Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 2

Tuesday 31 October 2017 (afternoon)

Candidate session number

1 hour 15 minutes

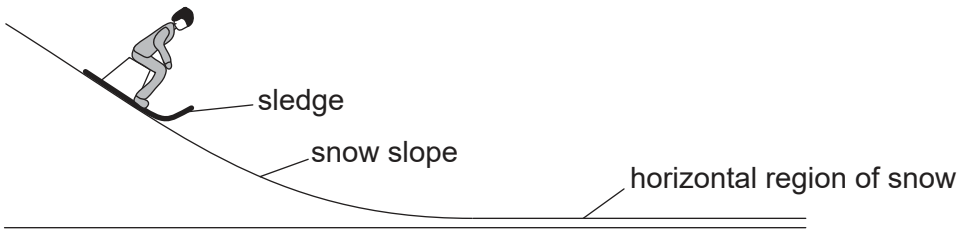
Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

8817 – 6505

Answer **all** questions. Answers must be written within the answer boxes provided.

1. A girl on a sledge is moving down a snow slope at a uniform speed.



(a) Draw the free-body diagram for the sledge at the position shown on the snow slope. [2]

(b) After leaving the snow slope, the girl on the sledge moves over a horizontal region of snow. Explain, with reference to the physical origin of the forces, why the vertical forces on the girl must be in equilibrium as she moves over the horizontal region. [3]

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(Question 1 continued)

(c) When the sledge is moving on the horizontal region of the snow, the girl jumps off the sledge. The girl has no horizontal velocity after the jump. The velocity of the sledge immediately after the girl jumps off is 4.2 m s^{-1}. The mass of the girl is 55 kg and the mass of the sledge is 5.5 kg. Calculate the speed of the sledge immediately before the girl jumps from it. [2]

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(d) The girl chooses to jump so that she lands on loosely-packed snow rather than frozen ice. Outline why she chooses to land on the snow. [3]

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(Question 1 continued)

(e) The sledge, without the girl on it, now travels up a snow slope that makes an angle of 6.5° to the horizontal. At the start of the slope, the speed of the sledge is 4.2 m s^{-1}. The coefficient of dynamic friction of the sledge on the snow is 0.11.

(i) Show that the acceleration of the sledge is about –2 m s^{-2}. [3]

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(ii) Calculate the distance along the slope at which the sledge stops moving. Assume that the coefficient of dynamic friction is constant. [2]

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(f) The coefficient of static friction between the sledge and the snow is 0.14. Outline, with a calculation, the subsequent motion of the sledge. [2]

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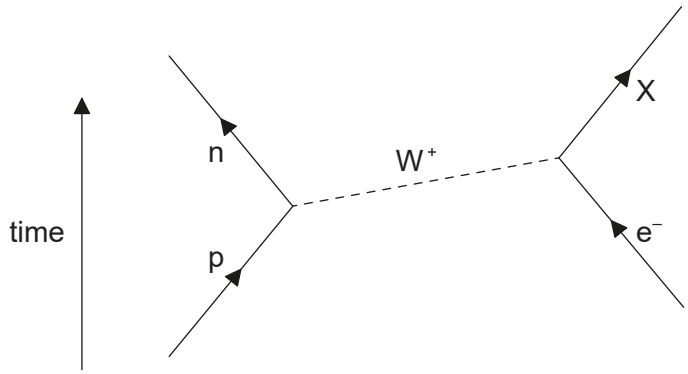
2. The Feynman diagram shows electron capture.



(a) Deduce that X must be an electron neutrino. [2]

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(b) Distinguish between hadrons and leptons. [2]

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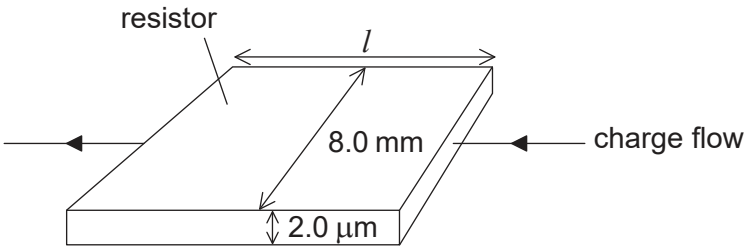
3. Electrical resistors can be made by forming a thin film of carbon on a layer of an insulating material.

(a) A carbon film resistor is made from a film of width 8.0 mm and of thickness 2.0 μm. The diagram shows the direction of charge flow through the resistor.



not to scale

(i) The resistance of the carbon film is 82 Ω. The resistivity of carbon is $4.1 \times 10^{-5}\,\Omega\,\text{m}$. Calculate the length l of the film. [1]

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(ii) The film must dissipate a power less than 1500 W from each square metre of its surface to avoid damage. Calculate the maximum allowable current for the resistor. [2]

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(iii) State why knowledge of quantities such as resistivity is useful to scientists. [1]

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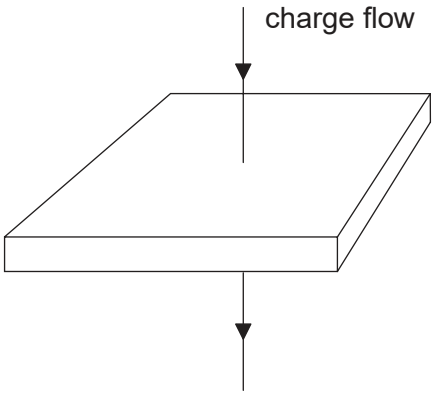
(Question 3 continued)

(b) The current direction is now changed so that charge flows vertically through the film.



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Deduce, without calculation, the change in the resistance. [2]

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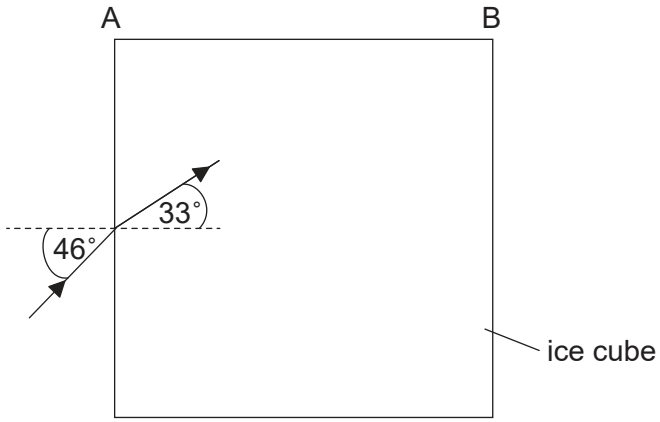
(c) Draw a circuit diagram to show how you could measure the resistance of the carbon-film resistor using a potential divider arrangement to limit the potential difference across the resistor. [2]

4. (a) A large cube is formed from ice. A light ray is incident from a vacuum at an angle of 46˚ to the normal on one surface of the cube. The light ray is parallel to the plane of one of the sides of the cube. The angle of refraction inside the cube is 33˚.



(i) Calculate the speed of light inside the ice cube. [2]

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(ii) Show that no light emerges from side AB. [3]

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(iii) Sketch, on the diagram, the subsequent path of the light ray. [2]

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(Question 4 continued)

(b) Each side of the ice cube is 0.75 m in length. The initial temperature of the ice cube is –20 °C.

(i) Determine the energy required to melt all of the ice from –20 °C to water at a temperature of 0 °C. [4]

Specific latent heat of fusion of ice $= 330\ \text{kJ kg}^{-1}$
Specific heat capacity of ice $= 2.1\ \text{kJ kg}^{-1}\ \text{K}^{-1}$
Density of ice $= 920\ \text{kg m}^{-3}$

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(ii) Outline the difference between the molecular structure of a solid and a liquid. [1]

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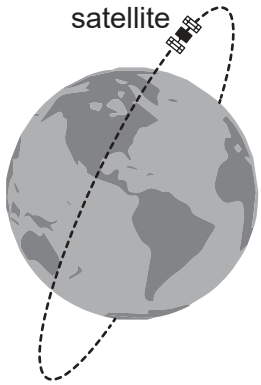
5. A satellite powered by solar cells directed towards the Sun is in a polar orbit about the Earth.



The satellite is orbiting the Earth at a distance of 6600 km from the centre of the Earth.

(a) Determine the orbital period for the satellite. [3]

$$\text{Mass of Earth} = 6.0 \times 10^{24}\ \text{kg}$$

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(Question 5 continued)

(b) The satellite carries an experiment that measures the peak wavelength emitted by different objects. The Sun emits radiation that has a peak wavelength λ_S of 509 nm. The peak wavelength λ_E of the radiation emitted by the Earth is 10.1 μm.

(i) Determine the mean temperature of the Earth. [2]

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(ii) Suggest how the difference between λ_S and λ_E helps to account for the greenhouse effect. [3]

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(c) Not all scientists agree that global warming is caused by the activities of man. Outline how scientists try to ensure agreement on a scientific issue. [1]

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Please **do not** write on this page.

Answers written on this page
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