AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

Level 3 Certificate and Extended Certificate in Applied Science

KEY CONCEPTS IN SCIENCE

Unit Number: J/507/6497

Monday 23 January 2017 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- You will be provided with a copy of the Periodic Table and formula sheet.
- There are three sections in this paper:
  Section A – Biology
  Section B – Chemistry
  Section C – Physics.
- You should answer **all** questions in each section.
- You should spend approximately 30 minutes on **each** section.
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

Advice
- Read each question carefully.

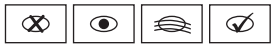
Section A – Biology

Answer **all** questions in this section

In the multiple choice questions, only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

0 1 Sports scientists study breathing and respiration. Breathing and respiration are different processes.

(a) Select the correct feature of breathing.

Breathing is:

[1 mark]

A physical and external.

B chemical and external.

C physical and internal.

D chemical and internal.

(b) Respiration occurs in cells. Respiration has different stages. Glycolysis is one of the stages of respiration.

Where in a cell does glycolysis occur?

[1 mark]

A Cytoplasm ⬭

B Lysosomes ⬭

C Mitochondria ⬭

D Nucleus ⬭

(c) The Krebs cycle occurs in mitochondria. **Figure 1** shows a mitochondrion.

Figure 1

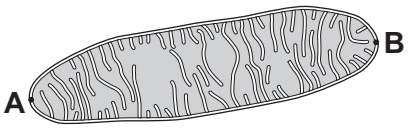


Figure 1 shows a mitochondrion that has been magnified 5000 times. In **Figure 1** the distance between point **A** and point **B** is 4.6 cm

Calculate the length of the mitochondrion, in micrometres (μm), before magnification.

[2 marks]

Length = _____ μm

(d) Describe the role of NADH in respiration?

[1 mark]

(e) A sports scientist is measuring the basal metabolic rate (BMR) of different people. BMR is the minimum amount of energy required to maintain essential body processes. The sports scientist uses direct calorimetry to determine the BMR of the different people.

Describe how BMR is measured using direct calorimetry.

[4 marks]

(f) Another sports scientist measured the BMR of men and women using indirect calorimetry. The men and women in the study had different body masses. **Table 1** shows the mean BMR values for different body masses.

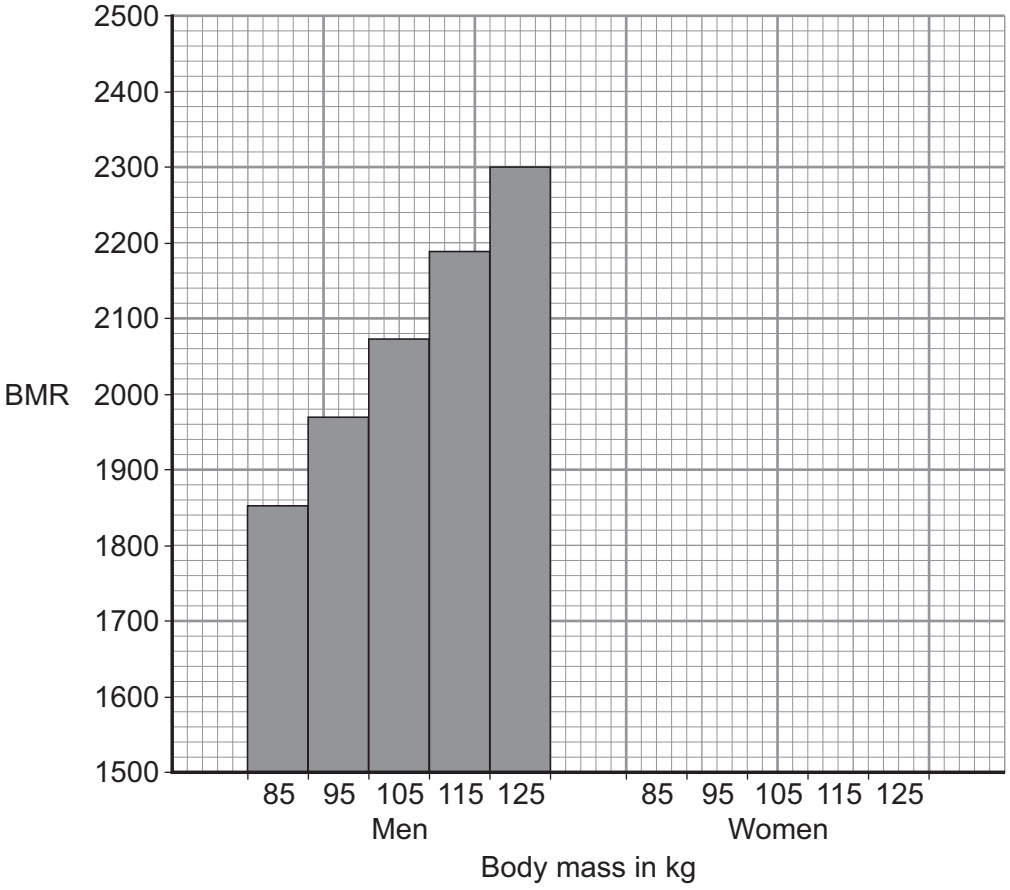
Table 1

	BMR	
Body mass in kg	**Men**	**Women**
85	1855	1550
95	1970	1620
105	2075	1700
115	2187	1775
125	2300	1855

Complete the bar chart in **Figure 2** to show the data for the women. The results for the men have been done for you.

[2 marks]

Figure 2



(g) **Table 1** shows that BMR for men is higher than BMR for women of the same body mass.

Give **one** reason for this pattern.

[1 mark]

_____

_____

Turn over for the next question

0 2 The global human population is rapidly increasing. The production of sufficient food for the increasing number of people is a major global concern. Food poverty is when people do not have enough food for a healthy diet. Scientists try to increase the efficiency of food chains and ecosystems to help reduce food poverty. The efficiency of different ecosystems can be assessed by comparing primary production.

(a) What is meant by gross primary production (GPP)?

[1 mark]

(b) The GPP of a tropical rainforest is estimated to be 160 000kJ m^{-2} per year. The net primary production (NPP) of the tropical rainforest is 40 000 kJm^{-2} per year.

Explain why the NPP is lower than the GPP.

[2 marks]

(c) The NPP in a temperate rainforest in the UK is estimated to be 26 000 kJm^{-2} per year.

Suggest **three** reasons why the NPP in a temperate forest is lower than in a tropical rainforest.

[3 marks]

Reason 1

Reason 2

Reason 3

(d) Some dieticians promote a meat-free diet. This would improve the efficiency of food chains.

Give **two** reasons why the efficiency of a food chain would increase if more people ate a meat-free diet.

[2 marks]

Reason 1 _____

_____

Reason 2 _____

_____

20

Turn over for Section B

Section B – Chemistry

Answer **all** questions in this section

0 3 Material scientists consider the properties of a substance carefully before choosing it for a particular function. The properties of a substance depend upon the type of bonding and the forces between the particles.

A material scientist requires a substance to conduct electricity at 900°C, but be an insulator in temperatures below 900°C. The material scientist selects an ionic substance.

(a) Draw a labelled diagram to show the ionic structure of solid sodium chloride. Your diagram should be a 3-dimensional representation.

[2 marks]

(b) Explain why sodium chloride will only conduct electricity at high temperatures.

[2 marks]

(c) Magnesium oxide (MgO) is used as an insulator in electrical heating elements.

Explain why magnesium oxide has a higher melting point than sodium chloride.

[2 marks]

(d) Metal hydroxides are ionic substances.

(i) Give the formula for calcium hydroxide.

[1 mark]

(ii) Barium hydroxide will react in a similar way to calcium hydroxide.

State why.

[1 mark]

(iii) Write the balanced symbol equation for the neutralisation of barium hydroxide by hydrochloric acid (HCl).

[2 marks]

Turn over for the next question

0 4 Copper is widely used as an electrical conductor.

(a) State in which block of the Periodic Table copper is located.

[1 mark]

(b) Copper is extracted from copper ore. High-grade copper ore consists mostly of copper carbonate ($CuCO_3$).

(i) 10 tonnes of copper ore contains 54% $CuCO_3$.

Calculate the mass of copper carbonate in the ore. Give the correct unit in your answer.

[2 marks]

Mass = _____

(ii) During processing, the copper carbonate is reacted with sulfuric acid to make copper sulfate.

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

The relative molecular mass (M_r) of copper carbonate is 123.5.

Calculate the relative molecular mass (M_r) of copper sulfate ($CuSO_4$).

[1 mark]

Relative molecular mass (M_r) = _____

(iii) Calculate the mass of copper carbonate required to give 3 tonnes of copper sulfate. Assume 100% yield.

[3 marks]

Mass = _____

(c) Aqueous copper ions (Cu^{2+}) are a blue colour.

(i) Give the electron arrangement of a Cu^{2+} ion.

[1 mark]

(ii) Explain why aqueous copper ions are blue. Use the idea of electron transitions in your explanation.

[2 marks]

20

Turn over for Section C

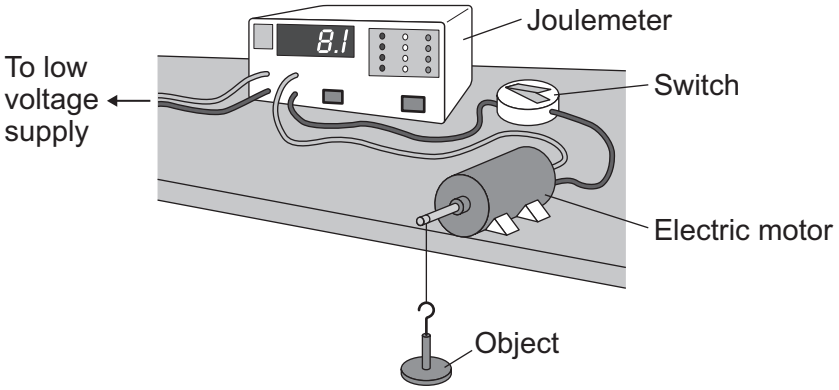
Section C – Physics

Answer **all** questions in this section

0 5 A technician thinks the efficiency of an electric motor depends on the mass being lifted. She wants to design an experiment to calculate the efficiency of an electric motor as it lifts different masses from the floor onto a laboratory bench. She has a joulemeter to measure the energy transferred by the motor as the mass is lifted.

Figure 3 shows some of the equipment she plans to use.

Figure 3



(a) Describe how she would do this experiment.
In your description you should state:

- the measurements she would take
- how she should ensure that her results are valid
- how she should present her results.

[5 marks]

Extra space

Question 5 continues on the next page

(b) (i) A 400 g mass is lifted 0.85 m from the floor to the bench.

Calculate the change in gravitational potential energy of the mass as it is lifted. Assume g = 9.8 ms^{-2}.

[1 mark]

Change in gravitational potential energy = _____ J

(ii) The joulemeter reading is 8.1 J

Calculate the efficiency of the electric motor.

[2 marks]

Efficiency = _____

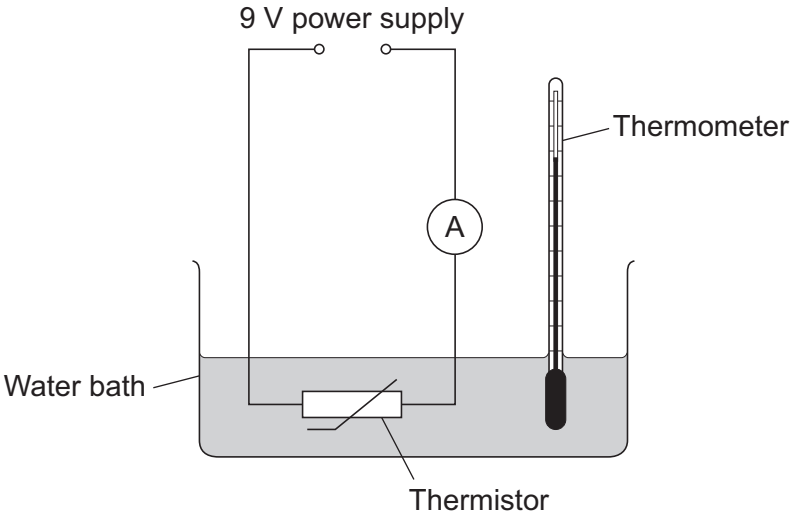
(c) Give **one** reason why the efficiency of the electric motor is not 100%.

[1 mark]

0 6 An apprentice engineer investigates the properties of a thermistor as its temperature changes. He uses a water bath to change the temperature of the thermistor.

Figure 4 shows the apparatus used.

Figure 4

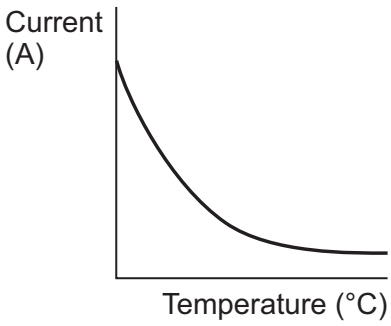


(a) (i) Which graph shows the change in current as the thermistor is heated?

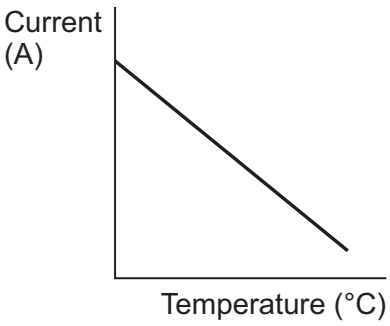
Circle the correct letter.

[1 mark]

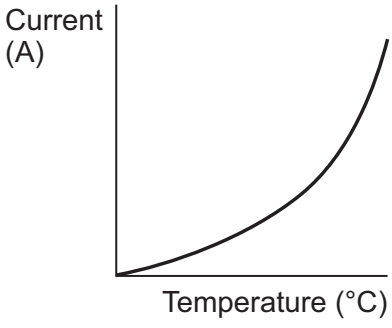
A



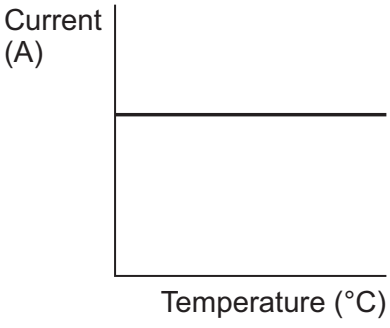
B



C



D



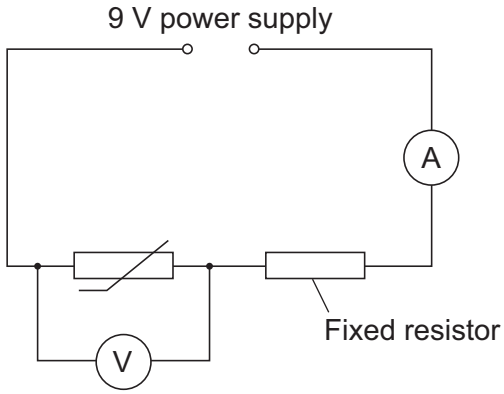
(ii) Explain why you have chosen the graph in question **(a) (i)**.

[2 marks]

(b) The apprentice engineer uses the thermistor to make a potential divider circuit.

Figure 5 shows the potential divider circuit.

Figure 5



The voltage across the thermistor decreases as the thermistor is heated.

State what happens to the voltage across the fixed resistor.
Give **one** reason for your answer.

[2 marks]

(c) Give **one** use for a potential divider circuit which includes a thermistor.

[1 mark]

0 7 **Figure 6** shows a sprinter at the start of a race.

Figure 6

(a) Explain why the sprinter accelerates forwards when using the starting blocks.

Use Newton's Laws of Motion in your explanation.

[3 marks]

(b) At the start of the race the sprinter accelerates uniformly at 1.3 m s^{-2}.

He reaches a maximum speed of 10.4 m s^{-1}.

Calculate the distance he has run when he has reached his maximum speed.

[2 marks]

Distance = _____ m

20

END OF QUESTIONS

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