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Examiners' Report
June 2019

GCSE Physics 1PH0 2H

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Introduction

This was the second examination of paper 2, at higher level, for the new specification. Questions were set to test students' knowledge, application and understanding from these nine topics in the specification:

- Topic 1 – Key concepts of physics
- Topic 8 – Energy – forces doing work
- Topic 9 – Forces and their effects
- Topic 10 - Electricity and circuits
- Topic 11 - Static Electricity
- Topic 12 – Magnetism and the motor effect
- Topic 13 – Electromagnetic Induction
- Topic 14 – Particle model
- Topic 15 – Forces and Matter

It was intended that the examination paper would allow every candidate to show what they knew, understood and were able to do. Within the question paper, a variety of question types were included, such as objective questions, short answer questions worth one or two marks each and longer questions worth three or four marks each. There was a new emphasis, too, in the inclusion of questions designed at targeting students' knowledge and understanding of practical work. This included assessing their fundamental knowledge of practicals specified in the specification, together with further application, especially where they were asked to propose improvements to a procedure. The assessment of students' mathematical skills involved recall of some equations and became more demanding as the paper progressed. There were also two extended open response questions, worth six marks each.

Successful candidates:

- were well-acquainted with the content of the specification
- had been engaged with practical work during their course
- were competent in quantitative work, especially in being able to recall and rearrange equations and use numbers in standard form
- recognised key command words such as "describe" and "explain" and constructed their responses accordingly.
- were willing to apply physics principles to the novel situations presented to them.

Less successful candidates:

- had gaps in their knowledge of the topics of this paper

- had gaps in their procedural knowledge, relating to their practical work
- failed to set out calculations in a logical way that could be easily followed by the examiner.
- did not focus sufficiently on what the question was asking
- found difficulty in applying their knowledge to new situations.

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

Question 1 (a) (ii)

Candidates were asked to analyse the difference between two paint spray patterns; one of which was comprised of charged paint drops. They needed to be able to explain how repulsion between the charged paint drops results in a wider, more dispersed spray.

Examiners saw good knowledge of repulsion as well as good analysis explaining how it led to the spray pattern. The most common misconception is that the charged paint drops would be more evenly dispersed.

(ii) Figure 2 shows the spray pattern from two different paint sprayers.

Figure 2

Sprayer X does not charge the paint drops. Sprayer Y gives the paint drops a positive charge.

Explain how charging the paint drops changes the shape of the spray pattern.

(2)

• similarly charged particles (all positive) repel eachother
• This means that as the particles are sprayed out, they will push away from eachother causing a wider spray.

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Examiner Comments

A good response that fully answers the question.
Full marks.

(ii) Figure 2 shows the spray pattern from two different paint sprayers.

Figure 2

Sprayer X does not charge the paint drops. Sprayer Y gives the paint drops a positive charge.

Explain how charging the paint drops changes the shape of the spray pattern.

(2)

x The positively charged paint drops spread out and cover a larger area whereas the uncharged paint drops go straight.

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Examiner Comments

There is a mark for describing that the charged drops cover a larger area. However, this response does not explain how this happens. To gain full marks there needs to be a reference to the charged drops repelling each other and that this causes the spray to spread out.

Question 1 (a) (iii)

Candidates were asked to explain why the object being painted by the charged spray was connected to earth by a metal wire. Marks were awarded for explaining that this would prevent charge building up on the object because the metal wire is an electrical conductor.

Many candidates tended to focus on potential dangers such as sparks, shocks and fire and repeated the fact that the object was earthed as an explanation.

(iii) Sprayer Y is used in a factory to paint a metal object.

The object hangs by a metal wire that is connected to earth.

Explain why a metal wire is used to connect the object to earth.

(2)

Because metal is an electrical conductor and will ~~allow~~ allow the charge to flow to the earth more easily.

ResultsPlus
Examiner Comments

There is a mark for identifying that the metal wire is a conductor but no further marks for repeating the information about the earth given in the question.

metal is a conductor of electricity so electrons can travel up or down the wire to prevent a static charge building up on the object.

ResultsPlus
Examiner Comments

A clear explanation that scores 2 marks.

Question 1 (b)

Candidates were required to draw the electric field between two charged plates. Examiners saw many clear drawings that included at least three straight lines with arrows from positive to negative plate. One of the main errors was that candidates failed to note the arrows would represent the direction in which a positive test charge would move. Many candidates did not draw the lines with a ruler

(b) Figure 3 shows two charged metal plates.

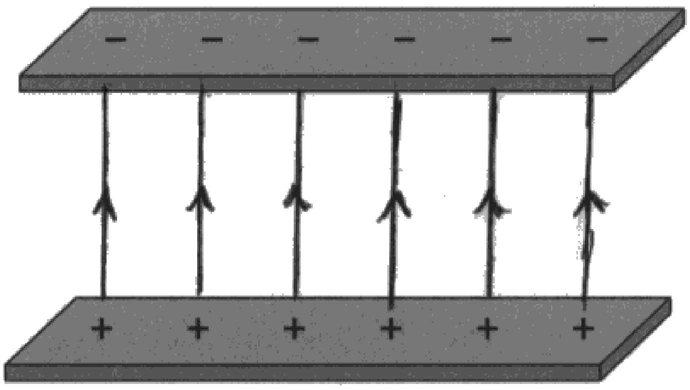

Figure 3

The top plate has a negative electric charge.

The bottom plate has a positive electric charge.

On Figure 3, draw the electric field lines between the two plates and show the direction of this electric field.

(2)

ResultsPlus
Examiner Comments

A clear drawing that scored 2 marks.

Question 2 (b) (i)

Question 2 was set in the context of a ball being dropped and allowed to bounce several times.

Candidates were first asked to use the equation for change in gravitational potential energy when the ball was lifted through a vertical distance.

Most candidates carried out this calculation correctly. However, a large number carried out an unnecessary conversion from kg into g.

(b) A ball has a mass of 0.046 kg.

(i) Calculate the change in gravitational potential energy when the ball is lifted through a vertical height of 2.05 m.

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

ΔGPE ~~= 0.046 × 10 × 2.05~~

~~= 0.943J~~

= 46 × 10 × 2.05

= 943J

0.046kg = 46g

change in gravitational potential energy = 943 J

ResultsPlus Examiner Comments

The candidate actually started with the correct substitution and then changed it to convert kg into g. This was unnecessary and resulted in an incorrect evaluation. Examiners allowed 1 mark out of a possible 2 where it was clear that the calculation was otherwise correct.

ResultsPlus Examiner Tip

In Physics, mass is measured in kilograms (kg). Other science subjects may be different.

(b) A ball has a mass of 0.046 kg.

(i) Calculate the change in gravitational potential energy when the ball is lifted through a vertical height of 2.05 m.

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

= 0.046 × 10 × 2.05

= 0.943

change in gravitational potential energy = 0.943 J

ResultsPlus
Examiner Comments

Full marks.

Question 2 (b) (ii)

Candidates were required to recall and use the equation for kinetic energy.

Most candidates could recall the equation and substitute the required values.

Once again, the most common error was to convert kg into g. In addition, many weaker candidates did not square the value for velocity.

(ii) The ball is released.

Calculate the kinetic energy of the ball when the speed of the ball is 3.5 m/s.

(3)

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

$\frac{1}{2} \times 46 \times 3.5^2 = 281.75$

kinetic energy of the ball = 281.75 J

ResultsPlus
Examiner Comments

Once again, the candidate has converted kg into g.

(ii) The ball is released.

Calculate the kinetic energy of the ball when the speed of the ball is 3.5 m/s.

(3)

$KE = \frac{1}{2} \times mass \times velocity^2$

$0.5 \times 0.046 \times 3.5^2 = 0.28175$

kinetic energy of the ball = 0.28 J

ResultsPlus
Examiner Comments

Correct answer for 3 marks.

Question 2 (b) (iv)

Candidates needed to analyse a diagram showing how the ball bounced. The height reached by the ball decreased over several bounces and they were asked to explain why.

Very many candidates gave a good explanation in terms of energy being dissipated during the bounce. Weaker candidates often incorrectly used terms such as force and power. It is noteworthy that there still seems to be a common notion that momentum somehow carries an object along, and losing momentum will cause it to slow down.

(iv) Explain why the ball does not bounce back to its starting height of 2.05 m.

(2)

It loses kinetic energy after making contact with the floor on the first bounce and ~~so do~~ so doesn't have enough energy to reach the same height.

ResultsPlus
Examiner Comments

There is a mark for identifying that the ball has "lost" kinetic energy during the bounce. However, for full marks, there needs to be a description of what happened to that energy.

(iv) Explain why the ball does not bounce back to its starting height of 2.05 m.

(2)

Because the ball is losing kinetic energy and momentum and so slows down and this means it cannot bounce as high

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Examiner Comments

It is not quite correct to say that an object slows down because it loses momentum. Instead, an object loses momentum because it slows down.

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Examiner Tip

Remember: an object has momentum because it is moving. It does NOT need momentum to move.

Question 3 (b) (i)

Question 3 was set in the context of a lamp in an electrical circuit. The resistance of the lamp changed as the potential difference (pd) across the lamp was increased.

Candidates were required to recall and use the equation linking current, pd and resistance to calculate the resistance for a given pd.

Most candidates were able to calculate the resistance for a potential difference of 5.0 V and a current of 0.26

Question 3 (b) (ii)

This required candidates to analyse a table of values of pd, current and resistance and comment on a suggestion that the resistance was directly proportional to the pd.

Good answers always included some evidence of processing the data in the table to support an analysis that resistance was not directly proportional to voltage. There was evidence of a weak understanding of 'direct proportionality' and many struggled to articulate it. Many candidates saw a positive correlation between pd and resistance and agreed with the conclusion without realising that the relationship was not directly proportional. Candidates who stated that it was incorrect often gave a clear explanation that the doubling of one did not result in the doubling of the other and many used data to support this. Better candidates argued that direct proportionality required the current to be constant; which was clearly not the case in this data.

(ii) The student writes this conclusion:

'The resistance of the lamp is directly proportional to the potential difference.'

Comment on the student's conclusion.
Use information from Figure 5 in your answer.

(3)

The student is incorrect. Although the resistance increases as the potential difference increases this is not done at a steady rate. For example, the difference between 1V to 2V was 3 Ω but the difference from 3V to 4V was 1 Ω. If it was directly proportional both Ω differences would be the same.

ResultsPlus
Examiner Comments

The candidate has processed data from the table to support the analysis that resistance is not directly proportional to voltage.

Full marks.

The student's conclusion is incorrect, the resistance is not directly proportional to the potential difference, since if you double the potential difference, the resistance does not double. Instead, the student could say they are proportional since increasing the potential difference does increase the resistance.

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Examiner Comments

A good comment that would have scored full marks if it had been supported by the use of the data. 2 marks out of 3.

(ii) The student writes this conclusion:

'The resistance of the lamp is directly proportional to the potential difference.'

Comment on the student's conclusion.
Use information from Figure 5 in your answer.

(3)

The Student is wrong. The resistance is not directly proportional to the voltage. The voltage increases in regular increments, but the resistance doesn't. At the start it rose from 11 Ω to 14 Ω and then 17 Ω, but then it was 18 Ω to 19 Ω and finally 20 Ω.

ResultsPlus
Examiner Comments

The candidate has attempted to use information from the table but has simply repeated the values. This is not enough for the third mark. 2 out of 3

Question 3 (b) (iii)

Candidates were asked to suggest a component that could be added to provide a continuously variable pd.

Candidates often stated that a variable resistor should be used, and this scored one mark. However they very often did not describe how it should be added in series with the power supply and the lamp for the second mark. Examiners saw many responses that suggested changing the power supply to one that had a continuously variable output. This is not an addition to the circuit; it is replacing one component with another. No marks were awarded for this type of response. There were a surprising number of responses that suggested that a voltmeter could provide a variable potential difference.

despite the same 1V voltage increase.

(iii) The student used a power supply that had fixed output voltage settings.
Each of these outputs was a whole number of volts.

Describe how the student could add a component to the circuit that would provide a continuously variable voltage across the lamp.

(2)

The student could add a variable resistor to the circuit, this would change the resistance and as voltage is directly proportional to resistance this would vary also.

ResultsPlus
Examiner Comments

There is a mark for correctly stating that a variable resistor could be used. However, the answer given does not describe how the component should be added to the circuit.

(iii) The student used a power supply that had fixed output voltage settings. Each of these outputs was a whole number of volts.

Describe how the student could add a component to the circuit that would provide a continuously variable voltage across the lamp.

(2)

They could add a variable resistor in series before the lamp, so that some voltage is needed to overcome it and less gets to the lamp.

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Examiner Comments

A much better answer that describes how the component (a variable resistor) should be added to the circuit. Full marks.

Question 4 (b) (i)

Candidates were asked to analyse a diagram that illustrated the principle of moments. Candidates usually multiplied the values of force and distance on each side of the pivot to obtain numerical values of 300 and 360. However, it was not always clear that this was a calculation of moments because it simply showed multiplication of numbers.

In very many cases it was clear that the calculation was, in fact, of work done. Even those who had clearly used moments in the calculations went on to use forces in their explanation and did not score the 3rd mark.

Many candidates are clearly uncertain about the difference between work done and moment of a force; especially because they both require multiplication of a force and a distance.

(b) Figure 7 shows a person trying to lift a large rock using a metal bar.

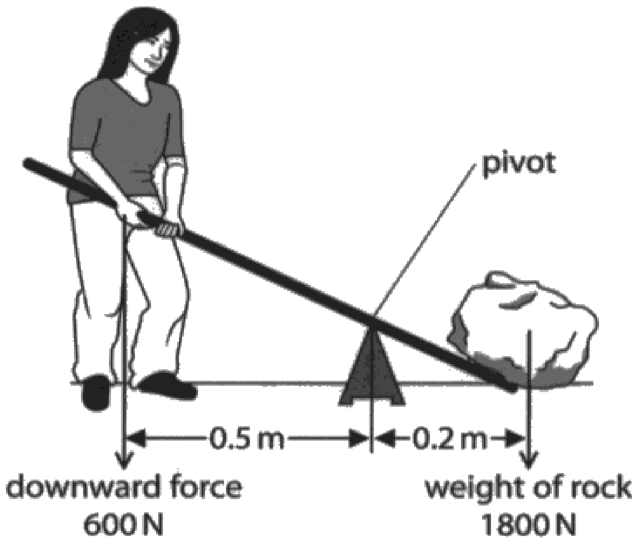

Figure 7

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock.

(3)

Moment = force × Distance

person = 0.5 × 600 = 300

ResultsPlus Examiner Comments

This response starts with a correct calculation of moments and so scores the first two marks. However, the explanation is about resultant forces, which is incorrect.

(b) Figure 7 shows a person trying to lift a large rock using a metal bar.

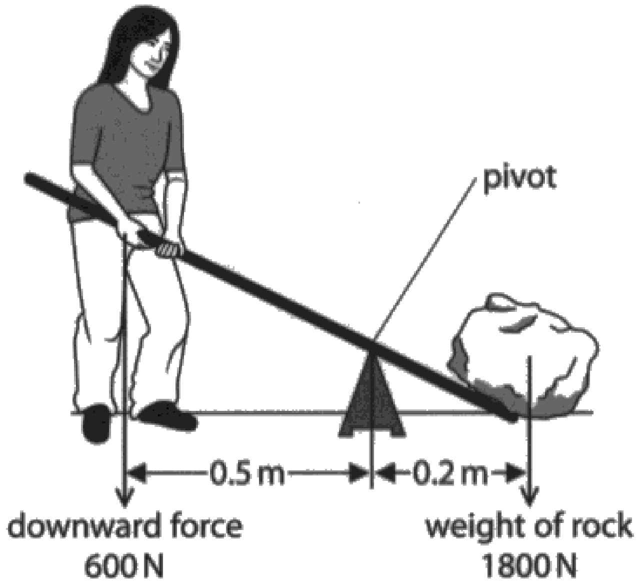

Figure 7

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock.

(3)

0·5 × 600 = 300 J — person's input

1800 × 0·2 = 360 J — rock

ResultsPlus
Examiner Comments

The two calculations are numerically correct but it not clear what this is a calculation of moments. Only one mark can be awarded. The explanation confuses forces and energy and scores no marks.

(b) Figure 7 shows a person trying to lift a large rock using a metal bar.

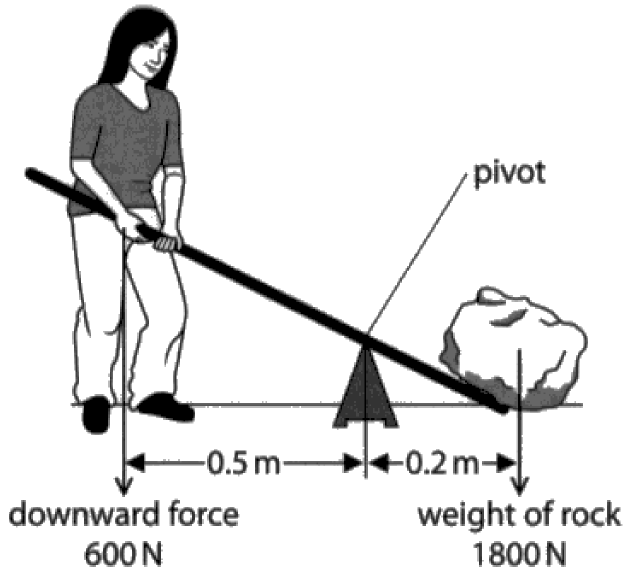

Figure 7

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock. **(3)**

(rock) 0.2 × 1800 = 360 Nm

(peson) 0.5 × 600 = 300 Nm.

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Examiner Comments

There are two calculations. Although the candidate has not written down the formula, these are clearly calculations of moments because the units (Nm) are the units of moment. The explanation is very clear. Full marks.

Question 4 (b) (ii)

Most candidates described changing either the distance between the person and the pivot or the distance between the rock and the pivot; although a significant number thought that the rock needed to be placed further away from rather than closer to the pivot. Better candidates gave an explanation in terms of moments but examiners saw many examples of incorrect discussion of forces and work. Units of N and N/m were often seen.

(ii) Explain **one** change to the arrangement that will make it possible for this person to lift the rock.

(2)

One change to the arrangement that may make it possible for the person to lift the rock is by moving the person further back so there is a greater distance between themselves and the pivot

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Examiner Comments

A correct description of one way of changing the arrangement, but not an explanation as to why this would be effective.

(ii) Explain **one** change to the arrangement that will make it possible for this person to lift the rock.

(2)

the person needs to increase the distance from herself to the fulcrum/pivot to 1.5, this would help her produce a bigger force with no additional effort required from her.

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Examiner Comments

A correct description of how the arrangement could be changed but the explanation is incorrect. Changing the distance between the force and the pivot does not increase the size of the force itself.

(ii) Explain **one** change to the arrangement that will make it possible for this person to lift the rock.

(2)

The fulcrum/pivot could be moved closer to the rock ~~to~~ which will increase the momentum of the person and decrease the moment of the rock so it can be lifted

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Examiner Comments

A correct explanation for 2 marks.

Question 4 (c) (i)

The calculation using gear ratio was usually done correctly.

Question 4 (c) (ii)

Candidates were asked to explain how applying oil to the moving parts of a bicycle wheel assembly would improve efficiency of the bicycle.

Candidates usually recognised that the oil would reduce friction and scored one mark. Few answers went on to explain how the efficiency of the bicycle would be improved. Efficiency has a specific meaning in Physics and examiners were looking for the idea that less input energy would be required to transfer the same amount of useful energy to the bicycle. Common answers included "it is a lubricant which reduced friction which meant less energy was wasted" This scored two of the possible three marks. However, equally common responses were along the lines of "by reducing friction it is easier to pedal which makes the bike more efficient". This could only score 1 mark.

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

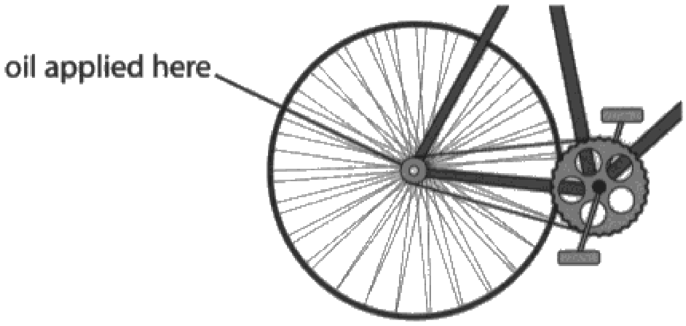

Figure 9

Explain how the oil improves the efficiency of the bicycle.

(3)

The oil acts as a lubricant. With this, the gear on the wheel can turn faster and more more easily/smoothly. Therefore, if the gears are moving faster

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Examiners would award a mark for the idea of lubrication. The remainder of the response does not correctly describe an improvement in efficiency.

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

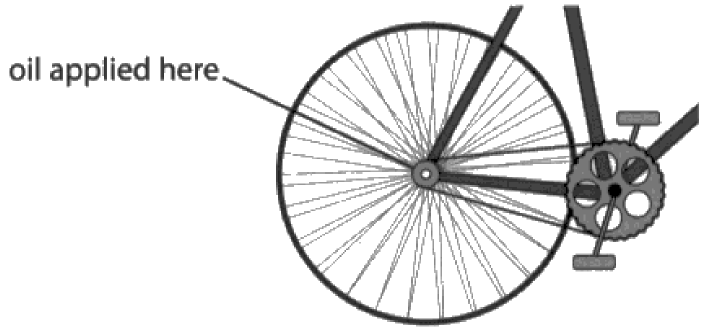

Figure 9

Explain how the oil improves the efficiency of the bicycle.

(3)

When the gears are moving they are being slowed down due to friction. However, once oil has ~~applied~~ been applied there is less friction and therefore less energy lost/wasted through friction making it more

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Examiner Comments

A better answer that explains that less energy would be wasted.

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

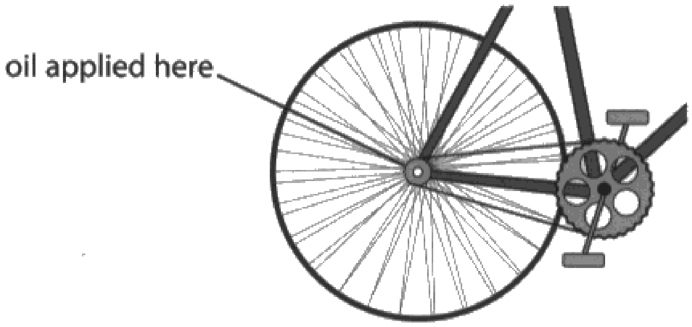

Figure 9

Explain how the oil improves the efficiency of the bicycle.

(3)

reduces the fricton between the gears and the chain. Therefore less energy is wasted through energy transfer such as thermal energy. So the bike becomes more efficent as more energy is transferred

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Examiner Comments

An excellent answer that fully explains why the oil can improve the efficiency of the bicycle.

Question 5 (a) (ii)

This question required candidates to describe a practical investigation of the magnetic field around a current-carrying wire.

Candidates were clearly familiar with such investigations and gave clear descriptions of the procedure. Examiners would credit methods that used one or more plotting compasses as well as methods that used iron filings (or similar).

Of those that used a plotting compass, many did not go on to explain what to do with the dots once they had been plotted.

Descriptions of the use of iron filings were usually less detailed than those that used a plotting compass.

(ii) Describe how the student could develop the investigation to find the shape of the magnetic field produced by the current.

(3)

The student could develop their investigation to find the shape of the magnetic field by following the direction of the plotting compasses at equal distances. By marking the direction of each plotting compass, it provides a rough pathway of the magnetic field surrounding it.

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Examiner Comments

Although the use of the plotting compass is described the response does not make it clear what to do with points once they had been created.

(ii) Describe how the student could develop the investigation to find the shape of the magnetic field produced by the current.

(3)

The student should place the compass next to the wire + draw a dot where the compass points. ~~It~~ They should then move the compass on top of that dot + repeat the process of dotting where it points and then moving it. Then connect these dots up with a curved line and that will be your magnetic field.

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Examiner Comments

A clear description of using a plotting compass that scored full marks.

Question 5 (b) (ii)

Candidates were asked to compare the forces on a magnet and a current-carrying wire in that magnetic field. Examiners were looking for a simple statement that the two forces were equal in magnitude but opposite in direction.

They saw few such answers. There was sometimes reference to being either equal or to being opposite but rarely both. Action and reaction were mentioned but with no further detail. Most candidates wrote extremely long responses, and emphasis should be made that multiple paragraphs are not expected for a one-mark question.

(ii) The interaction between the magnetic fields produced by the magnet and the current in the wire produces forces on the magnet and the wire.

Compare these two forces.

(1)

These two forces are opposite.

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Examiner Comments

This only supplies part of the answer.

(ii) The interaction between the magnetic fields produced by the magnet and the current in the wire produces forces on the magnet and the wire.

Compare these two forces.

(1)

The forces produced on the wire will be the same as those on the magnet.

ResultsPlus
Examiner Comments

This only supplies part of the answer.

(ii) The interaction between the magnetic fields produced by the magnet and the current in the wire produces forces on the magnet and the wire.

Compare these two forces.

(1)

The two forces are equal in size but opposite in direction.

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Examiner Comments

A simple, correct answer.

Question 5 (b) (iii)

This question required candidates to select and use the equation for the force on a current-carrying wire in a magnetic field. It required rearrangement of the equation.

Examiners saw many fully correct answers for three marks.

Successful answers usually started by substituting the given values and then rearranging to arrive at a correct evaluation. Those who found it difficult to rearrange their equation could gain partial credit if the substitution was clear.

Less successful answers usually started by attempting to rearrange; often by drawing a "triangle" containing the variables. Candidates should be discouraged from using this technique which may sometimes be helpful with equations having three variables but seems to lead to confusion when four variables are involved.

There was some uncertainty with units, especially in converting mm to m.

(iii) Figure 12 shows a different wire inside a uniform magnetic field.

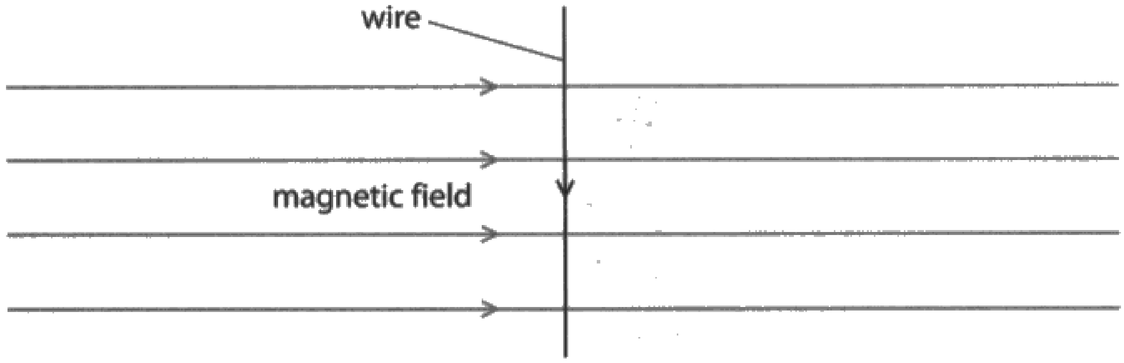

Figure 12

The magnetic flux density of the magnetic field is 0.72 N/A m.
The length of the wire inside the field is 30 mm.
The size of the force due to the magnetic field on the wire is 0.045 N.

Calculate the size of the current in the wire.

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

(3)

30mm = 0.03m

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Examiner Comments

A well laid-out, fully correct answer.

(iii) Figure 12 shows a different wire inside a uniform magnetic field.

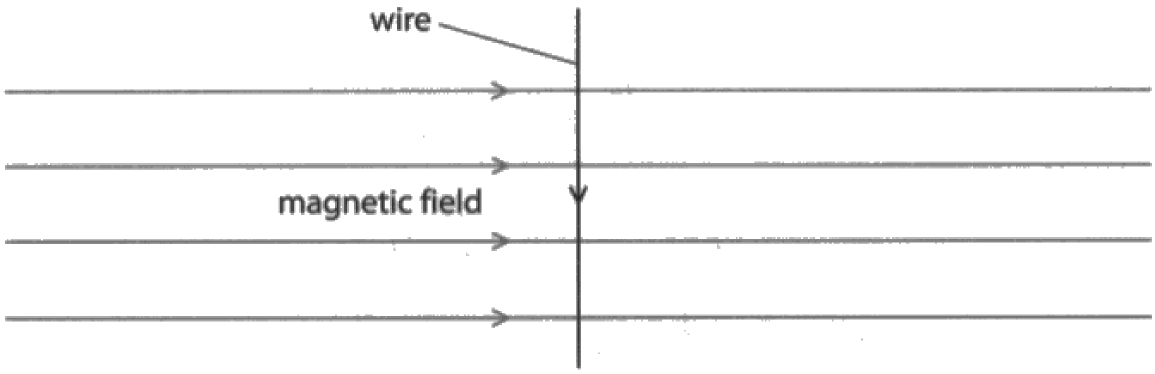

Figure 12

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The length of the wire inside the field is 30 mm.
The size of the force due to the magnetic field on the wire is 0.045 N.

Calculate the size of the current in the wire.

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

(3)

$F = B \times I \times L$

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Examiner Comments

The candidate did not convert 30mm into 0.03 m and therefore lost a mark.

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Examiner Tip

In Physics, distances are measured in meters (m). This may be different in other science subjects.

Question 6 (a) (i)

Candidates were asked to draw a simple diagram of how to demonstrate electromagnetic induction.

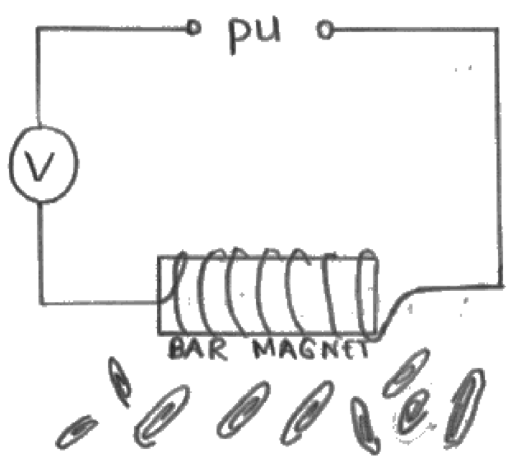
Examiners saw many good and clear drawings that indicated that candidates had at least observed this investigation, and had possibly carried it out for themselves.

It would seem, however, that many candidates were unclear about exactly how the coil and voltmeter were connected and simply drew a single wire to one end of the coil. In addition, many candidates seemed to confuse this with making an electromagnet and often included battery.

6 (a) A teacher is demonstrating electromagnetic induction.
The teacher has a bar magnet, a coil of wire and a sensitive voltmeter.

(i) Draw a diagram to show how the teacher should arrange the apparatus.

(1)



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Examiner Comments

The candidate seems to have confused making an electromagnet with demonstrating electromagnetic induction.

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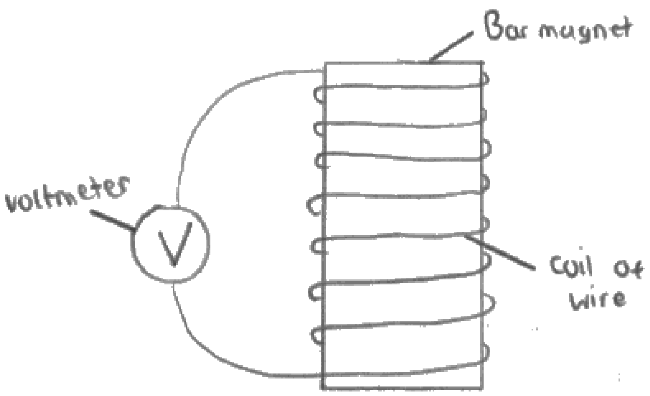
Examiner Tip

Electromagnets and electromagnetic induction may sound very similar but they are very different ideas. Make sure you know the difference.

6 (a) A teacher is demonstrating electromagnetic induction.
The teacher has a bar magnet, a coil of wire and a sensitive voltmeter.

(i) Draw a diagram to show how the teacher should arrange the apparatus.

(1)



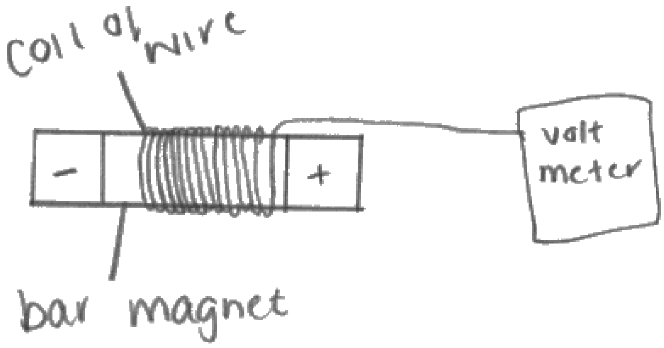
ResultsPlus
Examiner Comments

A perfectly acceptable drawing that shows the three items correctly arranged.

6 (a) A teacher is demonstrating electromagnetic induction.
The teacher has a bar magnet, a coil of wire and a sensitive voltmeter.

(i) Draw a diagram to show how the teacher should arrange the apparatus.

(1)



ResultsPlus
Examiner Comments

This was very common to see. The voltmeter is left hanging somewhere to the side.

ResultsPlus
Examiner Tip

A voltmeter has two terminals that must both connected to the circuit.

Question 6 (a) (ii)

This question expanded on the previous part by asking how this apparatus could be used to demonstrate the factors affecting direction and size of the induced potential difference.

Examiners were looking for answers that detailed what should be done (for example, move the coil slowly then more quickly) and how this would be shown (for example, by a small then a larger deflection on the voltmeter)

Correct answers usually described changing the number of turns on the coil or moving the magnet at different speeds to vary the size of the induced potential difference, and reversing the orientation of the poles of the magnet to change the direction of the induced pd. However, very many responses only described how the magnet and coil would be used and made no reference to the voltmeter.

(ii) **Explain how the teacher could use this apparatus to demonstrate the factors affecting the size and direction of the induced potential difference.**

(4)

The teacher could slowly move the magnet through the coil, and show the students the voltmeter. She should do the same but move the magnet faster and show that the readings on the voltmeter have increased. She should than turn the magnet around and do the same thing again. The voltmeter should show a negative value.

ResultsPlus
Examiner Comments

A good answer that fully described how to use the apparatus.

(ii) Explain how the teacher could use this apparatus to demonstrate the factors affecting the size and direction of the induced potential difference.

(4)

The teacher could rotate the magnet so that the north and south poles swap over. This will show a change in direction of the induced potential difference. The teacher could move the magnet at different speeds to show how this affects the size of the potential difference.

ResultsPlus
Examiner Comments

This was typical of many responses. There is a good description of how the coil and magnet should be used but no mention of the voltmeter to show the actual size or direction of the induced pd.

Question 6 (b) (i)

This question required candidates to explain the changing magnetic field in the core of a transformer. Some candidates seemed to read the question as asking for a description of how the transformer can change the size of an alternating pd. However, most candidates correctly identified that an alternating current was responsible for the changing magnetic field, for one mark but very often failed to state where this alternating current was for the second mark.

(b) There is a changing magnetic field in the core of a transformer.

(i) Describe the cause of the changing magnetic field in the core of the transformer.

(2)

Alternating current is supplied, meaning that the magnetic field is constantly changing, along with the current and potential difference.

ResultsPlus
Examiner Comments

This response has a correct reference to an alternating current, but then simply repeats the information in the question.

(b) There is a changing magnetic field in the core of a transformer.

(i) Describe the cause of the changing magnetic field in the core of the transformer.

(2)

The changing magnetic field is caused by the alternating current of the primary coil, which induces a magnetic field. The interaction of the core and coil causes a changing magnetic field.

ResultsPlus
Examiner Comments

A much better answer that describes the cause of the changing magnetic field.

Question 6 (b) (ii)

Candidates were asked to select and use the equation linking the pd across the coils of a transformer with the number of turns on the coils. This required substitution and rearrangement.

Once again, most successful answers started with a substitution and gained at least partial credit. Many candidates found the subsequent rearrangement difficult, especially those who may rely on using a triangle instead of algebra.

Question 7 (a)

Candidates were asked to describe a practical procedure to determine the density of glass. There were four marks available for a clear description of the measurements to be made and an indication of how accuracy can be assured.

Examiners saw very many good descriptions of how to perform this investigation.

Most candidates described how to measure mass. However, many candidates seemed a little unsure about how to measure the volume of the marble(s). It was common to read about finding the mass of a measuring cylinder both empty and then containing water and/or the marble. There was also frequent descriptions of filling the measuring cylinder and then adding the marbles to cause it to overflow. Sometimes the displaced water was collected and measured but often simply weighed on a balance again. It appears that many candidates had carried out a similar investigation using a displacement can but could not exactly recall the significance of the measurements they made nor how to process them.

There was also some confusion about how to reduce errors. Many candidates seemed to think that finding the average of several, small, values of mass and volume of individual marbles would produce the most accurate result. Better candidates realised that ensuring that the measurements were as large as possible would reduce the effect of errors in measurement. This could be by using many marbles at once and / or by ensuring that the measuring cylinder was of a suitable capacity to give a measurable change in volume of water.

7 (a) A student measures the density of glass.

The student has

- a bag of marbles, all made from the same type of glass
- a weighing balance
- a plastic measuring cylinder containing water

Describe how the student could find, as accurately as possible, the density of the glass used for the marbles.

(4)

The student could weigh each marble, one at a time, to find the mass for each. Again one at a time, they should record the starting value of the measuring cylinder, drop a marble in, then record the value on the measuring cylinder once more to find the volume of each marble. Each mass should be divided by it's respective volume to find the density for each value, then the densities should be added together and divided by the number of marbles to find the average density, which is the most

ResultsPlus
Examiner Comments

Taking many readings and finding an average is usually good practice. On this occasion, however, it will not help if the measurements being made are very small compared to the scale on the measuring cylinder.

7 (a) A student measures the density of glass. density = $\frac{mass}{volume}$

The student has

- a bag of marbles, all made from the same type of glass
- a weighing balance
- a plastic measuring cylinder containing water

Describe how the student could find, as accurately as possible, the density of the glass used for the marbles.

(4)

The student could use the formula density = mass ÷ volume. To find the mass, the student should place the marbles on the weighing balance, and then measure and record the value. The student should then measure and record the volume of water in the measuring cylinder. The student should then place the same number of balls weighed in the measuring cylinder, and then measure and record the volume. The difference is volume of water with and

ResultsPlus
Examiner Comments

This is a better suggestion. Using several marbles at once will make the readings larger and this will reduce the effect of taking readings that are difficult to measure precisely.

Question 7 (b) (i)

Candidates were asked to select and use the equation relating change in thermal energy with change in temperature, mass and specific heat capacity. This required rearrangement and subtraction of the change in temperature from the final temperature to find the original temperature.

This was generally well done. As usual, the most common error was in rearrangement and the most successful candidates showed correct substitution into the equation before attempting to rearrange. The next most common error was to simply take the change in temperature calculated as the answer without using this to find the original temperature.

(b) A beaker contains 0.25 kg of water at room temperature.
The beaker of water is heated until the water reaches boiling point (100 °C).
The specific heat capacity of water is 4200 J/kg °C.
The total amount of thermal energy supplied to the water is 84 000 J.

(i) Calculate the temperature of the water before it was heated.

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

(3)

Δthermal energy = mass × specific heat capacity × Δtemperature

100° – 80° = 20°

84 000 = 0.25 × 4200 × Δtemp.

84 000 = 1050 × Δtemp

$\frac{84000}{1050} = 80$.

temperature before heating = 20 °C

ResultsPlus
Examiner Comments

A nicely laid out, correct answer.

(b) A beaker contains 0.25 kg of water at room temperature.
The beaker of water is heated until the water reaches boiling point (100 °C).
The specific heat capacity of water is 4200 J/kg °C.
The total amount of thermal energy supplied to the water is 84 000 J.

(i) Calculate the temperature of the water before it was heated.

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

(3)

$\Delta Q = m \times c \times \Delta\theta$

$\frac{84{,}000}{0.25 \times 4200} = 80^{\circ}$

temperature before heating = 80° °C

ResultsPlus
Examiner Comments

A correct calculation of the change in temperature. However, this needs to be subtracted from the final temperature (100 degrees C) in order to find the temperature before heating.

Question 7 (b) (ii)

Most candidates were able to select and use the equation for calculating specific latent heat.

Question 7 (b) (iii)

Candidates were required to interpret a graph showing change in volume with temperature and relate this to describe how the density changed.

Examiners saw many good, clear descriptions of the density increasing to reach a maximum at 4 degrees and then decreasing.

However, a great many answers simply either described the change in volume or stated that the change in density would be the same as the change in volume.

(iii) The graph in Figure 13 shows how the **volume** of 1 kg of water changes with temperature.

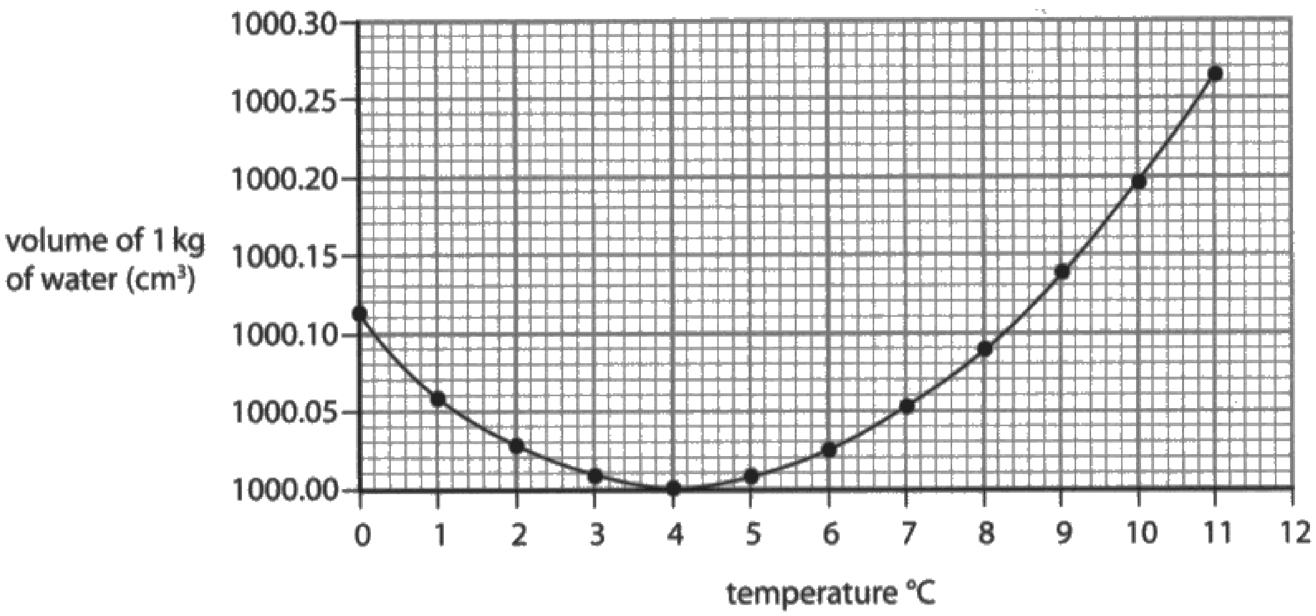


Figure 13

Describe how the **density** of water changes with temperature over the range of temperature shown in Figure 13.

Calculations are not required.

(2)

The density decreases as the temperature

ResultsPlus
Examiner Comments

This was a very common, incorrect response. The meaning of density is often not understood.

(iii) The graph in Figure 13 shows how the **volume** of 1 kg of water changes with temperature.

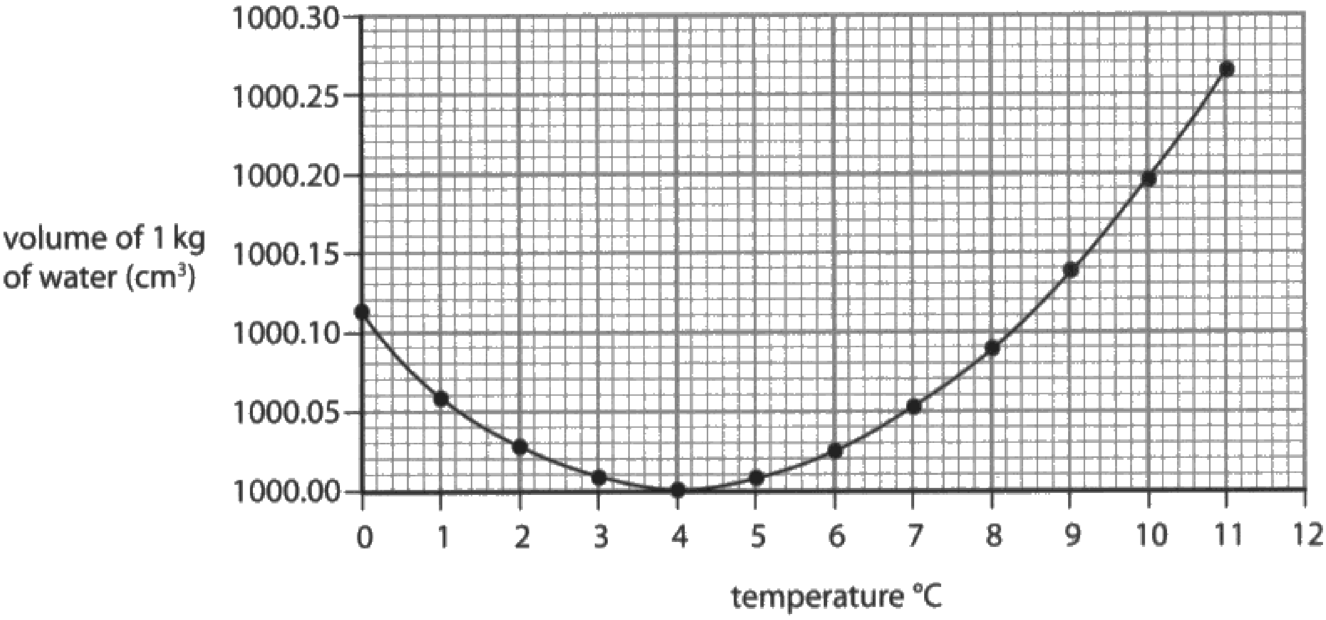


Figure 13

Describe how the **density** of water changes with temperature over the range of temperature shown in Figure 13.

Calculations are not required.

(2)

as the volume of the water

ResultsPlus
Examiner Comments

Although the candidate did not refer to the graph, examiners would award a mark for a clear statement that did correctly relate density to volume.

(iii) The graph in Figure 13 shows how the **volume** of 1 kg of water changes with temperature.

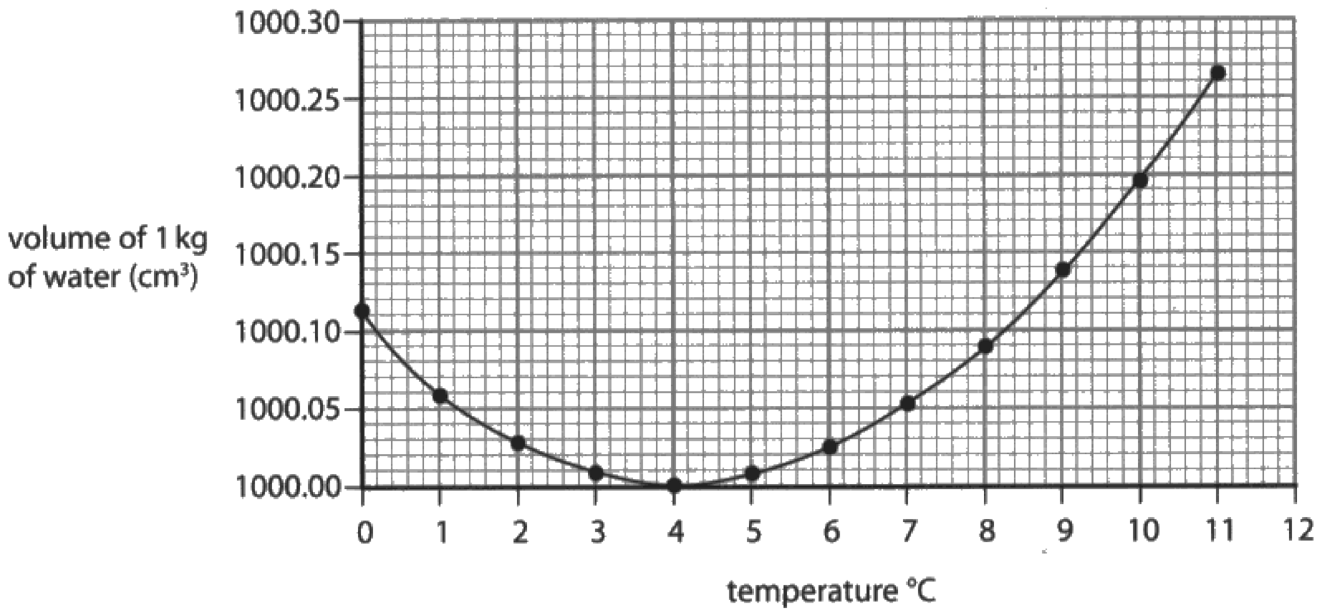


Figure 13

Describe how the **density** of water changes with temperature over the range of temperature shown in Figure 13.

Calculations are not required.

M

D V

(2)

From temperatures 0°C to 4°C the density

ResultsPlus

Examiner Comments

A fully correct answer.

Question 8 (a) (i)

Candidates were usually able to calculate the power output of the athlete. The most common error was to multiply the values of work and time.

Question 8 (b) (i)

This question required a description of how to measure the extension of a piece of rubber during an investigation about elasticity.

Examiner read many good descriptions and one mark was almost always given for how to measure two lengths but candidates often forgot to mention calculating the difference and so lost out on the final mark.

It was noteworthy that few responses suggested using a fixed rule and reading the changing position(s) of the weight from it.

Question 8 (b) (ii)

This question was targeted at higher ability candidates. It showed a non-linear graph of force against extension for rubber that was probably unfamiliar to the candidates and asked them to compare this to a graph with which they should be familiar: the linear graph obtained from stretching a spring.

Examiners were looking for an explanation that recognised that is was indeed non-linear and also that the loading and unloading passed through different set of points whereas this would not be the case for a spring.

Many candidates indicated an awareness of the fact that there were two lines here instead of one but lacked the terminology to express it in a credit-worthy manner. A very large number thought that the difference was that the rubber returned to its original length when the force was reduced to zero. Such candidates often implied (or stated) that distortion of the spring mentioned in the stem meant permanent damage rather than a (temporary) change in length under load.

(ii) The student obtains a series of values of force and extension while loading the piece of rubber and then unloading it.

Figure 16 shows the graph of the student's values.

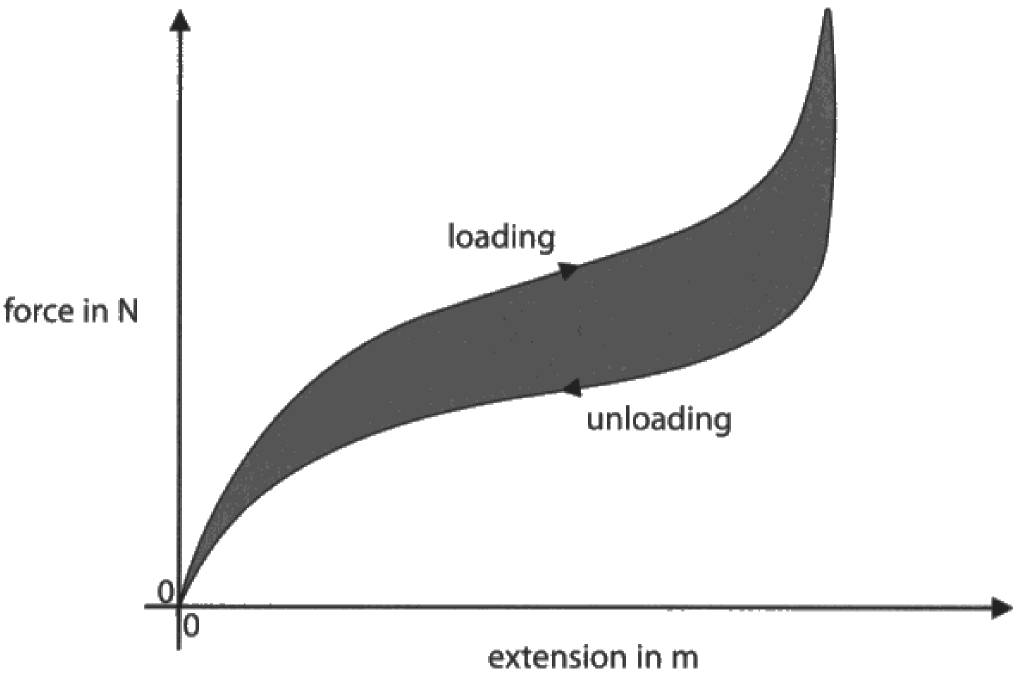


Figure 16

Explain how the shape of this graph shows that the distortion of the piece of rubber being stretched is different from the distortion of a spring being stretched.

ResultsPlus
Examiner Comments

This answer correctly identifies that the rubber graph is non-linear, but does not mention that the loading and unloading curves pass through different points.

(ii) The student obtains a series of values of force and extension while loading the piece of rubber and then unloading it.

Figure 16 shows the graph of the student's values.

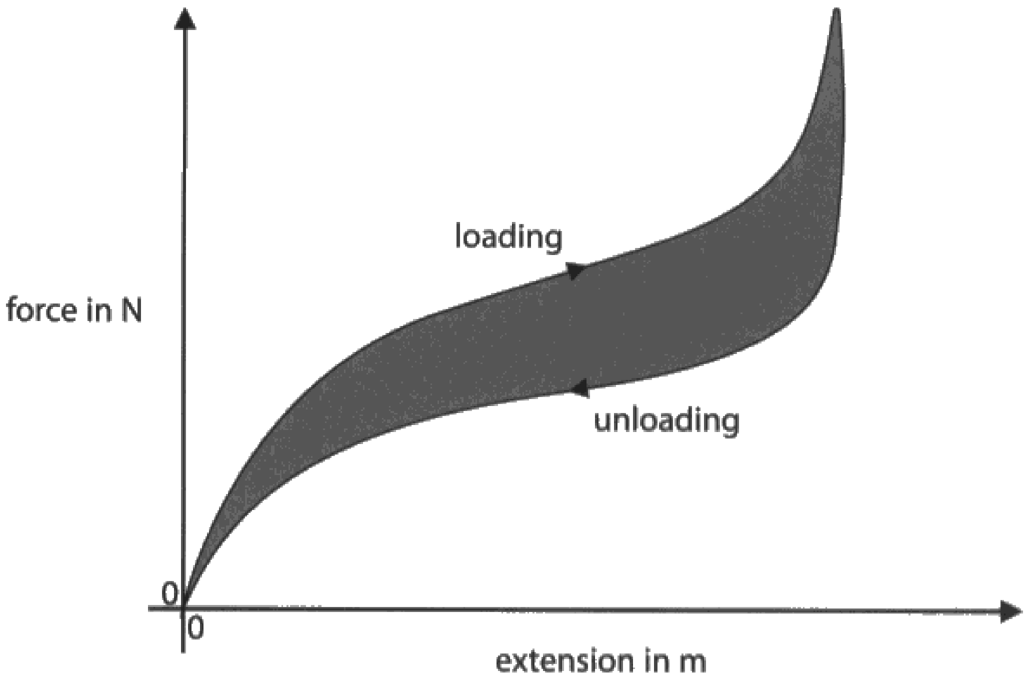


Figure 16

Explain how the shape of this graph shows that the distortion of the piece of rubber being stretched is different from the distortion of a spring being stretched.

ResultsPlus
Examiner Comments

A very good answer that describes the differences between this graph and the graph that would be obtained when stretching a spring.

(ii) The student obtains a series of values of force and extension while loading the piece of rubber and then unloading it.

Figure 16 shows the graph of the student's values.

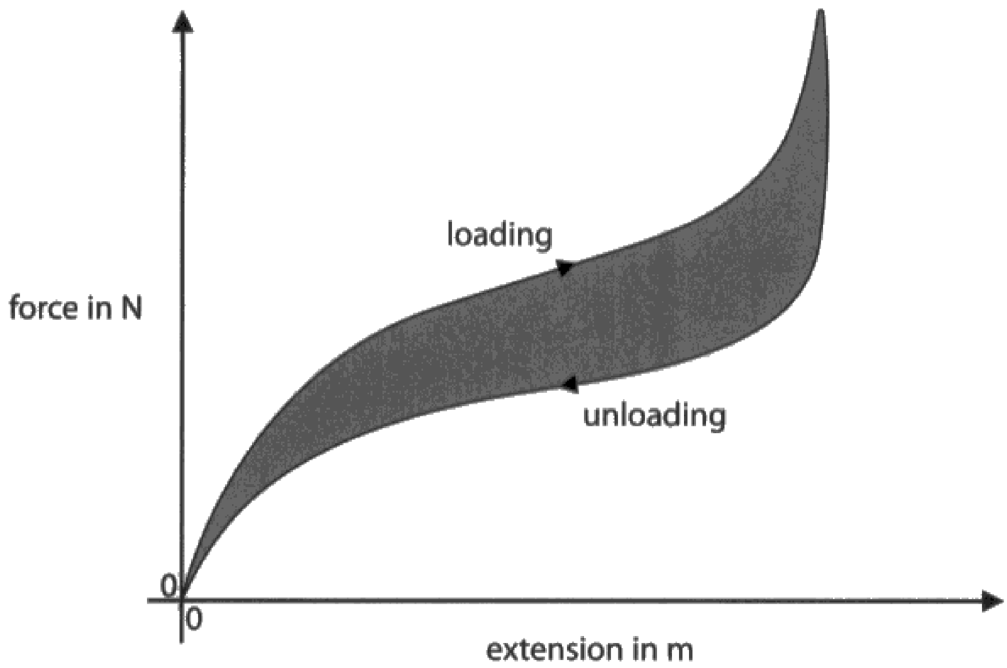


Figure 16

Explain how the shape of this graph shows that the distortion of the piece of rubber being stretched is different from the distortion of a spring being stretched.

ResultsPlus
Examiner Comments

A very common, incorrect, answer. Many candidates implied that distortion meant permanent damage rather than simply a change in dimensions.

Question 8 (c)

Once again, this was targeted at higher ability candidates. They were told that the area under each curve and the extension axis represented energy transferred and asked to suggest the significance of the shaded area (between the two curves). Examiners were looking for a response that simply identified the shaded area as representing the difference in energy transferred during loading and unloading for one mark. A further mark would be awarded for suggesting the significance of this difference such as a transfer to thermal energy.

Good candidates were able to score at least one of these marks with a pleasing number gaining both.

The difference between the work done or energy transferred between loading and unloading the weights.

ResultsPlus
Examiner Comments

A good suggestion that scored one mark.

The difference in energy loading and unloading and therefore the energy lost from loading to unloading as its been dissipated to surroundings. Or that less energy is reqaired to unload than to load.

ResultsPlus
Examiner Comments

A very good answer that suggests what might account for the difference in the two curves shown by the shaded area.

Question 9 (a) (i)

Question 9 was set in the context of a block of concrete submerged in a deep pool of water. The block is being lifted by a crane.

Candidates were first asked to recall and use the equation relating pressure, force and area. This required a simple rearrangement.

The first mark was awarded for recall of the equation. Candidates who wrote the equation down scored this first mark immediately. Those who started by directly attempting to calculate values were less likely to provide evidence for this mark unless they went on to rearrange and evaluate correctly or their working was very clear.

9 Figure 17 shows a crane lifting a concrete block from the bottom of a deep pool of water. The top of the block is a distance, *h*, below the surface of the water.

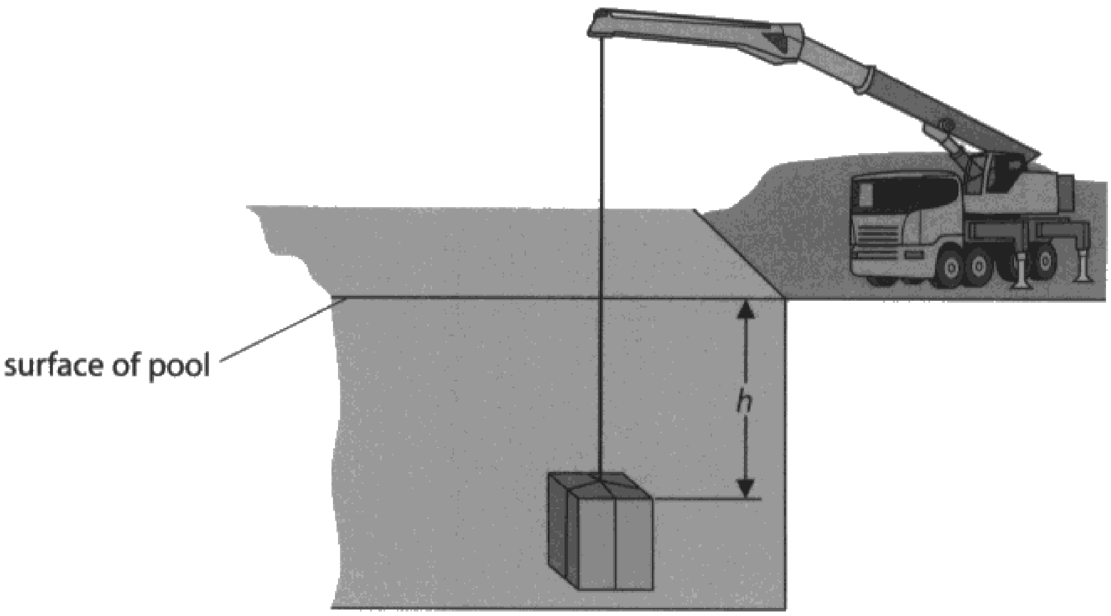
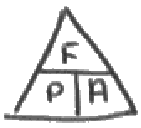


Figure 17



(a) The force on the top of the block due to the water above it is 41 000 N.

The pressure due to the water on the top surface of the block is 66 000 Pa.

(i) Calculate the area of the top surface of the block.

P = F   6   66000   = 1·60975

(2)

ResultsPlus
Examiner Comments

Here, the candidate has written down the correct equation and so the examiner can award a mark for recalling the equation; even though the rearrangement and evaluation is incorrect.

9 Figure 17 shows a crane lifting a concrete block from the bottom of a deep pool of water. The top of the block is a distance, *h*, below the surface of the water.

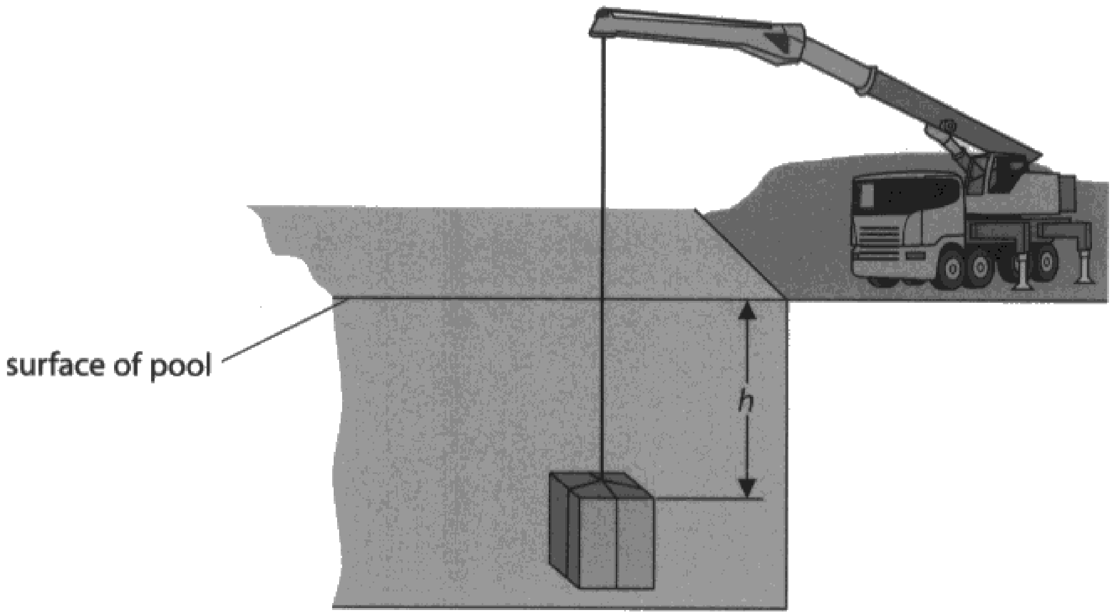


Figure 17

(a) The force on the top of the block due to the water above it is 41 000 N.

The pressure due to the water on the top surface of the block is 66 000 Pa.

(i) Calculate the area of the top surface of the block.

(2)

ResultsPlus
Examiner Comments

The expression F = P/A is incorrect and there is no evidence that the candidate has recalled the correct equation.

Note that a triangle is not an equation.

Question 9 (a) (ii)

Candidates were asked to select and use the equation relating pressure, depth, density and gravitational field strength. This required rearrangement.

As noted previously, successful candidates substituted values and then went on the rearrange to evaluate the distance between the top of the block and the surface of the water.

Less successful candidates either used the value for force instead of pressure and / or made mistakes with the rearrangement.

Question 9 (a) (iii)

Candidates were asked to explain why an object immersed in water experience an upthrust.

Examiners were looking for an explanation that identified the difference in pressures acting in the top and bottom surface and then linked this to a difference in forces on those (equally sized) surfaces.

Alternatively, examiners would fully credit a statement that described the upthrust on an object as being equal to the weight of water it displaces.

It was clear that a large proportion of the candidates were very insecure in their understanding of this concept.

Some candidates used pressure differences but were less clear about forces.

A large number quoted "action and reaction" with no further attempt at explaining why this might be relevant. Very many thought that concrete was less dense than water.

Those who mentioned displacement of water often did not go on to explain why this resulted in an upthrust.

(iii) Explain why there is an upthrust produced by the water on the block.

(2)

There is an upthrust produced by the water on the block because Newton's Laws say that every action has an opposite and equal reaction. This means that if the block is pressing down on the water, the water must also be slightly pushing up on the block. However the forces are not balanced.

ResultsPlus
Examiner Comments

This was typical of many incorrect responses. The significance of Newton's 3rd law is often misunderstood.

(iii) Explain why there is an upthrust produced by the water on the block.

(2)

Because the the ~~dt~~ pressure of the water on the block at the bottom of the block is greater than at the top of the block, because pressure increases with depth.

ResultsPlus

Examiner Comments

This partly explains upthrust but does not go on to state that the forces on the top and bottom are different as a consequence.

(iii) Explain why there is an upthrust produced by the water on the block.

(2)

There is an upthrust because the block is displacing a certain volume of water. So the force of the upthrust is the same as the weight of the volume of the displaced water

ResultsPlus

Examiner Comments

Examiners would award full marks for a statement like this that uses Archimedes' Principle.

Question 9 (a) (iv)

This question followed on from the previous introduction of the concept of upthrust. Candidates were asked to analyse a graph showing how the tension in the crane cable (and therefore the upwards force on the concrete block) changes as the block rises through the water to towards the surface, emerges from the water and then continues to rise in the air.

Examiners were looking for answers that interpreted the changes in the two variables (force and time) in terms of reasons why there were changing forces on the block during its journey. Candidates were asked to demonstrate their ability to evaluate the data by carrying out at least one calculation. This question was essentially about changing upthrust. An important section of the graph was between 120 and 140 seconds; which was when the block was emerging from the water and therefore the upthrust from the water was reducing as progressively less of the block was submerged.

To award level 1, examiners were looking for answers that considered one of the variables, usually force, and explained, in simple terms why it changed. To reach level 2, the answer needed to link the two variables; force and time by using data extracted from the graph; usually this was the change in force over a time period from 120s to 140s. Level 3 answers went on to describe the changes in force in more detail and carried out at least one relevant calculation; often the speed of the block as at travelled upwards; but many other of the possible calculations listed in the published mark scheme were seen.

Many good answers were seen with clear explanations involving upthrust. However, there were a large number of misconceptions; particularly that the amount of force increased as the block left the water as there was less resistance, meaning the crane could apply more force as it was "easier" to lift the block in air. Many candidates attempted to reason entirely in terms of pressure without mentioning upthrust. They often calculated the pressure due to the water and were under the impression that only the pressure of the water on top of the block affected the force that was required. It was also very common to read that the density of the block changed during its journey.

For the first 2 minutes the crane is lifting the block out of the water. Because of upthrust, the crane doesn't need to lift with ~~exert~~ ~~as~~ as much force as it would after 2 minutes. So it lifts with a force of 10.2KN. Once out of the water, the crane needs to lift with more force because

ResultsPlus
Examiner Comments

This answer explains why the force changes at different parts of the block's journey making clear reference to the values of time and force from the graph.

There is a calculation (the size of the upthrust).

This is a level 3 answer.

As during the first 120s the block is in the water which has a higher density then air meaning that the water will apply more pressure to the block so when it is raised up it will begin

ResultsPlus
Examiner Comments

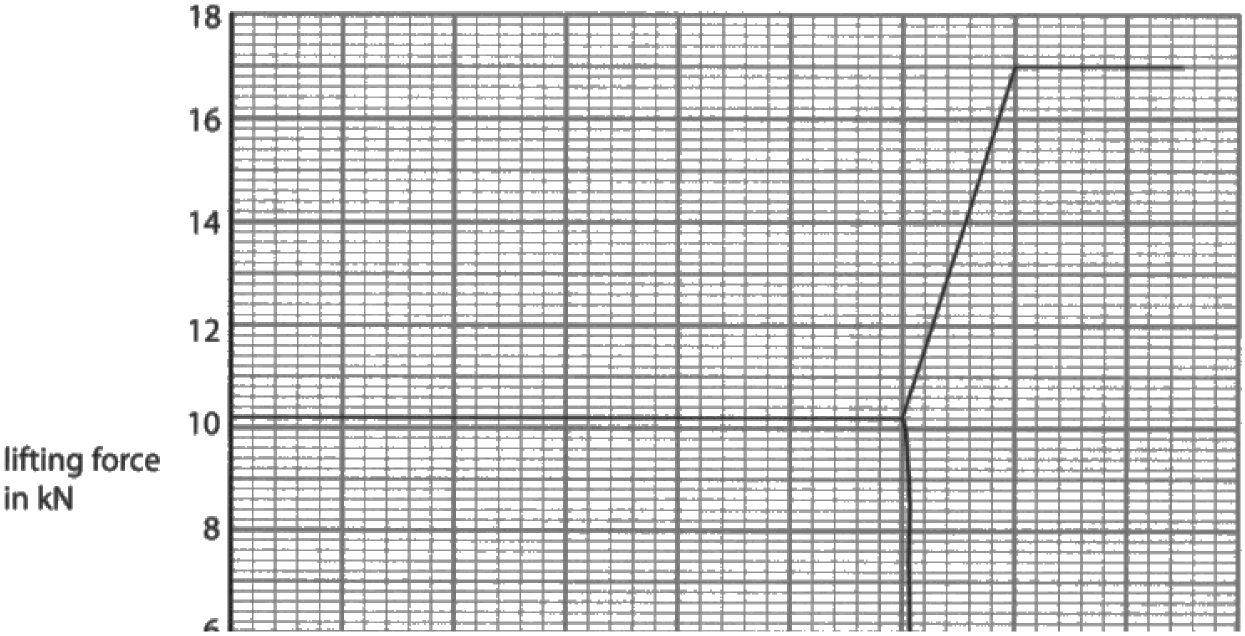
There are some statements that are not precise; such as "water will apply more pressure to the block". Even so, this answer explains that the force changes because the upthrust changes. It clearly identifies the times where this happens.

This is a level 2 answer.

*(iv) The crane raises the block until it is high enough out of the water to be loaded on to a lorry.

The block moves upwards at a constant speed even though the lifting force in the cable changes.

Figure 18 shows the graph of how the lifting force changes while the block is being raised.



Explain why the lifting force changes as shown on the graph in Figure 18.
Include calculation(s) in your answer.

(6)

The block is lifted with a force of 10kN at the beginning until it is out of the water. It stays constant whilst in the water as the pressure acts in all directions. Once the block being

ResultsPlus
Examiner Comments

This answer explains why the force changes, but it only makes reference to the size of the force. It does not make reference to the other variable on the graph: time.

This is a level 1 answer.

There are some inaccuracies in the statements about pressure but these are allowed at this level.

Question 10 (a) (i)

This question asked candidates to recall and use the equation linking power, current and resistance. It required a rearrangement. One mark was awarded for correct recall and substitution, one mark for rearrangement and a third mark for evaluation to an appropriate number of significant figures.

Very many candidates were unable to recall the expected equation and often simply (and incorrectly) tried to use P = I x R. This scored no marks.

Other candidates chose to first calculate the pd from the values of power and current and then use this value to calculate resistance from pd and current. This is a perfectly acceptable route and often led to scoring the first two marks at least.

Of the candidates who carried the calculation (by either route) correctly, many of them gave a final answer of 0.66 which is correctly expressed to the same number of significant figures as the power and current given in the question.

A common error in this last step was to round the calculator value of 0.66326… to 0.67; perhaps because values of 0.66666 are commonly encountered and these, correctly, can be rounded to 0.67.

Question 10 (a) (ii)

This question tested candidates understanding of an electrical current as a movement of electric charge.

Examiners were looking for a statement that the rate of flow of charge in the immersion heater was greater than that in the kettle for one mark. The second mark was awarded for recognising that the charge in a circuit connected to a battery moves continuously one direction whereas in one connected to the mains, the direction of movement alternates. Credit was not given for simply mentioning AC and DC; this question specifically asked about the movement of charge.

Examiners saw many concise and clear responses for both marking points.

Candidates were not expected to know if the greater rate of flow in the immersion heater was due to more charge overall in motion or a faster movement of the same amount of charge and credited either concept. The first mark was often awarded.

Candidates were less precise in distinguishing between movement of charge in a direct current and movement of charge in an alternating current and often failed to score the second mark.

(ii) The current in the heating element of the kettle is 8.3 A.

State **two** differences between the movement of charge in the heating element of the kettle and the movement of charge in the immersion heater.

(2)

1 There is more charge moving in ~~kett~~ the immersion heater per second than the kettle.

2 Immersion heater, current is d.c and kettle current is a.c

ResultsPlus
Examiner Comments

The first statement scores a mark but the second statement does not mention charge and so does not score.

(ii) The current in the heating element of the kettle is 8.3 A.

State **two** differences between the movement of charge in the heating element of the kettle and the movement of charge in the immersion heater.

(2)

1 In the kettle there is a slower rate of flow of charge, than in the immersion heater.

2 In the kettle, the flow of charge alternates in different directions; in the immersion heater, there is one direction of charge.

ResultsPlus
Examiner Comments

A good answer that scored both marks.

Question 10 (b)

The final question on this paper required candidates to demonstrate the function of the fuse and the earth wire in a domestic three-pin plug. In particular they were asked to consider what happens if the live wire comes into contact with the metal case of the kettle.

Examiners were looking for a description that first recognised that the earth wire is connected to the metal case. When the fault occurs there is a very low resistance between live and earth terminals and a very large current flows in the wires. Examiners were then looking for a description that this very large current also flows in the thin wire of the fuse, raising its temperature above melting point and thereby breaking the circuit and effectively disconnecting the live wire from the kettle. This renders the faulty kettle safe to touch and prevents potential damage to the house wiring.

Answers were scored in three levels, depending on how accurate and complete was the description given in the response.

Most candidates demonstrated that they understood the action of the fuse and better candidates gave a full description that linked ideas of low resistance, large current, rapid heating and subsequent melting that resulted in the disconnection of the live wire from the rest of the circuit.

Candidates were much less clear about the earth wire. It was frequently seen as a totally separate device that continuously prevented electric shocks and its function was often not linked to the fuse. Very many answers centred around concepts relevant to electrostatics such as discharging or preventing sparks, fire and explosions. It was rarely appreciated that, without an earthed connection to the metal case, the current in the fuse would not increase when the stated fault occurred (unless, of course, the neutral wire was also connected to the metal case).

In addition, many candidates wrote extensively about colours of cables and ancillary components of the plug such as cable grips and a plastic moulding. While important, they are not immediately relevant to the fault situation given in the question.

*(b) Figure 20 shows the three-pin plug used to connect the kettle to the mains.

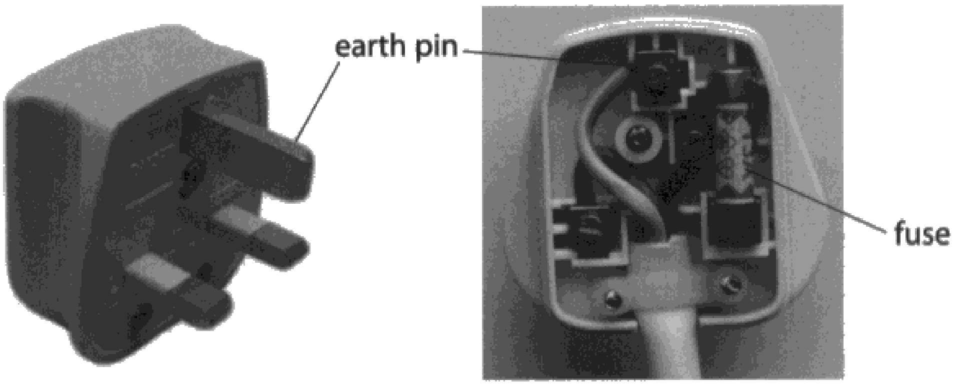


Figure 20

A fault occurs in the kettle causing the live wire to touch the metal case of the kettle.

Explain how the safety features of the plug operate when this fault occurs.

(6)

Earth pin

• The Earth pin is able to return the charge

ResultsPlus
Examiner Comments

There are correct statements about the fuse but the statements about the earth are not relevant in this situation.

This is a Level 1 response.

*(b) Figure 20 shows the three-pin plug used to connect the kettle to the mains.

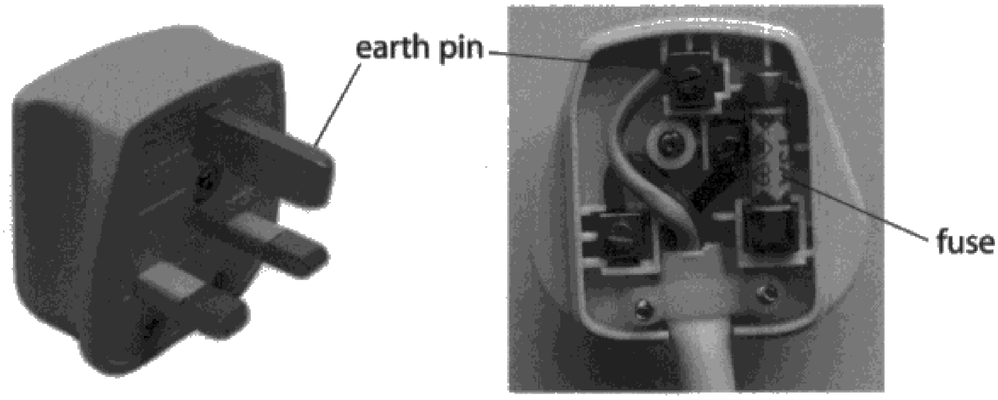


Figure 20

A fault occurs in the kettle causing the live wire to touch the metal case of the kettle.

Explain how the safety features of the plug operate when this fault occurs.

(6)

When a fault occus the live wire touch the metal casing it would immediately do two things. Firstly it would go

ResultsPlus
Examiner Comments

There is a description about the action of the fuse and a description about the action of the earth wire. This is a level 2 response. It lacks detail about both components to reach level 3.

*(b) Figure 20 shows the three-pin plug used to connect the kettle to the mains.

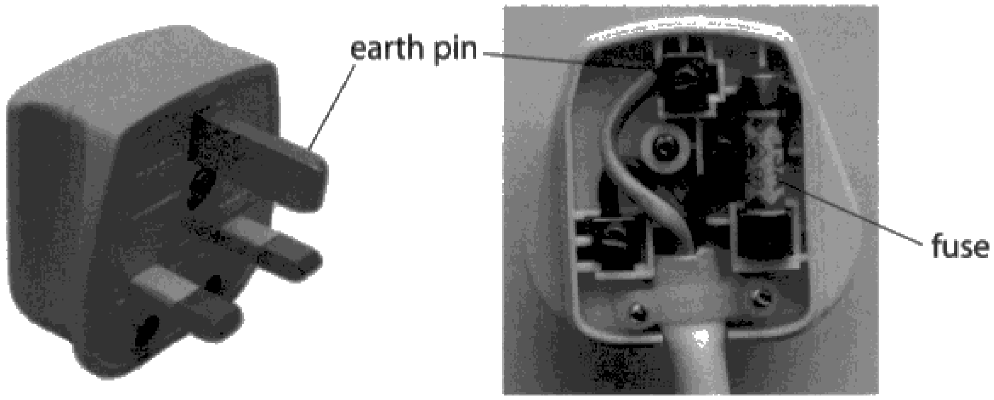


Figure 20

A fault occurs in the kettle causing the live wire to touch the metal case of the kettle.

Explain how the safety features of the plug operate when this fault occurs.

(6)

The earth pin is connected to the earth and the metal part of the plug. When there is a current flowing through the metal part, the current will go through the earth wire

ResultsPlus
Examiner Comments

This is a complete explanation of the action of the earth and the fuse and is a level 3 response.

Paper Summary

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

- make sure that they have a sound knowledge of the fundamental ideas in all the topics
- Start all calculations by writing down the equation. Then substitute the values that have been given BEFORE trying to rearrange the equation.
- Practice using algebra to rearrange equations. Do not rely on a triangle.
- get used to the idea of applying their knowledge to new situations by attempting questions in support materials or previous examination papers
- when describing a practical procedure, make sure they are clear about what is to be measured and how the measurements will be taken.

Grade Boundaries

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

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