# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Question 1(a)(i) &amp; (a)(ii)</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Question 1(b)(i), (b)(ii) &amp; (b)(iii)</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Question 1(b)(iii)</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Question 2(a)*</td>
<td>7</td>
<td>31</td>
</tr>
<tr>
<td>Question 2(b)</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>Question 3(a)(i) &amp; (a)(ii)</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>Question 3(a)(iii)</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>Question 3(b)(i) &amp; (b)(ii)</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Question 4(a)(i) &amp; (a)(ii)</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Question 4(b)(i)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Question 4(b)(i) &amp; (b)(ii)</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Question 5(a)(i) &amp; (a)(ii)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Question 5(b)(i) &amp; (b)(ii)</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Question 5(c)</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>
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.

Please always refer to the specification [http://www.ocr.org.uk/qualifications/gcse/gcse-twenty-first-century-science-suite-physics-b-j259-from-2016/] for full details of the assessment for this qualification. These exemplar answers should also be read in conjunction with the sample assessment materials and the June 2018 Examiners’ report or Report to Centres available from Interchange [https://interchange.ocr.org.uk/Home.mvc/index].

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/]).

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)(i) & (a)(ii)

(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.

Exemplar 1

Part (i) 1 mark, part (ii) 2 marks

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

\[ 10 \text{ lux} = 20 \text{ k}\Omega \]
\[ 70 \text{ lux} = 5 \text{ k}\Omega \]

Change in resistance = \(15\) kΩ [2]

Examiners’ commentary

These two parts, at the very beginning of the paper, were designed to provide a gentle start, and the results bore this out. In exemplar 1 we see a well-organised candidate who has annotated the question paper to help in sorting out what the task is and also marked the graph clearly (even if not very neatly) to tackle part (a)(ii).
**Exemplar 1**  Part (i) 3 marks, part (ii) 3 marks, part (iii) 1 mark

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

\[ \text{The total resistance at 30 lux is } 22000 \Omega. \]

\[ V = 4.5 \text{ V} \]

\[ I = \frac{V}{R} \]

\[ I = \frac{4.5}{22000} = 0.0002045 \]

Current = 0.0002045 A \[ \text{[3]} \]

(i) Calculate the current in the circuit.

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

\[ V = IR \]

\[ = 0.0002 \times 10,000 \]

\[ = 2.045 \]

Potential difference = 2.0 \[ \text{[3]} \]

(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.

As the illuminance increases, this will decrease the resistance and decrease the total resistance in the circuit. This will increase the current as \( V = IR \) and more current will be able to flow through it, this increases the voltage across the fixed resistor and decreases the voltage in the battery. \[ \text{[3]} \]
Examiners’ commentary

This high level candidate had no problem with parts (b)(i) and (ii) and has laid out the calculations in an exemplary fashion, even correctly rounding two 2 significant figures, which is appropriate, but not demanded in the mark scheme.

In part (b)(iii) the same candidate was less successful and the answer showed a number of errors. They gained a mark for p.d. increases. The candidate’s logic for this increase is based on an incorrect assumption (constant current) and increased resistance (also wrong), but because there is always the possibility that the candidate had changed their mind before writing ‘increases the voltage across the fixed resistor’ and had re-analysed the situation before writing that, the mark has be given.

In this part of the question, the mean mark scored was 1 out of 3 with few if any getting 3 out of 3.

Question 1(b)(iii)

Exemplar 1

1 mark

(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.

...will go up because more resistance is needed to cope with the change in illuminance and keep the current the same...

[3]

Examiners’ commentary

This candidate gained one mark for a p.d. increase by the application of a benefit of the doubt (BOD) because the marker has to interpret ‘it’ as meaning potential difference. ‘It’ is a notoriously vague word which candidates should avoid in their answers.
2 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. 2.1.

![Diagram of apparatus: electrical heater, boiling water, bubble of steam, top pan balance with a reading of 185.3g]

**Fig. 2.1**

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>185.3g</td>
</tr>
<tr>
<td>balance reading at the end</td>
<td>184.3g</td>
</tr>
</tbody>
</table>

**Table 2.1**

(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 2.1** give an answer that’s far too big.

Is Sarah right?
Exemplar 1

What could Sarah do to get an accurate value of the specific latent heat of vapourisation of water from her experiment?

\[ P = 3 \times 12 = 36 \text{ W} \]

This means that the energy change in internal energy should be \[ 36 \times 150 = 5400 \text{ J} \]. This is more than 2300 and the only way of water evaporates so Sarah is right.

In order to get an accurate value, Sarah should insulate the beaker more, so there is less energy lost to the surroundings. She could do this by putting a beaker in a polystyrene cup filled with cotton wool and putting a lid on the cup... [6]

Examiners’ commentary

In exemplar 6, the evaluation of Sarah’s comment in the first six lines are completely correct, and the remaining six lines identify heat losses as a shortcoming and suggest a reasonable way of improving them. The candidate’s expression is good – the Level 3 requirement for communication is *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* – and so this is a completely successful Level 3 response and gets 6 marks.
Exemplar 2

Level 2, 4 marks

Examiners’ commentary

This candidate has used the experimental data accurately to confirm that they give an answer which is too large. However, Level 3 requires specific evaluation/development and neither ‘increase the voltage’ nor ‘decrease the weight of the water’ qualifies, so this response is not Level 3. The correct calculation of 5400 J/g is enough for Level 2, and the communication requirement for Level 2 (There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.) is also met, so 4 marks are credited here. It is worth noting that this response was quite succinct, and that a single sentence more could easily have achieved Level 3.
Exemplar 3

GCSE (9-1) Twenty First Century Science Physics B
Exemplar Candidate Work

What could Sarah do to get an accurate value of the specific latent heat of vaporisation of water from her experiment?

The power from the circuit should be

\[ P = \frac{3 \times 12}{5} = 0.72 \text{ W} \]

This means that the energy change in internal energy \( \Delta E \) should be

\[ \Delta E = 0.72 \times 150 = 108 \text{ J} \]

This is more than 2.300 and the only gaseous water evaporates, so Sarah is right.

In order to get an accurate value, Sarah should insulate the beaker more so that less energy is lost to the surroundings.

She could do this by putting the beaker in a polystyrene cup filled with cotton wool and putting a lid on the cup.

Examiners’ commentary

Question 2 is the first of the two extended-response, six-mark questions on this paper, and is expecting candidates to evaluate the experiment done, both diagram and results, and judge Sarah’s comment in light of those, which does expect analysis of the data. Although an Overlap Question, this question was less successfully answered than 7(b)*, the other six marker level of response question.

Exemplar 4 has not really addressed the question. This is worth more than 0 because of the generic suggestion of repeating the experiment, which qualifies for Level 1, even if the candidate has confused precision and accuracy, which is common.

The whole response shows a lack of understanding of the physics involved. The communication expected for Level 1 (1 or 2 marks) is that there is an attempt at a logical structure with a line of reasoning and that the information is in the most part relevant.

This response does not meet these criteria, so the candidate was credited one mark instead of two.
Exemplar Candidate Work

Question 2(b)

Exemplar 1

3 marks

(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.

Hypothesis: Evaporating water may require more energy because the bonds between the water molecules are stronger and therefore have a higher boiling point. In contrast, alcohol has a lower density so it is easier to break apart. Alcohol may have a [3] larger smaller mass and be lighter than water, with particles already spread out more.

Examiners’ commentary

This part of the question expected an open response to the question Why do liquids have different specific latent heats? The command word ‘suggest’ meant that quite different approaches could be rewarded. As a consequence, during the standardisation meeting for marking, eight different legitimate marking points were identified, which suggests that there are a large number of ways (336) of achieving full marks. However, the open nature of the question increased the level of the difficulty substantially, and only 6% of the candidates gained full marks: the mean mark for this question was 1.1 marks.

The candidate here clearly has a good understanding on the physics involved, even if some aspects are a bit vague (‘Alcohol may also have a smaller mass and be lighter than water’) and answers in terms of bond between particles, which was rare.
Question 3(a)(i) & (a)(ii)

Exemplar 1  Part (i) 3 marks, part (ii) 3 marks

3 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, and Watney has a radioactive thermal generator. This contains radioactive plutonium-238 which emits alpha-particles, giving an isotope of uranium.

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

\[
\begin{array}{c}
\text{Pu}^{238} \rightarrow \text{U}^{234} + \alpha \\
94 \qquad \qquad \quad \text{Z:} \\
\end{array}
\]

(ii) The plutonium emits \(1.6 \times 10^{15}\) alpha particles every second, each with an energy of \(9.0 \times 10^{-13}\) J.

The energy released is all transferred to the internal energy of the generator.

Show that the input power of the generator is about 1500 W.

\[
P = E \times \text{number of alpha particles per second}
\]

\[
= 9.0 \times 10^{-13} \times 1.6 \times 10^{15}
\]

\[
= 1440 \text{ W} \approx 1500 \text{ W}
\]

Examiners’ commentary

This question, which was based on the book and film ‘The Martian’. Parts (a)(i) and (ii) of were quite accessible and most candidates scored well. This particular exemplar is notable for its clarity and accuracy: lower ability responses in (a)(i) did not know what an alpha particle was, even if they could then gain marks (by applying error carried forward/ECF) for correctly using their incorrect data for the alpha particle to predict A and Z for the uranium nuclide. About 8% left question (a)(ii) blank as they did not understand what the data was telling them.
**Question 3(a)(iii)**

**Exemplar 1**

(III) Watney uses the generator to heat up water for a bath. He heats 100 kg of water from 20°C to 37°C.

Show that it takes more than an hour (3600 s) for his bath to warm up using his 1500 W generator.

You can assume that all the input energy to the generator is transferred to the internal energy of the water.

Specific heat capacity of water = 4200 J/kg°C

\[
E = mc \times \text{temp. change} \\
= 100 \times 4200 \times 17 \\
= 7140000 \text{ J} \\

T = \frac{E}{P} = \frac{7140000}{1500} = 4760 \text{ s} \\
4760 \text{ s} > 3600 \text{ s}
\]

Examiners’ commentary

This candidate is the same one as for exemplar 8 and has laid out the answer perfectly. This response is absolutely spot on.

**Exemplar 2**

(III) Watney uses the generator to heat up water for a bath. He heats 100 kg of water from 20°C to 37°C.

Show that it takes more than an hour (3600 s) for his bath to warm up using his 1500 W generator.

You can assume that all the input energy to the generator is transferred to the internal energy of the water.

Specific heat capacity of water = 4200 J/kg°C

\[
20°C \rightarrow 37°C = 17°C \\
100 \times 4200 \times 17 = 7140000
\]

Examiners’ commentary

This candidate has correctly applied the internal energy/s.h.c. equation from the data sheet but, along with many candidates at this level, does not know how to relate energy to power and has come to a halt.


Question 3(b)(i) & (b)(ii)

Exemplar 1

Part (i) 4 marks, part (ii) 1 mark

To be rescued, Watney needs to drive a vehicle to a site 3200 km away. The vehicle is powered by batteries of capacity 18 kWh.

Watney knows that the vehicle can travel at 25 km/hour using 5 kW of power from the batteries to do this. When the batteries are discharged Watney has to wait until the next day to continue. He has solar panels to recharge the batteries after a day’s travel.

(i) Use these data to calculate the smallest number of days it would take to drive to his destination.

\[
\begin{align*}
&\text{Distance} = 3200 \text{ km} \\
&\text{Energy} = 18 \text{ kWh} \\
&\text{Power} = 5 \text{ kW} \\
&\text{Speed} = 25 \text{ km/h} \\
&\text{Time} = \frac{18}{5} = 3.6 \text{ h} \\
&\text{Distance} = 3.6 \times 25 = 90 \text{ km} \\
&\frac{3200}{90} = 35.5 \approx 36 \\
&\text{Number of days} = 36 \quad \text{days} [4]
\end{align*}
\]

(ii). Give one reason why it would actually take longer than the time calculated in (b)(i). 

\[
\begin{align*}
&\text{Average speed is not the fastest speed, so it would take longer.} \\
&3.6 \times 25 \text{ km/h is the fastest speed, not the average speed, so it would take longer.} \quad [1]
\end{align*}
\]

3.6 km/h. The batteries may also not be fully charged to 18 kWh every time.

Examiners’ commentary

Although this high-level response does not state what each calculation stage is, it is clear that the candidate is calculating the following stages: number of hours of travel per day from 18 kWh batteries; distance per day travelled using that time; number of days taken to travel 3200 km; and rounding to give the number of days needed.

In (b)(ii), the response in the answer space is not quite enough, as there is no suggestion why the average speed is less than 25 km/hour, but the candidate rescues this with the suggestion on the additional paper. That suggestion could have been improved with a reason why the batteries hadn’t charged fully, but the response there met the mark scheme criteria, as the reason there is bracketed, so not required for the mark.
Exemplar 2

Part (i) 3 marks, part (ii) 1 mark

(b) To be rescued, Watney needs to drive a vehicle to a site 3200km away. The vehicle is powered by batteries of capacity 18 kWh.

Watney knows that the vehicle can travel at 25km/hour using 5kW of power from the batteries to do this. When the batteries are discharged Watney has to wait until the next day to continue. He has solar panels to recharge the batteries after a day’s travel.

(i) Use these data to calculate the smallest number of days it would take to drive to his destination.

\[
\begin{align*}
3200 \div 25 &= 128 \\
18 \div 5 &= 3.6
\end{align*}
\]

Number of days = \[\text{[4]}\]

(ii) Give one reason why it would actually take longer than the time calculated in (b)(i).

\[\text{[1]}\]

Examiners’ commentary

This candidate has done the calculation in (b)(i) correctly but has rounded inappropriately and so lost the last mark. The mark for (b)(ii) just meets marking point 1: solar cell not charging enough and could be considered a benefit of the doubt (BOD) mark.
Question 4(a)(i) & (a)(ii)

4 This question is about a measurement of the speed of sound in air that Isaac Newton made over 300 years ago.

At Newton’s college in Cambridge there was a long outdoor corridor where clapping his hands would give a loud echo a fraction of a second later.

(a) Newton measured the distance from where he stood to the reflecting wall as 64 m.

To measure the time, he made a very tiny pendulum – a weight swinging on a thin cotton thread – and adjusted the length until one to-and-fro swing of this pendulum matched the time between the clap and the echo.

This happened when the length $L$ of the pendulum was 4.6 cm (0.046 m).

(i) Newton showed that the time of one swing, $T$, was given by the equation:

$$T^2 = kL$$

$L =$ the length of the pendulum
$k =$ 4.02 s$^2$/m.

Calculate the swing time $T$ of his 0.046 m pendulum.
Exemplar 1

Part (i) 3 marks, part (ii) 2 marks

Examiners’ commentary

In (a)(i), three-quarters of the candidates scored full marks for substituting into the equation, calculating $T^2$ and then finding $T$. Weaker candidates were distracted by the unusual units for the constant $k$ (s $^2$/m) and used $k^2$ or $\sqrt{k}$ in their substitution.

In (a)(ii), most candidates scored 2/3 just as in this exemplar as they omitted to double the distance to the wall. Some of those candidates went on in (b)(ii) to suggest that Newton’s value for the speed was too low because he had omitted to double the distance, even though that was exactly what they had done.
Question 4(b)(i)

Exemplar 1

(b) Newton’s calculated value for the speed of sound was low when compared with the speed found by modern measurements.

(i) Explain which of Newton’s measurements (distance or time) was likely to be the least accurate.

Time. This is because he didn’t use a stopwatch. [1]

Examiners’ commentary

Although most candidates realised that the time measurement was the least accurate, this exemplar is typical: it was necessary to refer to the extremely short pendulum that Newton used or the very short time he was trying to determine rather than just say that he didn’t have more modern apparatus.
Question 4(b)(i) & (b)(ii)

Exemplar 2

Part (i) 1 mark, part (ii) 2 marks

(b) Newton’s calculated value for the speed of sound was low when compared with the speed found by modern measurements.

(i) Explain which of Newton’s measurements (distance or time) was likely to be the least accurate.

Time, because he had to line up the pendulum swing to the clap – this is unlikely to be perfectly matched due to human error. [1]

(ii) Explain why Newton’s value for the speed was too low.

The time for each pendulum swing must have been slightly too long – this is because a longer time would have increased the result for the speed. [2]

Examiners’ commentary

In (b)(i) this candidate identified the difficult of synchronising the clap and the pendulum position (in the actual experiment Newton stamped his foot) and so gained the mark. In (b)(ii) both marks were earned for recognising that Newton’s time must have been too long to produce a value of speed which was too small.
Question 5(a)(i) & (a)(ii)

5 Alex is investigating how the initial kinetic energy of a trolley will affect the distance it travels before it stops.

Fig. 5.1 shows his apparatus.

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

Exemplar 1

(a) Alex makes this calculation to find the energy.

Kinetic energy gained by the trolley = gravitational potential energy stored at the top of the slope.

\[ \text{mass} \times g \times \text{height} = \frac{800 \text{g} \times 10 \text{N/kg} \times 20 \text{cm}}{1} = 160 \text{J} \]

The value for the energy calculated by Alex is too large.

(i) Identify mistakes that Alex has made in his measurements and in his calculation.

He should convert the mass into kilograms so that

\[ 800 \text{g} = 0.8 \text{kg} \]

and convert the height into metres so that

\[ 20 \text{cm} = 0.2 \text{m} \]

His calculation should then be in kilojoules [kJ]. [2]
Examiners’ commentary

Most candidates here were able to identify one or two mistakes made by Alex in his calculation in (a)(i) but the wording in (a)(ii) was too ambiguous for most, as ‘how should Alex have done this experiment’ did not lead them to ‘how should Alex have make appropriate measurements for this approach to finding the kinetic energy’ but rather to think of redesigning the whole experiment on a different basis, e.g. using \( \frac{1}{2} mv^2 \). Some did query the height through which the trolley fell but, rather than identifying the fault that the centre of mass of the trolley had fallen, from the diagram, less than 20 cm they wanted to measure the vertical height of the starting point.
**Question 5(b)(i) & (b)(ii)**

**Exemplar 1**  
Part (i) 1 mark, part (ii) 2 marks

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

Table 5.1 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>

Some of these data are plotted on the graph in Fig. 5.2.

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

This shows when no energy is given, the object will remain still (Newton’s 1st law), plotting it makes it easier to see a correlation.

(ii) Plot the three remaining points on the graph in Fig. 5.2 and draw an appropriate best fit curve.

---

**Examiners’ commentary**

For (b)(i), the candidate needs to show understanding that an object with no kinetic energy will not travel any distance, and this candidate has done that in the first sentence. The second sentence is answering a different question from that asked: ‘Why is it a good idea to plot kinetic energy-distance values on a graph?’ and this was seen often.

Part (b)(ii) was competently done by most, with over three-quarters of the candidates getting a mark for plotting the three points to within 1 small scale division and a second mark for a reasonable best-fit curve. In this case, the curve could have been smoother, but hand-drawing a curve under examination conditions is not easy and few attempts were too poor to gain credit here. Very few attempted to fit a best-fit straight line.
Exemplar 1 3 marks

Discuss the statements made by Mia and Kai.

Kai is wrong, because a greater force means a larger energy transferred as well, so the distance also increases. On the other hand, the friction force will be relatively larger because of the faster speed. As for Mia, I agree with her comment, because there’s not enough data (after 5J) to see if the correlation ends or changes even more, especially if the last value is incorrect. To be sure about the distance and energy transferred, more experiments must first take place.

Examiners’ commentary

In this part, candidates were invited to examine the statements made by Mia and Kai, some of which were true and others of which were not. In each case, they needed to base their judgements on the graph and the data which produced it. This candidate expressed their ideas clearly, and obtained the last three marking points in the mark scheme (greater range of data needed, faster motion involves greater friction and higher KE gives greater distance travelled) but omitted to state the point that the graph does seem to be levelling off at some value which they could extrapolate from the graph, which would have gained the first two marking points (Graph is levelling out, checks maximum value from graph).
Question 6(a) & (b)

6. This diagram shows air molecules in a small volume of the atmosphere near to a wall. The arrows show the velocity of each molecule.

Exemplar 1

Part (a) 3 marks, part (b) 3 marks

(a) Explain, using ideas of momentum and force, how air molecules exert pressure on the wall.

The air molecules will hit the wall. Even though they have a small mass, there will be momentum (mass x velocity) and as there’s a change in direction, there will be a change in momentum (force x distance), resulting in a force acting on the wall.

(b) As you go further from the Earth’s surface, the atmospheric pressure gets smaller.

Explain this in terms of the movement of the molecules at different heights.

There are more particles above you if you are closer to the Earth, this means that the density lower down is higher, there’s also a larger area for pressure because more force is given in a certain area. The molecules high up will be more spread out and move slower, and as there’s a larger area and a smaller force, the pressure will decrease as less molecules interact with each other.

Examiners’ commentary

Only the better candidates, such as this one, were able to relate force to change in momentum in part (a). This candidate also had full marks in part (b) but needed to ‘feel around’ for the answer rather than going straight for an explanation of smaller pressure in terms of molecular movement. A few did attempt to answer the question by analogy with pressure changes with depth in the ocean, which is true, but does not answer the question as set.
Question 7(a)

Solar farms are large power stations made up from many photovoltaic (PV) panels. They have become very common in Britain.

Exemplar 1  3 marks

(a) A large solar farm in England has a total area of 216 000 m$^2$ covered by PV panels. Every square metre of the solar panels receives about 1000 W of power from the Sun during each day.

The panels have an efficiency of energy transfer of 15%.

Calculate the daily average electrical power produced by the solar farm.

Give your answer in MW (1 MW = 1 000 000 W).

\[
\frac{216000 \times 1000 \times 24}{1000000} \times 0.15 = 324000000
\]

\[
\frac{324000000}{1000000} = 32.4 \text{ MW}
\]

Average electrical power = 32.4 MW [3]

Examiners’ commentary

Although this candidate is not the neatest, the organisation of the calculation is clear and efficiently done; they even kindly explained to the examiner that 15% was 0.15. It was nice to see the use of an arrow to mean ‘leads to’ where so many candidates put in an incorrect equals sign.
Exemplar Candidate Work

GCSE (9-1) Twenty First Century Science Physics B

Question 7(b)*

Exemplar 1

Level 3, 5 marks

Examiners’ commentary

This candidate has written a shorter answer but they have incorporated Jane’s ideas and gone beyond them to make good comparisons of the relative pollution aspects of the two system and the idea of needing an energy mix. The communications skills displayed here are a little weak: the use of rather colloquial English is not a shortcoming, but more substantiation of the statements here (minorly detrimental? Why is it important to have an energy mix?) would have strengthened the argument, as would some suggestions about reliability or fuel costs. This response contained appropriate science content for Level 3 but the communication was not strong enough to get Level 3: 6 marks.
Exempiar 2

Level 2, 4 marks

(b)* Many people are not in favour of solar farms.

Jane
Solar farms are ugly and take up such a lot of space. Their output power is very small. A
gas-burning power station can provide
1000 MW all day and night, the whole year long,
and in any weather.
I’m told that extracting and purifying the material
for the PV panels is very polluting, so it’s not
as green as people say.

Discuss what Jane has said about solar farms and gas-burning power stations.

Jane is correct about solar farms taking up a
large amount of space and being unappealing
look at, but they provide a reliable source of
renewable energy. As a while they may not be as
green as gas burning power stations, however
are highly reliable, so they are worth favouring
expensive all their environment at they could
be high in the air of gases which pollute
comparing to the construction of solar panels,
they are not very polluting and more...

As well as with the gas burning power station will
take a long of energy to heat, and it will require

Examiners’ commentary

This response is too long, and the candidate automatically went to the additional answer space pages to finish off the last sentence, which could easily have been added in the blank space below with answer lines for 7(b). At least one advantage and disadvantage of each type of power supply is mentioned (solar farm: renewable but ugly/occupy a lot of space, and gas burning: highly reliable, but more polluting) which satisfies the Level 2 criteria and the communication skills are met, despite a slip at the beginning of line 5 where the candidate has written ‘renewable’ where they clearly meant ‘reliable’ In fact, the candidate is not clear about reliability, as in line 3 they states that solar farms are reliable. These confusions are enough to show that the candidate has not reached Level 3, so Level 2: 4 marks were credited here.
Exemplar 3

Discuss what Jane has said about solar farms and gas-burning power stations.

Jane is against solar farms because the making of them involves adding to the greenhouse effect. Meaning, solar farms are not as effective as we believe them to be. She states that they don’t provide much power so this could suggest how uneffective it is. Solar farms are and the manufacturing is bad.

Examiners’ commentary

In exemplar 21, the candidate attempted to précis what Jane had said and did so inaccurately and with no decision as to whether Jane was correct or not. For a Level 1 response it was necessary to give an advantage and disadvantage of one type of power station, or an advantage or disadvantage of each, and that has not been done here. If there had been one correctly-expressed advantage or disadvantage of either, it could well have been credited Level 1: 1 mark, but the communication skills required are also not met. There is no attempt at a logical structure with a line of reasoning and no supporting information is used.
8 This question is about the radioactive isotope americium-241, which is found in smoke detectors.

The graph shows how the activity of a sample of americium-241, with an initial activity of 800 counts per second, would change with time.

(a) Use the graph to obtain an estimate of the half-life of americium-241.
Show your working on the graph.

Half-life = 4.30 years [2]
Examiners’ commentary

In part (a) the candidate has clearly annotate the graph to show working for the first marking point and then read off a value for half-life which was in the range of acceptability, so gained both marks here. In (b) the candidate has identified the fact that the activity of the americium source will still be high after 10 years, that α-particles are highly ionising and that α-particles can damage cells. By applying benefit of the doubt (BOD) the candidate has been credited for covering contamination by ingestion for the idea of the radioactive material getting under the fingernails. Although this is not technically ingestion the candidate clearly realises that the contamination is of americium from the disposal of the detector; many candidates considered alpha particles to be the contaminants. It is true than some alpha-emitting material lodged under the fingernails could damage sensitive cells in the nail-bed (possibly) even though subsequent transfer to the mouth is a more realistic hazard.
Exemplar 1

Question 8(c)(i), (c)(ii) & (c)(iii)

Exemplar Candidate Work

Part (i) 1 mark, part (ii) 1 mark, part (iii) 2 marks

Examiners’ commentary

Few candidates were able to relate the simulation described here to radioactive decay suggesting that this was something they had not met, even though it features in the specification section P5.1 under suggested practical work. This candidate clearly realised that one die = one nucleus/atom, one roll = one interval of time and each six in a roll means that the nuclei concerned have decay/emitted radiation; as a result, the answers to (c)(i) and (c)(ii) were very good. In (c)(iii), some successful candidates compared the number of remaining dice with the initial number (which was what had been expected) while others took the valid approach of comparing the activity during roll 1 (18 decay) with the activity 4 rolls later – this was the approach taken in exemplar 25, although it was only with application of benefit of the doubt (BOD). This candidate also gained a mark for pointing out the random nature of the process.
Question 8(c)(iii)

Exemplar 1

2 marks

(iii) Explain why the data in this table suggest that the half-life is about 4 'rolls' but that it's not possible to be exact.

Examiners’ commentary

This candidate has achieved the same two marks, but the halving mark is more clearly earned than in exemplar 25 while the second half of the first sentence gets the 'random' mark (marking point 1). Some candidates criticised the simulation exactly on the grounds that rolling dice is a random process whereas radioactive decay is 'proper' physics and not just a game; the last sentence in this response, which is not clear, does seem to suggest this.
Question 9(a), (b)(i) & (b)(ii)

Exemplar 1

Part a 2 marks, part b(i) 2 marks, part b(ii) 0 marks

Examiners’ commentary

In part (a), about 90% of all candidates could identify one of the two correct statements in this objective question, with about one in three of those getting both. This candidate has clearly chosen partly correctly and then reconsidered and has amended the choices unambiguously to get full marks.

Part (b) presented more difficulties. Few candidates realised that the part (a) diagram, on the left-hand page, showed refraction when a wave travels between media when it slows down and then speeds up and that they were required to apply that to the refraction of earthquake waves in part (b), which was the facing page. This candidate has picked up both marking points in (b)(i) and so have transferred the knowledge from optical refraction as intended. Part (b)(ii) was trickier as they needed to realise that the refraction, which was continuous, was in the opposite direction as the wave neared the core meaning that the wave speed was increasing with depth in the mantle. This candidate had not transferred that knowledge from (a) and (b)(i) and so gained no marks in (b)(ii).
**Exemplar Candidate Work**

**GCSE (9-1) Twenty First Century Science Physics B**

**Question 9(b)(i) & (b)(ii)**

**Exemplar 1**

Part (i) 2 marks, part (ii) 2 marks

---

**Examiners’ commentary**

In (b)(i), this candidate correctly related the direction of refraction to change in the speed of wave A entering the core and correctly explained in (b)(ii) why the reverse direction of refraction in wave B showed that the wave speed increased as the wave travelled deeper, and so had full marks here.
We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

OCR Resources: the small print
OCR's resources are provided to support the delivery of OCR qualifications, but in no way constitute an endorsed teaching method that is required by OCR. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources. We update our resources on a regular basis, so please check the OCR website to ensure you have the most up to date version.

This resource may be freely copied and distributed, as long as the OCR logo and this small print remain intact and OCR is acknowledged as the originator of this work.

Our documents are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published support and the specification, therefore please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: resources.feedback@ocr.org.uk

OCR acknowledges the use of the following content:
Square down and Square up: alexwhite/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

Looking for a resource?
There is now a quick and easy search tool to help find free resources for your qualification: www.ocr.org.uk/i-want-to/find-resources/

www.ocr.org.uk
OCR Customer Contact Centre

General qualifications
Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk

OCR is part of Cambridge Assessment, a department of the University of Cambridge. For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.

© OCR 2018 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA. Registered company number 3484466. OCR is an exempt charity.