Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8963555644

PHYSICS **5054/22**

Paper 2 Theory **May/June 2024**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (DE/SW) 336607/4

1 Fig. 1.1 shows two trolleys. On the front of trolley A, there is a wooden rod. Trolley B is initially at rest.

As trolley A moves towards the right, the rod enters the modelling clay. Trolley A slows down and trolley B starts moving.

The trolleys then stick together and continue moving towards the right.

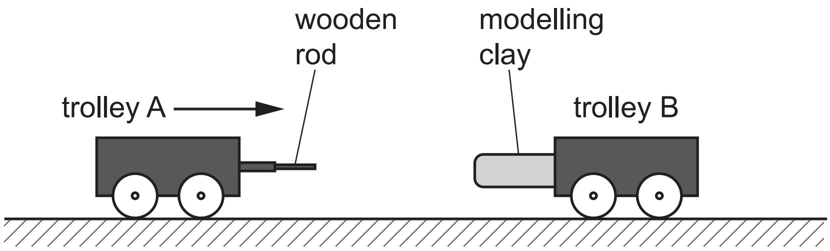

Fig. 1.1

Fig. 1.2 shows the speed−time graph for the two trolleys.

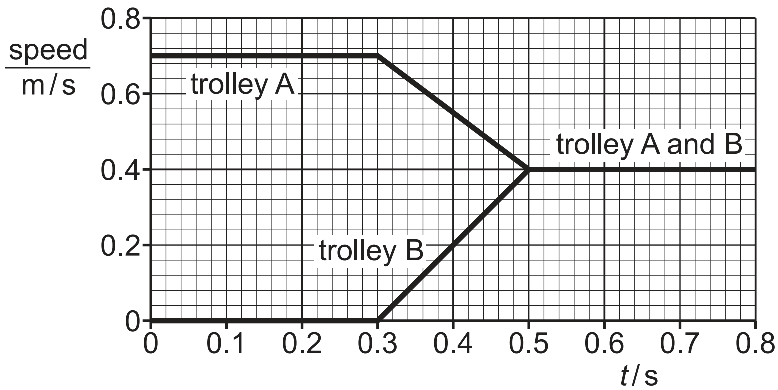

Fig. 1.2

The trolleys start to collide at time t = 0.30 s. At t = 0.50 s, the trolleys are moving at the same speed.

(a) **(i)** State how Fig. 1.2 shows that, during the collision, trolley B has a uniform acceleration.

....

.... [1]

(ii) Describe how the graph in Fig. 1.2 shows that the magnitude (size) of the acceleration of trolley B is larger than the magnitude of the deceleration of trolley A.

....

.... [1]

(iii) Calculate the acceleration of trolley B when $t = 0.40\,s$.

acceleration = ... m/s^2 [2]

(b) The mass of trolley A = 0.80 kg. The mass of trolley B = 0.60 kg.

Show that momentum is conserved in the collision.

[2]

(c) In another collision between the same trolleys, the rod and modelling clay are not present. Trolley A hits trolley B with the same initial speed.

Explain why the force between the trolleys is larger in this collision.

....

....

....

.... [2]

[Total: 8]

2 Fig. 2.1 shows a small swimming pool containing water.

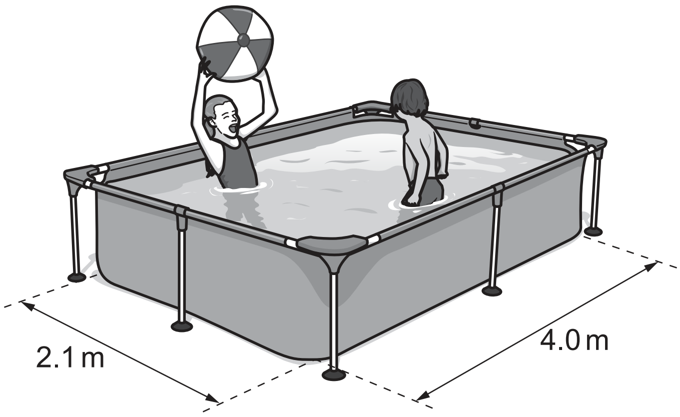

Fig. 2.1

The depth of water in the pool is 0.80 m. The density of water is 1000 kg / m^3.

(a) (i) Show that the mass of water in the pool is approximately 6700 kg.

[2]

(ii) Define ‘pressure’.

....

.... [1]

(iii) Calculate the pressure on the base of the pool due to the water.

pressure = ... Pa [2]

(iv) The water in the pool is initially at a temperature of 10 °C.

The temperature rises when 5.1×10^8 J of energy is transferred to the water.

The specific heat capacity of water is 4200 J / (kg °C).

Calculate the final temperature of the water.

temperature = ... °C [3]

(b) (i) Explain, in terms of the movement of particles, how evaporation causes cooling.

....

....

....

.... [2]

(ii) Changes to factors in the environment of the swimming pool can cause an increase or decrease in the amount of evaporation from the surface of the water.

State **two** changes to environmental factors that **increase** the amount of evaporation from the surface of the water.

1 ....

2 ....
[1]

[Total: 11]

3 Fig. 3.1 shows a solar-powered charger connected to a cell phone (mobile phone).

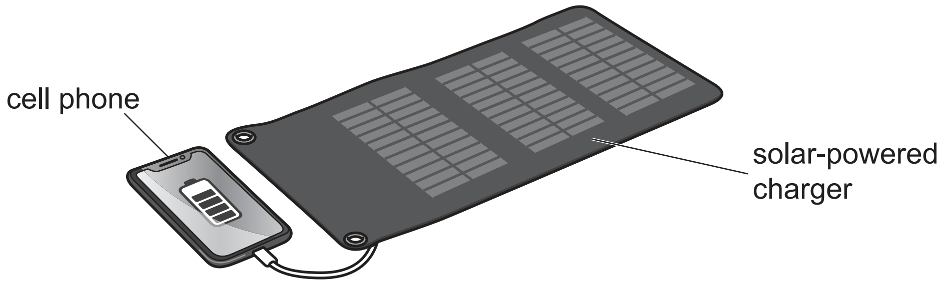

Fig. 3.1

The battery inside the cell phone is charged by the solar-powered charger.

(a) **(i)** Complete Fig. 3.2 to show the useful transfer of energy from the Sun to the battery.

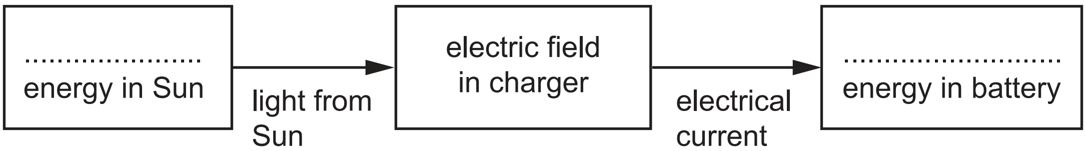

Fig. 3.2

[2]

(ii) Explain why the battery takes a long time to charge on a cloudy day.

....

.... [1]

(b) After use, the outside surface of the cell phone is warm. When switched off, the cell phone cools down.

Name and describe the **three** processes by which thermal energy is transferred as the cell phone cools down.

1 ....

....

2 ....

....

3 ....

....

[3]

(c) It takes 4.5 hours to charge the battery with an average current of 300 mA.

Calculate the quantity of charge that enters the battery. Give the unit of your answer.

charge = ... unit .... [3]

[Total: 9]

4 **(a)** Fig. 4.1 shows light passing through a triangular glass prism.

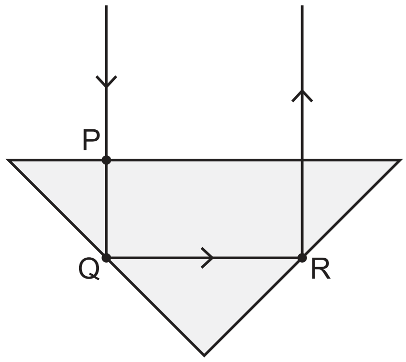

Fig. 4.1

(i) State the value of the angle of incidence at point P.

angle of incidence = ... ° [1]

(ii) Draw the normal and the angle of incidence at point R.

Label the angle of incidence. [2]

(iii) State **two** conditions needed so that no light refracts from the glass into the air at point Q.

1 ....

....

2 ....

....
[2]

(b) Information is sent across the internet using pulses of visible light through long, thin glass fibres and electrical signals through copper wires.

(i) State the name of **one** other type of electromagnetic radiation used to transmit information through long, thin glass fibres.

.... [1]

(ii) Suggest **two** advantages of using glass fibres rather than copper wires to transmit information from the internet.

1 ....

....

2 ....

....
[2]

[Total: 8]

5 An initially uncharged rubber balloon is rubbed with a woollen cloth as shown in Fig. 5.1.

Rubbing the balloon causes the balloon to have a negative charge.

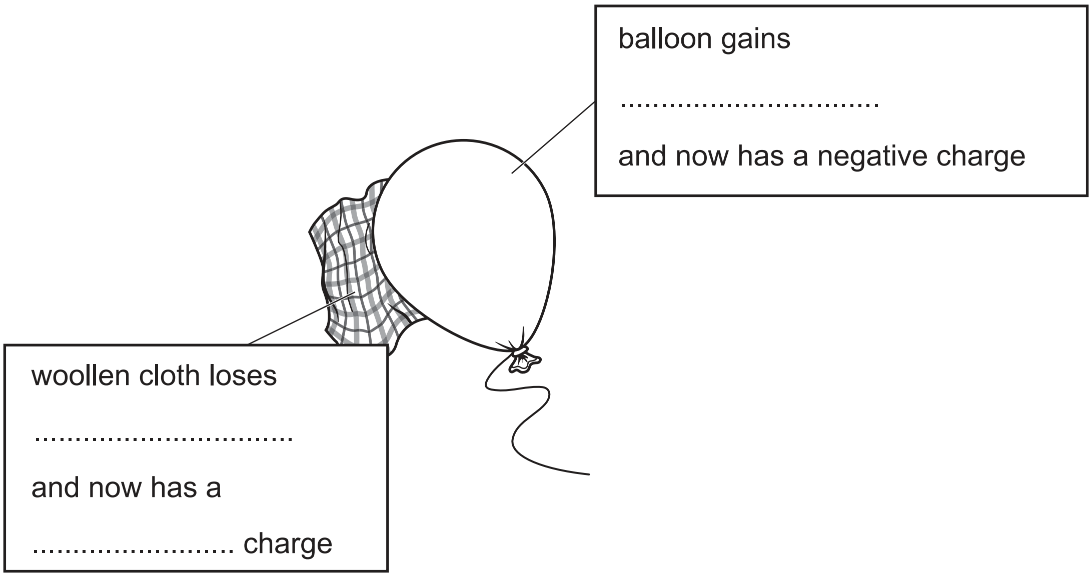

Fig. 5.1

(a) **(i)** On Fig. 5.1, complete the labels on the diagram. [2]

(ii) Explain why the balloon stays negatively charged for a long time.

....

....

....

.... [2]

(b) Rubbing the balloon causes the temperature of the air inside it to rise.

Explain, in terms of the particles of air, why the volume of the balloon increases when the temperature of the air rises.

....

....

....

....

....

.... [3]

[Total: 7]

6 Fig. 6.1 shows a circuit diagram containing a battery, a light-dependent resistor (LDR) and a fixed resistor of resistance 240 Ω connected in series.

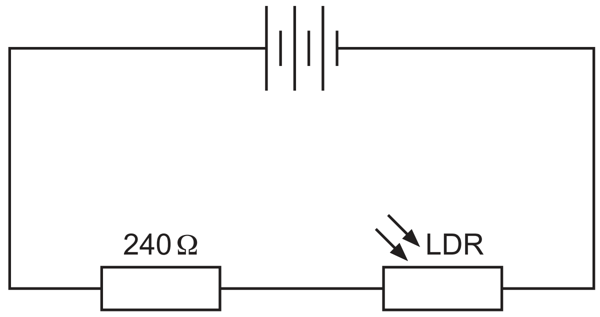

Fig. 6.1

There is a lamp near the circuit. Light from the lamp is incident on the LDR when the lamp is switched on.

Fig. 6.2 shows the current−voltage graph for the LDR with the lamp switched on and with the lamp switched off.

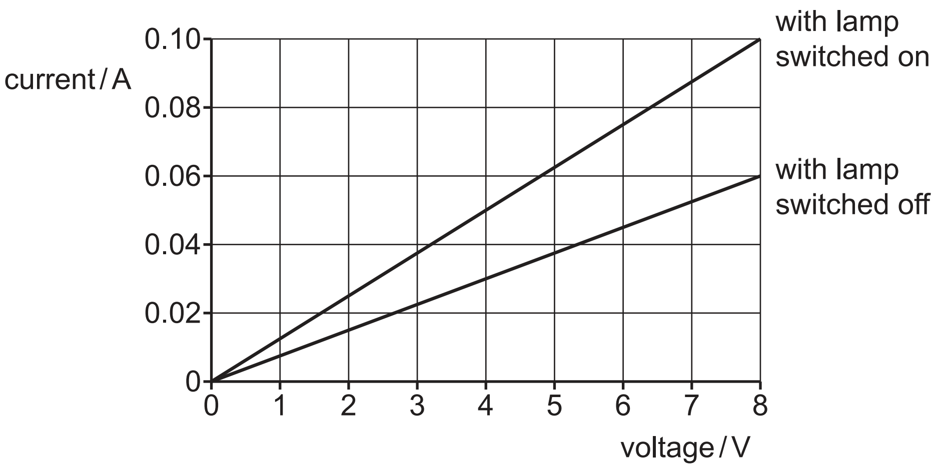

Fig. 6.2

(a) State Ohm's law.

....

....

.... [2]

(b) Explain how the graph lines in Fig. 6.2 show that Ohm's law applies to the LDR.

....

....

.... [1]

(c) Use values from Fig. 6.2 to explain the effect of light on the resistance of the LDR.

....

....

.... [2]

(d) With the lamp switched on, the current in the LDR is 0.050 A.

(i) Determine the current in the fixed resistor.

current in fixed resistor = ... A [1]

(ii) Calculate the electromotive force (e.m.f.) of the cell.

e.m.f. = ... V [3]

[Total: 9]

7 **(a)** A plotting compass contains a needle. The needle is a small magnet that can rotate about its centre.

Fig. 7.1 shows the plotting compass placed close to a bar magnet.

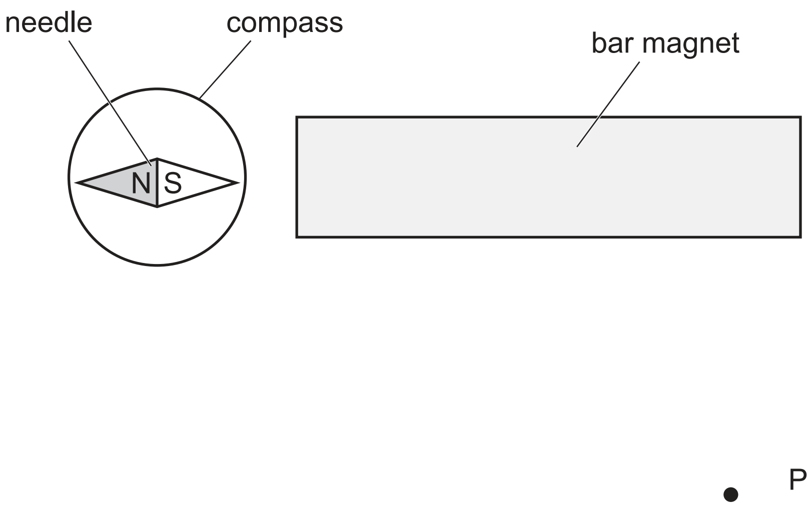

Fig. 7.1 (not to scale)

(i) On Fig. 7.1 mark the magnetic poles on the bar magnet. [1]

(ii) There is a piece of paper underneath the magnet.

Describe how the compass is used to plot the magnetic field line that passes from one pole to the other and through P.

....

....

....

....

....

.... [3]

(iii) Describe how to use the compass in Fig. 7.1 to determine the direction of the magnetic field at P.

....

.... [1]

(b) Fig. 7.2 shows the apparatus a student uses to produce an alternating current (a.c.).

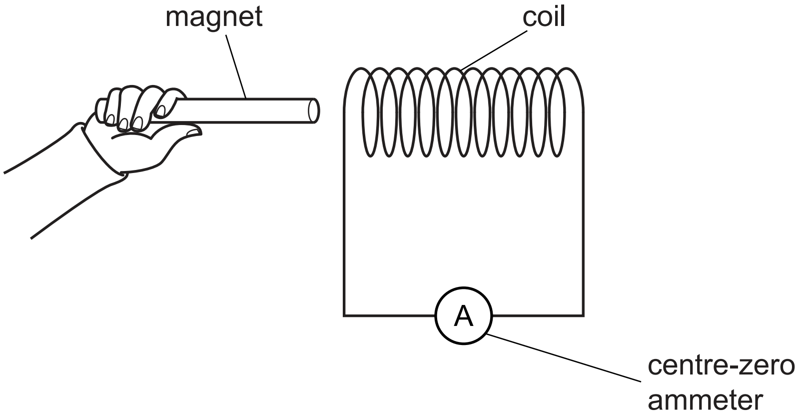

Fig. 7.2

The magnet is moved into and out of the coil.

(i) Explain why a current is produced when the magnet moves.

....

....

.... [2]

(ii) Describe the movement of the magnet that produces an a.c. of frequency 0.50 Hz.

....

.... [1]

(iii) Describe how the centre-zero ammeter shows the current is a.c. rather than d.c. (direct current).

....

.... [1]

(iv) Explain why increasing the frequency of the a.c. produced also increases the magnitude (size) of the a.c produced.

....

.... [1]

[Total: 10]

8 Fig. 8.1 is a picture of a nebula formed from a supernova.

Fig. 8.1

(a) State what is meant by 'a supernova'.

....

.... [2]

(b) Describe how a protostar forms inside a nebula.

....

....

.... [2]

(c) Our Sun is in a circular orbit around a black hole at the centre of our galaxy.

(i) State the name of the galaxy that contains our Sun.

.... [1]

(ii) State what is meant by a light-year.

.... [1]

(iii) The time taken for one complete orbit of our Sun around the black hole is 7.3×10^{15} s.

The distance from our Sun to the black hole is 26 000 light-years.

1 year = 3.2×10^{7} s   speed of light = 3.0×10^{8} m/s

Calculate the speed of our Sun as it orbits the black hole.

Show your working and give your answer in m/s.

speed = ... m/s [3]

[Total: 9]

9 Alpha particles are sometimes emitted from the nuclei of radioactive elements.

This emission is both random and spontaneous.

(a) Describe what is meant by 'spontaneous' emission.

....

.... [1]

(b) Describe the composition of an alpha particle.

....

.... [2]

(c) Alpha particles are detected using the tracks shown in a cloud chamber or by the sparks produced in a spark counter.

(i) Describe the structure of **either** a cloud chamber **or** a spark counter. Include a labelled drawing of the apparatus.

....

.... [3]

(ii) Describe how the emission of alpha particles is shown as random in the apparatus you described in **(c)(i)**.

....

.... [1]

(iii) A radioactive source produces 120 tracks in one minute in a cloud chamber.

6.0 hours later, the same source produces 15 tracks in one minute.

Without the source present, no tracks are produced.

Calculate the half-life of the radioactive isotope in the source.

half-life = ... hours [2]

[Total: 9]