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Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J[redacted]50
For first teaching in 2016

J260/03 Summer 2018 series

Version 1

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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. 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 can be downloaded from OCR.

Paper J260/03 series overview

J260/03 is the written examination component for the Physics content of the 21st Century Combined Science B GCSE. It is the foundation examination for knowledge and understanding of chapters P1-P6 and includes some Ideas about Science and Practical Skills.

Overall Candidate Performance

Candidates performed well on simple calculations (e.g. 2b, 3bii, 4a, 5bii, 5c, 6ci and 6cii). However candidates were less successful when recall of an equation was required (e.g.4d and 8c). In addition many candidates were unable to deal with the units and unit conversions required by some calculations (e.g. 5bi, 5c and 8c).

There was evidence to suggest that many candidates had not carried out the practicals in questions 6 and 8. This disadvantaged some candidates who were unable to provide the level of detail expected in their responses.

Whilst there were some very good responses to questions that asked for definitions or the meaning of scientific words (e.g. 5ai, 6b and 7a) most candidates performed very poorly. These types of questions are common on a foundation paper and practice at writing definitions or meanings would clearly benefit many candidates.

There was no evidence that any time constraints had led to a candidate underperforming and scripts where there was no response to the final question also had large sections of the paper which had not been tackled.

Question 1 (a)

1 This question is about electromagnetic radiation.

(a) Which of the following is electromagnetic radiation?

Put a (ring) around the correct answer.

radio waves **sound waves** **water waves** **waves on a rope**

[1]

This question was answered well by most candidates.

Question 1 (b) (i)

(b) Amaya uses a prism to produce a spectrum of the electromagnetic radiation from the Sun, as shown in **Fig. 1.1**.

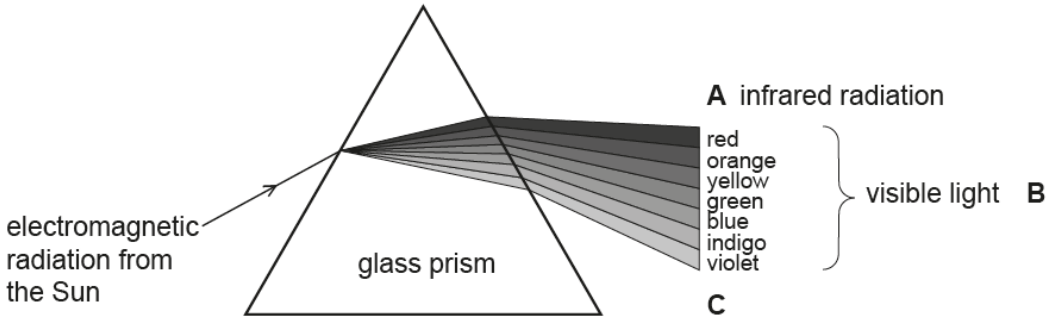


Fig. 1.1

(i) What is the electromagnetic radiation arriving at point **C** in **Fig. 1.1**?

Tick (✓) **one** box.

- Microwave ☐
- Sound wave ☐
- Ultraviolet ☐
- X-ray ☐

[1]

This question was answered well by most candidates.

Question 1 (b) (ii)

(ii) Describe how Amaya could detect the infrared radiation arriving at point **A** in **Fig. 1.1**.

.....

..... **[2]**

Candidates had difficulty identifying a method of detect infrared radiation. A common error was to suggest it was red in colour. A common misconception was to confuse infrared and ultra-violet radiation.

Question 1 (c)

(c) Give **one** example of how infrared radiation can be used.

.....

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

Again confusion between infrared and ultra-violet with sunbeds being a common error. Some candidates incorrectly suggested infrared is used to detect heat. Lower ability candidates language was often too vague, for example saying used 'in a TV' instead of use in a TV remote control.

Question 2 (a)

2 The largest egg ever recorded was an ostrich egg.

(a) Complete the following sentences about the weight of the egg.

Use words from the list.

area **attraction** **force** **mass** **pressure** **repulsion**

Weight is the ..... on the egg due to the gravitational

..... of the Earth.

The weight of the egg is proportional to its ..... . **[3]**

Common errors involved using pressure in place of attraction and area in place of mass.

Question 2 (b)

(b) The egg had a mass of 2.6 kg.
Gravitational field strength = 10 N / kg

Calculate the weight of the egg.

Use the equation: weight = mass × gravitational field strength

Weight = ... N **[2]**

This question was answered well by most candidates.

Question 2 (c)

(c) The weight of an egg can be measured by attaching a pan to a Newton meter, as shown in **Fig. 2.1**.

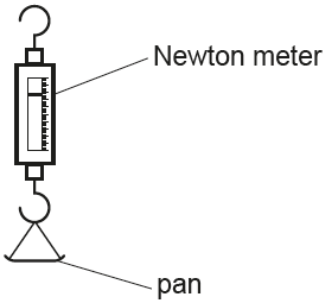


Fig. 2.1

Describe how the weight of an egg can be measured using the apparatus in **Fig. 2.1**.

.....

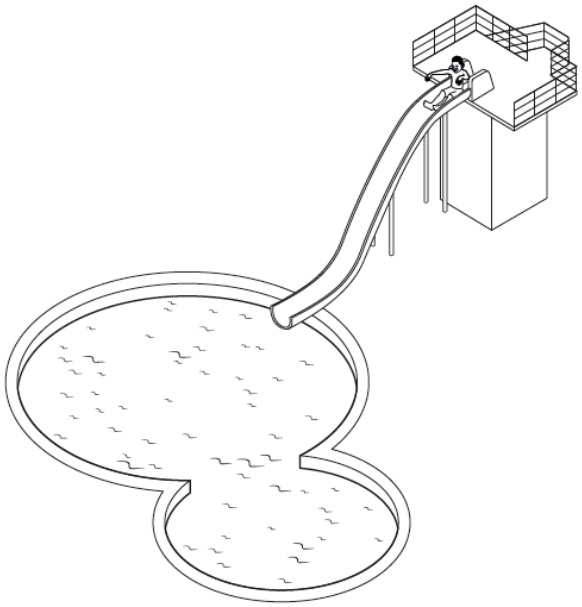
.....

..... **[2]**

The majority of candidates did not understand the importance of subtracting the weight of the pan. This is a very easy experiment to do with candidates and demonstrate the detail of how measurements are made. This could also be related to real life i.e. in the supermarket buying fruit etc.

Question 3 (a)

3 This question is about a water slide.



(a) Ben sits at the top of the slide. The water is **not** flowing and he is **not** moving.

Name the **two** forces acting on Ben and give the direction they act in.

Force 1 .....

Direction .....

Force 2 .....

Direction .....

[4]

Many candidates had difficulty applying their knowledge in this novel situation. Gravity acting downwards was the most common correct answer. Very few used the term 'reaction' for an upwards force. A common mistake was to suggest 'upthrust' as an appropriate force.

Question 3 (b) (i)

(b) The water is switched on and flows past Ben. He can feel the water pushing him, but it does not move him forward.

(i) What force stops him moving forward?

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

A common error here was to suggest weight instead of friction.

Question 3 (b) (ii)

(ii) Ben moves himself to the start of the slope. He slides down.

His mass is 40 kg and he accelerates at 5 m/s^2.

Calculate the force accelerating him.

Use the equation: force = mass × acceleration

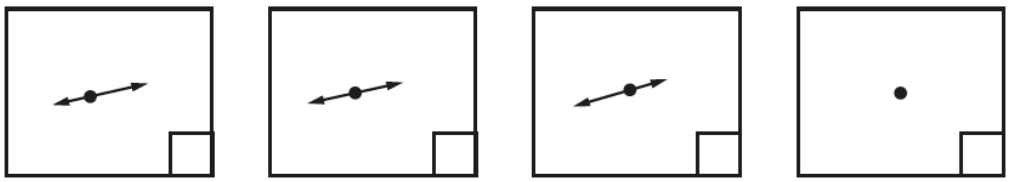
Force = ... N **[2]**

This question was answered well by most candidates.

Question 3 (c)

(c) Ben reaches the shallow slope at the bottom of the slide. Now he slides at a steady speed.

Put a tick in the box by the diagram that shows the forces on Ben as he slides parallel to the shallow slope.



[1]

A significant number of candidates incorrectly chose the 3rd option, presumably because Ben is moving down the slope.

Question 4 (a)

4 A portable electric heater can be used with a 12 V car battery to heat a car. **Fig. 4.1** shows the electric circuit for the heater.

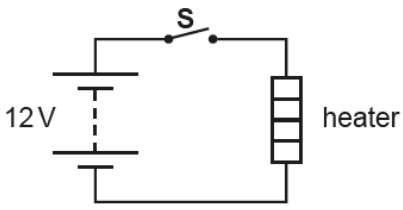


Fig. 4.1

When the switch, **S**, is closed there is a current in the heating element.

(a) Calculate the current in the heater. The power is 165 W.

Use the equation: current = power ÷ voltage

Give the units in your answer.

Current = ... units ..... **[3]**

The calculation was performed well by most candidates. However the unit for current was very rarely given as Amps or A. Lower ability candidates misunderstood the term units and gave answers of the form '13 unit 75'. This style of question is quite common on foundation papers and candidates should be shown examples.

Question 4 (b)

(b) The statements below about the circuit in **Fig. 4.1** are either **true** or **false**.

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

	True	False
If the current changes the resistance of the heating element remains constant.		
The size of the current depends on the potential difference across the heating element.		
The size of the current depends on the resistance of the heating element.		

[3]

This question was answered well by most candidates. With most candidates scoring 2 or 3 marks. The first statement gave rise to most incorrect responses.

Question 4 (c) (i)

(c) Energy is transferred from the car battery, by the electric current and the heater, to the air in the car.

(i) What is the energy store at the start?

Tick (✓) **one** box.

- Chemical ☐
- Elastic ☐
- Gravitational ☐
- Thermal ☐

[1]

This question was answered well by most candidates. The most common error was 'Thermal'.

Question 4 (c) (ii)

(ii) Complete these sentences to describe how the energy is transferred in the circuit in **Fig. 4.1**.

Put a (ring) around the correct answer.

The electric current transfers energy by **doing work / storing energy / convection** on the heater.

The heater transfers energy by **electricity to / storing energy for / heating** the air in the room.

[2]

Candidates most frequently got the 'doing work' answer wrong, commonly choosing 'storing energy'. The second sentence was more often completed correctly with 'heating'.

Question 4 (c) (iii)

(iii) What is the energy store at the end?

Tick (✓) **one** box.

- Chemical ☐
- Elastic ☐
- Gravitational ☐
- Thermal ☐

[1]

This question was answered well by most candidates.

Question 4 (d) (i)

(d) The energy transferred depends on the length of time that the heater is switched on.

(i) Write down an equation that links the energy transferred with the power of the heater and the time it is switched on.

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

This equation is one candidates are expected to remember, However many candidates simply got this wrong. Energy = power / time was common as were equations involving other variables. Some lower ability candidates did not provide complete equations.

Question 4 (d) (ii)

(ii) The power of the heater is 165 W.

Calculate the energy transferred in 60 s.

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

Like other calculations this was answered well when an equation had been given in part 4d(ii). Many candidates still scored marks for using an incorrect equation from 4d(ii).

Question 5 (a) (i)

5 Sound waves can be used to measure distances.

(a) **(i)** Sound is a longitudinal wave.

Describe the difference between a longitudinal wave and a transverse wave.

You may draw labelled diagrams to help you describe the waves.

.....

.....

..... **[2]**

The majority of candidates did not score any marks. The link between vibrations and direction of motion was very rarely made clear. Students have some grasp of the idea of parallel and perpendicular but did not link it to oscillations or the direction of motion of the wave. Candidates need to take care that they give full explanations of scientific terms.

Question 5 (a) (ii)

(ii) Put a ring around the correct word to complete the following sentence:

An echo is heard when sound waves are **absorbed / amplified / reflected / refracted**.

[1]

This question was answered well by most candidates. The most common error was 'refracted'

Question 5 (b) (i)

(b) **Table 5.1** shows the speed of sound in different materials.

Material	Speed of sound (m/s)
air	340
bone	4100
iron	
rock	6000
seawater	1500

Table 5.1

(i) The speed of sound in iron is 18 000 **kilometres per hour (km/h)**.

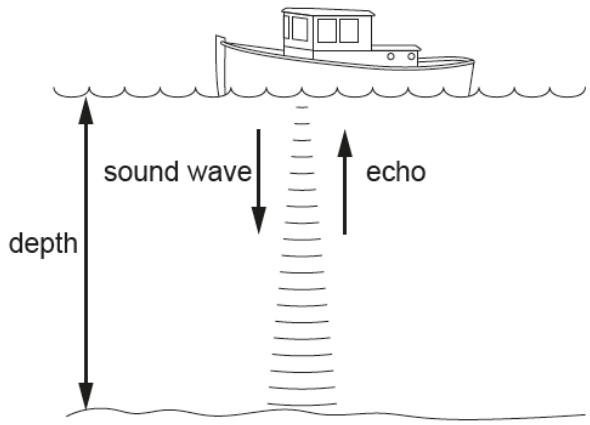
Calculate the speed of sound in **iron** in **metres per second (m/s)**.

Speed of sound = ...m/s **[2]**

This calculation was very rarely performed correctly. Candidates clearly have problems with changing units. Many candidates did not show their working and hence could not gain any method marks. Candidates should always be encouraged to show working.

Question 5 (b) (ii)

(ii) A boat uses the echo of sound waves from the sea-bed to measure the depth of the sea.



A sound wave is sent towards the sea-bed. The echo returns to the boat after 1.8 s.

Use data from **Table 5.1** to help calculate the distance travelled by the wave.

Use the equation: distance = speed × time

Distance travelled = ... m **[3]**

This question was answered well by most candidates.

Question 5 (b) (iii)

(iii) What is the depth of the sea?

Depth of sea = ... m **[1]**

Only the higher ability candidates identified the depth as half the distance found in part 5b(ii).

Question 5 (c)

(c) Sound waves with a frequency of 20 kHz are called ultrasound. They are used to produce images of inside the body.

Calculate the wavelength of these ultrasound waves in **bone**.

Use data from **Table 5.1** and the equation: wavelength = wave speed ÷ frequency

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

Wavelength = ... m **[4]**

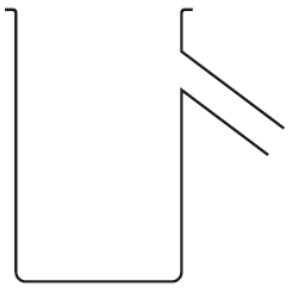
By far the most common error was to not convert the frequency to hertz, this left them with answer of 205 which only a few candidates could express as 205.00 to 2 decimal places.

Question 6 (a) (i)

6 Mia is investigating the density of different materials.

(a) Mia has a stone with a mass of 220.0 g. She wants to measure its volume.

She pours water into the can shown in this diagram.



(i) What other equipment does she need to measure the volume of the stone?

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

When carrying out any form of measuring of liquid practical candidates need to be told that a measuring cylinder is the piece of equipment to use rather than a beaker etc.

Question 6 (a) (ii)

(ii) State **two** steps Mia must follow when using the can to get an accurate measurement of the volume of the stone.

1 .....

.....

2 .....

..... **[2]**

It would appear few candidates had done this experiment. If candidates carry out the practical then they will have seen themselves why not to put their fingers into the water or to start with a measuring cylinder that contains a liquid already. Lots of candidate's suggestions were inappropriate e.g. use the same amount of water, repeat the investigation.

Question 6 (b)

(b) Complete this sentence to define density.

Density is ..... **[1]**

This question was not well answered. Candidates need to learn the definitions of simple quantities.

Question 6 (c) (i)

(c) **(i)** Mia repeats the volume measurement five times.

These are her results.

Measurements	**1**	**2**	**3**	**4**	**5**
Volume of the stone (cm^3)	43.0	44.5	43.0	45.0	44.5

Calculate the mean volume of the stone.

Mean volume = ... cm^3 **[2]**

This question was answered well by most candidates.

Question 6 (c) (ii)

(ii) Calculate the density of Mia's 220.0 g stone.

Use your answer to part **(c)(i)**.

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

This question was answered well by most candidates. An error carried forward was allowed from part c(i).

Question 6 (d) (i)

(d) **Table 6.1** gives the densities of some materials.

Material	Density (g / cm^3)
chalk	2.3
sandstone	2.3
granite	2.7
malachite	3.9
haematite	5.1

Table 6.1

(i) Which of the materials in **Table 6.1** could Mia's stone be made of?

Tick (✓) **one** box.

Chalk ☐

Sandstone ☐

Granite ☐

Malachite ☐

Haematite ☐

[1]

This question was answered well by most candidates. An error carried forward was allowed from part c(ii).

Question 6 (d) (ii)

(ii) Mia discusses her experiment with Sundip.

Mia
Measuring the density is a useful way to identify any type of rock.

Sundip
I don't think you can identify rocks by their density alone.

Use the data in **Table 6.1** to help you decide whether Mia or Sundip is correct.

Explain your reasoning.

.....

.....

.....

..... **[3]**

Many candidates did well on this question identifying that some rocks have the same density and could use the data in the table to demonstrate their point. The most common error was to suggest that different size samples of rock would mean density could not be used.

Question 7 (a)

7 This question is about radioactive decay.

(a) Explain what the half-life of a radioactive isotope means.

.....

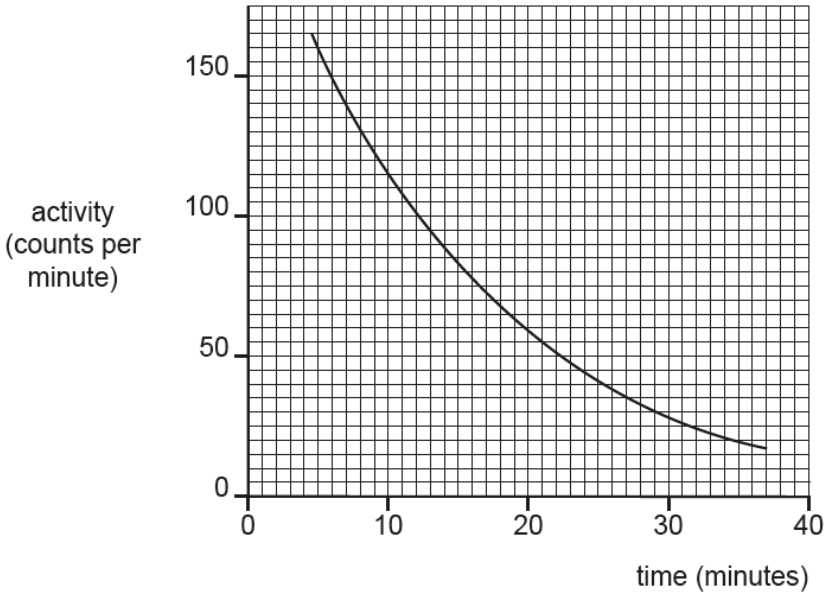
.....

..... **[2]**

Very few candidates were able to give any idea of the meaning of half-life. The ability to explain key scientific terms is a skill that needs developing.

Question 7 (b)

(b) This graph shows how the activity of a cerium-131 source changes over time.



Use the graph to find the half-life of cerium-131.

Show your working on the graph.

Half-life = ...minutes **[2]**

Very few candidates constructed two lines on the graph at appropriate activities and found the time interval between them. Most just drew one line and read the value of the time. Practice in carrying out this procedure should help future candidates.

Question 8 (a)

8 Alex and Jack are talking about stretching objects.

Alex
The diagrams below show how a spring and a rubber band can be stretched.

Jack
I don't agree. The force will just move the rubber band or the spring.

(a) Is Alex or Jack correct?
Give a reason for your answer.

Alex ☐

Jack ☐

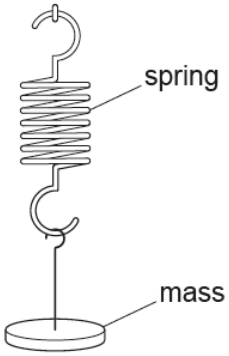
Reason .....

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

Only the higher ability candidates were able to apply an understanding of forces to this situation and clearly express the need for a second force to stretch the spring or rubber band.

Question 8 (b) (i)

(b) Alex wants to know how much a spring will extend when he hangs different masses from the end of it.



He attaches a mass to the end of the spring and records its weight, in N, and the extension of the spring. He repeats this for different masses.

(i) State **two** safety precautions he should take while doing the experiment.

1 .....

.....

2 .....

..... **[2]**

Many answers here were too vague e.g. use a safety screen, be careful, don't over stretch the spring, with no explanation of how these should or could be used. Goggles to protect the eye was the most common correct response.

Question 8 (b) (ii)

(ii) Alex did not know how to work out the extension of the spring.

What measurements should Alex record and how should he use them to find the extension?

.....

.....

.....

..... **[3]**

This appeared to be another example of an experiment that many candidates had not done and hence had difficulty explaining details of the measurements required. Poor language skills often meant that answers were too vague e.g. 'measure the spring' but no indication of what to measure.

Question 8 (b) (iii)

Alex plots the results of his experiment on the graph shown in **Fig. 7.1**.

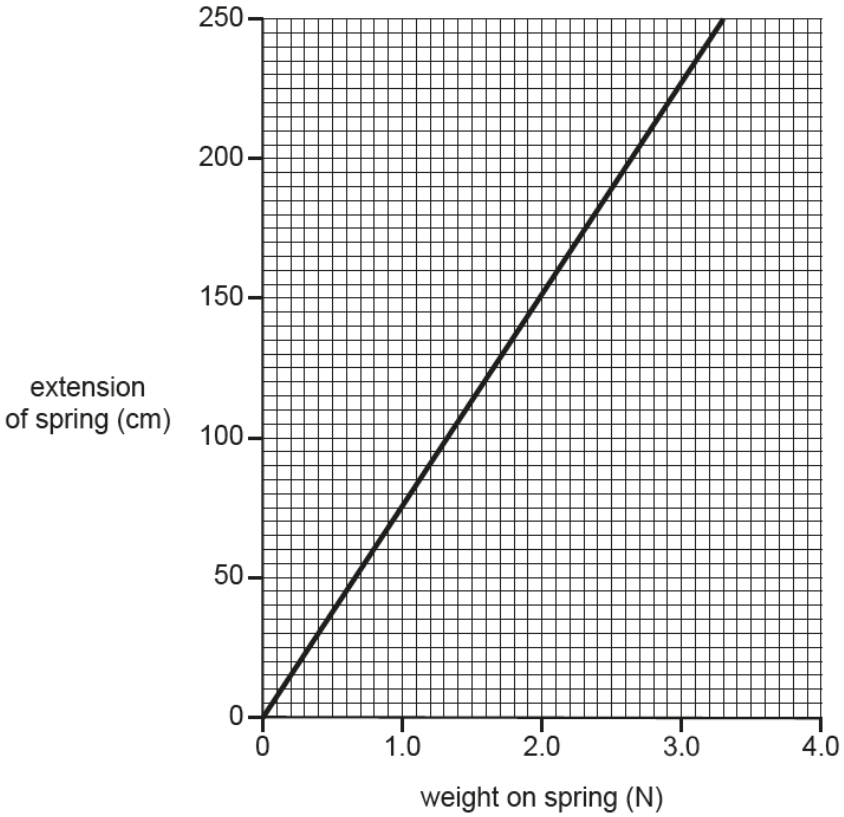


Fig. 7.1

(iii) Alex removes all the masses from the spring. He hangs a toy with a weight 1.2 N on the spring.

Use the graph in **Fig. 7.1** to find the extension of the spring.

Extension = ...cm **[1]**

This question was answered well by most candidates. .

Question 8 (c)

(c) Alex has a second spring. It has a spring constant = 8.0 N/m.

He hangs a bigger toy on this spring and the extension of the spring is 35 cm.

Calculate the weight of this toy.

Weight = ... N **[4]**

By far the most common problem here was that candidates could not remember the equation and hence did not carry out a correct calculation. Once again as in previous questions candidates did not convert the units from cm to m.

Question 8 (d)

(d) The masses are now hung from a rubber band.

Describe how the force - extension relationships for a rubber band and a spring are different.
You may include sketch graphs in your answer.

.....

.....

..... **[2]**

Only the higher ability candidates attempted to draw force-extension graphs and comment on them. Most candidates simply stated that there were different materials and the rubber band would snap, which did not gain any marks. Lower ability candidates often drew pictures of stretched elastic bands and springs.

Question 9 (a)

9 This question is about the structure of the atom.

(a) Describe the structure of the atom.
Include information about particles that make up the atom.
You may include a diagram.

.....

.....

.....

.....

.....

..... **[5]**

Most candidates did well on this question. Lower ability candidates often recalled that the atom is made up of protons, neutrons and electrons, but were muddled over the arrangement within the atom.

Question 9 (b) (ii)

(ii) How does the size of the nucleus compare to the size of an atom?

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

A common misconception of least able candidates was to confuse an atomic nucleus with a cellular nucleus.

Question 9 (c) (ii)

(ii) The model changed because of J.J. Thomson's discovery. Describe the new model J.J. Thomson suggested.

.....

.....

.....

..... **[3]**

Very few candidates were familiar with the work of JJ Thomson and many confused it with Rutherford's work. Candidates need to be familiar with early models of the atom and be able to describe them.

Question 9 (d)

(d) The element carbon has two isotopes, carbon-12 and carbon-14.

What is the difference between these two isotopes?

.....

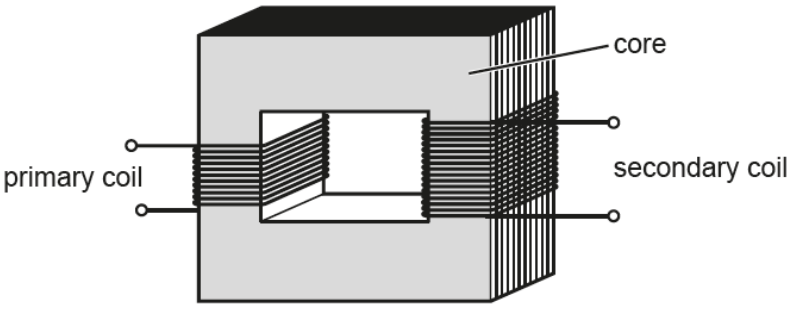
..... **[2]**

Candidates often got confused with chemistry here, talking about ions. Very few knew what an isotope was and could apply it in this example.

Question 10 (d)

10* Eve wants to connect an electric pump to the mains electricity supply.

She needs a transformer which can supply enough power for an **output** potential difference of **12 V** and an **output** current of **3 A**.

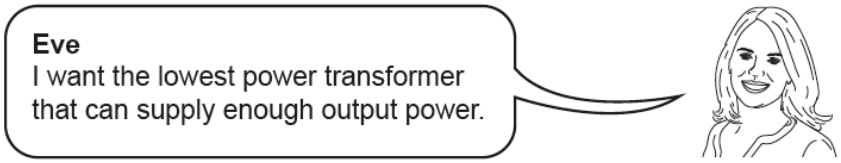


input power = potential difference across primary coil × current in primary coil

output power = potential difference across secondary coil × current in secondary coil

She has three transformers to choose from:

	Transformer A	Transformer B	Transformer C
Maximum input power (W)	30	60	60
Output potential difference (V)	12	12	15



Which transformer should Eve choose?
Justify your answer and use calculations to support your decision.

.....

.....

..... **[6]**

Most candidates attempted this question however all but the higher ability candidates were limited to Level 1 only. To achieve Level 2 or 3 candidates had to carry out calculations based on the table of data provided. Very few candidates could do this. Candidates would benefit from coaching to use the data provided in extended response questions.

Exemplar 1

Justify your answer and use calculations to support your decision.

L1 transformer B because ~~yes~~ it has can have the Mexium input of 60w and the little input of 12v. She could pick A but the Maximum input is only 30w, whereas B is 60w.

In this exemplar the candidate has correctly chosen transformer B and provided some reasoning to support this conclusion. Whilst the argument does use data from the table there is no attempt to carry out any calculations which indicates that this is a Level 1 response. There is an attempt at a logical structure with a line of reasoning and the information is relevant hence the candidate is awarded 2 marks.

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