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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/07 Summer 2023 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

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Paper 7 series overview

J260/07 is one of the four examination components for the Higher tier GCSE (9-1) Twenty First Century Science Combined Science B. This component assesses the contents of the physics chapters P1 to P6 and the practical skills in chapter BCP8. The question styles used include objective, short answer and one extended level of response

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• produced a clear answer to the level of response question (Question 2 (b)) that both described the data presented **and** described how electricity is generated using the energy resources given • stated correct equations in calculation questions and showed full working, including both substitution of numbers and rearrangement of equation • gave clear descriptions that were written in a logical order including all relevant steps. This is particularly important when describing experimental procedures such as in Question 6 (a) • showed the ability to analyse information to make conclusions and presented them in a clear and concise way • applied knowledge of correct scientific units, conversion of units, standard form and rearrangement of equations.	• did not show full working in calculation questions, which sometimes led to them missing method marks when the final value was wrong • often used everyday words and phrases rather than correct scientific terminology • did not structure longer descriptions and explanations in a logical order, for example the chronological order they would happen. This sometimes led to missing information or the creation of contradictions.

Question 1 (b) (i)

(b) **(i)** Complete the table by showing the main groups of the electromagnetic spectrum from long to short wavelengths.

Use words from the list.

Gamma rays	**Microwave**	**Radio**	**Visible**	**X-rays**	**Ultraviolet**

Electromagnetic radiation spectrum						
Long wavelength → **Short wavelength**						
		Infrared				

[3]

This question requires candidates to put the groups of the EM spectrum in order of increasing wavelength. Infrared was given to help. This is the most common ordering of the EM spectrum (from long to short wavelength); the incorrect responses appeared to be mainly candidates guessing, and very few tried to write them down in the reverse order.

Question 1 (c) (i)

(c) A new telescope in space called the JWST uses electromagnetic radiation to produce images of very distant galaxies.

(i) Suggest **one** benefit of seeing images of very distant galaxies.

....

.... **[1]**

Many candidates suggested that there may be dangers out in space or that we need to be watching for aliens, etc. There were also quite a few referring to stars and planets. Candidates who scored the mark here talked about improving our understanding or knowledge of the universe.

Misconception

Some common misconceptions about galaxies are:

- galaxies and stars are the same thing
- galaxies other than the Milky Way can be seen in great detail with their individual stars and planets studied
- galaxies exist at similar distances to the stars we see in the night sky.

Question 1 (c) (ii)

(ii) Suggest **one** reason why scientists looking at images from the JWST should tell everyone about their discoveries.

....

.... **[1]**

This question elicited similar incorrect responses to Question 1 (c) (i) and demonstrated the same misconceptions. Candidates scoring the mark here suggested the idea of wider collaboration and/or checking/peer reviewing the claimed discoveries. Another common correct answer was the idea of generating interest in astronomy from the general public.

Question 2 (a)

2 The UK uses a number of different energy resources including wind and nuclear fuel to generate electricity.

(a) Give **one other** example of a renewable energy resource and a non-renewable energy resource.

Renewable: ....

Non-renewable: ....
[2]

Most candidates scored both marks here, however there were some who incorrectly gave a renewable source as non-renewable and vice versa.

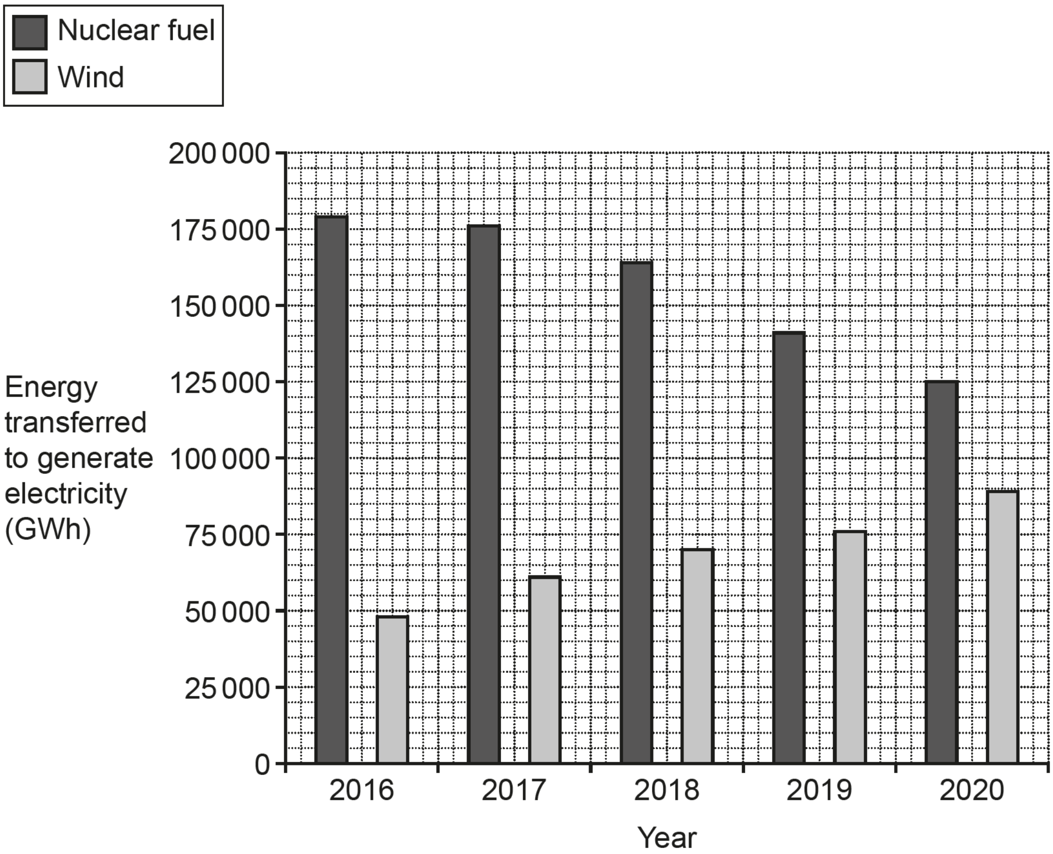
Misconception

A common incorrect response was to give biomass or biofuel as a non-renewable resource. It should be stressed to candidates that a renewable energy resource is either a resource that can be replenished in a relatively short time (such as biofuel) or a resource of which there is an endless supply (such as solar power).

Question 2 (b)*

(b)* Nuclear fuel and wind are used to generate electricity in the UK.

The graph shows the energy transferred to generate electricity from these resources between 2016 and 2020.



Describe how nuclear fuel and wind are used to generate electricity.

Include in your answer how the use of these energy resources has changed in the UK since 2016.

....

....

....

....

....

.... **[6]**

This question asked candidates to do two things. The first was to describe how nuclear fuel and wind are used to generate electricity. The second was to describe how the use of these two resources has changed over time. Generally candidates described the data shown on the graph very well, but very few candidates correctly described how both nuclear and wind are used to generate electricity. Those who did make an attempt to describe the use of energy resources in electricity generation sometimes did so by trying to combine the two descriptions together, and then responses often become unclear. Candidates should be encouraged to plan their level of response answers and separate their response out into distinct paragraphs or even bullet points.

Exemplar 1

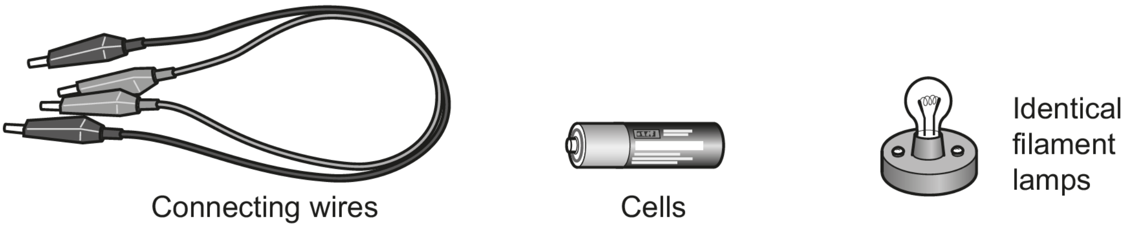
Nuclear fuel is used to generate electricity as it is highly ionising so it has a lot of energy, therefore has the capability to ~~has~~ have its energy converted to electricity and can power most of the UK. However, nuclear fuel is non-renewable so it will eventually run out meaning we have looked for a renewable source like wind. Using wind turbines, we can generate electricity by the wind pushing the turbine into spinning and powering a generator that turns the wind energy into electricity. Also, wind turbines are a lot safer and cheaper than nuclear power plants, hence why wind has **[6]** increased since 2016 and nuclear has decreased.

This is an example of a Level 2 response. This response gives some detailed (mostly correct) information about nuclear fuel, but none of the information is relevant to the question as it does not describe how nuclear fuel is used to generate electricity. There is enough relevant information about how wind is used. This response then finishes with a basic description of the data shown on the graph. A better analysis would have included some numbers taken from the graph to give some detail of the changes shown.

Question 3 (a) (i)

3 Ben wants to compare the brightness of filament lamps connected in a parallel circuit.

He can use as many of the components shown as he needs.



(a) (i) Draw a circuit diagram using circuit symbols to show **two** filament lamps connected in a parallel circuit with a cell.

[2]

This question tested candidates' ability to draw a circuit diagram containing correct symbols. Candidates should be encouraged to take care when drawing lines to make sure that they don't leave gaps in their circuits and to make sure symbols are connected in the correct places. Using a pencil helps, so lines can be rubbed out.

Question 3 (a) (ii)

(ii) Describe how Ben can find out how the brightness of the filament lamps connected in parallel change as more lamps are added in parallel.

....

....

....

.... **[2]**

This is an example of an experimental description question. Candidates had to give the independent variable (number of lamps connected in parallel) and dependent variable (brightness) and constant variable (number of cells). So a statement such as 'change the number of lamps connected in parallel and measure the brightness while keeping the number of cells the same' scores both marks.

Question 3 (b)

(b) Suggest how Ben could find out how the current in a filament lamp affects the brightness of a filament lamp.

....

....

....

.... **[2]**

This was another experimental question, this time requiring candidates to identify the methods for changing the current/brightness and the method for measuring the current. Many did correctly describe the use of an ammeter, although sometimes gave it as 'ampmeter'. However, very few candidates gave a correct method for changing the brightness or current, such as changing the number of cells or using a variable resistor.

Question 4 (b) (i)

(b) The lamp is connected to an electricity supply. The potential difference across the tube is 60 V.

(i) Calculate the charge that flows through the tube when 7500 J of energy is transferred.

Use the Equation Sheet.

Charge = ...C **[3]**

This question was very well answered with most scoring full marks. However there were some candidates who did not show any working and therefore if a mistake was made, they lost all 3 marks as method marks can only be given if working is shown.

Question 4 (b) (ii)

(ii) To supply the power to the neon lamp, a transformer uses a 240 V input power supply. The current in the primary coil is 0.2 A. The output potential difference is 60 V.

Calculate the current in the secondary coil of the transformer.

Use the Equation Sheet.

Current in secondary coil = ... A **[3]**

Very few candidates answered this question correctly. Many candidates saw the potential difference and current values and tried to use V=IR or P=IV without knowing how to develop their answer further.

Question 5 (a)

5 This table lists some data about an iodine radioactive isotope used to diagnose and treat cancer.

	Iodine
Chemical symbol	I
Number of protons	53
Number of neutrons	78

(a) Complete the label, using data from the table.

....
I
....

[2]

The convention in physics is to write the proton number on the bottom, however many candidates had the correct numbers, but with the mass on the bottom and proton number on top. This was an accepted correct answer as the candidate had correctly identified the proton number and determined the mass number. Also, the periodic table in the specification gives the relative atomic mass on the bottom and atomic number on the top. Therefore credit was given if the candidates knew how to obtain the correct numbers from the data given.

Question 5 (b)

(b) The iodine is used as a tracer to image cancer cells. Gamma rays are emitted when the iodine decays.

Explain how the gamma rays can have hazardous effects.

....

....

....

.... **[2]**

This question tested that candidates knew why gamma rays were dangerous and also knew the dangerous effect they can have on the human body. It was generally answered well with most candidates knowing that gamma rays are ionising along with a correct effect on the human body.

Question 5 (c) (i)

(c) (i) Gamma rays can be emitted when radioactive nuclei decay.

State **two** other possible emissions from radioactive nuclei when they decay.

1 ....

2 ....
[1]

Most candidates gave the answer 'alpha and beta', which is correct. Some did say 'electron' probably meaning 'beta emission', but this was not allowed as it is not specific enough.

Question 5 (c) (ii)

(ii) Why do radioactive nuclei decay?

.... **[1]**

This question tested that candidates knew that radioactive nuclei were unstable, most candidates scored the mark by either stating that they are 'unstable' or that they need 'to become stable'. Answers such as 'to release energy' or 'to emit radiation' were not enough.

Question 5 (d)

(d) In 2010 a new element was discovered. In 2015 the element was recognised officially. It is called tennessine.

Between 2010 and 2015 publications about tennessine went through the process of peer review.

Define **peer review**.

....

....

....

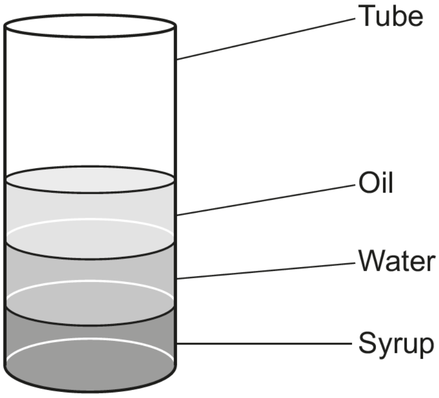
.... **[2]**

This question tested candidates understanding of the term peer review. Many candidates gave a good description here often stating that other scientists would check their publications or claims with some also stating that those scientists would have to work in the same field of study. Some candidates did not score here for vague comments about reviewing the work, which is almost a repeat of the question.

Question 6 (a)

6 **Fig. 6.1** shows that liquids separate. The liquid that settles at the bottom has the greatest density.

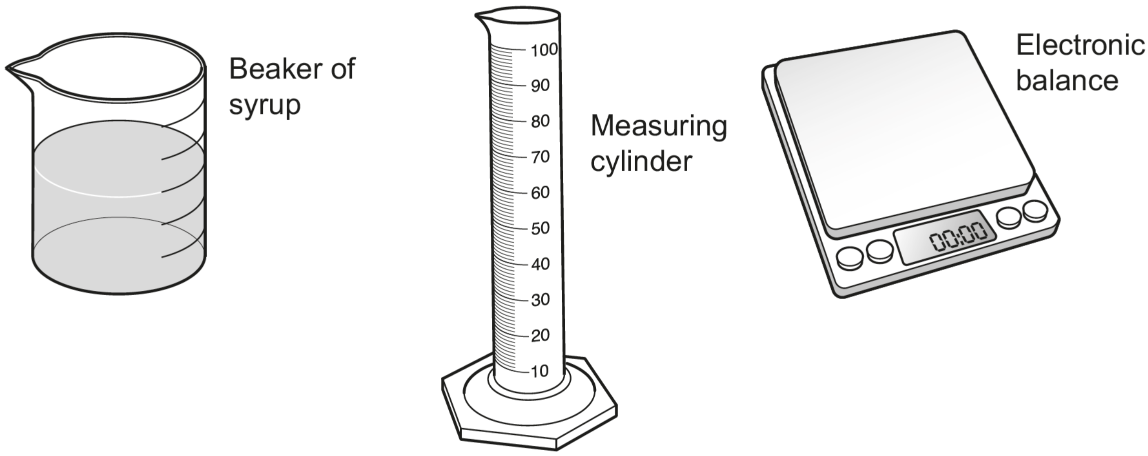
Fig. 6.1



(a) Mia has a sample of the syrup from **Fig. 6.1**.

She needs to determine the density of the syrup. She collects the equipment shown in **Fig. 6.2**.

Fig. 6.2



Describe how Mia can use this equipment to accurately determine the density of the syrup.

....

....

....

....

....

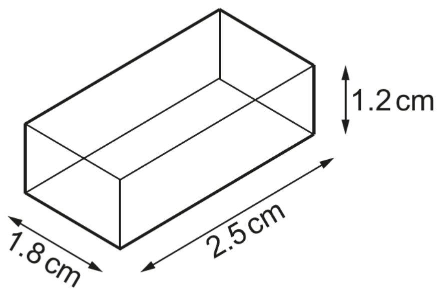
.... **[4]**

This question tested the candidates' ability to clearly describe an experimental method to determine the density of a liquid. The best responses included first measuring the mass of the empty cylinder on the balance before pouring the syrup into the cylinder to measure both its volume using the cylinder and its mass using the balance. Some candidates proposed measuring the mass on the balance using the beaker and then pouring into the cylinder to measure the volume. This would not give an accurate value for density since some syrup would be left in the beaker. Candidates should be encouraged to describe their answers to questions like this in the order that they would carry the experiment out physically. This also demonstrates the importance of candidates doing practical work in their centre.

Question 6 (b) (i)

(b) **Fig. 6.3** shows a small plastic block.

Fig. 6.3



The mass of the block is 7.02 g.

(i) Calculate the density of the block.

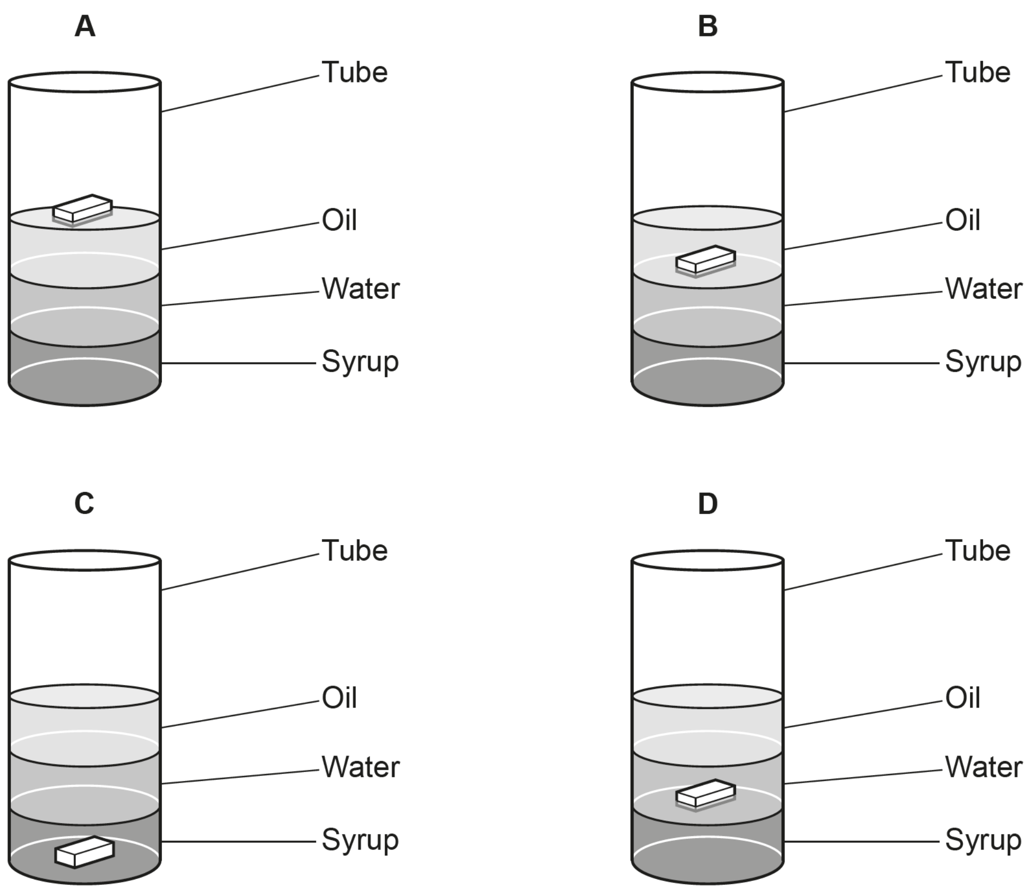
Density = ... g/cm^3 **[4]**

This question was well answered by most candidates. But again some candidates did not show much or any working and therefore had a much greater risk of losing marks if their final answer was wrong for any reason.

Question 6 (b) (ii)

(ii) **Fig. 6.4** shows 4 diagrams, **A**, **B**, **C**, and **D**. These diagrams show what happens to blocks of different densities that are dropped into the tube.

Fig. 6.4



The table shows the densities of the liquids in the tube.

Material	Density (g/cm^3)
Oil	0.85
Water	1.00
Syrup	1.45

Which diagram **A**, **B**, **C**, or **D**, shows what happens to a plastic block with a density of 1.15 g/cm^3 when it is dropped into the tube?

Diagram .... **[1]**

This question tested the candidates' understanding of how density affects whether or not objects will sink or float. The majority of candidates selected the correct answer, D.

Question 6 (b) (iii)

(iii) Suggest why the block moves to this position.

....

.... **[1]**

Many candidates stated that the block is less dense than syrup but did not also say that it is more dense than water and so did not score the mark.

Question 7 (a) (i)

7 An electric fan has a fast and slow setting.

(a) On the slow setting the current is 50 mA.

(i) Calculate the time for 30 C of charge to flow through the fan motor.

Use the Equation Sheet.

Time = ... s **[4]**

The most common answer here was 0.6 which scored 3 marks. This is due to many candidates not converting the 50 mA into 0.05 A.

Question 7 (a) (ii)

(ii) Define current.

....

....

....

.... **[2]**

The definition of current (at GCSE Level) is 'rate of flow of charge'. Some candidates did know this, but many did not. Many responses did not mention the word 'charge' in their answer.

Question 7 (b)

(b) On the fast setting the power transfer in the fan is 46 W. The current is 0.2 A.

Calculate the resistance of the fan.

Use the Equation Sheet.

Resistance = ... Ω **[3]**

Many candidates did select the correct equation here, and usually when they did, they scored full marks. However, there were a number of candidates who tried to use P=IV without much success. It was possible to use P=IV and V=IR to arrive at the correct answer and some did. It is this sort of question, practice using the equation sheet and working through a variety of different calculation questions helps prepare the candidate.

Question 7 (c)

(c) On the slow setting the power rating is 11.5 W.

Calculate the energy transferred by the fan in 240 s.

Use the equation: $\text{power} = \frac{\text{energy transferred}}{\text{time}}$

Energy transferred = ... J **[2]**

The equation was given here and most candidates calculated the correct answer.

Question 8 (a)

8 The table shows the typical speed of some activities.

Activity	Speed (m/s)	Speed (km/h)
Walking	1 to 1.5	3.6 – 5.4
Running	3	10.8
Cycling	7	……………..
Driving a car at 30 mph	13	46.8

(a) Complete the table. **[2]**

Most candidates did manage this conversion and it was pleasing to see that many had used the other data in the table to work backwards and discover the method required.

Question 8 (b)

(b) Leo is riding his bike along a flat road.

It takes Leo 17 s to accelerate from 3 m/s to 7 m/s.

Calculate the acceleration of the bike.

Give your answer to **2** decimal places.

Use the Equation Sheet.

Acceleration = ... m/s^2 **[4]**

This was a very well answered calculation question. Again the clearest answers were those that first stated the equation and then showed full substitution of numbers before processing and rounding their answer.

Question 8 (c) (i)

(c) Leo increases his speed by peddling harder. The bike accelerates because of forces between the wheel and the road.

(i) Draw **two** arrows on the picture to represent the interaction pair of forces between the **back wheel** and the road.

Label the force on the road: **X**
Label the force on the bike: **Y**

[2]

Very few candidates correctly identified the Newton's third law pair of forces here. Some did draw forces with equal magnitude and opposite directions, but it was clear that both force arrows were acting on the same object and, therefore, could not be an interaction pair.

Question 8 (c) (ii)

(ii) Later on in the journey, Leo travels at a constant speed.

Identify **three** forces acting on the **bike**.

1 ....

2 ....

3 ....

[3]

There were a variety of different responses given here. Many incorrect responses clearly related to energy stores such as 'GPE' or 'Kinetic' rather than forces. Other common incorrect forces were vague words such as 'push'. 'Upthrust' was another common incorrect answer, probably meaning reaction force.

Question 8 (d)

(d) Leo is carrying a heavy rucksack.

Which statement defines the weight of Leo's rucksack?

Tick (✓) **one** box.

The weight of the rucksack is the downward force on the rucksack due to the gravitational attraction of the Earth. ☐

The weight of the rucksack is the mass of the rucksack due to the downward force on the Earth. ☐

The weight of the rucksack is the pressure on the rucksack due to the gravitational attraction of the Earth. ☐

The weight of the rucksack is the pressure on the Earth due to the mass of the rucksack. ☐

[1]

This question tested the candidates knowledge of the word 'weight'. The correct answer was the most commonly selected response; however it was clear from the variety of responses seen that many candidates did not know the meaning of the word.

Question 9 (a) (i)

9 Hiro has a laser pointer which emits visible light.

The table shows the wavelength range for each colour in the visible light spectrum:

Colour of laser	**Wavelength range ($\times 10^{-7}$ m)**
Red	6.20 – 7.40
Orange	5.85 – 6.20
Yellow	5.75 – 5.85
Green	5.00 – 5.75
Blue	4.45 – 5.00
Indigo	4.25 – 4.45
Violet	3.90 – 4.25

(a) The frequency of the light from the laser pointer is 7.40×10^{14} Hz.

(i) Calculate the wavelength of the light.

Use the equation: wave speed = frequency × wavelength

The speed of light is 3.00×10^{8} m/s

Give your answer to **3** significant figures.

Wavelength = ... m **[3]**

Many candidates managed to arrive at the correct numerical answer here, but with an incorrect power of ten. Many candidates appeared to find manipulating large powers of ten difficult. Those who were more confident using standard form generally performed better in this question.

Question 9 (a) (ii)

(ii) The manufacturer claims that the laser pointer emits violet light.

Is the manufacturer correct?

Explain your answer.

....

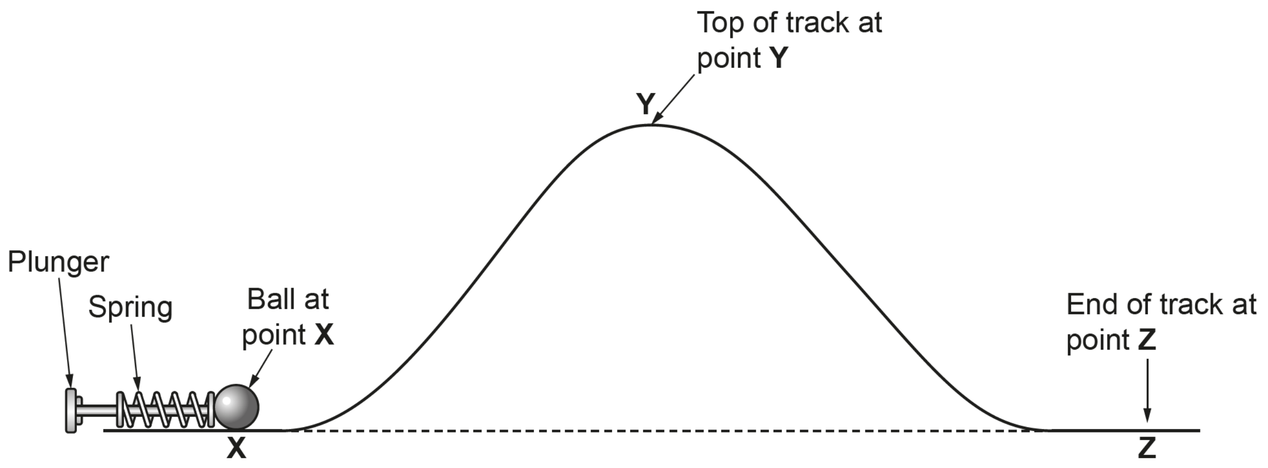
.... **[1]**

To score this mark, candidates had to state that the calculated wavelength is within the violet range. Many candidates did not score here because the given answer was too vague, for example an answer of 'yes, because it is violet' does not score the mark as the reason is not given.

Question 10 (a)

10 Gabi has a toy which uses a spring to fire a ball along a track as shown in **Fig. 10.1**.

Fig. 10.1



Gabi pulls back the plunger to compress the spring. When released, the spring sends the ball along the track to the top of the track at point **Y**.

(a) The initial length of the spring is 0.17 m. It is compressed to a length of 0.05 m.

Calculate the energy stored in the spring when it is compressed.

Assume the energy stored when compressing the spring is the same as the energy stored when extending it the same distance.

Spring constant of the spring = 11 N / m
Use the Equation Sheet.

Energy stored = ... J **[4]**

This question required candidates to first select the correct equation for the energy stored in a spring., This should then lead them to realise that they need to calculate the compression of the spring, before substituting the numbers into the equation. Common errors here include failing to calculate the spring compression and not squaring the compression value.

Exemplar 2

when extending it the same distance.

Spring constant of the spring = 11 N/m
Use the Equation Sheet.

0.17 − 0.05 = 0.12

$\frac{1}{2} \times 11 \times (0.12)^2 = 0.0792$

Energy stored = ...0.0792...... J **[4]**

This example response scores 4 marks and demonstrates very clear working. The candidate has first clearly shown where the compression number of 0.12 has come from, before showing full substitution into the equation and arriving at the correct response. The only improvement that could be made here would be to show the algebraic or word equation first.

Question 10 (b) (i)

(b) The ball continues to the end of the track at point **Z**.

Assume that no energy is transferred to any thermal stores.

(i) Complete this table to show the energy store that **increases** at each stage.

Action	Energy store that increases
Ball travelling up the track to **Y**.	
Ball travelling down the track to **Z**.	

[2]

Most candidates scored 1 mark here. Very few correctly identified both energy stores. The most common incorrect answers were 'kinetic' and 'gravitational' in the wrong box, either the same store in both boxes or the wrong way around. This perhaps shows that candidates generally understood that kinetic and/or gravitational stores were involved here but could not correctly link them to the ball's motion and position.

Question 10 (b) (ii)

(ii) Describe what happens to the total energy of the ball as it moves from **X** to **Z**.

.... **[1]**

Some candidates recognised that total energy remains the same here. But many thought that it must be changing as the speed of the ball is changing. This is related to the listed misconception below.

Question 10 (c) (i)

(c) **(i)** Explain how changing the compressed length of the spring affects the speed of the ball at point **Z**.

....

....

....

....

.... **[3]**

This is an example of a question where clarity of the candidate response makes a big difference. Many candidates did not clearly link the speed of the ball, or the energy changes, to the correct direction of change of spring compression. For the response to be clear, the candidate needed to pick a single direction, for example 'when the spring is more compressed' or 'when the spring is shorter' then link that to the correct effect, for example 'this will increase the energy stored in the spring' so 'the ball will have a greater speed at Z'.

Question 10 (c) (ii)

(ii) Explain how changing the height of the track at point **Y** affects the speed of the ball at point **Z**.

....

....

.... **[2]**

This question was rarely answered correctly. Most candidates stated that the ball would travel faster if the height was greater. The correct answer is to recognise that if the ball is reaching Z, then the height makes no difference due to energy conservation.

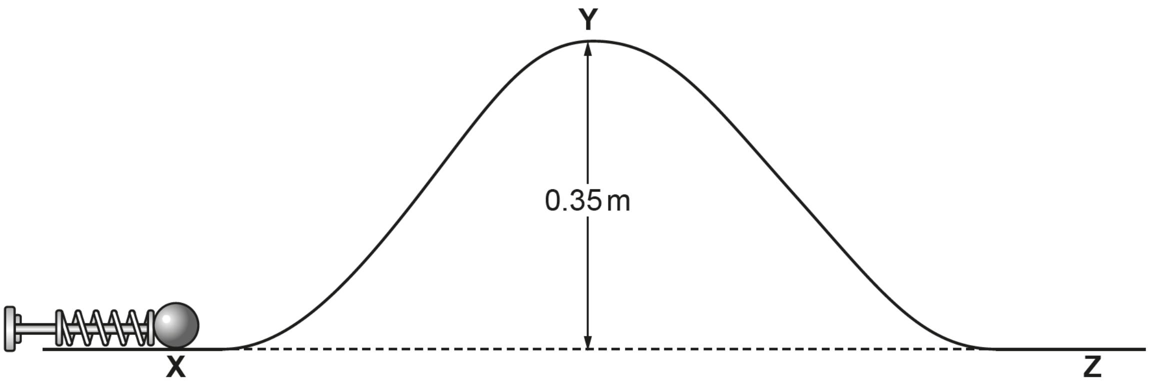
Misconception

A common misconception throughout this question is that energy is not conserved in something like a rolling ball, and instead energy just appears within the ball's kinetic or gravitational store as required by its position or motion.

Question 10 (d)

(d) The height between **X** and **Y** is 0.35 m as shown in **Fig. 10.2**.

Fig. 10.2



Gabi pulls the plunger so that the energy stored in the spring is 0.06 J. The plunger is released.

Calculate the maximum height the ball can travel up the slope.

Mass of the ball = 0.02 kg
Gravitational field strength = 10 N / kg

Use the Equation Sheet.

Maximum height = ... m **[3]**

This was a more difficult calculation as it required candidates to apply the gravitational potential energy equation to an unfamiliar context and realise that the gravitational store at the highest point is equal to the energy initially stored by the compressed spring. Despite this, many candidates did manage to score full marks.

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