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Introduction

These exemplar answers have been chosen from the summer 2018 examination series.

OCR is open to a wide variety of approaches and all answers are considered on their merits. These exemplars, therefore, should not be seen as the only way to answer questions but do illustrate how the mark scheme has been applied.


The question paper, mark scheme and any resource booklet(s) will be available on the OCR website from summer 2019. Until then, they are available on OCR Interchange (school exams officers will have a login for this and are able to set up teachers with specific logins – see the following link for further information [http://www.ocr.org.uk/administration/support-and-tools/interchange/managing-user-accounts/](http://www.ocr.org.uk/administration/support-and-tools/interchange/managing-user-accounts/)).

It is important to note that approaches to question setting and marking will remain consistent. At the same time OCR reviews all its qualifications annually and may make small adjustments to improve the performance of its assessments. We will let you know of any substantive changes.
**Question 1(a)**

Exemplar 1

1 Jamal is listening to the radio.
   
   (a) He can hear a musical instrument playing a steady note.

What type of wave is the sound that Jamal hears?

Put a (ring) around the correct answer.

- electromagnetic
- longitudinal
- radio
- transverse

[1]

**Examiner commentary**

About 50% of candidates picked the correct response. This candidate has applied good examination technique by highlighting important phrases in the stem of the question. A common error was to choose 'electromagnetic,' possibly because Jamal was listening to the radio. Radio waves are electromagnetic, but the radio converts the signals received into sound waves which can be heard by Jamal's ears.

**Question 1(b)**

Exemplar 1

(b) The sound waves that Jamal hears have a frequency of 400 Hz and a wavelength of 0.84 m.

Calculate the speed of the sound waves.

Use the equation: wave speed = frequency \times wavelength

\[
\begin{align*}
400 & \times 0.84 \\
= & \ 336
\end{align*}
\]

Wave speed = 336 m/s [2]

**Examiner commentary**

Over 80% of candidates calculated the wave speed correctly. This candidate has underlined important parts of the question stem and has written the calculation down clearly. This is an example of good exam technique.
Question 2(a)(i)

Exemplar 1 1 mark

(a) (i) Put a tick (✓) in the correct box in each row to show the correct descriptions of the live, neutral and earth wires.

<table>
<thead>
<tr>
<th>Wire</th>
<th>Connected to the National Grid</th>
<th>Is at the same voltage as the ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Neutral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth</td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

[2]

Examiner commentary

Although the first two rows are correct in this response, there are two ticks in the bottom row. Only one box should be ticked in each row, and it is not clear which is the answer the candidate wants to be marked. If a candidate wants to change an answer a single line through the unwanted tick should make it clear to the examiner.

Question 2(a)(ii)

Exemplar 1 1 mark

(ii) Put a (ring) around the voltage between the live and neutral wires.

0 V 12 V 230 V 25000 V

[1]

Examiner commentary

About 40% of candidates incorrectly thought that the voltage between the live and neutral wires was either 0V or 12V. This candidate has selected the correct response.
Question 2(b)

Exemplar 1

1 mark

(b) Batteries supply direct current (d.c).

Another type of current is alternating current (a.c).

Each statement in the table below may be true about d.c, or true about a.c, or true for both d.c and a.c.

Put a tick (✓) in the correct box in each row.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True only for d.c</th>
<th>True only for a.c</th>
<th>True for both</th>
</tr>
</thead>
<tbody>
<tr>
<td>The current always flows in the same direction</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The domestic supply in the UK uses this</td>
<td></td>
<td></td>
<td>✗</td>
</tr>
</tbody>
</table>

[2]

Examiner commentary

Most candidates correctly stated that current flows in only one direction in d.c. circuits. A number of candidates incorrectly thought that the domestic supply in the UK used both a.c. and d.c.

Question 3(a)

Exemplar 1

1 mark

Alex is planning his journey to school.

(a) Alex usually walks to school.

Which is the most likely speed at which Alex walks?

Put a (ring) around the correct answer.

0.12 m/s  1.2 m/s  12 m/s  120 m/s

[1]

Examiner commentary

This question was generally well answered with most candidates correctly choosing 1.2 m/s.
Question 3(b)

Exemplar 1

(b) He could travel by car. 

A car travels at 36 km/h (kilometres per hour).

Which is the correct calculation to work out this speed in m/s (metres per second)?

[Diagram with options: 36 × 60 \[\frac{1000}{60}\] 36 × 1000 \[\frac{1000}{3600}\] 36 × 3600 \[\frac{3600}{3600}\]

Examiner commentary

Candidates in general found converting units difficult. This candidate realises that the time in hours needs to be converted and has correctly stated that there are 60 minutes in an hour. The question refers to metres per second, so the time of 1 hour needs to be converted into 60 × 60 seconds. Also, the distance of 36 km needs to be converted to metres. It might help candidates to think that 36 km is going to be a much larger number in metres, so the conversion is × 1000 for the distance. Then if the car is going 36 × 1000 metres in an hour, it will move a much smaller distance in one second, so the distance needs to be divided by a large number so the correct response is \[\frac{36 \times 1000}{3600}\].
Question 3(c)(i)  

Exemplar 1  
2 marks

(c) In the end Alex decides to cycle to school.

The graph shows the first part of this journey.

(i) Put a tick (✓) in the one correct box in each row.

<table>
<thead>
<tr>
<th>In which section does Alex have an average speed of 3.5 m/s?</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examiner commentary

This candidate has annotated the graph to help them answer the question. This is a good examination technique that has helped them to get both parts correct.
Question 3(c)(ii)

Exemplar 1

3 marks

(ii) Calculate the acceleration in section A of the journey.

Use the equation: acceleration = change in speed ÷ time

\[ \text{acceleration} = \frac{7}{10} = 0.7 \text{ m/s}^2 \]

Acceleration = \[0.7\] m/s\(^2\) [3]

Examiner commentary

It is clear that this candidate has substituted the change of velocity of 7 m/s, read off the graph at the end of the initial straight line, and the time of 10 s into the given equation to calculate acceleration. The final value has been correctly calculated and written clearly on the answer line. Coordinates from any point along that line would also give the correct answer; for example, a change of velocity of 3.5 m/s and a time of 5 seconds.
**Question 4**

### Exemplar 1

3 marks

4. Eve has a mass of 23 kg. Calculate Eve’s weight.

Gravitational field strength = 10 N/kg

\[
\text{weight} = \text{Gravitational field strength} \times \text{mass} \\
\text{weight} = 10 \times 23 \\
\text{weight} = 230
\]

Weight = 230 N [3]

**Examiner commentary**

This candidate has laid out the calculation clearly. It starts with the word equation used, and the numerical values for gravitational field strength and mass have then been substituted into the equation. The final answer is clear on the third line of working.

Setting out workings clearly is a very good technique to minimise lost marks if an accidental error is made in the final answer. In this case the candidate has already achieved 2 marks before they give their calculated value for Eve’s weight. Without workings a candidate can only get all the marks or no marks.
Question 5

Exemplar 1

5 The figure shows Li and Mia balanced on a see-saw.

Examiner commentary

Many candidates were unable to recall the correct equation to use in this question. Although this candidate has not written down the equation, the quantities are written down with their units so it is clear which quantities need to be multiplied together. The unit given on the answer line can often help candidates to work out how to do the calculation. The unit for moment is Nm, so this means that a quantity in Newtons needs to be multiplied by a quantity in metres. So, in this case the weight of 200 N should be multiplied by the distance to the pivot of 2.0 m.
Examiner commentary

This candidate realises that the size of the moment from each child must be the same for the see-saw to balance, and has shown that Li's weight must be multiplied by the length to equal the moment calculated in part (a) of 400 Nm. The candidate then uses the 'triangle' to work out how to rearrange the equation to find the distance from the pivot correctly.

As long as changes are clear (by putting a single horizontal line through the incorrect answer) there is no need to spend time scribbling out your first attempt.
Question 6(a)

Exemplar 1

2 marks

Jane sees the reflection of the light bulb in her bathroom mirror.

(a) Complete the diagram to show the path taken by the reflected light.

Examiner commentary

The rays of light in this diagram have been drawn using a ruler, and there are no gaps showing the straight-line path of the light. Arrows have been included and the ray of light is shown to reflect towards Jane's eye. This is a good, clear ray diagram and gains both marks. The angle of incidence is roughly equal (by eye) to the angle of reflection.
Question 6(b)(i)

Exemplar 1

2 marks

(b) Jane fills the bath with hot water. The mirror ‘steams-up’ and is now covered in tiny drops of water. This makes the surface of the mirror look white.

(i) Jane says, ‘The water on the mirror came from the bath’.

Examiner commentary

This candidate uses the correct scientific terminology and gains both marks. It uses the words ‘evaporates’ and ‘condenses’ in appropriate contexts which shows good understanding. Although it doesn’t specifically state that condensation happens on the surface of the mirror, this is certainly implied.

Exemplar 2

1 mark

(b) Jane fills the bath with hot water. The mirror ‘steams-up’ and is now covered in tiny drops of water. This makes the surface of the mirror look white.

(i) Jane says, ‘The water on the mirror came from the bath’.

Examiner commentary

This is a lower level response as it does not use the scientific terminology to describe the change of state. This just meets the minimum required to gain the first mark as it refer to the water from the bath becoming so hot it ‘makes’ steam. Water ‘turning into’ or ‘becoming’ steam would have been more appropriate words to use. There is no suggestion of the steam converting back to water droplets, so the second mark cannot be credited.
Exemplar 1 2 marks

(ii) Explain why the water droplets covering the mirror make it look white.

Because the water droplets cause the normals of the reflection to be in different directions. ............................................................ [2]

Examiner commentary

This is an unusual response which was given full credit. It refers to the water droplets reflecting something and includes the technical term ‘normal’. The fact that the normals are in several different directions implies that the reflection must also be in several directions.

Exemplar 2 1 mark

(ii) Explain why the water droplets covering the mirror make it look white.

Because when you look into the mirror your looking at the water droplet that are on the mirror causing lots of little reflection of light so it appear to your eyes white. .................................................. [2]

Examiner commentary

This candidate refers to the water droplets reflecting light so gains one mark. In order to gain the second mark, the response needs to state that the many reflections are all in different directions to make it look white.
Question 7(a)(i)

Ali hangs a spring next to a ruler with a centimetre scale, as shown in the diagram A. He attaches a 20 newton (N) weight to the bottom of the spring.

The spring stretches as shown in B.

(a) (i) What is the correct extension (in metres) of the spring in diagram B?

Put a (ring) around the correct answer.

0.05 m 0.15 m 0.25 m 0.35 m

Examiner commentary

This response shows evidence of good examination technique by highlighting or underlining important phrases in the question stem and has given the correct response. About 70% of candidates picked the correct response to this question.
**Question 7(a)(ii)**

**Exemplar 1**

(ii) Show that the spring constant is 400 N/m.

\[ F = kx \]
\[ k = \frac{F}{x} = \frac{20}{0.05} = 400 \text{ N/m} \]

[3 marks]

**Examiner commentary**

This candidate has recalled the correct equation to use and written it in symbol form. The equation is then rearranged to give \( k \) (spring constant) as the subject of the equation. The numerical values for force and extension are then correctly substituted to give the final value.

**Exemplar 2**

(ii) Show that the spring constant is 400 N/m.

\[ \text{Energy stored in a stretched spring} = \frac{1}{2} \times \text{spring constant} \times (\text{extension})^2 \]
\[ = \frac{1}{2} \times 400 \times (0.05)^2 \]
\[ = 0.5 \]

[3 marks]

**Examiner commentary**

This candidate has found an equation relating to the extension of a spring in the formula booklet, but it is not the right one to use in this question. This is a ‘show that’ question and the candidate has used the data given in the question and substituted the numbers into the equation and has actually answered part 7b here, and gains no marks for part 7aii.
Question 7(b)

Exemplar 1

3 marks

(b) Calculate the energy stored in the spring when it is stretched as in (a). 

\[
\text{energy stored in a stretched spring} = \frac{1}{2} \times \text{spring constant} \times (\text{extension})^2 \\
= \frac{1}{2} \times 400 \times (0.05)^2 \\
= 0.5
\]

Examiner commentary

This candidate has shown good working for this calculation, by first writing down the correct word equation found in the formula booklet, and then substituting the correct numerical values. The final answer has been correctly calculated, and this response gains all 3 marks.
Question 7(c)

Exemplar 1 1 mark

(c) When Ali adds another 20 N weight, the extension doubles.

Describe the relationship between force and extension.

If you double the force then the extension will double as well. [1]

Examiner commentary

Although this response does not refer to direct proportionality, it does clearly state that as the force doubles the extension also doubles. This gains the mark.

Exemplar 2 0 marks

(c) When Ali adds another 20 N weight, the extension doubles.

Describe the relationship between force and extension.

Has force increases, the extension of the spring also doubles and increases. [1]

Examiner commentary

Although this candidate explains correctly that the extension increases when the force increases, this response is insufficient to gain the mark. If the word 'doubles' had been used for both the force and the extension, the mark would have been credited. The relationship between force and extension in this case is that of direct proportion.
Question 7(d)

Exemplar 1

2 marks

(d) Ali pulls the spring in diagram B downwards a further 2 cm and then lets go.

Examiner commentary

This candidate refers to an energy transfer between gravitational and kinetic energy stores, but in order to gain any marks it is necessary to give both the position or process and the type of energy store. This response is credited with 2 marks as it refers to gravitational energy store when the mass moves up, and the kinetic energy store when the mass is moving.

Exemplar 2

1 mark

When Ali lets pull the spring downward, energy store in spring increases. When he lets go, most of the energy is released through kinetic energy, there is still a weight on the spring, so the spring bounces around at first but this returns to normal position because energy is lost because the spring is bouncing up and down.
Examiner commentary

When candidates describe what happens to energy, they need to include both the type of energy store and the process or location of the energy transfer. This candidate has made a number of partially correct statements. The question stem refers to Ali pulling the mass downwards and this candidate does state that this increases the energy stored in the spring, but omits the type of energy store; in this case it is an elastic potential energy store. The candidate then goes on to suggest that when Ali lets go the energy store transfers to a kinetic energy store, but this only gets the mark because of the phrase added at the bottom which clarifies that this occurs when the spring is bouncing or moving. When energy is described as being lost, again there needs to be some reference to where the energy store has gone, or the process which is involved.
Question 8(a)(i)
Exemplar 1

8 Some smoke alarms contain the radioactive isotope americium-241.

(a) Americium-241 can be represented as

\[ ^{241}_{95}\text{Am} \]

(i) Which is the number of protons in americium-241?

Put a (ring) around the correct answer. [1]

95 \[ \text{ 241} \ \ \ \ 241 + 95 \ \ \ \ 241 - 95 \]

Examiner commentary
About 40% of candidates correctly recalled that the lower number represents the number of protons in the nucleus of americium.

Question 8(a)(ii)
Exemplar 1

(ii) Which is the number of neutrons in americium-241?

Put a (ring) around the correct answer. [1]

95 \[ \text{ 241} \ \ \ \ 241 + 95 \ \ \ \ 241 - 95 \]

Examiner commentary
Around 40% of candidates correctly identified the number of neutrons to be the difference between the higher number and the lower number.
Question 8(b)(i)

Exemplar 1 2 marks

(ii) The students agree that americium-241 emits alpha radiation but not beta radiation.

Examiner commentary

The response to this question required candidates to link the observations recorded with the fact that americium-241 emits alpha but not beta radiation. This candidate refers to the count rate reducing from 620 to 23 when paper is used (observation) and recalls the fact that alpha radiation is stopped by paper so gains both marks.

Question 8(b)(ii)

Exemplar 1 2 marks

(ii) They cannot tell from their results whether americium-241 emits gamma radiation.

Examiner commentary

The response to this question required candidates to link the observations recorded with the fact that americium-241 emits alpha but not beta radiation. This candidate refers to the count rate reducing from 620 to 23 when paper is used (observation) and recalls the fact that alpha radiation is stopped by paper so gains both marks.
Question 8(c)

Exemplar 1

(c) In fact, americium-241 emits both alpha radiation and gamma radiation.

E

Evaluate how dangerous it is to have a small amount of americium-241 in a smoke alarm.

alpha radiation is extremely ionising, meaning that it can be very harmful. It is swallowed by the body, not very penetrative, meaning it can't get into your body.

Gamma radiation is not very ionising so is not that harmful and is excreted naturally but it is penetrative so can get through the skin and into our body, so having small amounts of both alpha and the gamma is safe.

Examiner commentary

This candidate has correctly stated that alpha radiation is not very penetrating, and that gamma radiation is not very ionising and gains one mark. In order to gain the second mark, the candidate needs to either explain that alpha radiation would be absorbed by the casing of the smoke detector or explain that the not much gamma radiation would be absorbed by people. In either case this means that smoke detectors are not dangerous.

Exemplar 2

very dangerous because alpha

rays can be blocked by skin, but gamma is not blocked by skin, which can cause cancer. [2]

Examiner commentary

Although this candidate knows that alpha radiation will not enter the body as it is stopped by skin, and that gamma radiation is more penetrating, the response makes no reference to the smoke detector and also incorrectly assumes that the smoke detector is dangerous.
**Question 9(a)(i)**

Exemplar 1  

9 Sundip builds a circuit to investigate a mystery component.

(a) She builds this circuit. The mystery component is the box labelled \( Y \).

(i) Add a voltmeter to the circuit to measure the potential difference across component \( Y \). [1]

**Examiner commentary**

This candidate has added the voltmeter to the circuit correctly. It is a good clear diagram, helped by using a ruler to draw clear straight lines.
Exemplar 2

9 Sundip builds a circuit to investigate a mystery component.

(a) She builds this circuit. The mystery component is the box labelled Y.

Examiner commentary

This candidate has not drawn as clear a diagram as Exemplar 1, but it was adequate for the mark to be credited. There are multiple lines used for the wires and the letter within the circle is unclear. It looks as if the candidate has crossed out the original letter, and has then added a V below the symbol. It would have been better if the candidate had used a pencil so that they were able to erase their mistakes and write in the correct response more neatly.
9 Sundip builds a circuit to investigate a mystery component.

(a) She builds this circuit. The mystery component is the box labelled Y.

(i) Add a voltmeter to the circuit to measure the potential difference across component Y. [1]

Examiner commentary

This response shows a common error and over 60% of candidates did not get this question correct. The correct symbol has been used for the voltmeter, but it has been put in series in the circuit.
Question 9(a)(ii)

Exemplar 1

1 mark

(ii) Describe how to use component X to vary the current in the circuit.

- Component X is variable resistor, by applying resistance the current in the circuit can be varied. [2]

Examiner commentary

This candidate has correctly identified that component X is a variable resistor and therefore gains one mark. Although the candidate has attempted to state that changing the resistance of X will change the current, in order to gain the second mark, the candidate needs to give a direction of the change; for example, as the resistance of X increases the current decreases.

Exemplar 2

1 mark

Component X is called a resistor by increasing or decreasing the resistance in the circuit can vary the current in the circuit because current is shared through out a series circuit. [2]

Examiner commentary

This candidate also gains the first mark for explaining that the resistance of the component X can be varied. This statement is equivalent to identifying it as a variable resistor. Again, there is no direction for the relative change in current as resistance changes, so the second mark is not achieved.
**Question 9(b)(i)**

Exemplar 1

4 marks

The table shows Sundip’s results.

<table>
<thead>
<tr>
<th>Potential difference (V)</th>
<th>Current (A)</th>
<th>Resistance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>0.68</td>
<td>1.47</td>
</tr>
<tr>
<td>2.0</td>
<td>0.93</td>
<td>2.15</td>
</tr>
<tr>
<td>3.0</td>
<td>1.13</td>
<td>2.65</td>
</tr>
<tr>
<td>4.0</td>
<td>1.30</td>
<td>3.08</td>
</tr>
<tr>
<td>5.0</td>
<td>1.45</td>
<td>3.45</td>
</tr>
<tr>
<td>6.0</td>
<td>1.59</td>
<td></td>
</tr>
</tbody>
</table>

(i) Calculate the resistance when the potential difference is 6.0 V.

Give your answer to 3 significant figures.

\[
\text{resistance} = \frac{\text{potential difference}}{\text{current}}
\]

\[
\begin{align*}
\text{pD} &= 6.0 \text{ V} \\
\text{I} &= 1.59
\end{align*}
\]

\[
\text{resistance} = \frac{6.0}{1.59} = 3.777 \text{ Ω (correct to 3 significant figures)}
\]

Examiner commentary

This candidate has laid out the calculation clearly. It starts with the word equation used, and the numerical values for potential difference and current from the last line of the table have then been substituted into the equation. Although the calculated answer has been incorrectly rounded to 4 significant figures in the first instance, the final answer has been stated correctly to 3 significant figures on the answer line, so this candidate gains all 4 marks.
Question 9(b)(ii)

Exemplar 1 1 mark

(ii) Describe the relationship between current and resistance.

As the current increases in a circuit, the resistance will increase. [1]

Examiner commentary

This candidate has correctly stated that as the current increases, the resistance of component Y increases. There is no direct proportion in this case and there is only one mark available, so this is a sufficient response for this mark.
Question 9(b)(iii)

Exemplar 1 1 mark

(iii) Suggest what component Y is.

Explain your answer.

Component Y is ...a light bulb...

Explanation ...It would be used as a component in the circuit, which will help to detect the effect of the variable resistor on the current in the circuit. [2]

Examiner commentary

This candidate has correctly identified component Y as a light bulb so gains one mark. In order to gain the second mark, the candidate needs to explain that as the current increases the temperature of a bulb increases and this causes the resistance to increase.

Exemplar 2 1 mark

Explain your answer.

Component Y is A bulb

Explanation Because a bulb can cause resistance to increase therefore decrease potential difference. [2]

Examiner commentary

This candidate also correctly identifies component Y as a light bulb, and makes an attempt at explaining that a bulb does not have a constant resistance. However, reference to increasing temperature is required for the second mark to be credited.
Question 10(a)(i)

Exemplar 1

1 mark

The diagram shows the field around a bar magnet. Three points are labelled A, B, and C.

(a) (i) Where is the field strongest?

Tick (√) one box.

A √

B

C

Examiner commentary

Over 60% of candidates were able to correctly identify the region where the magnetic field was strongest.
Question 10(a)(ii)

Exemplar 1

(ii) Where would a magnetic compass point to the right?

Tick (√) two boxes.

A  

B  

C  

Examiner commentary

This candidate has correctly identified one region where a magnetic compass would point to the right, but the question tells candidates to tick two boxes. This is a typical response where the candidate has only ticked one box. Around 10% of candidates read the stem of the question, correctly ticked two boxes and so gained the one mark available.

Question 10(b)

Exemplar 1

(b) The bar magnet can pick up paper clips.

An iron bar can also pick up paper clips if it is held next to a bar magnet.

Describe the difference in magnetism between the bar magnet and the iron bar.

Bar magnet is a permanent magnet and iron bar is induced magnet.

Examiner commentary

This candidate has clearly, concisely and correctly explained that the bar magnet is a permanent magnet and that the iron bar is an induced magnet. Either of these statements alone would have been sufficient for the mark.
**Question 10(c)**

**Exemplar 1**

1 mark

(c) The diagram shows a section through the Earth.

The flag marks the position of the geographic north pole of the Earth.

The arrow Z shows the point at which a compass needle would point vertically down at the surface.

Here are some statements about the Earth’s magnetism, some are true, and some are false.

Put a tick (✓) in the correct box after each statement.

- A compass will always point towards the centre of the Earth. ✔️

- The Earth’s magnetic north pole is in the same place as the Earth’s geographic north pole. ✗

- The core of the Earth is magnetic and produces a magnetic field. ✔️

- The compass points down because the surface at the north pole is covered with iron. [2]

**Examiner commentary**

There are 2 marks available in this question for 4 correct ticks. In order to gain both marks, all 4 ticks had to be correct. This candidate has 3 correct ticks so only gains one mark.

The second statement is false. It is a misconception that in this style of question there needs to be equal numbers of true and false statements. Some candidates appeared to be influenced by what they expected the pattern of ticks to look like rather than the four statements about the Earth’s magnetism.
Question 11(a)

Exemplar 1

(a) Describe similarities and differences between the results for the black thermometer and the silver thermometer.

**Similarities**
They both steadily increase until around 2 and a half minutes and then they begin to level out.

**Differences**
The silver thermometer can only reach about 450° whereas the black thermometer reaches about 650°. The silver thermometer is unable to reach this.

Examiner commentary
This candidate has given two correct similarities; that both thermometers show an increase in temperature and then begin to level off. The fact that the black thermometer reaches a higher temperature than the silver thermometer is correctly identified as a difference. This candidate has used correct numerical values in the description.

Exemplar 2

Similarities
Over time both conduct heat from the lamp and get hotter.

Differences
The black thermometer gets hotter much quicker as black colours conduct more heat, whereas the silver slowly gets hotter.

Examiner commentary
This candidate has attempted to explain rather than describe the similarities and differences. The explanations offered are actually incorrect as they refer to conduction rather than absorption. These incorrect parts of the response are ignored, and this candidate gains 2 marks for one similarity (stating that both thermometers become hotter) and one difference (relating to the relative rate of heating of the two thermometers).
Question 11(b)

Exemplar 1

(b) Explain the results of the experiment.

In black thermometer case of temperature is more because black colour absorbs more radiation than silver surface. [2]

Examiner commentary

It is good to see the use of correct terminology in this response. This candidate refers to absorbing radiation rather than heat and gains the first mark for stating that the black thermometer absorbs more radiation than the silver thermometer. However, in order to gain the second mark this fact needed to be linked to the idea of more energy being transferred to the black thermometer.

Exemplar 2

(b) Explain the results of the experiment.

The black thermometer reached a temperature of around 61°C in the 4 minutes whereas the silver thermometer only got to around 45°C in the time of 14 minutes. [2]

Examiner commentary

This candidate has described the results in this question where the command word is ‘explain’. Effectively the two question parts have been answered the wrong way around. This response does not include any explanation so cannot gain any marks. This was quite a common error.
Exemplar 1

1 mark

(c) Identify a weakness with Ben's method and suggest how it could be improved using information from the diagram or from the graph.

The distance of the two thermometers from the source of light is different so one thermometer might have received more radiation than others. He must keep both thermometers at the same distance from bulb.

Examiner commentary

This candidate starts off well by clearly explaining that the distance between the lamp and the thermometer may not have been the same for both thermometers and gains one mark. In order to gain the second mark, the candidate needed to describe how the thermometers can be kept at the same distance; for example, by measuring the distance with a ruler. Two marks cannot be credited for saying that the distances may not be the same, and that the distances must be kept constant.

Exemplar 2

1 mark

The temperature doesn't start at 0°C of the same starting temperature so the temperature of the thermometer starts at two different temperatures. To improve both thermometers, should start at 0°C so the readings are more accurate.

Examiner commentary

This candidate has identified a different correct issue, that of the initial temperature of the two thermometers being different and therefore gains the first mark. The candidate's suggestion of starting both at 0°C does not actually affect the accuracy of the experiment and there are no practical details about how the two thermometers would actually start at the same temperature. It may cause other difficulties and actually is a fundamental change to the experiment to have an initial temperature below room temperature. In order to gain a mark, the candidate would need to describe how the thermometers would be kept at 0°C prior to starting the stopwatch for example.
12 Nina is writing a report about the Solar System. She has written an introduction.

The planets in our Solar System all move around the Sun. They orbit in perfect circles and in the same direction. Each planet has at least one moon orbiting it. The planets and their moons are all made of rock.

(a) Identify two mistakes in Nina’s introduction.

1. Planets do not orbit in perfect circles around the sun.

2. Planets and moons are not made of only rocks.

Examiner commentary

This response shows evidence of good examination technique. The candidate has annotated the text and then correctly written out two mistakes. The first line of this response is good as it only includes the first part of the text. A misconception was for candidates to suggest that all the planets do not orbit the Sun in the same direction; except for a few comets, all the main planetary bodies in the Solar System orbit the Sun in the same direction.
**Question 12(b)**

Exemplar 1  
2 marks

**(b)** Nina wants to include a section about how the Solar System was formed.

Describe how the Solar System was formed.

Solar System was formed from one big cloud of dust and gas. The gravity attracted all dust and gas particles together. [2]

**Examiner commentary**

This candidate has correctly described how the Solar System was formed. It mentions clouds of dust and gas for the first mark and then states that it is attracted together by gravity. Many candidates gave answers relating to the formation of the Universe rather than the Solar System.
Question 12(c)

Exemplar 1

(c) Nina researches how the Sun releases energy. She finds this information in a textbook.

The Sun releases energy by nuclear fusion. The Sun emits about \(4 \times 10^{26}\) J of energy every second. As a result, its mass falls by about 4 billion kilograms every second.

Examiner commentary

This candidate incorrectly states that helium is used up causing the Sun's mass to decrease. There is some confusion as helium is formed by fusion in the Sun.

Exemplar 2

Explain why nuclear fusion causes the mass of the Sun to decrease.

Because it uses up helium atoms. [1]

Examiner commentary

This candidate has correctly stated that hydrogen atoms come together to form helium atoms in the Sun, but this does not explain why the mass decreases. In order to gain the mark, the candidate needs to use the information given in the explanation. In this case it is the fact that the mass decreases as energy is released because in nuclear fusion mass is converted into energy.
Question 13(a)

13  A toothbrush uses a rechargeable battery.

(a) The energy that is stored in the battery comes from a power station.

State how the energy is transferred from the power station to the chemical store in the battery.

Examiner commentary

This candidate correctly states that the energy is transferred by an electric current. Many candidates referred to wires, cables or transformers which did not really answer the question.

Question 13(b)(i)

(b) The potential difference across the battery is 1.2 V.

During a typical use, 360 C of charge moves though the toothbrush motor over a time of 2 minutes.

(i) Calculate the total energy transferred by the toothbrush in one day if it is used two times a day.

\[
E = P \times t \\
= V \times I \times t \\
= V \times \frac{Q}{t} \times \frac{1}{2}t \\
= V \times \frac{360}{120} \times 2 \times 120 \\
= 864 \text{ J} \]

Examiner commentary

This candidate starts by recalling that energy is power multiplied by time. Then \( V \times I \) is substituted for power. The working then gets a little less clear as it looks like the candidate is muddling up some of the symbols. The time of 2 minutes has been correctly converted to 120 seconds and the current is correctly given as charge \( \div \) time (360 \( \div \) 120). The final line is correct as it shows that the total energy equals the voltage \( \times \) current \( \times \) no of time the toothbrush is used \( \times \) time in seconds. Full marks were credited because the candidate has given evidence of a correct method.
Question 13(b)(ii)

Exemplar 1

(ii) Calculate the current in the toothbrush when used for 2 minutes each time.

\[ I = \frac{Q}{t} = \frac{360}{120} = 3 \, \text{A} \]

Current = \[3\] \, A \, [4]

Examiner commentary

This candidate has laid out the calculation clearly, starting by recalling the correct equation with current as the subject. The time in minutes has been correctly converted to 120 seconds and then substituted into the equation to give the correct final answer.
Question 14(a)

Exemplar 1

2 marks

14 The diagram shows a common type of electric heater. It contains oil which is heated by an electrical element.

The table shows some information about the heater.

<table>
<thead>
<tr>
<th>Electrical power</th>
<th>1500 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage rating</td>
<td>230 V</td>
</tr>
<tr>
<td>Specific heat capacity of oil</td>
<td>1800 J/kg °C</td>
</tr>
<tr>
<td>Mass of oil</td>
<td>4.5 kg</td>
</tr>
</tbody>
</table>

(a) Show that more than 700,000 J of energy is needed to heat the oil from 20 °C to 120 °C.

Use the equation:

\[ \text{change in internal energy} = \text{mass} \times \text{specific heat capacity} \times \text{change in temperature} \]

\[ \text{change in internal energy} = 4.5 \times 1800 \times 100 \]

\[ = 720,000 \text{ J} \]

Examiner commentary

This candidate has laid out the calculation clearly. It starts with the word equation used, and the numerical values for mass, specific heat capacity and temperature change have then been substituted into the equation. The final answer is clear on the third line of working. There is no need to specifically state that 720,000 J is larger than 700,000 J.
Question 14(b)(i)

Exemplar 1 3 marks

(b) (i) Use your answer to (a) to calculate the minimum time for the oil to reach a temperature of 120°C, starting at 20°C.

\[ E = P \times t \]

\[ t = \frac{E}{P} = \frac{720,000}{1500} = 480s \]

Minimum time = ......................... s [3]

Examiner commentary

The working for this calculation is clear. This candidate has recalled the correct equation and correctly rearranged it to give time as the subject of the equation. The numerical value for energy calculated in the previous question has been substituted along with the numerical value for power given in the table. The final answer has been correctly calculated.
## Question 14(b)(ii)

**Exemplar 1**

(II) In practice, it will take longer than this for the heater to reach 120°C. State the reason for this.

Some energy might be lost to the surrounding. [1]

**Examiner commentary**

The question asks candidates to give a reason why the heater will take longer than calculated to reach 120°C. Candidates are expected to realise that their calculation only considers the energy needed to heat up the oil to 120°C, and that the heater also consists of wires and a metal casing. A good answer would state that some energy is used up or lost in heating these items. However, in this case ‘energy is lost to the surroundings’ is acceptable as it does include to where the energy is transferred.

**Exemplar 2**

because it has to heat up the heating element first. [1]

**Examiner commentary**

This candidate refers to the fact that some energy will be used to heat up the heating element inside the heater. The use of the word ‘it’ is somewhat ambiguous, so a better answer would include the term ‘energy’.
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