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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)(iii)  

Exemplar 1  

1. Over 300 years ago, Isaac Newton measured the speed of sound in air in a long outdoor corridor. Eve and Ali repeated this experiment by measuring the time between a clap and its echo.

(a) Eve clapped her hands, and Ali timed with a tablet computer.

The computer recorded the sound of the clap and its echo and produced the graph below.

(i) What time was the sound of the clap recorded?

Time = \(0.2\) seconds [1]

(ii) What time was the sound of the echo recorded?

Time = \(0.57\) seconds [1]

(iii) Calculate the time of travel for the sound wave to go from Eve to the wall and to return to the computer.

\[0.57 \times 0.2 = 0.37\]

Time of travel = \(0.37\) seconds [1]

Examiner commentary

The candidate has clearly indicated the values and scored full marks for these three parts. A common error made by other candidates was to give the answer to part (iii) to only one significant figure.
**Question 1(b)**

**Exemplar 1**

2 marks

(b) The distance from Eve to the reflecting wall is 64 m.

Explain how you can use the distance, together with a time from part (a), to calculate the speed of sound.

*You do not have to include the calculation.*

<table>
<thead>
<tr>
<th>Examinee response</th>
<th>Examiner comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 m and divide it by the time</td>
<td>A clear and concise explanation of the method used to measure the distance which scores full marks.</td>
</tr>
</tbody>
</table>

**Examiner commentary**

A clear and concise explanation of the method used to measure the distance which scores full marks.

**Exemplar 2**

1 mark

(b) The distance from Eve to the reflecting wall is 64 m.

Explain how you can use the distance, together with a time from part (a), to calculate the speed of sound.

*You do not have to include the calculation.*

<table>
<thead>
<tr>
<th>Examinee response</th>
<th>Examiner comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed is the distance travelled in unit time. Here distance travelled is two times distance travelled is two times distance between Eve reflecting wall.</td>
<td>Very few candidates recognised that it was necessary to double the distance.</td>
</tr>
</tbody>
</table>

**Examiner commentary**

This candidate has only answered half the question and has omitted the method of calculation used by Eve. However the candidate has explained that the distance travelled by the sound is twice the distance between the wall and Eve and scores marking point 2. Very few candidates recognised that it was necessary to double the distance.
(c) Isaac Newton’s value for the speed of sound was less accurate than the one given by this method.

Suggest and explain why Newton could not get an accurate answer.

Because he wouldn’t be able to get an accurate time.

Due to the lack of technology 300 years ago.

Examiner commentary

A very clear answer, identifying the inaccurate time as the reason for the inaccurate answer, and giving the reason why. Lack of technology was allowed here as it was clear candidates meant computer technology and accurate clocks from the context. In answers to most questions this would need to be stated more clearly.
Question 2(a)

Exemplar 1

2. This question is about light moving from one medium to another.

Mia uses a ray-box to send a ray of white light into a triangular glass prism. She sees a spectrum of colours coming out.

She slides a sheet of clear red plastic into the path of the light as shown in the diagram.

When the red plastic is in place, she sees that most of the colours in the spectrum have vanished.

(a) Complete the following sentences using the words below.

absorption    frequency    reflection    refraction    speed    transmission

When light goes from air into glass, it changes direction...

This change of direction is called ...refraction...

This happens because the light changes its ...speed..., when it enters the glass.

The red plastic removes all colours except red. This is called ...absorption...

Examiner commentary

All the sentences have been completed correctly.
Exemplar 2

2 marks

(a) Complete the following sentences using the words below.

absorption  frequency  reflection  refraction  speed  transmission

When light goes from air into glass, it changes direction

This change of direction is called ____________________________

This happens because the light changes its ____________________________ when it enters the glass.

The red plastic removes all colours except red. This is called ____________________________

Examiner commentary

Only two sentences have been completed correctly. The candidate used the good examination technique of crossing out the words used as they worked through the question.

Question 2(b)(i)

Exemplar 1

2 marks

(b) This behaviour can be modelled with water waves in a ripple tank.

The diagram shows water waves moving from deeper water into shallower water.

It is viewed from above the ripple tank, with the wave crests shown as thick grey stripes.

![Diagram of water waves in a ripple tank]

(i) The waves were produced at a frequency of 2.5 hertz (Hz).

Calculate the speed of the waves in the deeper water.

Use the equation: wave speed = frequency × wavelength.
Wave speed = \frac{\text{wavelength} \times \text{frequency}}{0.12 \text{ m} \times 2.5 \text{ Hz}} = 0.3 \text{ m/s} 

Wave speed = \underline{0.3} \text{ m/s} [2] 

Examiner commentary 

The candidate has clearly set out their calculation, rearranged the equation and substituted values in from the stem of the question. Writing down the equation using the numbers from the question allows a candidate to get some credit even if their final answer is incorrect.

Many middle and lower ability candidates lose a significant number of marks in physics examinations by choosing the high risk technique of only providing the final answer. Using this risky examination technique candidates will get all the marks if their answer is correct but if they make a minor mathematical error or miss-copying from their calculator display they get no marks. These candidates cannot be awarded any credit as there is no record of the potentially correct approach they took to the question.

Question 2(b)(ii) 

Exemplar 1 2 marks 

(ii) Explain how the ripple tank diagram helps to explain the behaviour of light shown in part (a).

\quad \text{you can see how the waves are getting shallower when it hits shallow water and changes direction towards the normal line (parallel to tank)}

Examiner commentary 

The answer lines available and the marks for each part of a question indicate what a candidate is expected to write. The candidate has provided two separate areas of explanation to gain both marks:

\begin{itemize}
  \item the waves are slowing down
  \item the waves change direction
\end{itemize}

Exemplar 2 1 mark 

(i) Explain how the ripple tank diagram helps to explain the behaviour of light shown in part (a).

\quad \text{In ripple tank, ripple gets refracted from deeper water and shallow water. In some way it travels from one medium to either.}

Examiner commentary 

The candidate has identified that both light and water waves show refraction and is credited with one mark. However this is a 2 mark question and so at least one other way that the ripple tank explains the behaviour of light through the prism is required. They could have mentioned the change of speed, wavelength or direction, or the fact that this shows light is a wave.
Question 3(a)

Exemplar 1

3 The generator in a power station is connected to the National Grid through a transformer.

Near a town, other transformers are used to transfer power into homes.

Fig. 3.1 is a simplified diagram showing just one transformer near the homes.

Fig. 3.1

(a) The generator produces an alternating voltage, not a direct voltage.

Explain the difference between these two types of voltage.

direct voltage cannot change in frequency
no direction, it goes straight to where it needs to be. Alternating is the opposite
because it can change direction

Examiner commentary

This was one of the most challenging questions and candidates found it very difficult to explain the difference. Just over one in ten candidates gained any marks for their answer.

Many candidates have the misconception that ‘direct’ means the voltage goes straight from where it is produced to the consumer, whereas alternating voltage goes to lots of consumers. The National Grid distribution system appears to be partly responsible for the confusion. This candidate does refer to the direct voltage going ‘straight to where it needs to be’; but has already made clear that they know that direct voltage does not change direction.
Question 3(b)(i)

Exemplar 1

(b) (i) Using Table 3.1 calculate the output current for transformer B.

Use the equation:
Input potential difference × Input current = Output potential difference × Output current

Transformer A has already been completed.

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Input potential difference (V)</th>
<th>Input current (A)</th>
<th>Output potential difference (V)</th>
<th>Output current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>23000</td>
<td>300</td>
<td>23000</td>
<td>300</td>
</tr>
<tr>
<td>B</td>
<td>230000</td>
<td>300</td>
<td>230</td>
<td></td>
</tr>
</tbody>
</table>

\[ 230000 \times 300 = 230 \times \text{output current} \]

\[ \text{output current} = \frac{230000 \times 300}{230} \geq 300 \]

Examiner commentary

This exemplar is written by a candidate who gained full marks for this question and showed their working. Candidates often gained no marks because their final answer was incorrect and they had not detailed any working.

One possible conclusion is that candidates who show their working are more likely to get a correct answer.

The candidate in this exemplar has set out their response in an ideal way:

- The calculation is clearly set out
- The correct values from the table have been substituted in
- The equation is rearranged to make output current the subject
- The final calculation is correct
Question 3(b)(ii)

Exemplar 1

(ii) Use the input data for transformer A to show that the output power of the generator is more than 60 megawatts (MW).

\[ 1 \text{ MW} = 1000000 \text{ W} \]

\[ 23000 \times 3000 = 69,000,000 \text{ W} = 69 \text{ MW} \]

Output power = 69 MW [3]

Examiner commentary

The calculation is clearly set out. The data for the input transformer A has been correctly used to calculate the output power in watts and then this has been converted to megawatts. A common mistake was to ignore the instruction to use the input power and use the output power.

Question 3(b)(iii)

Exemplar 1

(iii) A typical home needs a power of 10 kilowatts (kW).

\[ 1 \text{ kW} = 1000 \text{ W} \]

Calculate the number of homes that this power station could supply. Use your answer to (b)(ii).

\[ \frac{69,000,000}{1000} = \frac{69,000}{10} = 6900 \text{ kW} \]

Number of homes = 6900 [2]

Examiner commentary

The calculation is clearly set out with the unit conversion and the calculation of the number of homes. Setting out workings is very important to minimise lost marks. At least 30% of the marks in GCSE Physics examinations are for questions that require the application of mathematics, which are at least 27 marks in a J259 question paper. Comparison of the marks gained by middle and lower ability candidates who do and do not write down their workings suggest that candidates who provide no workings give away between 9 and 12 marks per paper that they could have gained for a correct method, but an incorrect final mark.
Question 3(c)

Exemplar 1

2 marks

(c) All power stations use step-up transformers like transformer A between the generator and the National Grid power cables. Explain how using 230,000V instead of 23,000V for the cables across the country makes energy transfer more efficient.

Energy is lost as heat when current passes through long a cable. By decreasing current this loss can be minimised. So using 230,000V can be minimised. So using 230,000V instead of 23,000V is more energy efficient.

Examiner commentary

Candidates found this question difficult. The candidate in Exemplar 1 has correctly explained that energy is dissipated as current is transmitted through the power lines. They have then gone on to explain the fact that decreasing the current minimises this loss.

Exemplar 2

0 marks

This is more power so it will keep moving across the country it won’t stop. 23,000V may not be enough so will not get where it needs to be.

Examiner commentary

Exemplar 2 is typical of many of the other candidates. They have given one of the most common misconceptions that the National Grid increases the power available to homes by increasing the voltage in the power lines.
Exemplar 3

Examiner commentary

Exemplar 3 shows the other common misconception that the energy will travel faster at a higher voltage. The candidate is interpreting efficiency as ‘better in some way’ and they have chosen faster energy transfer as better.

Candidates (like those in Exemplars 2 and 3) had an incorrect understanding of efficiency. Most foundation tier candidates do not understand that electricity is distributed through the National Grid at high voltages to reduce energy losses. Many have the misconception that the National Grid is being used to increase the energy available and the rate that it is transferred to consumers.

Question 4(a)(i)

Exemplar 1

4 Solar farms are large power stations made up from many photovoltaic (PV) panels. Even though they are now very common, most of Britain’s electricity is generated by burning gas.

(a) Here are some data about these two types of power station.

<table>
<thead>
<tr>
<th>Type of power station</th>
<th>Solar farm</th>
<th>Gas-burning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power output (MW)</td>
<td>35</td>
<td>1400</td>
</tr>
</tbody>
</table>

(i) Calculate the number of solar farms that would be needed to give the output power of this gas-burning power station.

\[ 1400 \div 35 = 40 \text{ farms} \]

Number of solar farms = 40 [2]
Examiner commentary

The candidate in Exemplar 1 has set out their calculation is clearly set out:
• data values taken from the stem of the question
• calculation completed correctly

Setting out your method and workings clearly is a very good examination technique to minimise the number of marks that could be lost for minor errors or incorrectly copying results down from a calculator display. Comparing candidates of similar ability who do and do not write down their workings suggests that if you do not write down your workings you are probably losing between 9 and 12 compensatory marks that could have been gained for a correct method but an incorrect final answer.

Question 4(a)(ii)

Exemplar 1

(ii) In the table, the 35 MW power of the solar farm is the maximum power it can produce. Give two reasons why the output power is often less than 35 MW.

1. Because it depends on the sun's light, which means it can't always reach maximum.
2. At night it is dark, meaning that very little power is produced. [2]

Examiner commentary

The number of answer lines and the marks available are a guide to what a candidate is expected to write in their answer. In Exemplar 1 the candidate has given two clear reasons and gained full marks. The candidate's writing style is also very clear and concise, an excellent approach for scientific writing.

Exemplar 2

(ii) In the table, the 35 MW power of the solar farm is the maximum power it can produce. Give two reasons why the output power is often less than 35 MW.

1. Some gets lost when travelling to houses.
2. Sun may not be cut (clouds) all of the day, so it may not work all the time. [2]

Examiner commentary

The candidate in Exemplar 2 has highlighted parts of the question stem to aid with interpreting the question. However having highlighted the stem of the question (good examination technique) they have then ignored this in their response. Exemplar 2 does get 1 mark for their second reason, but the use of common everyday language, rather than technical terms, means that this is a lower ability answer, compared to Exemplar 1. Using technical scientific language can help candidates to be clear and unambiguous.
Question 4(b)

Exemplar 1

Level 3, 6 marks

Examiner commentary

Exemplar 1 is an example of a Level 3 answer which gained 6 marks. The candidate has made good use of bullet points in a table to answer this question clearly. The advantages and disadvantages of both types of power station are addressed, including whether the resources are renewable, and the answer is of an appropriate length.

This candidate has written 65 words in their response. Other 6 mark Level 3 responses which were written in a scientific continuous prose writing style were typically 90 to 110 words long. Although we saw fewer over-long answers than on the higher tier papers, it is still worth noting that these tend to gain fewer marks, because they contain irrelevant detail and often contradict or repeat points made earlier.
Exemplar 2

Describe the advantages and disadvantages of both power stations using Jane and Ben's views.

An advantage of using solar farms is that it takes up a lot of space and could also cause habitat loss for some animals. However, an advantage is that they do not need to burn fossil fuels.

A disadvantage of using gas-burning power stations is that the let off a lot of harmful gas. However, an advantage is that it enables work in the area, bringing in more money.

Examiner commentary

Exemplar 2 is an example of a Level 2 answer which gained 4 marks. The candidate addresses the advantages and disadvantages of both power stations in a clearly structured response and the candidate's response is well written, using an appropriate scientific writing style. Many other candidates used a story telling writing style which meant that they wrote overly long answers some of which were over 200 words long.

To progress to Level 3 this candidate needs to address the important point that one resource is renewable and the other is not.

Exemplar 3

Describe the advantages and disadvantages of both power stations using Jane and Ben's views.

...Gas is non-renewable so will run out.
...Much power means more energy, more waste product that will affect the environment.
...The output is small so will release less pollutants and ... will have less cost.
...CO2 is done will damage the environment such as nitrogen that means less oxygen and more cost.
...Renewable energy like wind, etc... will not run out.
...Nuclear is non-renewable.
Examiner commentary

Exemplar 3 is an example of a Level 1 answer which gained 2 marks. The candidate has explained the difference between renewable and non-renewable resources and each type of power station is correctly stated to be renewable or not renewable. Nuclear power stations are not one of the two options discussed by Jane and Ben and including irrelevant details that are not part of the question makes the quality of written communication worse not better.

To progress to Level 2 the response needs a sustained line of reasoning, and a more obvious logical structure. No credit can be given for advantages or disadvantages as it is not clear which statements refer to advantages and which to disadvantages.

Question 5(a)(i)

Exemplar 1

2 marks

5 There is a film about an astronaut named Mark Watney. He is left alone on the planet Mars. He has to use science to stay alive until he can be rescued.

(a) Mars is a cold planet. Watney uses a radioactive thermal generator to heat himself. The generator contains radioactive plutonium-238 which emits alpha-particles (α).

(i) Complete the radioactive decay equation for plutonium-238.

\[
\begin{align*}
238 & \quad 94 \quad \text{Pu} \\
 \rightarrow & \quad \text{U} + 2\alpha
\end{align*}
\]

Examiner commentary

Lower ability (particularly male) candidates found this question very challenging, and two fifths of candidates gained no marks. In this exemplar the candidate clearly understands the standard nuclear notation and has calculated and written the mass number and atomic number correctly.

Question 5(a)(ii)

Exemplar 1

2 marks

(ii) The radioactive plutonium-238 is sealed inside a case with thin walls made of aluminium. The plutonium-238 emits a large number of high energy alpha-particles each second.

Two of the following statements, taken together, explain why Watney is not at any risk from irradiation.

Tick (✓) two boxes.

Alpha particles cannot penetrate a thin sheet of paper. ✓

Alpha radiation is never dangerous. ×

Alpha radiation is not part of the electromagnetic spectrum. ×

The aluminium in the case is thicker and denser than thin paper. ✓

He always wears safety glasses when he handles the plutonium-238.
Examiner commentary

The two correct statements are ticked. In Exemplar 1 the candidate has used good examination technique and put a cross by each answer that he or she knows to be incorrect while working down the list.

Question 5(b)(i)

Exemplar 1

(b) To be rescued, Watney needs to travel 3200 km across Mars to a rocket.

He drives there using a battery-powered vehicle. The battery is recharged using solar panels.

The Sankey diagram in Fig. 5.1 shows the energy transferred in one hour by the solar panels.

16 kWh from solar radiation

heating the surroundings

1.6 kWh generating electricity

Fig. 5.1

(i) Calculate, as a percentage, the efficiency of the solar panels.

Use the equation: efficiency = (useful energy transferred ÷ total energy transferred) × 100

\[
\frac{16 - 1.6}{16} = \frac{14.4}{16} = 0.9 = \frac{90}{100} = 90\% \]

Examiner commentary

In this exemplar the candidate has given two sets of calculations. In the first set, they have used an incorrect method and calculated the useful energy as a percentage of the ‘wasted’ energy.

In their second set of calculations they have correctly calculated useful energy as a percentage of the input energy from the sun. Notice how the candidate has clearly crossed-out the incorrect answer on the answer line and replaced it with the correct answer.

Some candidates will spend time scribbling out wrong answers, it is much better to simply strike though a wrong answer with a single horizontal line. It would also have been sensible to cross out the incorrect method to avoid any confusion.
Question 5(b)(ii)

Exemplar 1

(ii) The rechargeable battery stores 18 kWh of energy.

Use data from Fig. 5.1 to show that the solar panels need more than 10 hours to recharge the battery.

\[ 1.6 \times 10 = 16 \text{ kWh which is less than } 18 \text{ kWh which is required} \]

He needed 18 kWh

Examiner commentary

In this exemplar the candidate has written out a clear calculation showing that in 10 hours the energy transferred from the solar panels is less than the required 18 hours. The comparison with 18 hours is needed for the second mark.

This method was popular. Some candidates chose a different method and calculated the number of hours required to transfer 18 kWh. Both methods were equally acceptable.
Exemplar 1

Question 5(c)

4 marks

This exemplar is an excellent candidate response which demonstrates how the graph needed to be completed for full marks:

- The end co-ordinate of the diagonal line has been correctly calculated as [4,100].
- Distance time line starts at the origin [0,0] and has been clearly drawn with a ruler.
- The co-ordinate of the inflection point/end of diagonal line [4,100] is correctly plotted.
- The time distance line stops at [14,100]

Note that all points must be correctly plotted to ±½ a small square
Exemplar 2

(c) Watney sets off on his journey to the rocket.

He drives for 4 hours at a steady speed of 25 km/hour.

He then stops to let the battery re-charge for 10 hours.

Complete this distance-time graph.

Examiner commentary

Exemplar 2 is an example of lower ability scientific drawing skills, where the candidate has only been credited for plotting two of the points on the graph:

- The end co-ordinate of the diagonal line has been correctly calculated as [4,100].
- The co-ordinate of the inflection point/end of diagonal line [4,100] is correctly plotted

The end point of the time distance line [14,100] is incorrectly plotted, the lines joining the three points are not straight.

Although candidates can choose whether to draw diagrams and graphs using a pencil (you may use an HB pencil) all candidates are instructed on the front cover of every OCR science question paper that they 'must have a ruler.' Candidates are expected to be able to plot points onto a graph accurately (i.e. ±½ a small square) and lines of best fit (scatter graphs) or lines joining data points (time series line graphs) are expected to be straight lines/smooth curves depending on what the data shows.
Question 6(a)(i)

Exemplar 1

6 Alex is investigating the forces acting on a trolley to slow it down on different surfaces.

Fig. 6.1 shows his apparatus. Each time, he starts the trolley at the same marked point and measures how far it goes along the test surface before it stops. The centre of the trolley is marked with a dot.

![Diagram](https://example.com/diagram)

Fig. 6.1

(a) (i) Here are measurements that Alex takes.
Mass of trolley = 0.80 kg
Height = 0.20 m

Assume gravitational field strength = 10 N/kg

Calculate the gravitational potential energy transferred when the trolley leaves the ramp.

\[
P_{\text{GPE}} = \text{mass} \times \text{Gravitational field strength} \times \text{height} = 0.80 \text{ kg} \times 10 \text{ N/kg} \times 0.20 \text{ m} = 1.6 \text{ J}
\]

Gravitational potential energy transferred = 1.6 J [3]

Examiner commentary

In this exemplar the candidate has clearly set out their workings in a way that is easy to follow, for both the candidate and the examiner.
Question 6(a)(ii)

Exemplar 1

2 marks

(ii) Alex says that the kinetic energy of the trolley when it leaves the ramp is the same as the gravitational potential energy transferred.

Which of the following statements must be true if Alex is to assume this?

Tick (✓) two boxes.

Air resistance is very small. [✓]
Gravity acts downwards on the trolley. [✓]
The ramp is very flat. [ ]
The trolley is very light. [ ]
There is not much friction acting on the trolley. [✓]

Examiner commentary

Candidates will change their minds – sometimes several times – about which answers to tick. Their final answer must be clear and unambiguous. Examiners will accept any clear indication of the candidate's choice. In this case the candidate's final answer is two clear choices.
Question 6(a)(iii)

Exemplar 1

1 mark

(iii) Alex repeats the experiment five times. He measures the distance the trolley travels along the test surface each time.

Table 6.1 shows his results.

<table>
<thead>
<tr>
<th>Reading</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance travelled (m)</td>
<td>1.2</td>
<td>1.4</td>
<td>1.2</td>
<td>0.6</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Table 6.1

Calculate the mean distance the trolley travelled along the test surface.

Tick (✓) one box.

1.1 m
1.2 m
1.3 m
1.4 m

Examiner commentary

Most candidates used all five values from the table to calculate the mean. This candidate has correctly evaluated the data table and concluded that the 4th reading is an outlier (or anomalous result) that should be excluded from the calculation.

In this case as result 4 is half or less than half of all the other values, and the candidates experience of such experiments should enable them to make a sensible decision that in this case reading 4 cannot be correct, and it should be excluded from the analysis.
Question 6(b)(i)

Exemplar 1

1 mark

(b) Alex carries out this experiment for a range of kinetic energy values.

Table 6.2 shows his results.

<table>
<thead>
<tr>
<th>Initial kinetic energy (J)</th>
<th>0.8</th>
<th>1.6</th>
<th>2.4</th>
<th>3.2</th>
<th>3.9</th>
<th>4.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean distance travelled (m)</td>
<td>0.80</td>
<td>1.35</td>
<td>1.60</td>
<td>1.85</td>
<td>1.90</td>
<td>1.95</td>
</tr>
</tbody>
</table>

Table 6.2

These data are plotted on the graph in Fig. 6.2. Three points have been left off.

(i) State the reason why Alex was right to plot a point at the origin, (0,0).

Trolley was at rest when Alex started the experiment, hence initial kinetic energy was [1]

Examiner commentary

Most candidates who answered this question successfully reasoned that if the trolley hadn't moved it would have no kinetic energy. Exemplar 1 gives a response which is more or less the answer given in the mark scheme guidance.
Question 6(b)(ii)

Examiner commentary
The incorrect point has been deleted and replaced with the correct point, so that all points are plotted accurately. A smooth curve of best fit has been drawn through the points. The heavier line can be assumed to be the candidate’s final answer.

In an examination situation we do not expect that candidates will complete plotting and curve drawing without any errors at their first attempt, but only that any alterations they make must make their final answer clear. It would have been a good idea to use pencil to plot the points so that incorrect points could be erased. Alternatively, they could be labelled ‘incorrect.’

Question 6(c)

Examiner commentary
Most candidates were able to answer the first part of this question, but the second point (that the rate gets lower) was rarely seen. This candidate chose a clear and concise way of describing the trend and gained both marks.
Exemplar 2

(c) Describe the pattern shown by these results.

There is a positive correlation so it shows that the higher the initial kinetic energy the higher the distance travelled. [2]

Examiner commentary

Exemplar 2 is a typical 1 mark response. ‘Positive correlation,’ and ‘the higher the energy the higher the distance,’ refer to the first part of the pattern and either gains the first mark.

Question 7(a)(i), (ii), (iii) and (iv)

Exemplar 1

7 This question is about the particles in a gas and the pressure they exert on a container.

(a) The diagram below shows four samples of the same gas in containers of the same size.

Each particle is shown as a circle.

The arrow on each particle shows its velocity.

Answer each question with one of the letters A, B, C or D.

(i) Which sample has the fastest particles?

D [1]
Examiner commentary

For multiple choice questions like this it is important for the candidate to write a clear response. Many candidates made alterations and changes that were unclear.

It can help with this style of question to annotate the four options given, and to be aware that each option could be used more than once. To change your answer, clearly cross through the incorrect option letter and replace it with a clearly written correct option letter. Avoid scribbling out answers as the effort involved is unnecessary and the scribble may cause confusion over what was intended.

Question 7(b)

Exemplar 1

2 marks

(b) A tight-fitting moveable piston traps gas in a cylinder as shown in the diagram.

The gas has volume 300 cm$^3$ and pressure of 100 kilopascals (kPa).

The piston is now pushed in and changes the volume of the gas to 150 cm$^3$.

The temperature of the gas has not changed.

Calculate the new pressure of the gas.

Use the equation: old pressure $\times$ old volume = new pressure $\times$ new volume

\[ 100 \times 300 = \text{new pressure} \times 150 \]

\[ \text{new pressure} = \frac{100 \times 300}{150} \]

\[ \text{New pressure} = \frac{2,000}{150} \text{ kPa} \]
Examiner commentary

This exemplar is another example of a candidate setting out their workings clearly.

**Question 7(c)**

**Exemplar 1**

3 marks

(c) The piston is moved to a new position.

The force with which the gas pushes out on the piston is now 300 N.

The area of the piston is 0.002 m$^2$.

Calculate the pressure of the gas in pascals (Pa).

\[
\rho = \frac{F}{A} = \frac{300 \text{ N}}{0.002 \text{ m}^2} = 150000 \text{ Pa}
\]

Examiner commentary

Calculation clearly set out. The area of 0.002 m$^2$ is used. Some candidates assumed this value was a length and squared it to find the ‘area’.
Question 8(a)(i)

Exemplar 1

This question is about using an LDR (light-dependent resistor) to measure light intensity.

(a) The resistance $R$ of an LDR varies with illuminance (the amount of light energy per unit area hitting a surface) as shown in the graph.

(i) Which of the following statements correctly describes this variation?

Tick (✓) one box.

- The resistance is directly proportional to the illuminance.
- The resistance and the illuminance have a positive correlation.
- As the illuminance increases, the change in resistance becomes less and less.
- The resistance is greater at 80 lux than at 20 lux.

Examiner commentary

This is a clear answer. The options in multiple choice questions are usually the main misconceptions that candidates make. It can help some candidates to strike out the options that are clearly incorrect and then concentrate on deciding between the options that are left.
Question 8(a)(ii)

Exemplar 1

(ii) Use the graph to estimate the change in resistance of the LDR when the illuminance increases from 10 lux to 70 lux.

\[ 10 = 20 \Omega \]
\[ 70 = 6 \text{k} \Omega \]

Change in resistance = \[\text{.........................} \text{k} \Omega \] [2]

Examiner commentary

Exemplar 1 is a clear well set out answer. The values of resistance at 10 lux and 70 lux have been stated and the difference calculated. The value for 70 lux is within the allowed range, leading to a final answer within range.

Question 8(b)(i)

Exemplar 1

(b) The LDR is connected in series with a fixed resistor of resistance 10 kΩ and a 4.5 V battery.

The total resistance at 30 lux is 22 000 Ω.

\[ 4.5V \]
\[ 10 \text{k} \Omega \]

(i) Calculate the current in the circuit.

\[ I = \frac{V}{R} = \frac{4.5}{22000} = 0.000204 \text{A} \]

Current = \[0.000204 \text{A} \] [3]

Examiner commentary

This exemplar is a clearly set out answer stating the equation and showing the correct substituted values for potential difference and total resistance. It was common to see the value of the fixed resistance, 10 kΩ, used in error.
**Question 8(b)(ii)**

**Exemplar 1**

3 marks

(ii) Calculate the potential difference across the fixed 10 kΩ resistor when the illuminance is 30 lux.

\[ V = IR = \frac{0.0002 \times 10000}{20000} \]

Potential difference = \( \frac{2}{2} \) V [3]

**Examiner commentary**

In this exemplar the candidate has recalled the correct equation, substituted in the correct values for current and total resistance converted to Ω, but the conversion from kΩ to Ω has not been explicitly stated. If the equation (i.e. \( V = I \times R \)) had been incorrectly recalled it is unlikely that the method would have been clear enough for a mark to have been credited for the conversion.

**Question 8(b)(iii)**

**Exemplar 1**

2 marks

(iii) Describe, without any calculations, how the potential difference across the fixed resistor will change when the illuminance increases from 30 lux to 100 lux.

Potential difference directly proportional to the resistance and current. As the resistance of the LDR decreases with increase of illuminance from 30 lux to 100 lux, potential difference across LDR decreases and potential difference across fixed resistor increases. [3]

**Examiner commentary**

This was a challenging question, and no foundation tier candidate gained all 3 marks. In this exemplar the candidate has identified that as the illuminance increases the resistance of the LDR decreases for 1 mark. They have then reasoned that the potential difference across the LDR decreases and so have been credited with a second mark for stating that the potential difference across the fixed resistor increases.

Higher tier candidates observed that the resistance changes got smaller as the illuminance increased which meant that the p.d. changes also got smaller in size.
9 Sarah carries out an experiment to measure the specific latent heat of vaporisation of water. She does this by finding the energy needed to evaporate a known mass of water.

The apparatus she uses is shown in Fig. 9.1.

Using this apparatus, Sarah takes these readings.

<table>
<thead>
<tr>
<th></th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>current</td>
<td>3.0A</td>
</tr>
<tr>
<td>potential difference</td>
<td>12 V</td>
</tr>
<tr>
<td>time</td>
<td>150 s</td>
</tr>
<tr>
<td>balance reading at start</td>
<td>185.3 g</td>
</tr>
<tr>
<td>balance reading at the end</td>
<td>184.3 g</td>
</tr>
</tbody>
</table>

**Table 9.1**

(a)* Sarah is not happy with her results.

Sarah

The book says the specific latent heat of vaporisation of water should be 2300 J for every gram evaporated. The readings in **Table 9.1** give an answer that’s far too big.
**Examiner commentary**

This was a challenging question. A Level 3 answer required use of the data to calculate the specific latent heat. Exemplar 1 is an example of a Level 3 answer which gained 5 marks. This candidate calculated the energy transfer and equated it to the specific latent heat, but without stating that the mass of the water evaporated was 1 g.

Together with a suggested improvement of repeating the experiment this was considered a Level 3 answer. However, the later part of their data analysis is confused and there was not enough detail of the calculation, or the reasons why repeats (which mainly improve precision rather than accuracy) would help Sarah to get a more accurate result. For these reasons this is a 5 mark rather than a full 6 mark response.
Exemplar 2

Examiner commentary

Exemplar 2 is an example of a Level 2 answer which gained 4 marks. The candidate has not considered the data. They have made a number of suggestions, such as repeating the experiment to check for outliers and increasing the time. Both of these suggestions are valid improvements, so this answer reaches the top of the level. Note that only one valid improvement is needed for Level 2.

To progress to Level 3 the candidate would need to offer a reason why increasing the time would improve the accuracy of Sarah's results. They would also need to carry out some mathematical analysis of the results to check whether the value of specific latent heat is greater than 2300 J/g.
What could Sarah do to get an accurate value of the specific latent heat of vapourisation of water from her experiment? 

Sarah is correct when looking at her results and using the equation: \[ \text{energy} = \text{mass} \times \text{specific latent heat} \]. This can be improved to get a more accurate value of specific latent heat by working out the energy change so her results can go in easily into the equation. Also to improve her accuracy she should repeat the experiment as many times as she can and get it checked by someone in the end. This also improves reliability. 

Examiner commentary

Exemplar 3 is an example of a Level 1 answer which gained 1 mark. The candidate calculated the mass of the water and the energy required to evaporate 1 g, verifying Sarah’s statement. However, they did not make any attempt to calculate the energy used in the experiment. The only improvement they have suggested is the generic one of repeating the experiment, but this is incomplete as there is no suggestion of checking for outliers or taking a mean. Reliability is too vague and gains no credit. To progress to Level 2 the candidate could instead have discussed the repeatability, reproducibility, precision and/or accuracy of the readings made by Sarah.
Question 9(b)

Exemplar 1

(b) Sarah’s book has this information about vaporisation of two liquids.

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Specific latent heat of vaporisation (J per gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>2300</td>
</tr>
<tr>
<td>alcohol</td>
<td>950</td>
</tr>
</tbody>
</table>

Suggest why it takes more energy to evaporate 1 gram of water than it does to evaporate 1 gram of alcohol.

The energy required to evaporate gram of water depends on the intermolecular force of attraction between water molecule. Hence the intermolecular force in water molecule is higher than in alcohol molecule. [3]

Exemplar 2

Because water is probably higher in density than alcohol, meaning water has more matter per gram than alcohol does. [3]

 Examiner commentary

Foundation tier candidates found this question very challenging. Candidates that gained 2 marks generally gained their second mark for a poorly expressed second suggestion that was given a benefit of the doubt (BOD).

The two examples shown were selected as they give clearly expressed examples of the two most common reasons given by foundation tier candidates. The candidate in Exemplar 1 has written a detailed suggestion of how the intermolecular attraction force between water molecules is higher than between alcohol molecules. The candidate in Exemplar 2 suggests how the higher density affects the energy needed to evaporate water compared to alcohol.

Other suggestions that would have gained credit include:

- Bonds must be broken to change state
- Specific latent heat of alcohol < specific latent heat water
- Alcohol is more volatile than water
- More molecules in 1 g of water compared to 1 g of alcohol
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