OCR
Oxford Cambridge and RSA

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Friday 16 June 2017 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE PHYSICS A/ADDITIONAL SCIENCE A

A182/02 Modules P4 P5 P6 (Higher Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

A182/02

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil ( ).
- A list of useful relationships is printed on page **2**.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful relationships

The Earth in the Universe

distance = wave speed × time

wave speed = frequency × wavelength

Sustainable energy

energy transferred = power × time

power = voltage × current

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

momentum = mass × velocity

change of momentum = resultant force × time for which it acts

work done by a force = force × distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight × vertical height difference

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric circuits

power = voltage × current

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive materials

energy = mass × [speed of light in a vacuum]^2

Answer **all** the questions

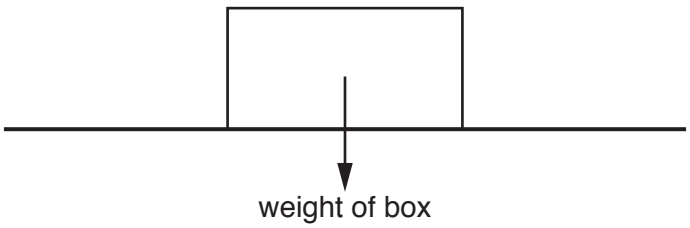
1 **(a)** The diagram shows a box moving across a horizontal floor after it has been given a push.

The box is moving from **left to right** and is **slowing down**.

The weight of the box is indicated on the diagram by an arrow representing its magnitude and direction.

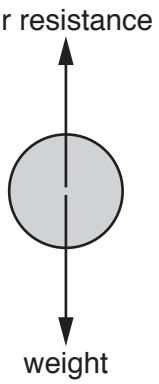
Complete the diagram by drawing labelled arrows for the other forces acting on the box.

Show both the magnitude and direction for each force. No calculation is needed.



[3]

(b) This is the force diagram Chris draws for a ball falling vertically at constant speed.



Chris says that the two forces are equal and opposite as they are an interaction pair and the resultant force on the ball is zero.

Comment on Chris's reasoning.

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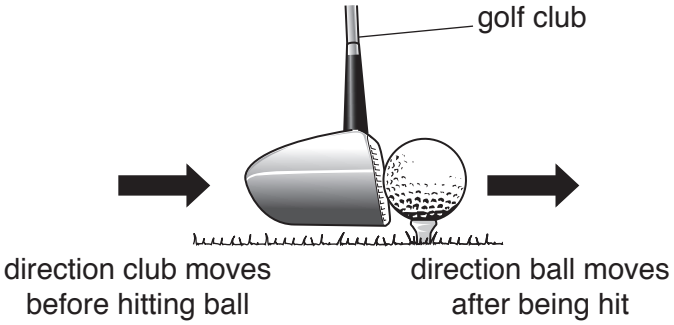
..... **[2]**

[Total: 5]

2 Anika is playing golf. She swings her golf club so that it hits a stationary ball.



The ball has velocity 40 m/s and kinetic energy 40 J after it has been hit.

(a) (i) Calculate the mass of the ball in grams.

Show your working.

mass = ... g **[2]**

(ii) Give **two** reasons why the club has more kinetic energy before hitting the ball than the ball gains.

1 .....

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2 .....

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[2]

(b) (i) Calculate the momentum of the ball after it has been hit.

Give the answer and the unit.

Show your working.

momentum = ... unit ..... **[2]**

(ii) The club hits the ball with a force of 4.0 kN.

How long is the club in contact with the ball?

Put a (ring) around the correct answer.

0.50 ms **0.50 s** **2.0 s** **500 s** **[1]**

(iii) Explain how Anika can use a smaller force but still make the ball go at 40 m/s.

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

[Total: 9]

3 A car travels along a straight horizontal road.

The table shows how the displacement of the car varies for part of its journey.

Time (s)	0	10	20	30	40	50	60	70	80
Displacement (m)	0	200	400	600	800	975	1100	1175	1200

Describe and explain the motion of the car.

Use the data to support your answer.

You may draw a **sketch** graph with important points labelled clearly to help you answer the question.

The quality of written communication will be assessed in your answer.

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[Total: 6]

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4 Callum is a car mechanic working on an electric car.

The car's source of energy is a battery and he has been given the following information about the car:

- Voltage of battery: 200 V
- Maximum power of car's motor: 30 kW.

(a) (i) Calculate the current through the motor when working at maximum power.

Show your working.

current = ... A **[2]**

(ii) Thin wires have more resistance than thick wires.

The wires connecting the battery to the motor are thick because the current from the battery is large.

Suggest what would happen to thin wires if they were used to connect the battery to the motor.

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

(iii) The wire is made up of atoms which contain protons and electrons.

There is a current in the wire.

Which of the following correctly describes what is moving and the direction in which it moves?

Put a tick (✓) in the box next to the correct answer.

What moves?	**Which way do they move?**	
both electrons and protons	in opposite directions	☐
only electrons	towards the negative terminal of the battery	☐
only electrons	towards the positive terminal of the battery	☐
only protons	towards the negative terminal of the battery	☐
only protons	towards the positive terminal of the battery	☐

[1]

(b) Callum checks the voltage and current from the battery.

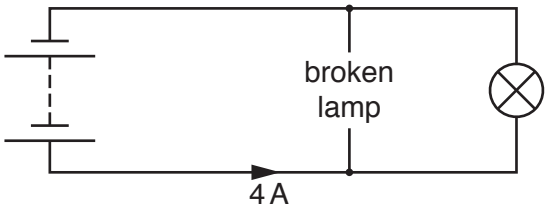
He connects a voltmeter and ammeter to the motor circuit.

Complete the circuit diagram he should use.

[2]

(c) The car's headlights are connected in parallel.

When one of the headlights is not working the current from the battery to the headlight circuit is 4 A.



Callum's friend, Noah, says that when the broken lamp is replaced the 4 A current will be shared between the two lamps, so each gets 2 A. The total current from the battery will still be 4 A. (You may assume that the lamps are alike.)

Do you agree with Noah?

Give reasons for your answer.

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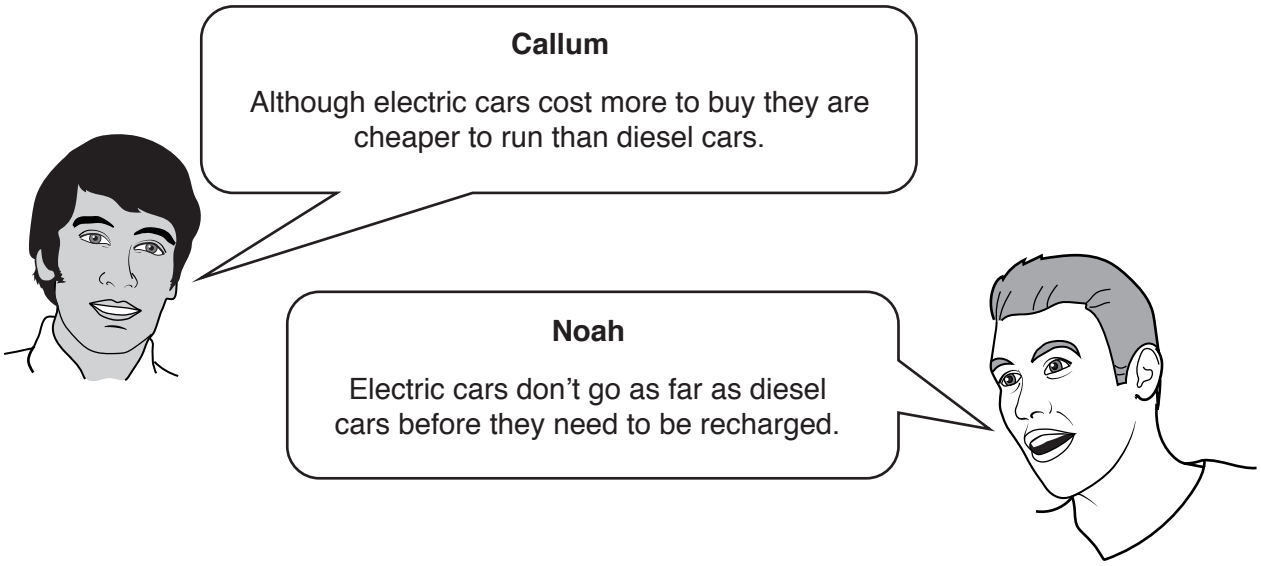
(d) Callum discusses with Noah the advantages and disadvantages of electric cars compared with diesel powered cars.



Suggest one other **advantage** and one other **disadvantage** of electric cars compared with diesel powered cars.

Advantage .....

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Disadvantage .....

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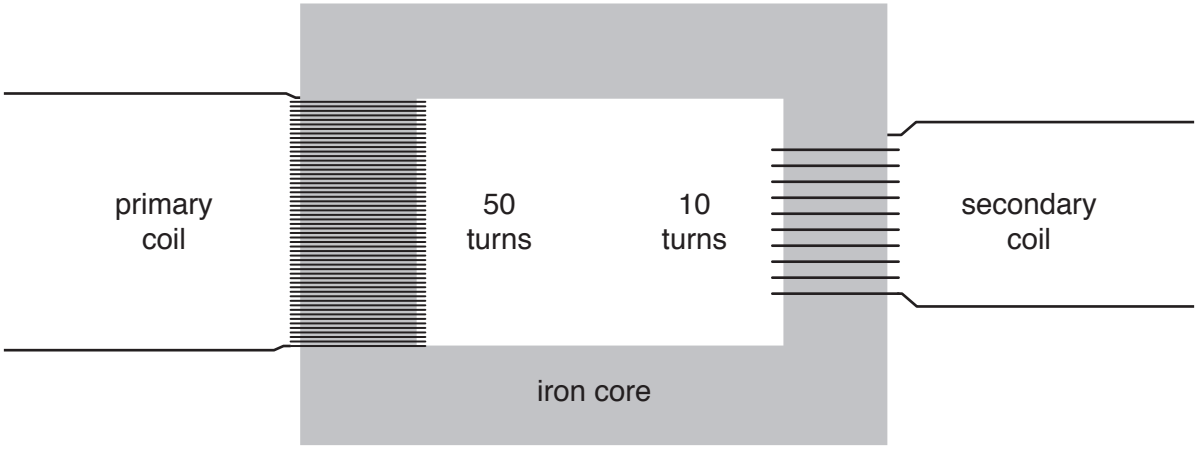
[2]

[Total: 10]

5 A transformer is used to change the size of an alternating voltage.



(a) A voltage is produced across the secondary coil when an alternating voltage is put across the primary.

Describe the process by which this happens.

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

(b) The input to the transformer above is 20 V.

What is the output?

Put a (ring) around the correct answer.

0.4 V **2 V** **4 V** **100 V** **1000 V** **[1]**

[Total: 4]

6 Zac and Megan are doing an experiment with a thermistor.

They use a 12 V power supply and an ammeter and voltmeter connected to the thermistor.

They put the thermistor in a beaker of water and gently heat the water.

They record the voltmeter and ammeter readings as well as the temperature of the water.

Here are their results.

Temperature (°C)	10	20	30	40
Voltage (V)	12	12	12	12
Current (mA)	0.60	1.0	1.5	2.4

Zac says: "There is no correlation between **temperature** and **current**."

Megan says: "The **resistance** of the thermistor changes as it gets warmer."

Comment on Zac and Megan's statements.

Use the data to justify your answer.

The quality of written communication will be assessed in your answer.

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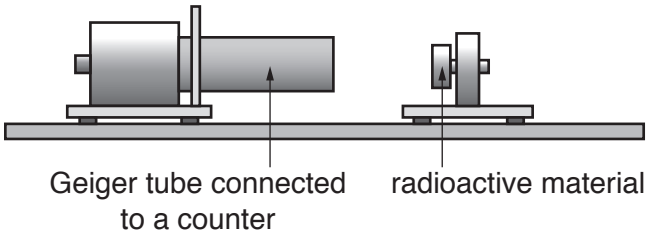
[Total: 6]

7 Dan and Lucy watch a demonstration experiment about a radioactive material.



The teacher measures the background count rate before and after the experiment.

(a) Why is the background count rate measured before and after the experiment?

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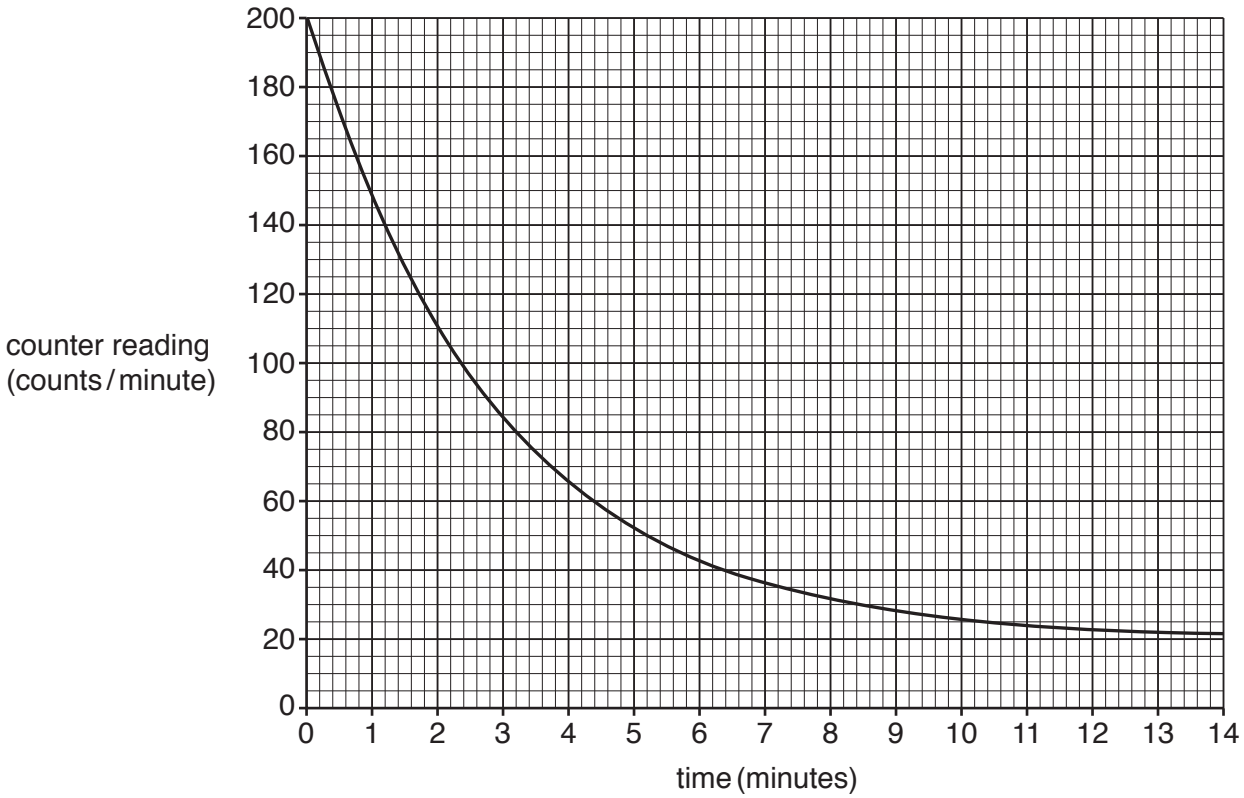
..... **[1]**

The mean value for the background count rate is 20 counts per minute.

The radioactive material is placed in front of the Geiger tube and a reading of the counter taken every 5 minutes.

Here is the graph that Dan and Lucy draw from the results.



(b) Dan and Lucy use the graph to find a value of the half-life of the radioactive material.

Dan says that it is 2.3 minutes, but Lucy thinks it is 2.0 minutes because of the background count.

Whom do you agree with?

Give reasons for your choice and use data from the graph to justify your answer.

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

(c) Use the graph to find how many half-lives the material has gone through by the time the counter reading has dropped to 50 counts / minute.

number of half-lives ..... **[1]**

(d) If the teacher had put the radioactive material closer to the Geiger tube, how would it have affected the initial reading on the counter and the half-life?

Put a tick (✓) in the box next to the correct effects on both initial reading and half-life.

Initial reading	**Half-life**	
no change	changes	
no change	no change	
changes	changes	
changes	no change	

[1]

[Total: 6]

8 Background radiation is slightly higher in areas of the UK where there is granite rock.

Granite is radioactive, emitting gamma rays and radon gas.

Some of the decay products of radon are also radioactive, emitting alpha particles.

These decay products can stick to atmospheric dust. We breathe in this dust and it gets lodged in our lungs.

(a) What is meant by background radiation?

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

(b) Use the information above about granite and radon decay products to explain the difference between **contamination** and **irradiation**.

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

(c) Radon-222 decays to polonium (Po) by emitting an alpha particle (α).

Complete the nuclear decay equation.

$$^{222}_{86}\text{Rn} \longrightarrow \square^{218}\text{Po} + \square^{\square}\alpha$$

[2]

(d) Radon-210 is another isotope of radon.

How does radon-210 compare with radon-222?

Give one similarity and one difference.

Similarity .....

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Difference .....

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

[Total: 8]

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9 Sam has been advised by the hospital to have radiotherapy to treat a cancerous tumour.

The hospital proposes to use a 'gamma knife'. The 'gamma knife' technique is non-invasive and involves directing many beams of gamma rays from 200 different directions so they meet at the tumour.

Sam has read about the risks of radiation and has found this information about radiation doses.

	Dose (millisievert)
Average background dose per year	2.7
Lowest dose per year definitely linked to an increase in cancer later in life	100
Fatal dose	5000
Recommended highest dose per year	50
Chest X-ray	0.10
Dental X-ray	0.01
Eating one banana or 100 g of Brazil nuts	0.01

The hospital has told Sam that the 'gamma knife' delivers a total dose of 2000 millisievert to the tumour.

Explain the risks of this treatment and how the hospital can minimise these.

Use the data to support your answer.

The quality of written communication will be assessed in your answer.

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[Total: 6]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).