GCSE (9-1)

Exemplar Candidate Work

GATEWAY SCIENCE
COMBINED SCIENCE A

J250
For first teaching in 2016

J250/05 Summer 2018
examination series

Version 1

www.ocr.org.uk/combinedsciencea
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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.

Please always refer to the specification [https://www.ocr.org.uk/qualifications/gcse/gateway-science-suite-combined-science-a-j250-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

Exemplar 1

1 Four springs A, B, C and D are made of four different materials.

Use the equation: Force = Extension × Spring constant

Which of the springs has the greatest spring constant?

Your answer: A

Examiner commentary

The candidate has used an 'equation triangle' as a useful tool to rearrange the equation provided. This suggests that they may have made the spring constant the subject which is greatest when F/e has the largest value.

Question 2

Exemplar 1

2 What is the current at point Q in the circuit?

Your answer: 2A

Examiner commentary

This response highlights the importance for candidates to check their answers. Initially, the candidate had added the two currents in the circuit diagram and chosen distractor C. After checking, they realised that the correct answer was option B.
Question 6

Exemplar 1

1 mark

6 Which of the following transfers the most energy?

A 1.0 kW over one hour

B 2.0 kW over two hours

C 3.0 kW over one hour

D 500 W over four hours

Your answer [B]

Examiner commentary
The candidate has used a very helpful examination technique of writing down their calculations for each option. They have recalled and used the correct equation to enable them to work out the energy transferred so that they can tell which option transfers the most energy. Even though the candidate cannot gain credit for writing down equations and calculations for 1 mark multiple choice questions, it increases the likelihood of achieving the correct answer compared to carrying out each step mentally.

Question 7

Exemplar 1

0 marks

7 Which of the following is not part of the atomic model?

A Almost all of an atom's mass is contained in the nucleus.

B An atom's nucleus contains positive neutrons.

C An atom's nucleus is located in the centre of the atom.

D An atom's nucleus is surrounded by electrons.

Your answer [A]

Examiner commentary
This is an example of a negative question which candidates often find more difficult to answer correctly. Candidates may benefit from underlining the 'not' in the question to help them focus on what the question is asking. Another useful examination technique would be for candidates to work methodically through the distractors and discard the ones that they think are most likely to be incorrect.
Question 10

Exemplar 1

10 Four compasses are each placed near to a wire at points A, B, C and D. Each wire has a current flowing through it. The distance of each compass from its wire is shown.

Which compass experiences the greatest magnetic field strength?

Your answer: C

Examiner commentary

The candidate has used two very helpful techniques. They have highlighted some of the numbers on the diagrams which has helped them to discard two of the incorrect distractors. This enables them to focus on only two answers that they think may be correct.
**Question 11 (a)**

**Exemplar 1**

11 A student has one cell and two lamps. She wishes to connect them so that both lamps have maximum brightness.

(a) Draw a complete circuit diagram to show how she can achieve this.

![Diagram of a parallel circuit with two lamps](image)

**Examiner commentary**

This is an excellent example of how a circuit should be drawn, with the lamps in parallel to achieve maximum brightness. The candidate has drawn the correct circuit symbols, rather than 'pictures' of the components which will not gain credit.

**Exemplar 2**

11 A student has one cell and two lamps. She wishes to connect them so that both lamps have maximum brightness.

(a) Draw a complete circuit diagram to show how she can achieve this.

![Diagram of a parallel circuit with two lamps](image)

**Examiner commentary**

This response has only gained 1 mark, even though it is very close to being a fully correct circuit. The mark for correct circuit symbols cannot be gained as there are lines drawn through the centre of each lamp symbol. The mark for a correct working circuit cannot be scored either as the circuit includes an extra symbol, other than those allowed. The circuit correctly shows the candidate's lamps in parallel so credit can be gained for this.
Question 11 (b) (i)

Exemplar 1 3 marks

(b) The student then investigates an unknown component. She records values for current through the component and the potential difference across the component.

<table>
<thead>
<tr>
<th>Potential difference (V)</th>
<th>Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>5.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Examiner commentary

This is an excellent example, gaining full credit. The candidate has plotted the points on the graph accurately (within ±½ a small square) using crosses. The line of best fit has been drawn using a ruler, which was appropriate as in this example the line of best fit was a straight line.
Examiner commentary

The candidate has correctly plotted all of the points so two marks are awarded. The third mark cannot be gained as the line of best fit has not been drawn. Candidates may find it useful to underline the key parts of the question so that they are less likely to miss necessary parts out.
Question 11 (b) (ii)

Exemplar 1

1 mark

(ii) Describe what these results show.

As potential difference increases, the current also increases. [1]

Examiner commentary

This response demonstrates a clear, straightforward description of the graph. The candidate has used the simple technique of stating what happens to the dependent variable as the independent variable changes.

Exemplar 2

0 marks

(ii) Describe what these results show.

The results show that the potential difference is always less away from the current. [1]

Examiner commentary

The candidate has struggled to describe a clear pattern in the results. Many candidates as in Exemplar 2 only described single specific changes or stated that there was a correlation. Neither of these approaches will gain credit on their own. Candidates would benefit from practising describing both familiar and unfamiliar graphs.
Examiner commentary

This response is set out in an ideal way. 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 exams by choosing the high risk technique of only providing the final answer. These candidates can be awarded all the available marks if their answer is correct but a minor mathematical error or mistake copying from a calculator display means that they cannot be awarded any credit.

Examiner commentary

The candidate has demonstrated a good understanding of practical equipment, with any of their listed answers (including the stopwatch) gaining credit. The experience of practical activities that this candidate experienced in the classroom allows them to avoid inappropriate equipment such as 15 cm ruler or watch. [Using a short ruler would increase the systematic errors and a non-stopping clock would introduce additional sources of error.]
Question 12 (a) (ii)

Exemplar 1 1 mark

(ii) State how he can calculate the average speed using these measurements.

\[ \text{Distance} \div \text{Time} \] [1]

Examiner commentary

A simple response where stating the equation to calculate average speed was sufficient to gain credit. This is an excellent example of how, in a physics exam, writing down an equation is a more appropriate way to answer this type of question than rewriting a mathematical formula as a long detailed description (e.g. I would measure the distance that the toy car travelled and then …). 

Exemplar 2 0 marks

(ii) State how he can calculate the average speed using these measurements.

Find the mean by adding speeds up and dividing by how many times he did it. [1]

Examiner commentary

This response shows a common answer by many less able candidates. They misinterpreted the words ‘average speed’ and instead described how to calculate the mean of a set of speed measurements. Averaging sets of observations and using repeats were stock answers that many candidates had rehearsed and often applied uncritically such as Exemplar 2.
Question 12 (b) (i)

Exemplar 1  3 marks

(b) The student has an idea about this experiment. He thinks that the greater the angle of the ramp, the greater the average speed of the car.

Look at his results.

<table>
<thead>
<tr>
<th>Angle (°)</th>
<th>Distance (m)</th>
<th>Time (s)</th>
<th>Average speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.2</td>
<td>1.3</td>
<td>0.63</td>
</tr>
<tr>
<td>20</td>
<td>1.2</td>
<td>2.0</td>
<td>0.08</td>
</tr>
<tr>
<td>30</td>
<td>1.2</td>
<td>1.3</td>
<td>0.62</td>
</tr>
</tbody>
</table>

(i) Calculate the average speed for the 20° angle.

Write your answer to 2 significant figures.

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$\frac{1.2}{2.0} = 0.60 \text{ m/s}$$

Answer = ........................................... [3]

Examiner commentary

The candidate has highlighted important keywords in the stem of the question. This can be a very useful examination technique as it helps candidates focus on the key information e.g. remembering to give the answer to two significant figures. This response is also set out in an ideal way. Writing the correct equation and substituting the values from the question allows compensatory marks to possibly be awarded even if the candidate’s final answer is incorrect.

Question 12 (b) (ii)

Exemplar 1  0 marks

(ii) Do these results support the student’s idea?

Explain your answer.

yes because the average speed increased as the angle of the ramp increased. ........................................... [1]

Examiner commentary

The candidate has not gained credit for this answer as they have merely repeated the original hypothesis of the student in the stem of the question. The candidate could improve their answer by including data from the table to support or disagree with the original student’s hypothesis. For example, the average speed at 30° was 0.92 m/s which was higher than the average speed at the lower angles.
Exemplar 2

(ii) Do these results support the student’s idea?

Explain your answer.  

No as it got slower in the second one.

Examiner commentary

Although the candidate appears to have the correct idea, poor quality of communication has prevented them from gaining credit as we cannot be sure of what the ‘second one’ is referring to. If the candidate had stated that the middle angle had the slowest speed, they would have gained credit. Where candidates, such as in Exemplar 2, imply an answer they are relying on the scientific knowledge and understanding of the person reading the answer, rather than demonstrating their own scientific knowledge and understanding.

Question 12 (c)

Exemplar 1

(e) Another student thinks that this experiment could be improved.

Suggest one problem with this experiment and explain how the experiment could be improved.

Problem: The 20° doesn’t go faster than 10°.

Improvement: Re-do the experiment several times and calculate an average of all the speeds.

Examiner commentary

This is a good attempt as most candidates found this question, based on Assessment Objective 3, very challenging. The candidate did not link the improvement to a relevant problem but the improvement suggested (using the idea of repeated measurements and calculating the average) was sufficient for 2 marks.
13* The graph below shows the change in temperature of a material as it cools.

![Graph showing temperature vs. time](image)

Describe the graph and explain what it tells us.

The graph tells us many things about a material cooling. It is clear that at 100°C, the material is changing state. The material stays at 100°C for a longer amount of time than any other temperature tells us. That 100°C is its boiling point, or point of which the change of state takes place. We also can see that the material material cools quicker before 100°C than after. The steeper gradient on the graph hints that the material is changing from a gas to a liquid. This process is called condensation. The material cools below 100°C before the end of the experiment. This shows that the experiment was not conducted at room temperature.

Finally, the graph shows that, due to the gradient decreasing towards the end of the experiment, the change of state would soon again be approaching. However, we can be aware that another change of state from a liquid to solid would have to be below 100°C.
Examiner commentary

This response is a very good example of a Level 3 response worth 6 marks. The candidate has used all the answer lines provided in a well-structured answer that follows a logical sequence. They have used specific data correctly interpreted from the graph to support their answer and have identified differences in the cooling rate before and after the material changes state. In the last sentence of their answer the candidate has moved beyond the expected performance of a GCSE candidate by interpreting what the shape of the cooling curve implied about the ambient temperature of the laboratory.

Exemplar 2

The graph below shows the change in temperature of a material as it cools.

Describe the graph and explain what it tells us.

The material gradually cools down as it reaches a constant temperature. When the material is changing state at 42°C, it then starts decreasing again and stops at 30°C. It tells us that the material changes state at 42°C.

Examiner commentary

This response is a good example of a Level 2 response worth 4 marks. The candidate has included a concise description of the temperature change throughout the graph and explained the middle section in terms of a change in state. To achieve Level 3, the candidate could have either discussed the rate of temperature decrease at different points or drawn a conclusion about the material’s property.

Exemplar 2 is 43 words long. Some candidates will write much longer answers. Some candidates will write enough to fill all 12 answer lines and the space below and then a full additional answer page at the back of the booklet. The longest LoR answers can be over 250 words long. These very long answers tend to gain the lower mark in the appropriate level as candidates find it very difficult to sustain a well-developed line of reasoning which is clear and logically structured. Very long answers will often repeat earlier parts of the answer, contain irrelevant information and may contradict earlier parts of the answer.
Exemplar 3  

13* The graph below shows the change in temperature of a material as it cools.

Describe the graph and explain what it tells us.

when the material starts to cool it cools quickly until it hits 41°C and then stops cooling for a while however, the graph still shows us the amount of time it stopped for. After a amount of time the material starts to drop in temperature again, it carries on doing this until it hits 18°C and then it stops cooling. The graph as a whole shows us the amount of temperature a material takes to cool.

Examiner commentary

The candidate has only attempted to answer the first half of the question. They have written a detailed description of the shape of the cooling curve on the graph but have made no attempt to explain what the shape of the curve tells us about the nature of the material. All three sections of the curve are described in terms of temperature change but there is no explanation in terms of changes of states nor specific latent heat. However there is sufficient detail to gain 2 marks at the top of Level 1.
Question 14 (a)

Exemplar 1

Examiner commentary

This is an excellent example of a succinct response which describes clearly which measurements need to be taken and the equation required. Where questions ask the candidate to write all or part of a procedure for carrying out a practical activity (such as find the density of the wooden cube, include the measurements needed) it can help to set them out as a set of clear instructions such as:

- find the mass of the cube using a balance
- find the volume of the cube by multiplying the length, width and height
- find the density by dividing the mass by the volume.

An easy check is then to look at the instructions and see if they can be followed and do they answer the question asked. In this case yes they are easy to follow and yes they would give you the density of the cube.

Exemplar 2
Examiner commentary

Although this response gains all 3 marks, the candidate has written a very long story describing what they would do. Candidates should use the answer lines available as a guideline to how much they should write in their response. To help candidates improve their scientific writing they need to practise writing procedures for activities or rewriting their first attempt as simple to follow instructions.

Exemplar 2 is 120 words long which is three times longer than Exemplar 1. It would have been better for this candidate to write out their experimental procedures as instructions or use bullet points in order to help them be more concise. For example:

- measure the mass of the cube
- measure the volume of liquid in a measuring cylinder
- drop the cube inside the measuring cylinder and check the volume again
- the difference between the volume of water with the cube inside and at the start is the volume of the cube
- to find the density of the cube use the equation \( \text{density} = \frac{\text{mass}}{\text{volume}} \)

This is only 61 words long and much easier to understand. Writing it out this way helps candidates to see problems (would the wooden cube float on the water?) and instructions that could be written more clearly (such as bullet point four).

Exemplar 3

14 (a) A student has a wooden cube.

Explain how she could find the density of the wooden cube.

Include the measurements needed.

First she would need to say it to find the mass and then she would need to find the volume and times them together to get the density. [3]

Examiner commentary

This candidate has made a creditable attempt to answer the question and has been given one of the three marks. As in Exemplar 2 they have used ‘the story of what I would do’ approach and described the equation to calculate density in continuous prose rather than as a mathematical formula. Practising writing in a scientific way can help candidates of all abilities to express scientific ideas more clearly. If candidates do not experience appropriate scientific writing in their science classroom they will use the creative writing style that they use in their English classroom.

It can help candidates to see that difficulties they have with English need not be a barrier to success in physics. For example show the candidate how their prose would look as a set of instructions.

Physics candidates of all abilities appear to find working with equations more straightforward than writing long answers about physics ideas. Writing down an equation is a different process to writing a long sentence with the same information. Encouraging physics candidates to use a more mathematical approach to writing in the classroom may make the physics more accessible to those who struggle with creative writing and the continuous prose style.
Examiner commentary

The candidate has gained 3 marks by correctly drawing the particle diagrams. The candidate has repeated the stem of the question in their written answer rather than explaining how changes of state results in changes in density, so could not access the final marking point. However they have been able to communicate quite complex scientific ideas in their diagrams:

- densely packed regular face centred cubic structure in the solid, implying a crystalline material
- irregular structure in the liquid, but notice that most particles are in contact with the neighbouring particles (a common misconception was to draw something like a gas with more ‘floating’ particles)
- dispersed nature of the particles in the gas which fills the container but not in a regular way.

A significant number of candidates found scientific drawing challenging and did not appreciate that drawing pictures of different numbers of circles was less important than the relationships between the circles.
Question 15 (a) (i)

Exemplar 1

During launch, a rocket accelerates when the upwards force is greater than the downwards force.

![Rocket diagram]

(a) (i) Name the upwards and downwards forces on the rocket during launch.

- Upwards force: **Up-thrust**
- Downwards force: **Gravity**

Examiner commentary

A very common error made by candidates was to identify the upwards force as ‘upthrust’ rather than ‘thrust’. Upthrust is the force that a fluid exerts on a body floating in it and is associated with buoyancy. If they had written ‘upwards thrust’ or just ‘thrust’ then credit would have been gained for the upwards force from the rocket engine.

Exemplar 2

(a) (i) Name the upwards and downwards forces on the rocket during launch.

- Upwards force: **Air resistance**
- Downwards force: **Gravity**

Examiner commentary

This candidate is probably more used to describing scenarios with falling objects. Resolving forces and free body diagrams make good starter activities as they will often throw up common misconceptions or allow you to refine the understanding of candidates, for example using an image of a rocket launch and asking what forces are acting on it.
Question 15 (a) (ii)

Exemplar 1

2 mark

(ii) At launch, the upwards force is 10 000 N and the downwards force is 8 000 N.

Write down the size of the resultant force in Newtons.

\[ 10 000 - 8 000 = 2 000 \]

Answer = 2 000 N [1]

Examiner commentary

The candidate has written down their calculation as, even though it would not gain credit on its own in this 1 mark question, it can reduce the likelihood of an error being made compared to the candidate working out the answer mentally.

Question 15 (a) (iii)

Exemplar 1

3 marks

(iii) The rocket has a mass of 800 kg.

Calculate its acceleration.

Use the equation: Force = Mass × Acceleration

\[ F = ma \]

\[ \frac{F}{m} = \frac{\text{Force}}{\text{mass}} = \frac{2 000}{800} = 2.5 \text{ m/s}^2 \]

Answer = 2.5 \text{ m/s}^2 [3]

Examiner commentary

The candidate has written the equation provided for force into an 'equation triangle'. This has enabled them to correctly rearrange the equation in order to calculate the acceleration of the rocket. All stages of the candidate's calculations have been written down including writing down the rearranged equation and substituting the correct values from the question. This reduces the likelihood of an error being made and allows compensatory marks to possibly be awarded even if the candidate's final answer is incorrect. When a candidate only writes down their final answer they are choosing to gain either full marks or no marks.
Examiner commentary

This response is set out in an ideal way. Recalling and writing down the correct equation and substituting the values from the question allows compensatory marks to possibly be awarded even if the candidate’s final answer is incorrect. Writing down the process used to reach the answer is a very good exam technique to minimise losing marks.

Examiner commentary

This response is set out in an ideal way. Recalling and writing down the correct equation and substituting the values from the question allows compensatory marks to possibly be awarded even if the candidate’s final answer is incorrect. Many candidates who provide some workings gain some marks in this type of question.
Question 16 (b) (i)

Exemplar 1

(b) The motor uses 2 cells in series.

Each cell has a potential difference of 1.5 V.

(i) Write down the total potential difference of the cells.

\[ 1.5 + 1.5 = 3 \text{ V} \]

Examiner commentary

Writing down calculations is a good practice to develop in physics, even though it may not gain credit on its own in a 1 mark question. This technique reduces the likelihood of an error being made compared to the candidate working out the answer mentally or making an error on their calculator.

Question 16 (b) (ii)

Exemplar 1

(ii) The motor has a resistance of 6.0 Ω.

Calculate the current in the circuit when the motor is in use.

Use the equation: Potential difference = Current × Resistance

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

\[ 6 \div 1.5 = 4 \]

Examiner commentary

This is a good example of where the candidate has written down the rearranged equation which has enabled them to gain a compensatory mark even though they then substituted the incorrect values and therefore their final answer was incorrect.
**Question 16 (c)**

**Exemplar 1**  
1 mark

(c) The student wishes to increase the time taken to lift this toy car vertically through the 1.0 m distance shown.  
Suggest a change he could make to this experiment to achieve this.

[Student's response]

**Examiner commentary**

The individual parts that make up Question 16 form a story that leads candidates through all the different physics ideas needed to answer Question 16c (such as work done, power, \( V = IR \)). Unfortunately many candidates ignore these clues in the early parts of Question 16 and treat every item as a stand-alone question. Other candidates ignore the stem of the question and answer a different question where they could use a different toy car lifted through a different distance.

At first reading it looks like this candidate has provided two valid responses. The first suggestion uses non-technical language (get a heavier toy car) but the second suggestion uses scientific language and is unambiguous (use 1 cell instead of 2). Although the candidate's first statement was ignored, they did also suggest removing one cell, which scored one mark. In this instance the comments on the car itself could be separated into two possibilities:

- get the toy car to be heavier by adding some mass to it – valid suggestion
- get a completely new toy car of greater mass – incorrect suggestion

**Exemplar 2**  
0 marks

(c) The student wishes to increase the time taken to lift this toy car vertically through the 1.0 m distance shown.

Suggest a change he could make to this experiment to achieve this.

[Student's response]

**Examiner commentary**

This is a good example of where the candidate has not read the question carefully enough and the suggestion made would actually decrease the time taken. Their second suggestion is also invalid because the toy car has to be lifted ‘through the 1.0 m distance shown’ rather than a different distance. It is very helpful if candidates underline or highlight key words in the stem of the question. They can then review their response to check that they have answered the question they were asked.

Would any of these suggestions increase the time taken to lift this toy car through 1.0 m?

- increase the speed of the electric motor – incorrect
- add a resistor to the circuit – correct as decreases current
- decrease the distance the car is lifted – incorrect
- use a toy car of greater mass – incorrect as it uses a different car
- add blu tack® to the toy car to increase the mass – correct as increases work done
- change cells to be in parallel not series – correct as decreases potential difference
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