



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

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**PHYSICS**

**5054/02**

Paper 2 Theory

**October/November 2009**

**1 hour 45 minutes**

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

**Section A**

Answer **all** questions.

Write your answers in the spaces provided on the Question Paper.

**Section B**

Answer any **two** questions.

Write your answers on the lined pages provided and, if necessary, continue on the separate answer paper provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Q9	
Q10	
Q11	
Total	

This document consists of **16** printed pages.



Section A

Answer **all** the questions in this section.

For  
Examiner's  
Use

1 A diver holds his breath and dives into the sea from a boat to a depth of 25.0m. The atmospheric pressure is  $1.05 \times 10^5$  Pa.

(a) (i) Explain why the pressure at this depth is greater than the atmospheric pressure.

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

(ii) Other than the depth and the atmospheric pressure, state **one** quantity that affects the pressure in a liquid.

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

(b) (i) The pressure due to 25.0m of sea-water is  $2.55 \times 10^5$  Pa. Calculate the total pressure at this depth.

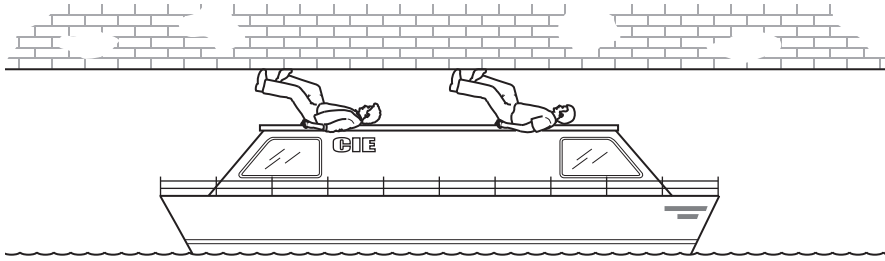
pressure = .....[1]

(ii) As the diver holds his breath and descends to a depth of 25.0m, the greater pressure causes the volume of the air trapped in his lungs to change.

When he is on the boat, the total volume of the air in his lungs is  $6000 \text{ cm}^3$ . Calculate the volume of this air at a depth of 25.0m.

volume = .....[2]

- 2 Fig. 2.1 shows a boat stationary in still water in a narrow tunnel.



**Fig. 2.1**

To move the boat, two men lie on the top of it and push against the tunnel roof with their legs. They exert a total forwards force of 1680 N on the boat.

- (a) The men push the boat 50.0 m to the end of the tunnel. Calculate the work done on the boat by the men.

work done = ..... [2]

- (b) Explain why the kinetic energy of the boat at the end of the tunnel is less than the work done on the boat by the men.

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

3 A hockey player trains on a nylon-fibre surface. As he runs around, his shoes rub against the surface and he becomes positively charged.

(a) (i) Explain, in terms of the particles involved, how he becomes positively charged.

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

(ii) State what happens to the nylon-fibre surface as he becomes positively charged.

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

(b) At the end of the training session, the hockey player touches a metal gate and feels an electric shock.

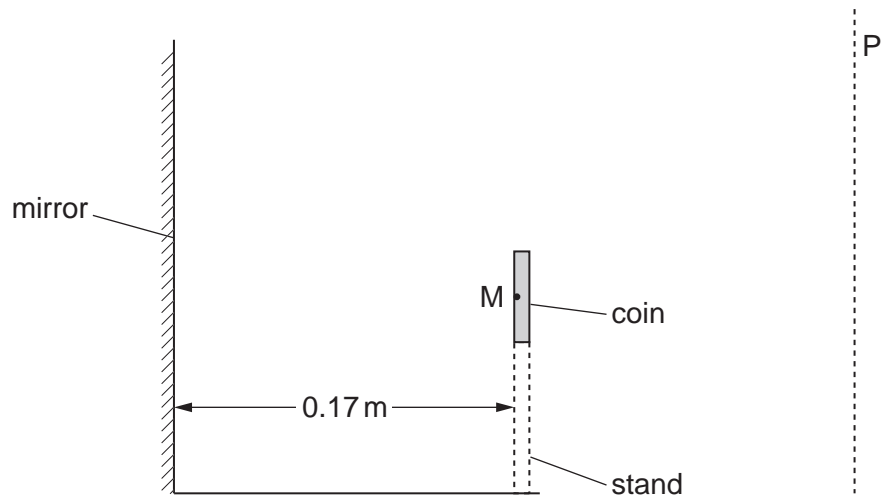
(i) State how this shock is produced.

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

(ii) The shock lasts for 0.15 ms. During this time, the current has an average value of 1.6 mA. Calculate the size of the charge on the hockey player just before he touches the gate.

charge = ..... [3]

- 4 Fig. 4.1 shows an old coin displayed in a museum.



**Fig. 4.1**

The coin is vertical and is supported by a transparent stand. A vertical mirror 0.17 m behind the coin ensures that the back of the coin can be seen by a visitor looking from the line P.

M is a point on the back of the coin.

- (a) On Fig. 4.1,

(i) draw **two** rays of light from M to show how its image is produced, [2]

(ii) label the image I. [1]

- (b) State the distance from point M on the coin to its image.

distance = ..... [1]

5 Fig. 5.1 is a full-scale diagram that represents a sound wave of frequency 5.1 kHz in air.

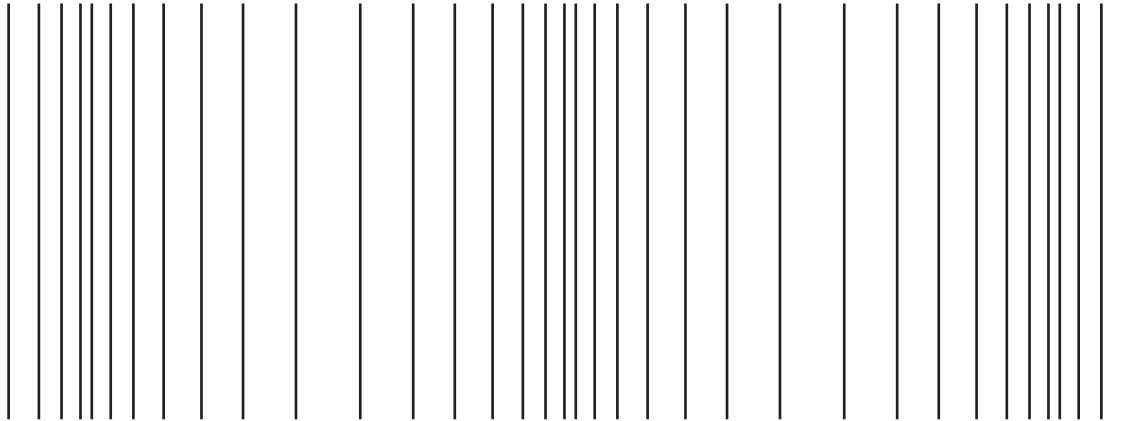


Fig. 5.1

(a) (i) On Fig. 5.1, mark the position of one compression with the letter C and of one rarefaction with the letter R. [2]

(ii) Using the full-scale diagram, measure the wavelength of this sound wave.

wavelength = ..... [1]

(iii) Calculate the speed of sound in air.

speed = ..... [3]

(b) A sound wave is longitudinal. Describe how a longitudinal wave differs from a transverse wave.

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

6 A microwave oven is rated at 650W and is connected to a 230V mains supply.

(a) (i) Calculate the current from the supply when the microwave oven is switched on.

current = ..... [2]

(ii) Suggest a rating of the fuse for use with this oven.

fuse rating = ..... [1]

(b) The insulation of the mains cable has worn away. The live wire touches the outer metal casing of the microwave oven.

(i) Explain the hazard that results if the outer metal casing is not earthed.

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

(ii) Explain how connecting the earth wire to the outer casing and using a fuse of a suitable rating removes this hazard.

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

- 7 Fig. 7.1 shows a rectangular concrete slab of weight 18 000 N. It rests on a brick wall and is the roof of a bus shelter. The concrete slab is 3.0 m wide.

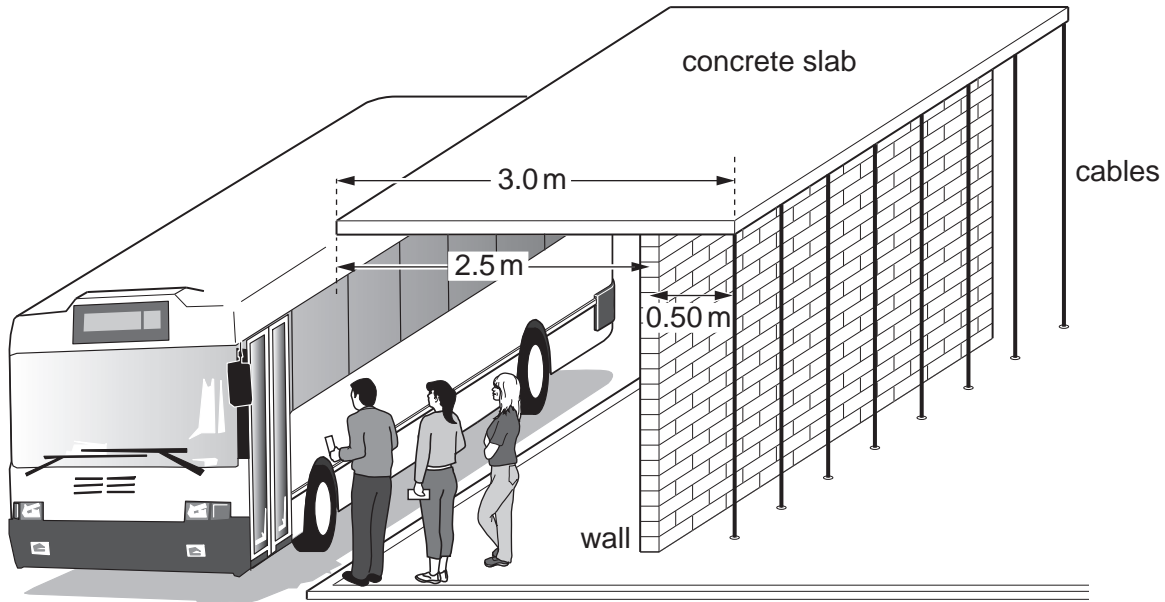


Fig. 7.1

The wall is 2.5 m from the front of the concrete slab and 0.50 m from the back. The cables behind the shelter pull downwards and stop the slab toppling forwards.

- (a) The concrete slab is of uniform thickness and density. Determine the perpendicular distance between the wall and the centre of mass of the slab.

distance = ..... [1]

- (b) (i) State the principle of moments.

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

- (ii) Calculate the total downward force exerted by the cables on the slab.

force = ..... [2]



8 (a) State the number of

(i) electrons in a neutral atom of the isotope  ${}^7_3\text{Li}$ ,

number of electrons = .....[1]

(ii) nucleons in an atom of the isotope  ${}^{208}_{82}\text{Pb}$ ,

number of nucleons = .....[1]

(iii) protons in an atom of the isotope  ${}^{23}_{11}\text{Na}$ .

number of protons = .....[1]

(b) An atom of the isotope chlorine-35 contains 17 protons.

For an atom of the isotope chlorine-37, state the number of

(i) protons,

number of protons = .....[1]

(ii) neutrons.

number of neutrons = .....[1]

## Section B

Answer **two** questions from this section.

Use the lined pages provided and, if necessary, continue on the separate sheets available from the Supervisor.

- 9 Fig. 9.1 shows an electric boiler in a school kitchen.

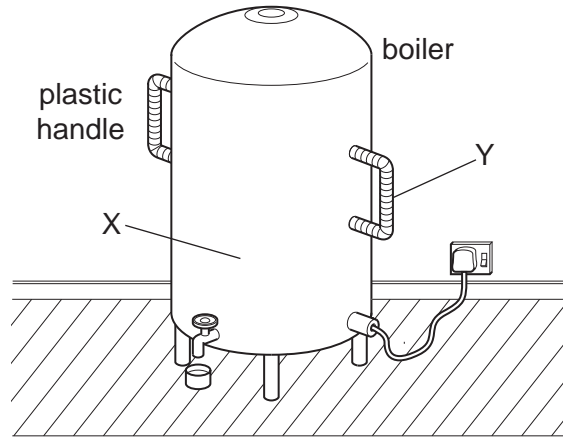


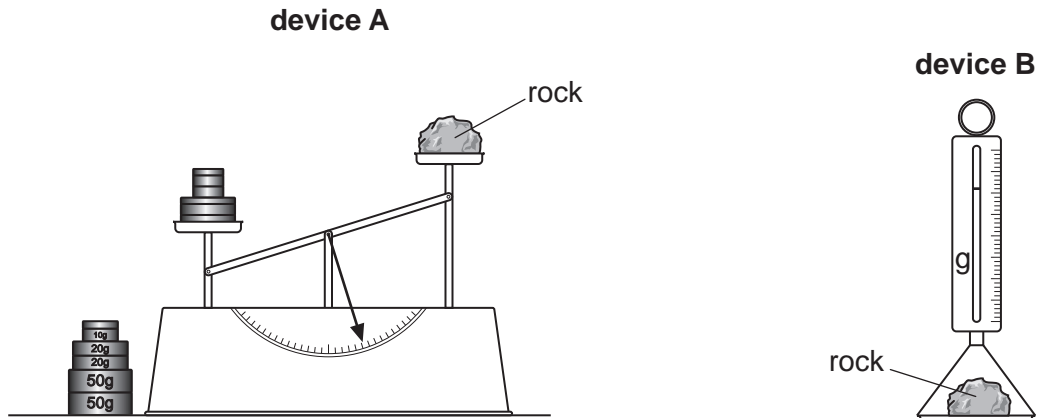
Fig. 9.1

The boiler contains 35 kg of water at 22 °C. The specific heat capacity of water is 4200 J/(kg °C).

- (a) (i) Calculate the thermal energy (heat) needed to raise the temperature of the water from 22 °C to its boiling point. [3]
- (ii) The water in the boiler is heated with a 2600W immersion heater. Calculate the minimum time for the heater to bring the water to its boiling point. [2]
- (iii) Suggest **one** reason why the actual time is greater than the time calculated in (ii). [1]
- (b) (i) The immersion heater is placed in the water at the bottom of the boiler. Explain in detail how this ensures that the thermal energy (heat) is transferred throughout the water. [4]
- (ii) The boiler is made of steel and has two large plastic handles. When the water is boiling, the steel surface at X is hot while the plastic handle at Y is cool. Explain why. [2]
- (c) Before the water reaches boiling point, water vapour is seen escaping from the boiler.
- (i) State the name of the process that produces this water vapour. [1]
- (ii) State **two** differences between this process and boiling. [2]

10 A space research organisation plans to send astronauts to Mars to examine rocks on its surface. The organisation will produce a report containing information about conditions on Mars.

- (a) (i) The gravitational field strength on the surface of Mars is  $3.7\text{ N/kg}$ . Calculate the weight, on Mars, of a rock of mass  $0.50\text{ kg}$ . [2]
- (ii) A rock dropped on Mars falls to the surface. State the acceleration of the falling rock. Assume that there is no air resistance on Mars. [1]
- (iii) Calculate the kinetic energy of a  $0.50\text{ kg}$  rock as it strikes the surface at a speed of  $3.2\text{ m/s}$ . [3]
- (b) While still on the surface of Mars, the astronauts will measure the mass of each rock collected. Fig. 10.1 shows two devices for measuring mass.



A lever arm balance and a set of brass discs. The mass of each disc is accurately determined on Earth and the value is marked on it.

A spring balance. The spring balance is accurately calibrated on Earth and the mass values are marked on the vertical scale.

Fig. 10.1

- (i) When the two devices are used on Mars, they will give different readings for the mass of the same rock. Explain why. [3]
- (ii) State which device will give the correct reading for the mass. [1]
- (c) The astronauts will also determine the density of each rock.
- (i) Apart from the mass of the rock, state what other information is needed in order to calculate the density of the rock. [1]
- (ii) Describe a method for determining the density of a small, irregularly shaped rock of known mass  $m$ . [4]

- 11 Fig. 11.1 shows a 9.0V battery connected in series with a  $16.0\Omega$  resistor and a small metal conductor X at room temperature.

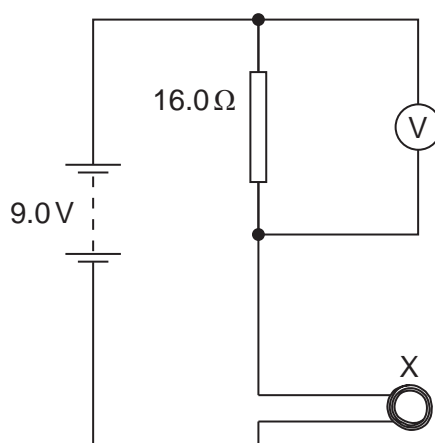


Fig. 11.1

A voltmeter measures the potential difference (p.d.) across the  $16.0\Omega$  resistor. At room temperature the resistance of X is  $4.0\Omega$ .

- (a) (i) Calculate the current supplied by the battery. [2]  
(ii) Calculate the p.d. across the  $16.0\Omega$  resistor. [1]
- (b) X is heated slowly to a very high temperature.
- (i) Sketch a graph to show how the resistance of a metal conductor depends on its temperature. [2]  
(ii) State and explain how the voltmeter reading changes as the temperature of X rises. [2]  
(iii) Suggest a suitable range for the voltmeter. [2]

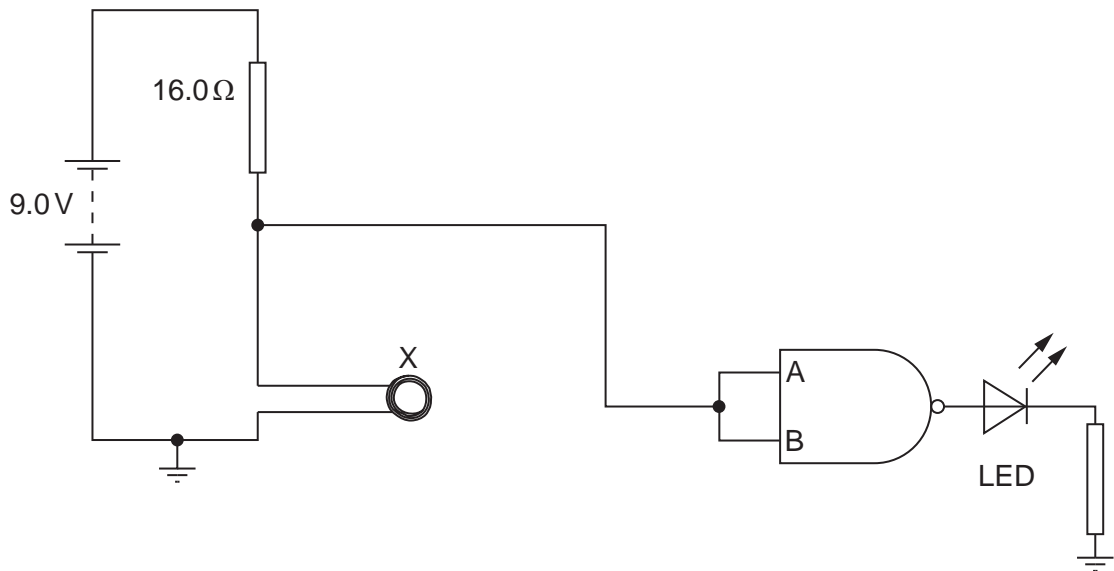
There is a choice of part (c) on the following page.

**EITHER (c) (i)** Describe in outline how the circuit in Fig. 11.1 can be used as a thermometer. [2]

**(ii)** State two advantages of a thermometer such as this over a liquid-in-glass thermometer. [2]

**(iii)** The change in voltmeter reading with temperature is non-linear. Explain what is meant by *non-linear*. [2]

**OR (c)** The voltmeter is removed from the circuit in Fig. 11.1 and the negative terminal of the battery is earthed. A connection is made from the circuit to the inputs A and B of a NAND gate. The output of the NAND gate is connected to an LED (light-emitting diode) and a resistor. This is shown in Fig. 11.2.



**Fig. 11.2**

**(i)** Draw the truth table for a NAND gate. [2]

**(ii)** The LED is lit. State the inputs at A and B and explain why these inputs cause the LED to light. [2]

**(iii)** X is slowly heated to a very high temperature. At a certain temperature, the LED switches off. Explain why this happens. [2]





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