Please write clearly in block capitals.

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

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________

AS
PHYSICS
Paper 1

Tuesday 24 May 2016 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a pencil
- a ruler
- a calculator
- a Data and Formulae booklet.

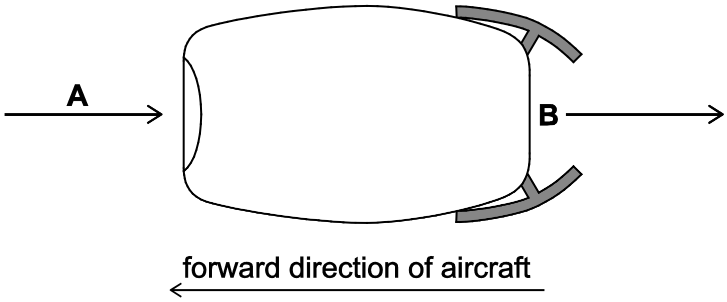
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work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

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70
- You are expected to use a calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

Answer **all** questions.

0 1 **Figure 1** shows a jet engine.

Figure 1



Air enters the engine at **A** and is heated before leaving **B** at a much higher speed.

0 1 . 1 State what happens to the momentum of the air as it passes through the engine.

[1 mark]

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0 1 . 2 Explain, using appropriate laws of motion, why the air exerts a force on the engine in the forward direction.

[3 marks]

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0 1 . 3 In one second a mass of 210 kg of air enters at **A**. The speed of this mass of air increases by 570 m s^{-1} as it passes through the engine.

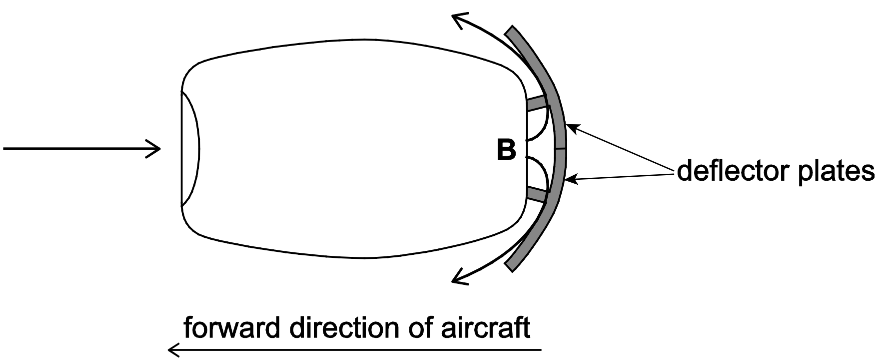
Calculate the force that the air exerts on the engine.

[1 mark]

force = ____________________ N

0 1 . 4 When an aircraft lands, its jet engines exert a decelerating force on the aircraft by making use of deflector plates. These cause the air leaving the engines to be deflected at an angle to the direction the aircraft is travelling as shown in **Figure 2**.

Figure 2



The speed of the air leaving **B** is the same as the speed of the deflected air.

Explain why the momentum of the air changes.

[2 marks]

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0 1 . 5 The total horizontal decelerating force exerted on the deflector plates of the jet engines is 190 kN.

Calculate the deceleration of the aircraft when it has a mass of 7.0×10^4 kg.

[1 mark]

deceleration = ____________________ $m\ s^{-2}$

0 1 . 6 The aircraft lands on the runway travelling at a speed of $68\ m\ s^{-1}$ with the deflector plates acting.

Calculate the distance the aircraft travels along the runway until it comes to rest. You may assume that the decelerating force acting on the jet engines remains constant.

[2 marks]

distance = ____________________ m

0 1 . 7 Suggest why in practice the decelerating force provided by the deflector plates may not remain constant.

[2 marks]

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Turn over for the next question

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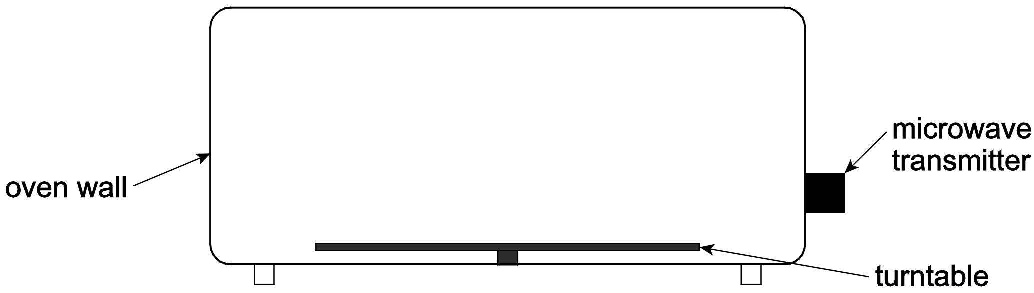
ANSWER IN THE SPACES PROVIDED

0 2 **Figure 3** is a diagram of a microwave oven.

Figure 3



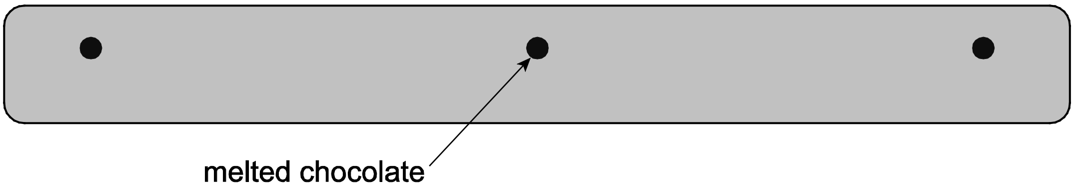
A student wants to use the stationary waves formed in the microwave oven to measure the frequency of the microwaves emitted by the transmitter.

0 2 . 1 Suggest how stationary waves are formed in the microwave oven.

[2 marks]

0 2 . 2 The student removes the turntable and places a bar of chocolate on the floor of the oven. He then switches the oven on for about one minute. When the chocolate is removed the student observes that there are three small patches of melted chocolate with unmelted chocolate between them. **Figure 4** is a full-sized diagram of the chocolate bar.

Figure 4



Suggest why the chocolate only melts in the positions shown.

[2 marks]

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0 2 . 3 Calculate, by making suitable measurements on **Figure 4**, the frequency of the microwaves used by the oven.

[5 marks]

frequency = ____________________ Hz

0 2 . 4 Explain why most microwave ovens contain a rotating turntable on which the food is placed during cooking.

[1 mark]

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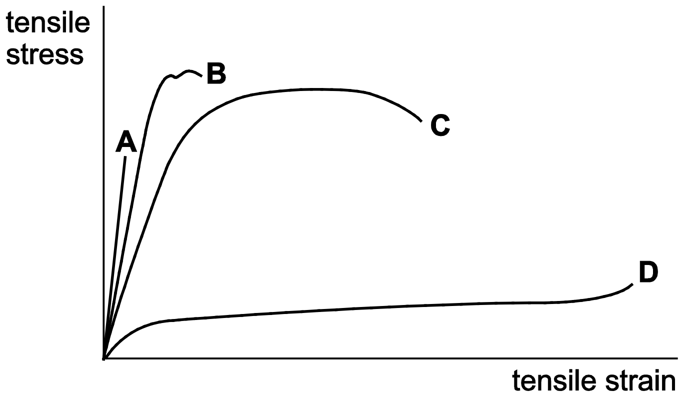
0 3 **Figure 5** shows the tensile stress–tensile strain graphs for four materials, **A**, **B**, **C** and **D**, up to their breaking stress.

Figure 5



0 3 . 1 State what is meant by tensile stress and tensile strain.

[2 marks]

tensile stress ______________________________

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tensile strain ______________________________

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0 3 . 2 Identify a property of material **A** using evidence from the graph to support your choice.

[2 marks]

property ______________________________

evidence ______________________________

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0 3 . 3 A cylindrical specimen of material **A** under test has a diameter of 1.5×10^{-4} m and a breaking stress of 1.3 GPa.

Calculate the tensile force acting on the specimen at its breaking point.

[3 marks]

tensile force = ____________________ N

0 3 . 4 Discuss which of the four materials shown on the graph is most suitable for each of the following applications:

- the cable supporting a lift in a tall building
- a rope or cable attached to a person doing a bungee jump.

For each application, you should discuss the reason for your choice and why you rejected the other materials.

[6 marks]

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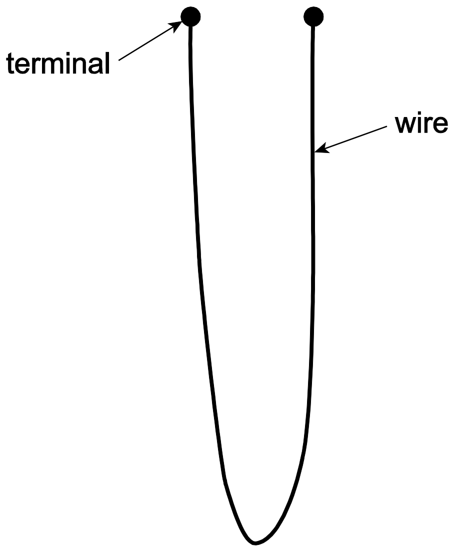
0 4 A wire probe is used to measure the rate of corrosion in a pipe carrying a corrosive liquid. The probe is made from the same metal as the pipe. **Figure 6** shows the probe. The rate of corrosion of the wire in the probe is the same as in the pipe.

Figure 6



0 4 . 1 The wire in an unused probe has a resistance of $0.070\ \Omega$ and a length of 0.50 m.

Calculate the diameter of the wire.

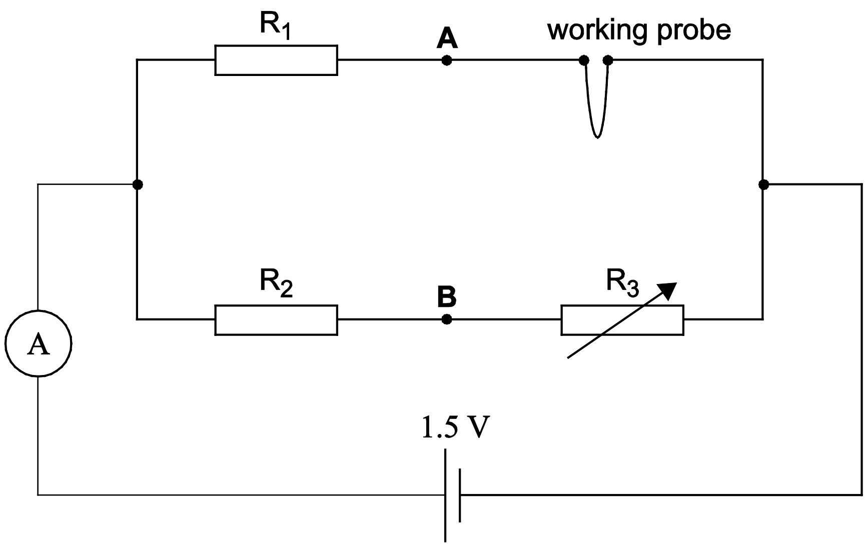
[3 marks]

resistivity of metal in the wire = $9.7 \times 10^{-8}\ \Omega\ \text{m}$

diameter = ____________________ m

0 4 . 2 In order to measure the resistance of a used working probe, it is connected in the circuit shown in **Figure 7**.

Figure 7



When R_3 is adjusted to a particular value the current in the cell is 0.66 A.

Calculate the total resistance of the circuit.
You may assume that the cell has a negligible internal resistance.

[1 mark]

resistance = ____________________ Ω

0 4 . 3 The resistance of R_2 is 22 Ω and the resistance of R_3 is 1.2 Ω.

Calculate the current in R_3.

[1 mark]

current = ____________________ A

0 4 . 4 Calculate the resistance of the probe when the resistance of R_1 is 2.4 Ω.

[3 marks]

resistance = ____________________ Ω

0 4 . 5 Calculate the percentage change in the diameter of the probe when its resistance increases by 1.6 %.

[2 marks]

percentage change = ____________________ %

0 4 . 6 A voltmeter is connected between points **A** and **B** in the circuit and R_3 stays at 1.2 Ω.

Explain, without calculation, why the reading on the voltmeter does not change when the cell in the circuit is replaced with another cell of the same emf but a significant internal resistance.

[2 marks]

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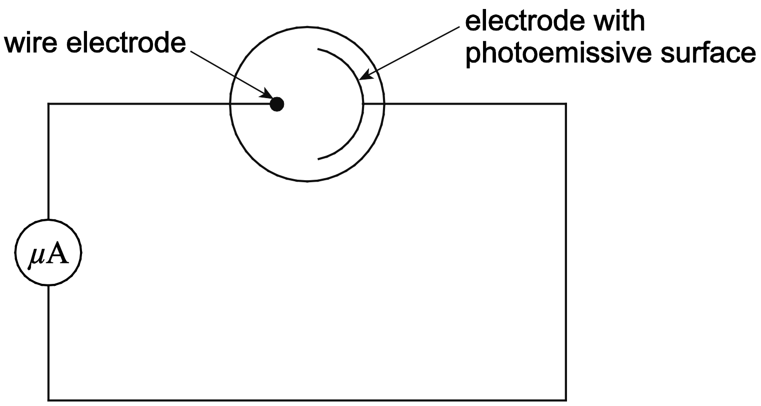
0 5 **Figure 8** shows a photocell which uses the photoelectric effect to provide a current in an external circuit.

Figure 8



0 5 . 1 Electromagnetic radiation is incident on the photoemissive surface.

Explain why there is a current only if the frequency of the electromagnetic radiation is above a certain value.

[3 marks]

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0 5 . 2 State and explain the effect on the current when the intensity of the electromagnetic radiation is increased.

[2 marks]

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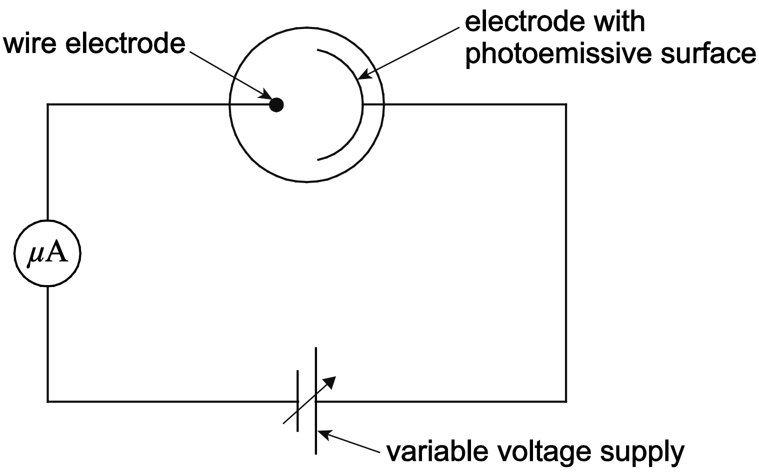
0 5 . 3 A student investigates the properties of the photocell. The student uses a source of electromagnetic radiation of fixed frequency and observes that there is a current in the external circuit.
The student then connects a variable voltage supply so the positive terminal is connected to the electrode with a photoemissive surface and the negative terminal is connected to the wire electrode. As the student increases the supply voltage, the current decreases and eventually becomes zero. The minimum voltage at which this happens is called the stopping potential. The student's new circuit is shown in **Figure 9**.

Figure 9



The photoemissive surface has a work function of 2.1 eV. The frequency of the electromagnetic radiation the student uses is 7.23×10^{14} Hz.

Calculate the maximum kinetic energy, in J, of the electrons emitted from the photoemissive surface.

[3 marks]

maximum kinetic energy = ____________________ J

0 5 . 4 Use your answer from **Question 5.3** to calculate the stopping potential for the photoemissive surface.

[1 mark]

stopping potential = ____________________ V

0 5 . 5 The student increases the frequency of the electromagnetic radiation.

Explain the effect this has on the stopping potential.

[3 marks]

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0 6 Helium is the second most abundant element in the universe. The most common isotope of helium is ${}^{4}_{2}\mathrm{He}$ and a nucleus of this isotope has a rest energy of $3728\ \mathrm{MeV}$.

In 2011, at the Relativistic Heavy Ion Collider, anti-helium nuclei were produced. Nuclei of anti-helium are made up of antiprotons and antineutrons.
It is suggested that an antineutron can decay to form an antiproton in a process similar to β^- decay.

In one particular collision between an anti-helium nucleus and a helium nucleus, the nuclei are annihilated and two photons are formed.

0 6 . 1 State what is meant by isotopes.

[2 marks]

0 6 . 2 Explain why two photons are formed instead of a single photon when a helium nucleus annihilates with the anti-helium nucleus.

[2 marks]

0 6 . 3 Calculate, using data from the passage, the maximum frequency of the photons produced in this annihilation of a $^{4}_{2}\mathrm{He}$ nucleus.

[4 marks]

frequency = ____________________ Hz

0 6 . 4 Complete this equation for the possible decay of an antineutron.

[2 marks]

$$^{1}_{0}\overline{\mathrm{n}} \rightarrow {}^{1}_{-1}\overline{\mathrm{p}} + {}^{\_\_}_{\_\_}\_\_\_\_ + \_\_\_\_$$

0 6 . 5 What interaction would be responsible for the decay in **Question 6.4**?
Tick (✓) the correct answer in the right-hand column.

[1 mark]

	✓ if correct
electromagnetic	
gravitational	
strong nuclear	
weak nuclear	

END OF QUESTIONS

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