between the planet and comet and just general statements about either object were given. The most common marking points were MP1 and MP4.

(b) Describe how the orbit of a comet compares with the orbit of a planet.

(3)

- Planet orbits at same speed and speed of comet orbit changes as orbital radius of comet is not constant. Therefore, it moves faster when radius is decrease and it moves slowly when radius increases due to gravity.

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Examiner Comments

This candidate was awarded 1 mark for MP3. The candidate has given further detail as to why the speed of a comet changes, but this is not reciprocated in their reasoning for why the speed of a planet is constant. Furthermore, the candidate has not looked at the number of marks for the question – it should be clear that three comparisons are required.

ResultsPlus
Examiner Tip

Use the number of marks in a question to guide you as to how many points you need to make.

(b) Describe how the orbit of a comet compares with the orbit of a planet.

(3)

The orbit of a comet is eliptical whereas, the orbit of a planet is circular. Both comet and planet circulate around the sun but the orbital speed of the comet varies with time ~~a~~ whereas the orbital speed of the planet remains constant.

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Examiner Comments

This concise response has been well-tailored to the number of marks allocated to the question. The candidate scored 3 marks for their three correct points (MP1, MP3 and MP4).

Question 3 (a)

Most candidates recognised that the frequency related to the number of waves produced per second. However, a significant proportion failed to convert 40kHz correctly into 40,000Hz so suggested 40 waves produced per second. Common incorrect answers included giving definitions of time period or using the incorrect unit of time eg per minute. Occasionally candidates wrote 40k instead of 40,000.

(a) Explain what is meant by a frequency of 40 kHz.

(2)

That the device emits 40KHz (complete waves) per second.

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Examiner Comments

This candidate scored one mark as it is clear they understand that frequency relates to the number of events per second. They did not get the first mark due to not converting dealing with kHz.

(a) Explain what is meant by a frequency of 40 kHz.

(2)

~~tt~~ It means there are 40,000 waves passing a certain point per second

ResultsPlus
Examiner Comments

An excellent response. This candidate was awarded both marks for their clear answer.

Question 3 (b)(i)

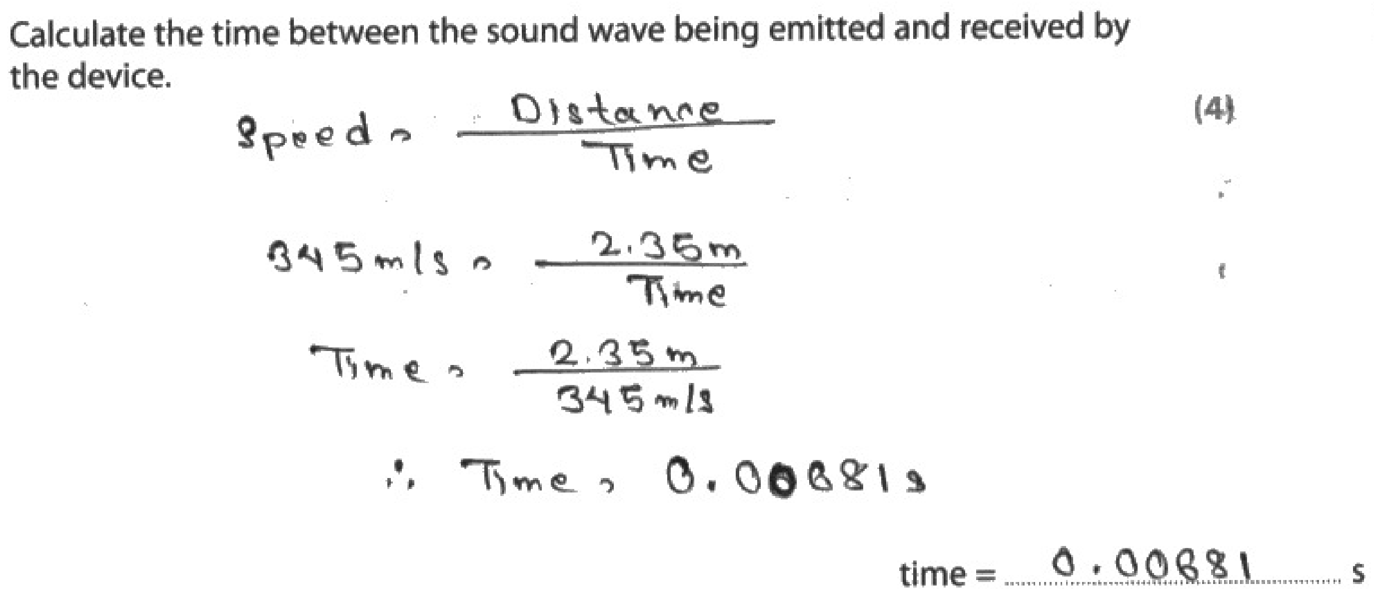
Due to its inclusion in the given formula sheet almost all candidates were awarded the mark in Q03(b)(i).

Question 3 (b)(ii)

A large number of candidates scored at least 2 marks in Q03(b)(ii) by rearranging the formula correctly and substituting the values correctly. However, not converting kHz to Hz (leading to an answer of 8.625m) was the most common reason for not gaining the third mark. Weaker candidates struggled to rearrange the formula, but were sometimes awarded a single mark if a correct substitution was shown in their working.

Question 3 (b)(iii)

It was encouraging to see most candidates perform well in Q03(b)(iii) and score at least 3 marks. The most common error was not doubling the distance, which resulted in 3 marks. Less able candidates experienced difficulty when rearranging the formula. The weakest candidates attempted to use T = 1/f, in their calculation, which resulted in no marks being awarded.



Calculate the time between the sound wave being emitted and received by the device.

(4)

Speed = Distance / Time

345 m/s = 2.35m / Time

Time = 2.35 m / 345 m/s

∴ Time = 0.00881 s

time = 0.00881 s

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Examiner Comments

This response shows a typical 3 mark answer. The candidate has performed everything correctly in the calculation, but has not doubled the distance travelled.

Question 3 (c)

Many candidates were not awarded the mark in Q03(c) as their suggestion for the inclusion of the red laser was not suitably scientific. Candidates had to link the visible aspect of the laser to the measuring capability of the device.

Question 3 (d)

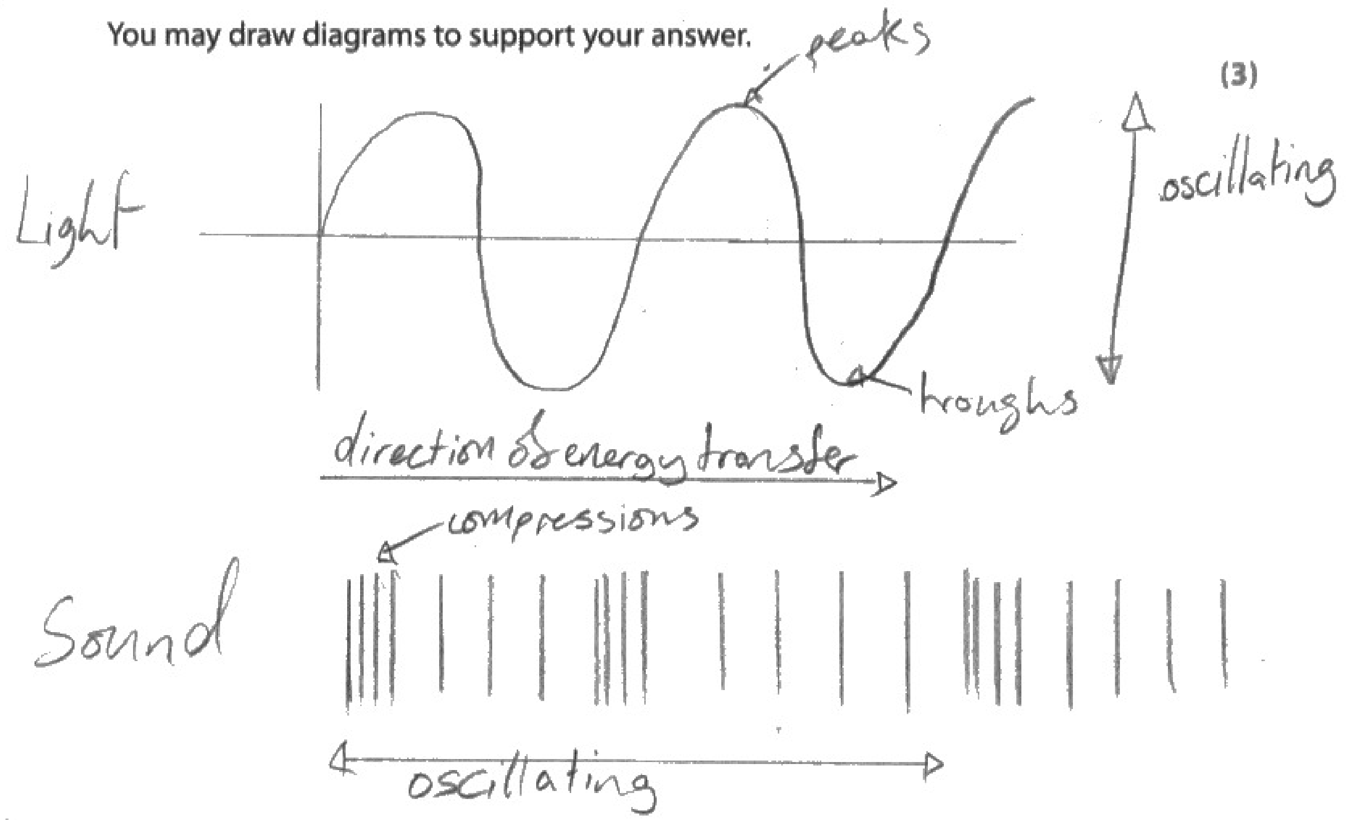
Despite many diagrams being drawn in Q03(d), few of them were detailed enough to gain more than just MP1. Labelling vibrations and the direction of wave travel is a simple way of distinguishing between light and sound or transverse and longitudinal waves. Candidates with scoring diagrams usually wrote an accepted explanation under their diagrams too, ie they would have scored (full) marks without drawing a diagram as well.

Candidates were able to express what a longitudinal/ transverse wave is very well. More often than not, candidates that scored MP1, scored MP2 too. MP4 was seen most after MP1 and MP2.

Weaker candidates often did not make full comparisons in their answers, eg stating that light could travel in a vacuum, but not stating that sound waves cannot.

You may draw diagrams to support your answer.

(3)



Light waves are transverse waves and oscillate perpendicular to the direction of energy transfer but sound waves are longitudinal waves and oscillate parallel to the direction of energy transfter. ~~Sound~~ Light waves are electromagnetic waves and can travel through a vaccum but sound waves need a medium. Light waves are much faster than sound waves.

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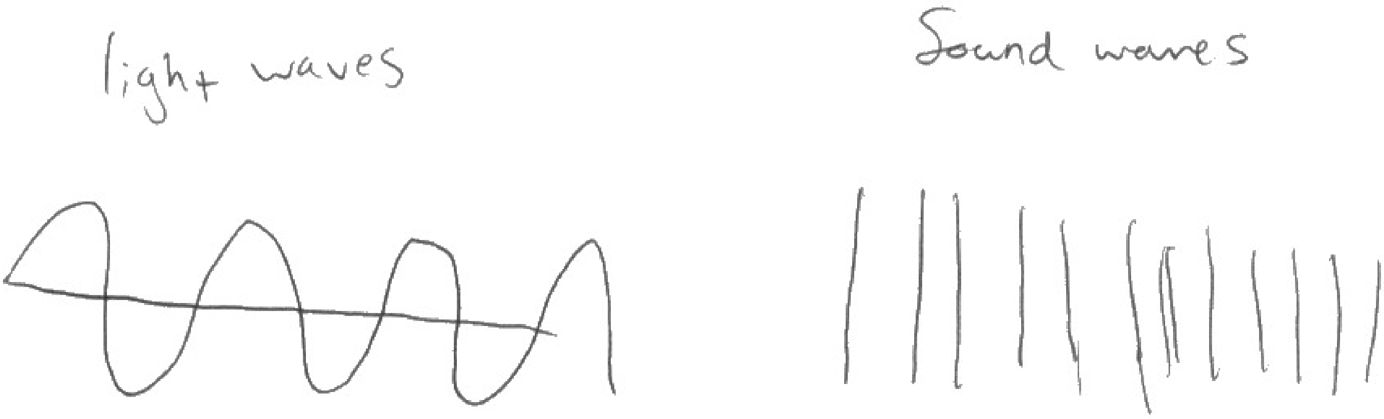
Examiner Comments

This candidate has made full use of the opportunity to draw a diagram. Their clearly labelled sketch is awarded MP1 and MP2. The written part of their response clearly covers MP4 and MP5 and would also have been awarded MP3 if they had said that sound waves are not electromagnetic.



Sound waves are transverse waves whereas light waves are longitudinal visible light has a faster wave speed than sound waves. Sound waves have a higher frequency than light waves

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Examiner Comments

This response was awarded 1 mark. The candidate's diagram is insufficient to gain any marks. In the written part of the response there is an incorrect link between light/sound and transverse/longitudinal waves, but MP5 is clearly expressed.

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Examiner Tip

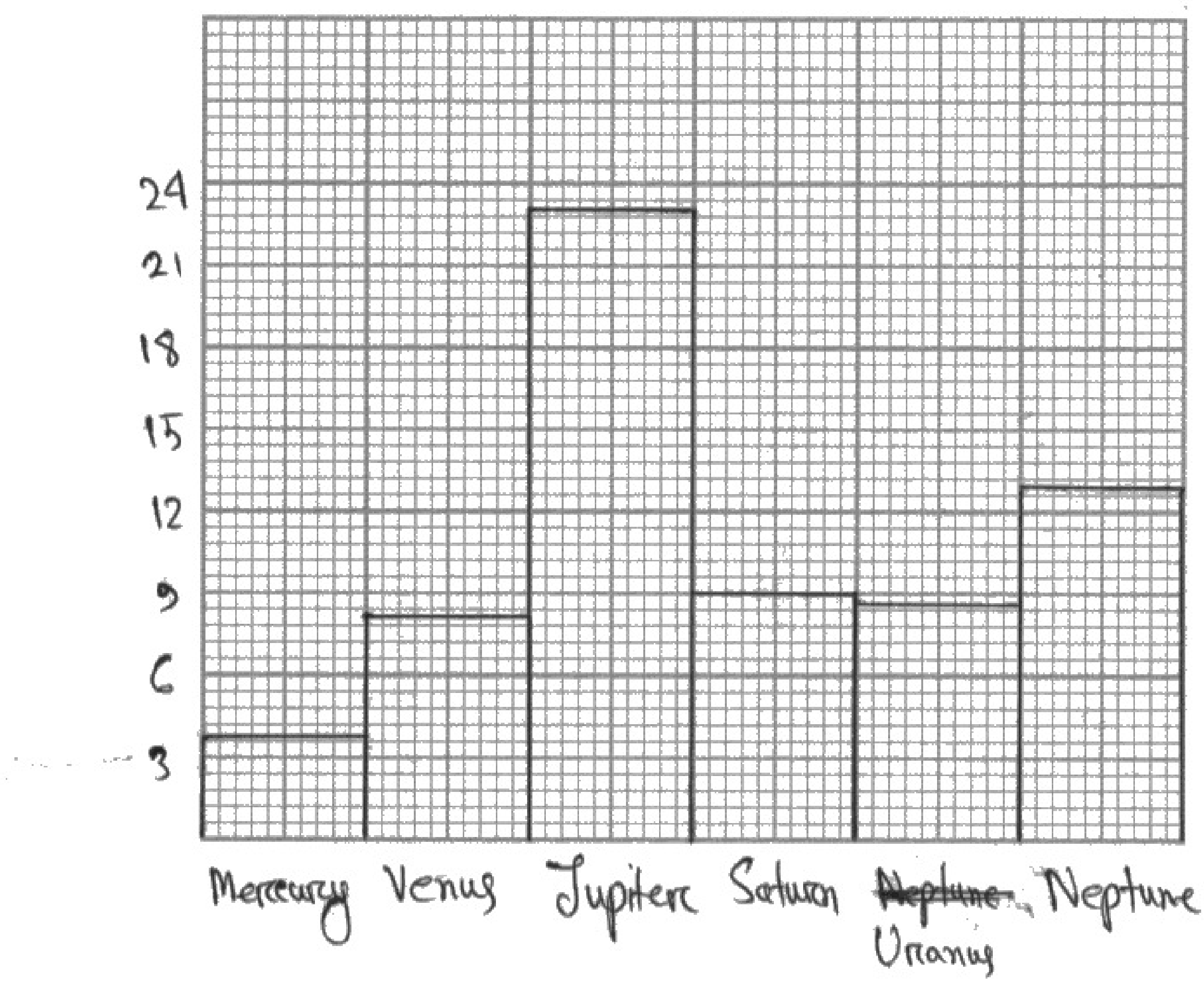
Diagrams need to be labelled to secure marks in most questions.

Question 4 (a)

Most candidates plotted the bar chart in Q04(a) well and scored all 3 marks. Common errors were omission of the y-axis label or unit and choice of an inappropriate scale, eg multiples of three, the latter often accompanied by misplotting. Non-linear scales and line graphs were rare.

(a) Plot a bar chart of the gravitational field strength for each planet.

(3)

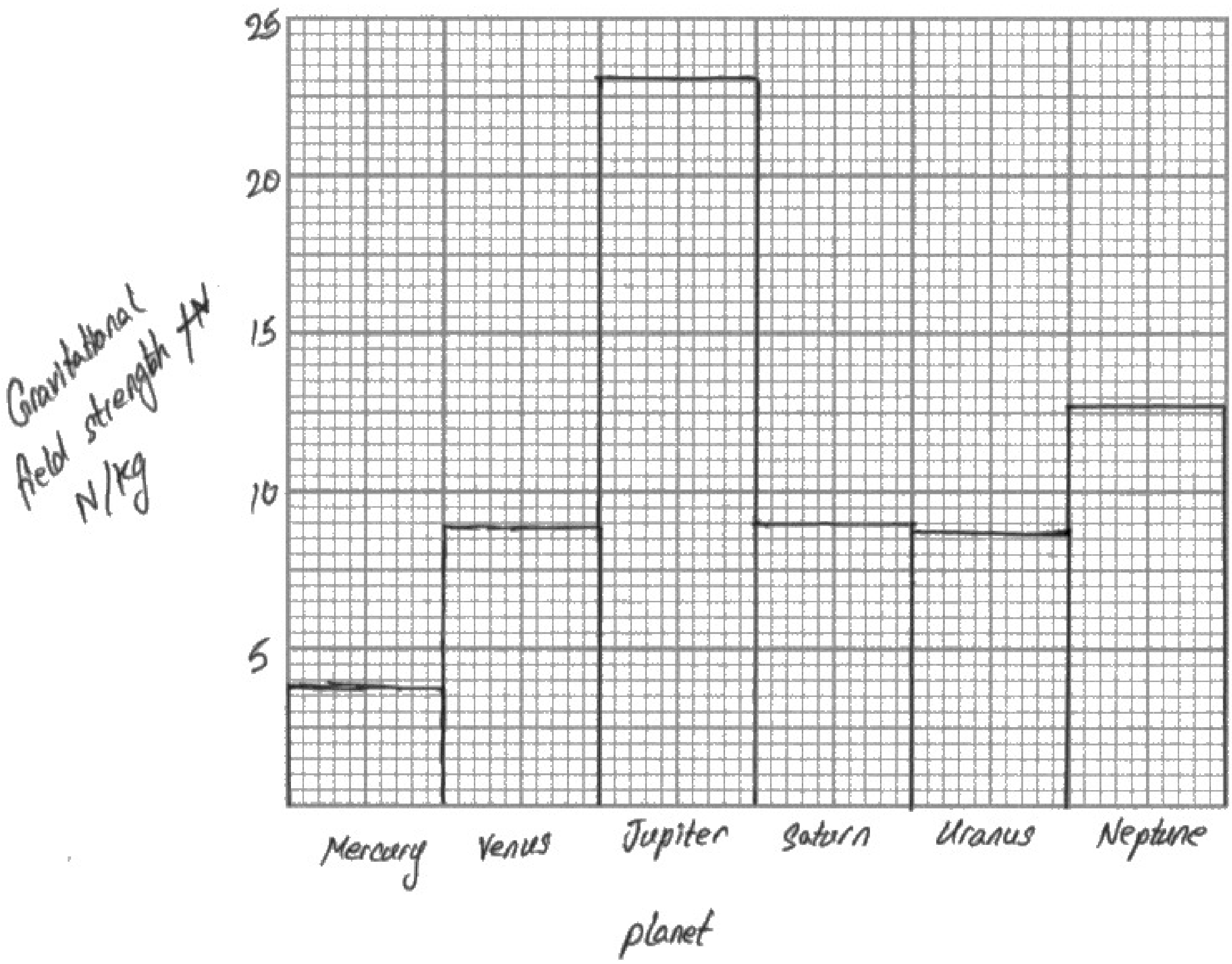


ResultsPlus Examiner Comments

This response was awarded 1 mark for the plotting of the data. The scales' mark has not been awarded since the candidate has chosen a scale of 3 for the y-axis, which makes plotting and reading data very difficult. In addition, the candidate has not labelled the y-axis.

(a) Plot a bar chart of the gravitational field strength for each planet.

(3)



ResultsPlus
Examiner Comments

A good example of a well-drawn bar chart, which scored all three marks.

Question 4 (b)

Most candidates gave accurate answers to Q04(b), however common errors included linking gravitational field strength to the distance between the planet and the sun. Candidates also quoted incorrectly that the weight of the planet affected the gravitational field strength rather than quoting mass.

Question 4 (c)

Q04(c) was accurately answered by most candidates, although occasional errors included that the orbital speed was directly proportional to the radius of the orbit.

Question 4 (d)

The calculation in Q04(d) was completed successfully by most candidates. However, some candidates did not use the formula provided and opted to use speed = distance/time instead. There were also occasional power of 10 errors due to unnecessary unit conversions.

(d) Calculate the time period of Mercury's orbit around the Sun.

(3)

$$\text{orbital speed} = \frac{2 \times \pi \times \text{orbital radius}}{\text{time period}}$$

$$47.4 = \frac{2\pi \times (57.9 \times 10^6)}{\text{time period}}$$

$$\Rightarrow \text{time period} = 47.4 \times 2\pi \times (57.9 \times 10^6)$$

$$= 1.724 \times 10^{10}$$

time period = 1.72×10^{10} s

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Examiner Comments

This candidate has set their working out neatly and carefully. They have been awarded 1 mark for the correct substitution, but then made an error rearranging the formula and no more marks were given.

ResultsPlus
Examiner Tip

Substitution marks are only awarded for correct substitutions into formulae. If a candidate rearranges the formula incorrectly, the substitution mark cannot be given. Candidates who find rearranging formulae difficult would benefit from substituting data before attempting to rearrange the formula.

(d) Calculate the time period of Mercury's orbit around the Sun.

(3)

$v = \frac{2\pi r}{t}$

$t = \frac{2\pi r}{v}$

$= \frac{2\pi(57.9 \times 10^6)}{47.4}$

$= 7.675 \times 10^6$ s

time period = 7.68×10^6 s

ResultsPlus
Examiner Comments

This response was awarded full marks. The working is clear and easy to follow.

Question 5 (a)

Q05(a) was answered well by most candidates but common errors were quoting CMBR, artificial sources such as fallout from nuclear weapons testing or quoting an element rather than a particular isotope.

Question 5 (b)(i)

Most candidates gained 2 marks in Q05(b)(i), with the most popular marking points being MP6 and MP7. Many candidates demonstrated some confusion when referring to MP8 eg alpha decay emits or **releases** a helium nucleus/protons and neutrons and beta decay **releases** an electron. Other candidates did not give full comparisons between alpha radiation and beta radiation, eg only giving a property for alpha rather than including the contrasting property for beta.

Question 5 (b)(ii)

It was very encouraging to see many candidates successfully set up simultaneous equations in Q05(b)(ii) and solve them to score full marks. Of those who scored 2 marks, the most common response was calculating the correct number of alpha particles (3), but not the correct number of beta particles. Some candidates scored 1 mark for showing some attempt (although usually incorrect) to balance the equation.

(ii) The incomplete nuclear decay equation summarises the decay sequence of thorium-232 into radon-220.

$$^{232}_{90}\text{Th} \longrightarrow\ ^{220}_{86}\text{Rn} + \boxed{3}\ ^{4}_{2}\alpha + \boxed{2}\ ^{0}_{-1}\beta$$

Calculate the number of alpha particles and the number of beta particles emitted in this decay sequence.

(3)

number of alpha particles = 232 − 220

= $\frac{12}{4}$

= 3

number of beta particles = 90 − (86 + 6)

= 90 − 92

= −2

∴ beta particles = 2

number of alpha particles = 3

number of beta particles = 2

ResultsPlus
Examiner Comments

This is an excellent response, which showcases clear working that leads to the correct final answers.

Question 5 (c)

Q05(c) was challenging and highlighted some significant misunderstandings surrounding contamination and irradiation. However, most candidates were able to gain at least 1 mark for a common general hazard of ionising radiation, eg cell mutations or cancer. Most common amongst the errors was ignoring the information in the question that thorium remains in the surface (so by definition cannot contaminate). Candidates seemed to believe that the surface was friable and so particles of thorium could still be removed by contact. The next most common misunderstanding was in the definition of the two keywords 'contamination' and 'irradiation'. There was much confusion here with many candidates contradicting themselves and freely interchanging the use of the two words. The most able candidates produced concise responses, which addressed the hazards posed by thorium and radon in separate passages.

(c) Thorium-232 is a solid and remains in the work surface.

Radon-220 is a gas and is emitted from the work surface.

Thorium-232 and radon-220 both emit alpha radiation.

Discuss the hazards due to the granite work surface when a person is working in the kitchen.

Refer to contamination and irradiation in your answer.

(3)

~~thorium is both radioactive~~ contamination is when a non-radioactive material comes into contact with a radioactive material, as graphite contains radioactives substances, items can be contaminated if they contact the graphite. - radioactive substances can cause skin burns so should be protected as radon gas is emitted.

ResultsPlus
Examiner Comments

This response was awarded no marks. Although the correct general idea of contamination is seen, it is not linked correctly to radon. The risk of skinburn was not accepted as a general hazard of ionising radiation.

(c) Thorium-232 is a solid and remains in the work surface.

Radon-220 is a gas and is emitted from the work surface.

Thorium-232 and radon-220 both emit alpha radiation.

Discuss the hazards due to the granite work surface when a person is working in the kitchen.

Refer to contamination and irradiation in your answer.

(3)

Thorium-232 and radon-220 ~~a~~ emit alpha radiation, ~~toxic~~ harmful to body, cause mutated cell. Gas is harmless, but solid is toxic for environment. ~~Need to wear a full suit with~~ Wear gloves, goggles. Alpha radiation very strong ionisation level, but very weak penetration. Can use a sheet of paper to block out radiation.

ResultsPlus
Examiner Comments

This response was awarded 1 mark only for MP1. The candidate has not addressed the demands of the question by referring to contamination and irradiation and their ideas are not sufficiently linked to the given context.

(c) Thorium-232 is a solid and remains in the work surface.

Radon-220 is a gas and is emitted from the work surface.

Thorium-232 and radon-220 both emit alpha radiation.

Discuss the hazards due to the granite work surface when a person is working in the kitchen.

Refer to contamination and irradiation in your answer.

(3)

Radon gas can cause contamination, if mixed with food and consumed. Alpha particles are highly ionising so if the source is consumed the alpha particles will damage internal structures (cause mutations, cancer) and it is not highly penetrating and thus won't escape.

Thorium can cause irradiation through touching /working on it as alpha particles will come into contact with the skin and food etc. however Thorium won't contaminate. It is less dangerous.

(Total for Question 5 = 8 marks)

ResultsPlus Examiner Comments

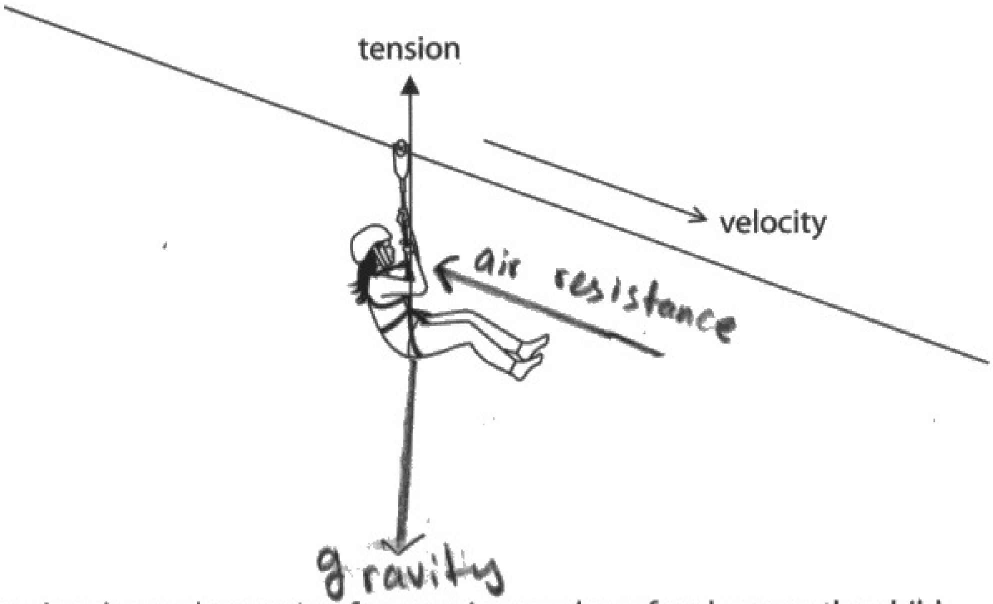
This response was awarded 3 marks. The candidate gained MP5 for the clear idea that radon causes contamination; MP1 for alpha causing cell mutations/cancer; MP2 for the idea that alpha is only dangerous when inside the body; MP4 for thorium causing irradiation.

Question 6 (a)

Most candidates were able to link direction to their definition in Q06(a). However, some candidates did not relate it to a general definition, ie a force with both direction and magnitude. Common errors include ‘a force with a direction’.

Question 6 (b)

Most candidates were awarded 3 or 4 marks in Q06(b). Common errors included the use of gravity (as a force label) and friction, which doesn't act directly on the child. Arrows were mostly added correctly but non vertical weight arrows were occasionally seen. Lists were sometimes seen for labels, eg gravity/weight, and should be discouraged.



The diagram also shows the tension force acting on the safety harness the child is wearing.

(a) Force and velocity are examples of vector quantities.

State what is meant by the term **vector quantity**.

(1)

vector quantity is a term given to the quantities that direction is changing.

(b) Draw labelled arrows on the diagram to show two other forces that act on the child.

(4)

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Examiner Comments

This response gained 3 marks. The arrow for the air resistance force is correct. The arrow for the weight force is on the limit of acceptability for being vertical, but the label is not acceptable.

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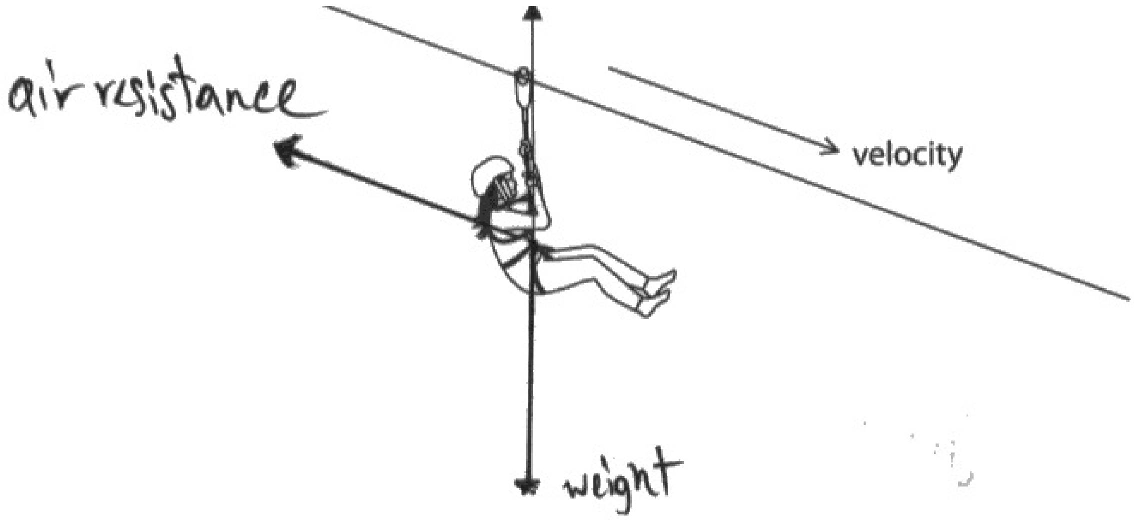
Examiner Tip

Candidates should be discouraged from labelling gravitational forces as 'gravity'.



The diagram also shows the tension force acting on the safety harness the child is wearing.

(a) Force and velocity are examples of vector quantities.

State what is meant by the term **vector quantity**.

(1)

direction and magnitude only.

(b) Draw labelled arrows on the diagram to show two other forces that act on the child.

(4)

ResultsPlus
Examiner Comments

This response was awarded full marks. Although the arrow for the weight force is not perfectly vertical, the intention is clear.

Question 7 (a)

Many candidates were able to link the current to time in Q07(a). However some candidates used the term 'number of electrons' per second rather than charge. Occasional incorrect answers included per minute.

7 (a) State what is meant by the term **electric current**.

(1)

The flow of electrons through a conductor.

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Examiner Comments

This response was frequently seen and does not match the specific definition of an electric current.

Question 7 (b)(i)

Most candidates were aware that the LED would emit light indicating if the circuit broke then the light would go out, but then some failed to be specific and link it to the fuse having been broken. Occasional incorrect answers quoted that the LED would allow the current to be measured as the LED would change brightness.

Question 7 (b)(ii)

Most candidates correctly drew an ammeter in series with the other circuit components in Q07(b)(ii). Common mistakes in this question included the ammeter connected in parallel with the fuse or a voltmeter connected.

Question 7 (c)

Candidates experienced little difficulty deducing the correct currents in Q07(c)(i) and Q07(c)(ii). The vast majority of candidates also identified lamp 3 as the brightest in Q07(c)(iii) and nearly all of these scored the second mark for citing ‘highest current’. Less candidates scored the third mark for either linking P=IV or noting that all the lamps had the same potential difference.

(i) Calculate the current I_1.

(1)

I_1 = 0.1 A

(ii) State the current I_2.

(1)

I_2 = 0.6 A

(iii) Explain which lamp is the brightest.

(3)

All of the lamps will have the same brightness, assuming there are no faults, because they are connected in parralled and each branch recieves the same number of volts, the total voltage of the power supply, assuming the bulbs are ~~identicle~~ identical.

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Examiner Comments

This candidate was awarded 1 mark in Q07(c)(ii). Although the idea of all the lamps having the same voltage scores a mark, the candidate has misunderstood the circuit and assumed all the lamps are identical (despite the currents being different). This has limited their ability to score further marks.

(i) Calculate the current I_1.

(1)

I_1 = 0.1 A

(ii) State the current I_2.

(1)

I_2 = 0.6 A

(iii) Explain which lamp is the brightest.

(3)

~~Although all the same~~ lamp 3 is brightest because it has the highest current going to it. Because it is in a parallel circuit, the voltage is the same throughout but because 3 has the highest current it is brightest

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Examiner Comments

This response demonstrates a comprehensive understanding of the circuit.

Question 8 (a)

Most candidates answered Q08(a) correctly. However, some imprecise language, eg using the term ‘lost’ instead of ‘destroyed’, failing to make clear that 'both energy cannot be created AND destroyed', led to the mark being withheld. Incorrect answers also used the idea of trying to reduce energy usage and energy resources, such as using energy-saving light bulbs.

Question 8 (b)(i)

Almost all candidates answered Q08(b)(i) correctly due to this formula's inclusion in the provided formula sheet.

Question 8 (b)(ii-iii)

Q08(b)(ii) was generally answered well with lots of candidates gaining the full four marks. However, some candidates stopped short and then did not calculate the wasted energy by taking away 25 from 165. Some candidates could not use the reverse percentages method to calculate the useful energy. Forming and rearranging an equation was also a barrier for these candidates. Other candidates did not identify the elastic store of 165J as being the input energy and treated it as the useful output.

Q08(b)(iii) polarised candidates in terms of their answers. Many candidates had clearly learnt how to construct scaled Sankey diagrams and scored very well, while a significant number lacked this skill in part or in total. Of the Sankey diagrams seen, up to a third lacked at least one of the three marking points. Mostly this was the relative scale of the base widths of the arrows. The secondary omission was usually the lack of one or more appropriate labels.

(ii) Calculate the energy transferred into the thermal store of the surroundings.

(4)

$$15\% = \frac{\text{useful energy output}}{165} \times 100$$

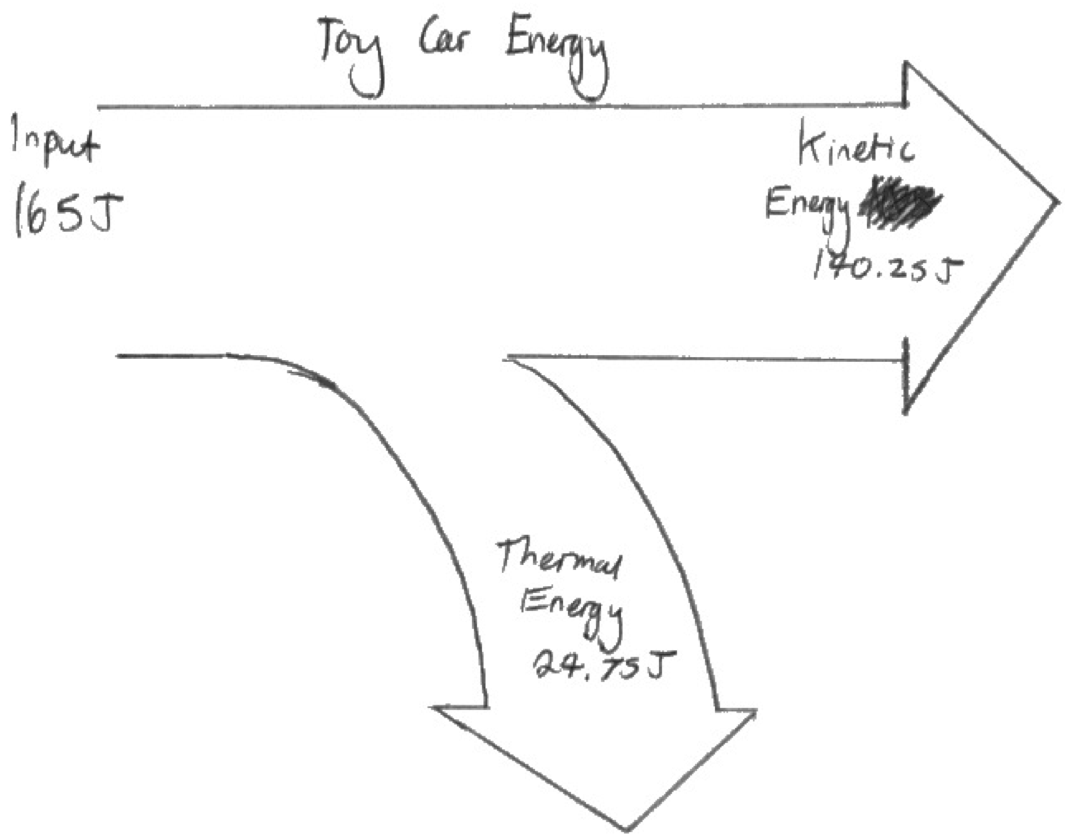
useful energy output = (15% ÷ 100) × 165

= 24.75

energy transferred to thermal store = 24.75 J

(iii) Draw a labelled Sankey diagram for this energy transfer.

(3)



165-24.75
=140.25

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Examiner Comments

This response illustrates some common errors in this question. The candidate's answer for Q08(b)(ii) has stopped short of calculating the wasted energy and scores 3 marks for calculating the useful energy. The response for Q08(b)(iii) only scores 2 marks as the scale element of the Sankey diagram is incorrect.

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Examiner Tip

Candidates should be reminded that Sankey diagrams should always be drawn to scale.

(ii) Calculate the energy transferred into the thermal store of the surroundings.

(4)

15 % of 165 = 24.75

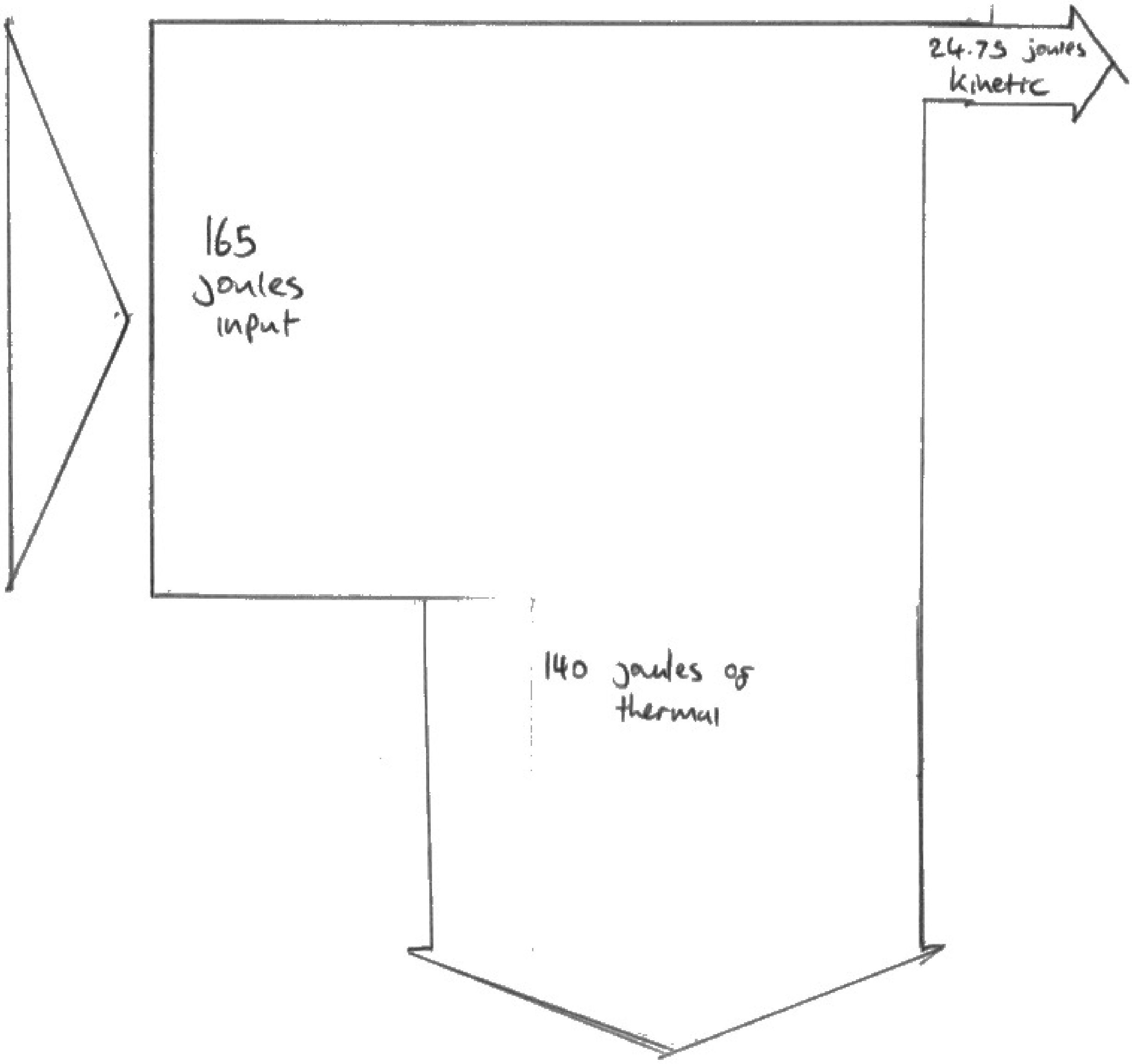
24.75 joules in kinetic energy

165 J - 24.75 J = 140.25 J of thermal energy

energy transferred to thermal store = 140.25 J

(iii) Draw a labelled Sankey diagram for this energy transfer.

(3)



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Examiner Comments

This response gains full marks. The candidate clearly understands the importance of scaling in Sankey diagrams.

Question 8 (c)(i)

Most candidates could state the useful work done on the car in Q08(c)(i). Some candidates misinterpreted the command word 'state' and chose to incorrectly calculate the work done using a formula.

Question 8 (c)(ii)

Many candidates scored zero marks in Q08(c)(ii) for calculating acceleration, rather than force. In this case, candidates opted to use an incorrect formula. Most candidates who selected the correct formula went on to complete the calculation without issue.

Question 9 (a)

Almost all candidates answered Q09(a)(i) correctly due to this formula's inclusion in the provided formula sheet. In Q09(a)(ii) most candidates scored at least 2 marks due to successfully manipulating and using the formula. Some candidates did not score full marks due to not correctly converting their answer to cm. A minority of candidates either failed to rearrange the formula correctly or omitted the value of g when substituting the data, which usually resulted in a mark of 0.

(i) State the formula linking pressure difference, height, density and gravitational field strength, *g*.

(1)

pressure difference = height x density x gravitational field strength

(ii) The pressure difference between the surface of the water and the water at the bottom of the bottle is 2300 Pa.

Calculate the depth of water in the bottle.

Give your answer in cm.
[density of water = 1000 kg/m^3]

(3)

$2300 = h \times 1000 \times 10$

$h = \frac{2300}{10000}$

depth = 0.23 cm

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Examiner Comments

This candidate has performed the calculation correctly, but not converted their answer to cm.

ResultsPlus
Examiner Tip

Read each question carefully. Some questions will have additional requirements, such as the need to convert to cm in this calculation.

Question 9 (b)(i)

Some candidates did not draw the correct curve on the diagram in Q09(b)(i) and the curve bent towards the bottle. Occasionally candidates incorrectly drew a line which reached the surface further away from the bottle or went straight down with no curved section to their line.

(b) Three holes are made in the bottle at positions A, B and C.

Diagram 2 shows the path of the water leaving the bottle from hole B.

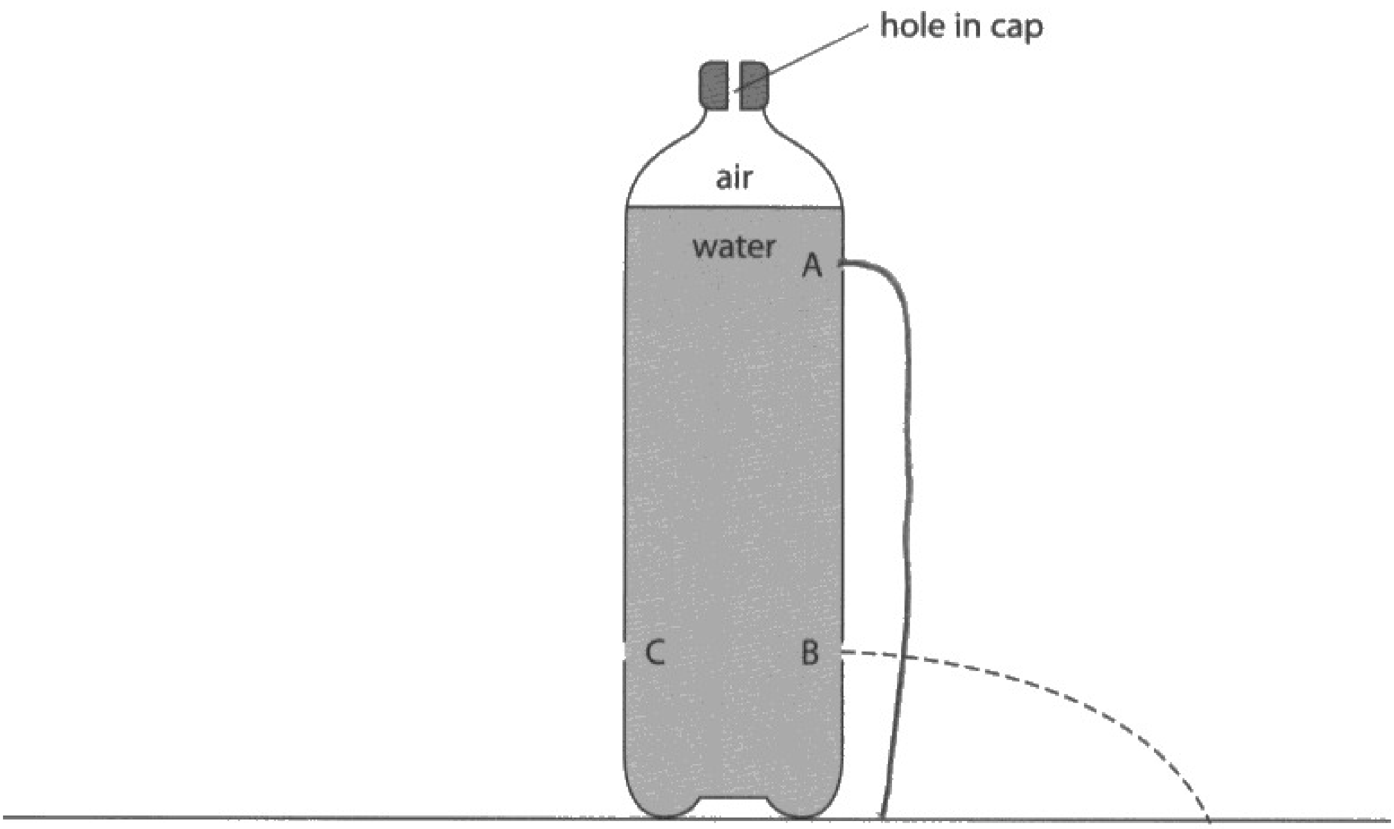

Diagram 2

(i) Draw a line on diagram 2 to show the path of the water leaving the bottle from hole A.

(1)

ResultsPlus
Examiner Comments

This path of water did not get the mark as it curves back towards the bottle.

Question 9 (b)(ii)

Most candidates scored at least 1 mark in Q09(b)(ii) for MP1 from the first alternative on the mark scheme. More able candidates were able to score a second mark for MP2, whilst MP3 was seen less often. Weaker candidates failed to reference A or the top of the bottle whilst others did not make comparisons to B, eg 'water leaves at low speed'; 'water is at low pressure/force'. Very few candidates elected to describe the geometric path of the water or the effects of gravity on that path. Those that did generally only got the second mark for 'gravity pulls the water down' or words to that effect.

(ii) Explain the path of the water leaving the bottle from hole A.

(2)

The water at hole A is at a lower pressure than the water at hole B, so the force at which the water leaves the hole would be less than that of hole B

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Examiner Comments

This concise response gains 2 marks from the first alternative on the mark scheme. The candidate has presented their ideas clearly as comparisons between holes A and B.

(ii) Explain the path of the water leaving the bottle from hole A.

(2)

The water leaving A is under pressure from ~~the~~ the air above and the water above. It therefore accelerates, due to the downwards force, out of hole A, where it no longer has any thrust and is ~~[illegible]~~ pulled downwards due to gravity.

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Examiner Comments

This response scores 2 marks from the second alternative on the mark scheme.

Question 9 (b)(iii)

Most candidates identified that the paths of water from C and B would be (essentially) the same in Q09(b)(iii). Most candidates explained this as being due to the same pressure. Very few candidates were able to score the third mark. Those that did mostly described pressure acting equally in all directions. Weaker candidates were confused about the path of the water and expected it to come out at a weaker/stronger path than B because B also had hole A above it.

(iii) Hole C is at the same depth in the bottle as hole B but on the opposite side of the bottle.

Explain the shape of the path of the water leaving the bottle from hole C.

(3)

It will have the Same shape of path B.
It will shoot out almost horizontaly but gradually lower itself to drop on the Surface due to its weight and the gravatational pull of the water.

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This response was awarded 1 mark for the recognition that the path would be the same as B. However, the candidate has not presented any valid justification for this.

(iii) Hole C is at the same depth in the bottle as hole B but on the opposite side of the bottle.

Explain the shape of the path of the water leaving the bottle from hole C.

(3)

The shape of the path of the water from C would be exactly the same as B except it will be reflected to the other side. This is because the pressure and therefore, the speed of water, will be the same, [redacted] and the time it is in the air will also be the same

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Examiner Comments

This high-level response was awarded three marks. It covers all the marking points with the exception of the idea of pressure acting in all directions.

Question 9 (b)(iv)

Most responses to Q09(b)(iv) were correct, identifying the need for air to flow in/let the water out. Common misunderstandings included the idea that air pressure needs to be relieved.

Question 10 (a-b)

Q10(a) was generally more challenging than expected. The candidates who realised they needed to use $v^2 = u^2 + 2as$ usually scored 2 or 3 marks. However, many candidates relied on speed = distance/time or used other incorrect methods. Some candidates forgot to square root their calculations whilst others could not equate a in the formula with g.

Almost all candidates answered Q10(b)(i) correctly due to this formula's inclusion in the provided formula sheet. Error carried forward (ECF) allowed many candidates to score the maximum mark in Q10(b)(ii). However, a surprising number of candidates forgot to square their value of speed when evaluating their substitution despite them writing the substitution correctly.

(a) Calculate the speed of the car when it has fallen 18 m.

(3)

speed = $\frac{\text{dist}}{\text{time}}$

speed = $\frac{18}{0}$

speed = 18 m/s

(b) (i) State the formula linking kinetic energy, mass and speed.

(1)

kinetic energy = $\frac{1}{2}$ × mass × speed²

(ii) The mass of the car and its passengers is 2.1 tonnes.

Calculate the kinetic energy of the car when it has fallen 18 m.

[1 tonne = 1000 kg]

(2)

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

m = 2.1
v =

$KE = \frac{1}{2} \times 2.1 \times 18^2$
= 340.2

kinetic energy = 340.2 J

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Examiner Comments

This candidate gains no marks in Q10(a) as their method is incorrect. 1 mark is awarded in Q10(b)(ii) as they have used their incorrect value correctly. However, the candidate has not converted from tonnes to kg, so loses a mark.

The car is pulled to the top of a vertical shaft and then released from rest.

The car then falls freely because of the force of gravity. initial (0^2)

(a) Calculate the speed of the car when it has fallen 18 m.

(3)

~~speed = distance / time~~

$v^2 = u^2 + (2as)$

$v^2 = 0^2 + 2 \times 18 \times 10$

$= 360$

speed = 360 m/s

(b) (i) State the formula linking kinetic energy, mass and speed.

(1)

kinetic energy = ½ × mass × speed² KE = ½ × m × v²

(ii) The mass of the car and its passengers is 2.1 tonnes.

Calculate the kinetic energy of the car when it has fallen 18 m.

[1 tonne = 1000 kg]

(2)

mass = 2.1 tonnes

= 2.1 × 1000 = 2100 kg

KE = ½ × 2100 × 360 = 378,000

kinetic energy = 378,000 J

ResultsPlus
Examiner Comments

This candidate scored 1 mark for their answer to Q10(a). Their substitution is correct, but not taking the square root of 360 prevented the rearrangement and evaluation marks from being awarded. The candidate's work in Q10(b) is given full credit as their answer to Q10(b)(ii) is the correct answer, despite it not being the answer they should have got by using their value from Q10(a). Benefit of the doubt has been applied here.

Question 10 (c)

Q10(c) discriminated well and produced a wide quality of responses. There were many weak answers that responded solely in terms of forces. Others discussed how kinetic energy was transferred to GPE (even as the ride fell down). The topic is a difficult one conceptually and one which elicited many other misunderstandings including the selection of correct energy store names (chemical, elastic potential, electrical and mechanical energies were all erroneously incorporated) and the idea that energy cannot just be lost but must go somewhere. Learning in this topic area continues to be widely differentiated. Typically, students were scoring 2 marks.

(c) The actual speed of the car when it has fallen 18 m is lower than the value calculated in (a).

Describe the energy transfers occurring from immediately before the car was released to when the car has fallen 18 m.

Refer to stores and transfers in your answer.

(4)

Just before being released the car had gravitational potential energy. This is then transferred mechanically to the kinetic energy store as it falls. Some of the energy is lost as thermal energy as a result of the friction caused by the kinetic energy.

ResultsPlus
Examiner Comments

This response was awarded 2 marks for MP1 and MP2. MP3 was not given as it is unclear which object's thermal store of energy is increasing.

(c) The actual speed of the car when it has fallen 18 m is lower than the value calculated in (a).

Describe the energy transfers occurring from immediately before the car was released to when the car has fallen 18 m.

Refer to stores and transfers in your answer.

(4)

before the car was released, energy was in the gravi-tational potential energy store of the car but once released it begins to transfer mechanichally to the kinetic store of the car. However while doing this, some energy would be transfered ~~as~~ by heat ~~to~~ to the thermal energy store of the surroundings and some as sound to the surrounding. Therefore, not all of the energy is in the kinetic store at 18m which is why the speed is less.

ResultsPlus
Examiner Comments

This is an example of a high-level response, which was awarded full marks. All four marking points are clearly covered in the response.

Question 11 (a)

Q11(a) discriminated well at all grade boundaries. Those candidates that addressed the scaffolding bullet points usually scored high marks. MP1 and MP3 were scored regularly when assessing the first bullet point, indicating that pupils know the difference between independent and dependent variables well. All three marking points were seen often when assessing the second bullet point. However, lots of candidates referred to using the same launcher, which was not credited. The final bullet point was answered less well. Although MP7 was seen in most responses, MP8 was awarded less frequently. Those candidates who gained this mark usually referred to using a video capture device or marking the ball with paint that would transfer to the floor on landing.

(6)

- keeping the launcher and the steel ball the same
- measure a distance of 10cm from the ground and launch the steel ball measure the distance from where it landed to the table, use sand floor so ball doesn't roll
- increase the height of the table by 10cm and repeat
- make sure to launch it the same each time and to keep the steel ball the same
- repeat it all 3 times and find an average
- plot a graph.

ResultsPlus
Examiner Comments

This response was awarded 2 marks. The candidate scored MP4 for a named control variable (same steel ball) and MP6 for the idea of taking repeats and finding the average.

ResultsPlus
Examiner Tip

Take note of the scaffolding bullet points in higher tariff questions. Candidates should ensure they address all of them to score high marks.

Firstly the student should have 10 varying table heights. He should then launch the ball off the table at these 10 heights and measure distance using a ruler as it is the indepent variable, height of table being the dependant variable. Once he has done this he should repeat the experiment 3 times to avoid any anomolous results and he should avoid parralax error when reading the ruler. Finally he should calculate an average to increase the accuracy of the overall experiment making it more of a fair test by keeping ~~constant~~ variables like the type of launcher, ~~to~~ ~~a~~ steel ball and floor the same.

ResultsPlus
Examiner Comments

This response was awarded 4 marks. The candidate scored MP3 for having at least 10 different heights, MP7 for measuring the range with a ruler, MP6 for repeats and average and MP4 for keeping the ball the same. The candidate has made some mistakes (the independent and dependent variables are the wrong way round) and their descriptions of other control variables are too vague.

The independent variable (what should be changed) is the height of the table. This should be varied by adding something on top of the table to increase the ~~h~~ height. This object must be flat and of the same material as the surface of the table. Control variables include the mass of the steel ball ~~as~~ (the same steel ball each time). The same force must be used each time as well so that it is a fair test. The dependent variable is the range-distance along the floor and should be measured with a metre ruler. Ensure you know where the ball hits the floor by adding paint to the bottom. Then you can measure accurately. Repeat for each height again for increased reliability. Calculate a mean for each height and plot a graph.

ResultsPlus
Examiner Comments

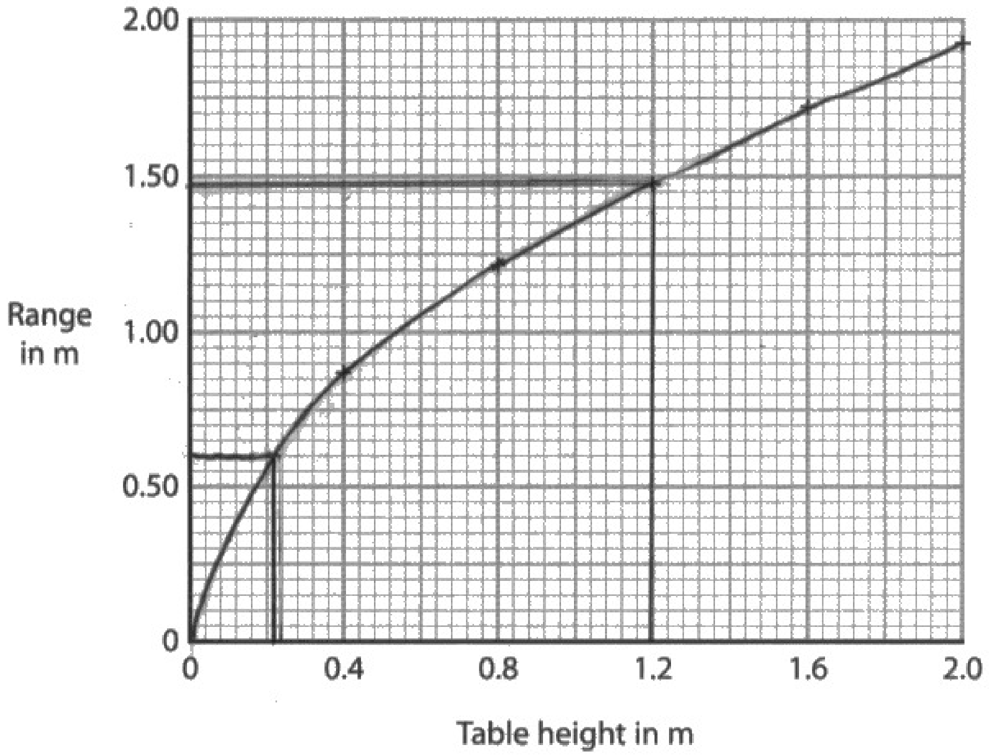
This is an example of a high-level response, which was awarded 6 marks. The candidate has covered MP1, MP2, MP3, MP4, MP7 and MP8. MP6 is also covered, but cannot be given in addition to MP4 and MP5.

This candidate has clearly read the scaffolding bullet points carefully and tailored their answer to meeting these separate demands.

Question 11 (b)

Most candidates were awarded the mark for their curve of best fit in Q11(b)(i). Those who lost the mark usually drew very thick lines or rough attempts at multiple lines, which made it impossible to judge the accuracy. In Q11(b)(ii), the mark was not awarded more often than expected due to mixing up the axes. Q11(b)(iii) was poorly understood and few candidates communicated the correct reason for a line graph. Most candidates thought it made the data easier to read, which was not credited. It was encouraging to see many candidates completed Q11(b)(iv) successfully. The question required accurate graph reading and then rearranging a complex (and unknown) formula. Some candidates only scored 3 marks for using the given value of the launch speed to calculate a range/height that corroborated their read value.

(b) The graph shows the student's results.



(i) Draw the curve of best fit.

(1)

(ii) Estimate what the height of the table would be when the range of the projectile is 0.60 m.

(1)

height = 0.22 m

(iii) Justify why the student has plotted a line graph rather than a bar chart.

(1)

As the data is continuos the student should plot a line graph not a bar chart.

(iv) The range of the projectile is related to the table height by this formula

$$\text{range} = \text{launch speed} \times \sqrt{\frac{\text{table height}}{5}}$$

Using data from the graph, show that the launch speed of the projectile is approximately 3 m/s.

(4)

at 1.2m table height, range = 1.475 m

$$1.475 = \text{launch speed} \times \sqrt{\frac{1.2}{5}}$$

$$\frac{1.475}{\sqrt{1.2/5}} = \text{launch speed}$$

launch speed = 3.0108

launch speed = 3.01 m/s

ResultsPlus
Examiner Comments

This is an example of careful graph drawing, reading and understanding. This high-level response was awarded full marks.

Question 12 (a-b)

It was pleasing to see so many candidates read the unusual scale on the ammeter correctly in Q12(a). The most common mistake led to an answer of 2.4A. Many candidates lost the mark in Q12(b)(i) as they did not appreciate that the needle moving in the opposite direction would be a negative current, most likely since the meter scale had no negative sign. However, most candidates understood that moving the wire faster would produce a larger current.

Question 12 (c)

Most candidates gained the mark in Q12(c). Using a stronger magnet (or words to that effect) and more turns on the coil were the most frequent responses. Many candidates gave a list of responses, which was penalised if more incorrect suggestions contradicted correct ones. Using a scale with smaller increments/more lines was a frequent incorrect response along with more coils and a thinner/smaller needle. Candidates frequently referred to using more coils where they meant more turns on the coil.

Suggest how the design of the ammeter could be modified to increase its sensitivity.

(1)

Use a longer needle to ~~sh~~ show higher displacement and resolution.

ResultsPlus Examiner Comments

Using a longer needle would increase the sensitivity.

Suggest how the design of the ammeter could be modified to increase its sensitivity.

(1)

More intermediate lines between each number.

ResultsPlus Examiner Comments

Adding more intermediate lines would not change the size of deflection for a given current, which is the sensitivity of the meter.

Suggest how the design of the ammeter could be modified to increase its sensitivity.

(1)

More coil of wire could be added.
or a stonger magnet.

ResultsPlus Examiner Comments

Adding more coils would not have been given the mark, but using a stronger magnet is acceptable.

Question 12 (d)(ii)

Most candidates identified the need to add/subtract the zero error from the ammeter readings in Q12(d)(ii). The actual amount of current stated varied wildly, indicating unfamiliarity with reading analogue scales.

Paper Summary

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

- Take note of the number of marks available for each question and use this as a guide for the amount of detail expected in the answer.
- Take note of the command word used in each question to determine how the examiner expects the question to be answered, for example whether to give a description or an explanation.
- Be able to use the formulae listed in the specification confidently in terms of substitution, rearrangement and evaluation.
- Know the SI units for physical quantities and be able to convert from non-SI units to SI units when required.
- Show all working so that some credit can still be given for answers that are only partly correct.
- Take advantage of opportunities to draw labelled diagrams as well as, or instead of, written answers.

Grade boundaries

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