Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8868783439

PHYSICS **5054/22**

Paper 2 Theory **October/November 2021**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **two** 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.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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Section A

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

1 Fig. 1.1 shows a jug of liquid and an empty measuring cylinder that is on an electronic balance.

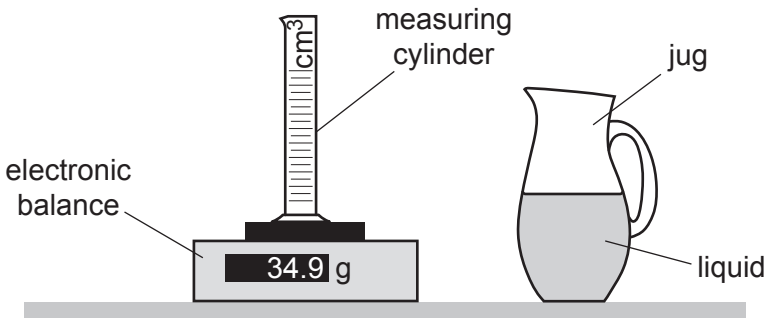


Fig. 1.1

(a) The electronic balance uses the weight of the measuring cylinder to determine its mass.

Weight and mass have different units.

State **two** other ways in which weight differs from mass.

1. .....

.....

2. .....

.....

[2]

(b) Describe how to determine the density of the liquid using the apparatus shown in Fig. 1.1.

.....

.....

.....

.....

.....

..... [4]

(c) The density of the liquid is 780 kg / m^3.

Determine the volume of 0.65 kg of the liquid.

volume = ... [2]

[Total: 8]

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2 Force is a vector quantity.

(a) State what is meant by a *vector*.

.....

..... [1]

(b) A swimmer reaches the end wall of a swimming pool and turns around under the water.

Fig. 2.1 shows the swimmer immediately after turning around.

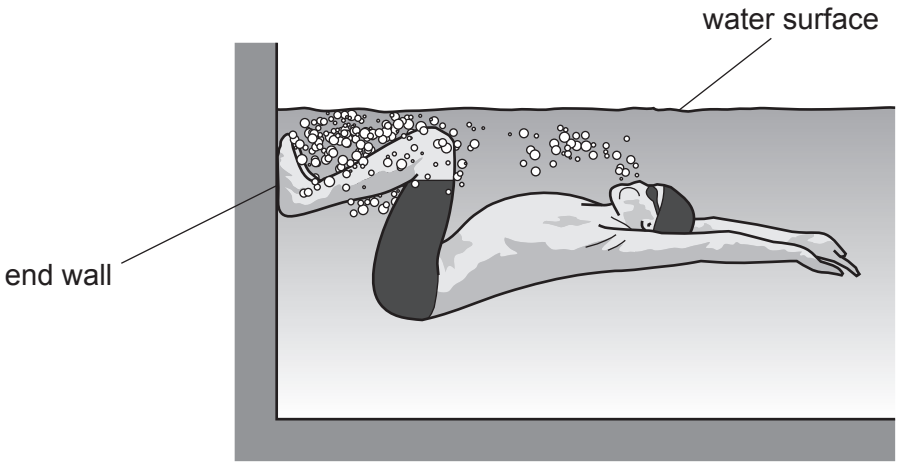


Fig. 2.1

(i) The swimmer pushes against the end wall of the pool with his legs.

Explain, in terms of Newton's third law, why the swimmer accelerates away from the end wall.

.....

.....

.....

..... [3]

(ii) While swimming, there is a constant forward force on the swimmer. His speed increases until eventually he reaches a constant speed.

Explain why he reaches a constant speed.

.....

.....

.....

..... [3]

[Total: 7]

3 Fig. 3.1 shows light entering a transparent block.

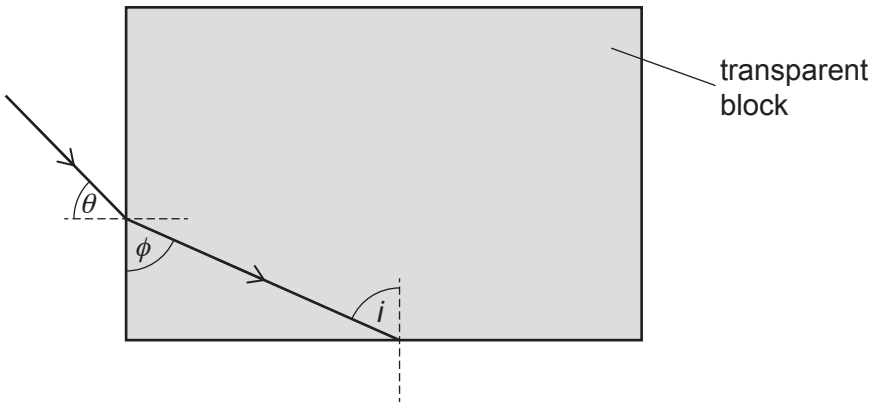


Fig. 3.1 (not to scale)

The light enters the block at an angle θ to the normal and travels through the block until it meets the bottom surface.

The angle between the ray in the block and the vertical side of the block is ϕ.

(a) Light travels more slowly in the block than in air.

(i) Explain how Fig. 3.1 shows this.

.....

.....

..... [2]

(ii) State what happens to the wavelength of the light and what happens to the frequency of the light as it enters the block.

wavelength .....

frequency .....
[2]

(b) The refractive index of the transparent material is 1.6. Angle θ is 45°.

(i) Determine angle ϕ.

ϕ = ... [3]

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(ii) The angle of incidence i at the bottom surface is equal to ϕ and the critical angle for the material of the block in air is 39°.

Explain what happens to the light after it meets the bottom surface.

.....

.....

..... [2]

[Total: 9]

4 A washing machine is working normally with both the water heater and the motor switched on. The washing machine is connected to the mains supply by a cable.

(a) The current in the live wire in the cable is 13A.

State the size of the current in:

(i) the neutral wire in the cable

current in neutral wire = ... [1]

(ii) the earth wire in the cable.

current in earth wire = ... [1]

(b) The insulation on the mains cable is now damaged and, as the washing machine vibrates, the live wire touches the metal casing.

(i) Explain how the earth wire and the fuse together prevent any more damage.

.....

.....

.....

.....

..... [3]

(ii) Explain why it is the live wire into which the fuse is connected.

.....

.....

..... [2]

[Total: 7]

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Question 5 begins over the page

5 EITHER

Fig. 5.1 shows a circuit that contains a direct current (d.c.) power supply, a light-dependent resistor (LDR), two fixed resistors, M and N, and two ammeters.

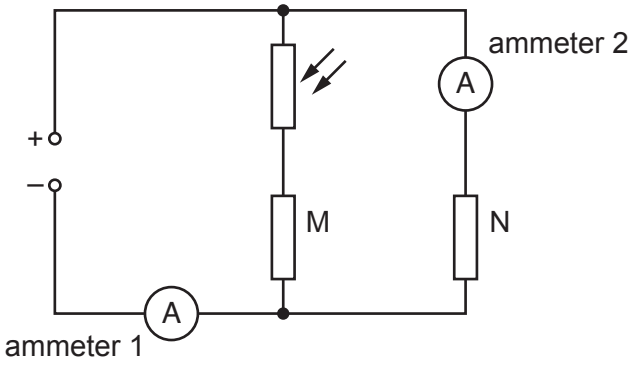


Fig. 5.1

(a) The reading on ammeter 1 is 1.6 mA.

Calculate the time taken for a charge of 7.2 C to pass through ammeter 1.

time = ... [2]

(b) Some time later, the brightness of the light incident on the LDR decreases.

Explain what happens to:

(i) the reading on ammeter 2

.....

..... [1]

(ii) the time taken for a charge of 7.2 C to pass through ammeter 1.

.....

.....

..... [2]

[Total: 5]

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OR

Fig. 5.2 shows the symbol for an electronic circuit component.

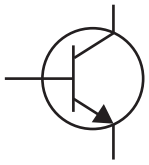


Fig. 5.2

(a) State the name of the component shown in Fig. 5.2.

..... [1]

(b) Fig. 5.3 is the diagram of a circuit that includes this component, a light-dependent resistor (LDR) and a relay.

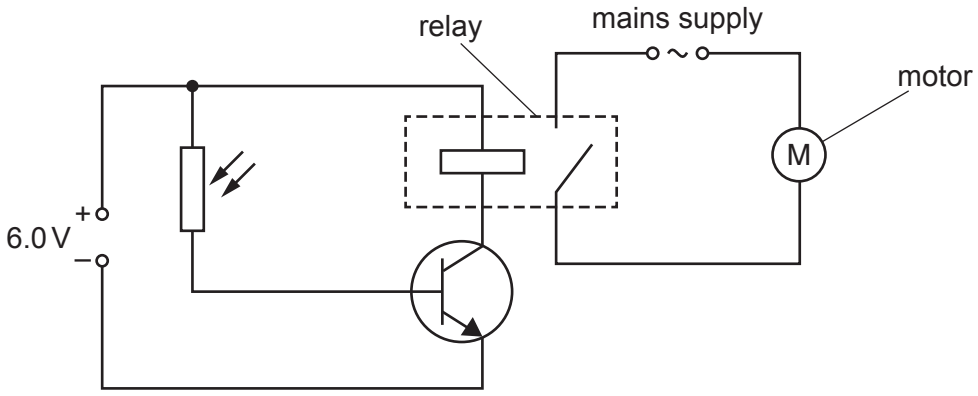


Fig. 5.3

The motor in Fig. 5.3 is part of the pump in a garden fountain. In the dark, the pump does not work.

In the morning, the brightness of the light incident on the LDR increases.

(i) State what happens to the LDR.

..... [1]

(ii) Explain why the motor switches on.

.....

.....

.....

..... [3]

[Total: 5]

6 Isotope X is radioactive. It decays by alpha-particle emission to a stable isotope.

(a) State how a nucleus of X changes when it emits an alpha-particle.

.....

.....

..... [2]

(b) There is a radiation detector in a laboratory where there are no radioactive samples.

The detector is switched on and shows an average count rate of 22 counts / minute.

(i) State why the radiation detector shows a count rate.

.....

..... [1]

(ii) A sample of isotope X is placed 2 cm from the detector and the reading displayed is 8000 counts / minute.

The sample is moved a distance of 10 cm from the detector. The reading returns to an average value of 22 counts / minute.

Explain why the reading returns to the original value.

.....

.....

..... [2]

(c) An alpha-particle passes into a region where there is a magnetic field. In the magnetic field, a force acts on the alpha-particle so that it follows a circular path. Fig. 6.1 shows that the particle passes through point J.

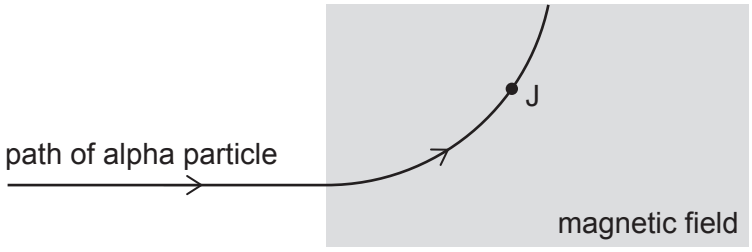


Fig. 6.1

(i) On Fig. 6.1, draw an arrow through point J to show the direction of the force on the alpha-particle at J. [1]

(ii) Determine the direction of the magnetic field and mark a tick in the box (✓) that indicates this direction.

- ☐ to the left
- ☐ to the right
- ☐ towards the top of the page
- ☐ towards the bottom of the page
- ☐ into the page
- ☐ out of the page

[1]

(iii) Explain whether this force does work on the alpha-particle as the particle moves along the circular path.

.....

.....

..... [2]

[Total: 9]

Section B

Answer **two** questions from this section. Answer in the spaces provided.

7 A hydraulic press is used at a recycling centre to compress waste material. Fig. 7.1 is a side view of the press.

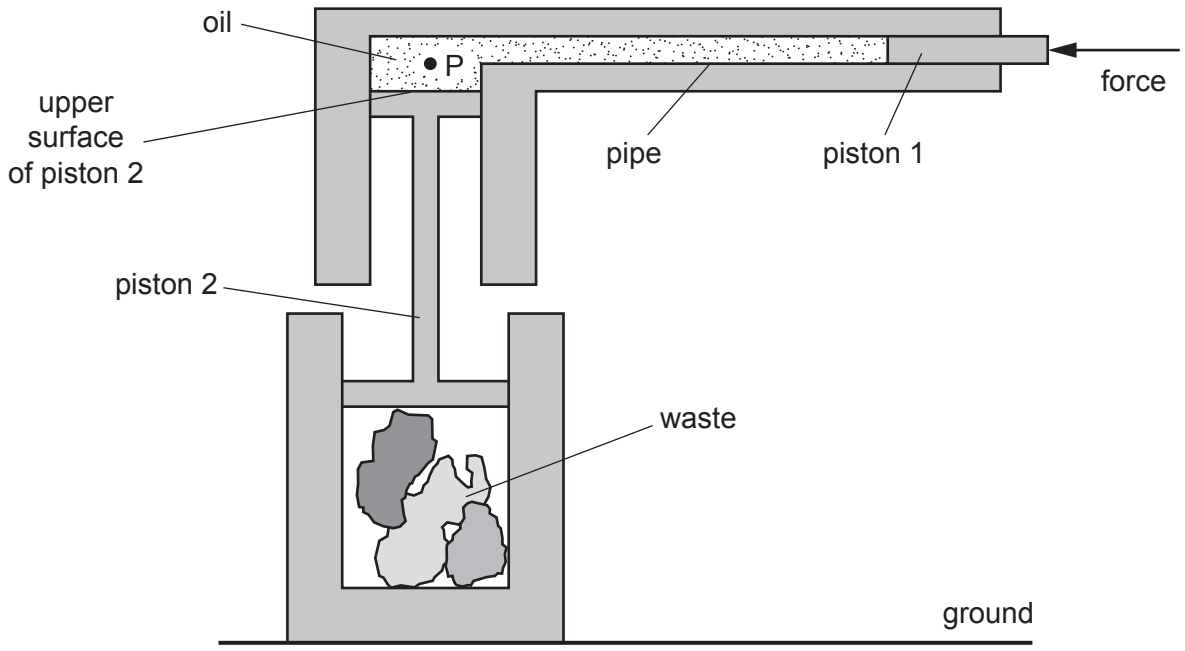


Fig. 7.1 (not to scale)

A force to the left is exerted on piston 1. Oil is pushed along the pipe and this moves piston 2 downwards. Piston 2 compresses the waste.

(a) Oil is a liquid.

(i) State the property of a liquid that makes it suitable for use in a hydraulic system.

.....

..... [1]

(ii) Explain, in terms of molecules, why a liquid has this property.

.....

.....

..... [2]

(b) Suggest one advantage of using oil as the liquid in a hydraulic press.

.....

..... [1]

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(c) The cross-sectional area of piston 1 is $0.018\,m^2$.

Piston 1 exerts a force of 4500 N on the oil.

(i) Calculate the pressure of the oil due to this force.

pressure = ... [2]

(ii) The pressure of the atmosphere is 1.0×10^5 Pa.

Calculate the total pressure of the oil in the pipe.

total pressure = ... [1]

(iii) The area of piston 2 that is in contact with the oil is $1.4\,m^2$. Initially, the upper surface of piston 2 is level with point P.

Calculate the force exerted on piston 2 due to the pressure calculated in **(c)(ii)**.

force = ... [1]

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[Turn over

(d) (i) As piston 1 moves along the pipe:

- the pressure of the oil in the pipe at point P remains constant
- piston 2 moves downwards
- the pressure of the oil at the upper surface of piston 2 increases.

Explain why the pressure at the upper surface of piston 2 increases.

.....

.....

..... [1]

(ii) The density of the oil is 900 kg / m^3. The upper surface of piston 2 is now 0.50 m below the level of the pipe.

Calculate the increase in the force exerted at the upper surface of piston 2 by the oil.

[gravitational field strength g = 10 N / kg]

increase in force = ... [3]

(e) There is air trapped in the plastic bags that contain the waste.

The temperature of the air in the bags remains constant.

Explain, in terms of molecules, why the pressure of the trapped air increases as it is compressed.

.....

.....

.....

.....

..... [3]

[Total: 15]

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8 The turning effect of a force is measured by its moment.

(a) Fig. 8.1 shows a force *F* acting on an object at point P. The object is free to rotate about an axis at X that is perpendicular to the page.

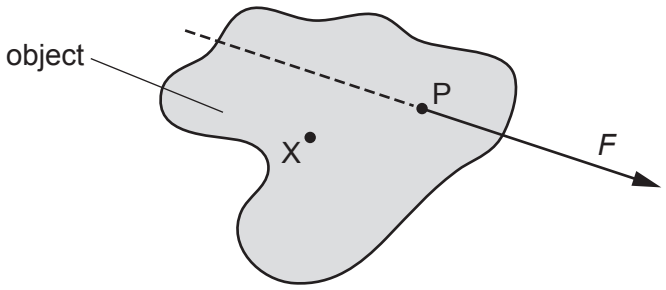


Fig. 8.1

Write down an expression for the moment of *F* about the axis at X. Draw on Fig. 8.1 to show what is meant by any other term used in your expression.

.....

..... [2]

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

.....

.....

..... [2]

(ii) Describe an experiment to verify the principle of moments. Include a diagram to help the description.

.....

.....

.....

.....

.....

..... [3]

(c) A worker carries a ladder on his shoulder. His shoulder acts as a pivot. Fig. 8.2 shows that the ladder is horizontal.

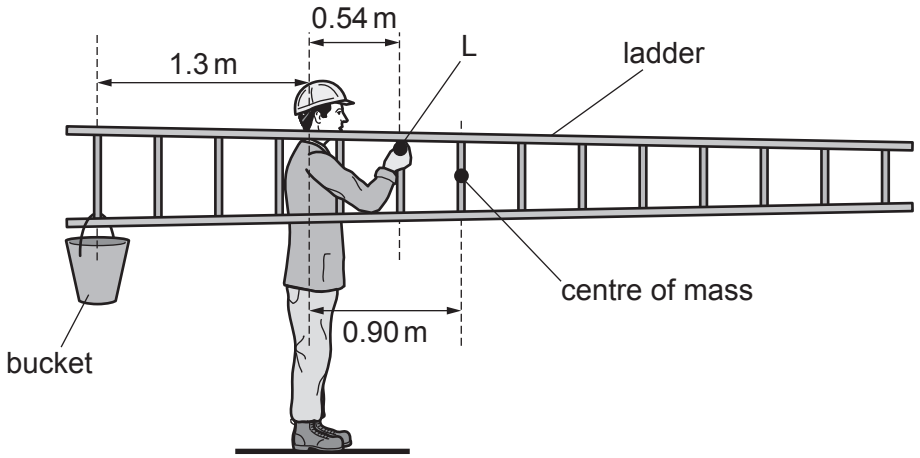


Fig. 8.2

The ladder is wider at one end than at the other end. The mass of the ladder is 8.0 kg.

(i) The gravitational field strength is 10 N / kg.

Calculate the weight of the ladder.

weight = ... [1]

(ii) State what is meant by *centre of mass*.

.....

..... [1]

(iii) The centre of mass of the ladder is not halfway along its length.

State what this shows about the ladder.

.....

..... [1]

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(iv) The centre of mass of the ladder is a horizontal distance of 0.90 m from the worker's shoulder.

Calculate the moment about the worker's shoulder of the weight of the ladder.

moment = ... [2]

(v) A bucket of weight 87 N is suspended from the ladder at a horizontal distance of 1.3 m from the worker's shoulder.

The worker keeps the ladder horizontal by exerting a vertical force at point L. L is a horizontal distance of 0.54 m from his shoulder.

Determine the size and direction of the force exerted at L.

size of force = ...

direction = ...
[3]

[Total: 15]

9 A filament lamp is connected to a 240 V alternating current (a.c.) mains supply.

(a) Describe how the output of an a.c. supply differs from the output of a direct current (d.c.) supply.

Sketch **two** voltage–time graphs in the blank space to help your explanation.

.....

..... [3]

(b) The lamp is rated at 60 W and is designed to be used with a 240 V supply.

(i) Calculate the current in the lamp.

current = ... [2]

(ii) Calculate the resistance of the lamp.

resistance = ... [2]

(iii) A room is lit by five of these filament lamps connected in parallel.

State **two** advantages of connecting the lamps in parallel rather than in series.

1. .....

.....

2. .....

.....

[2]

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(iv) The five lamps in **(b)(iii)** are lit for an average time of 5.5 hours a day for a year. Electricity costs \$0.15 / kW h.

Calculate the cost of using these lamps for a year.

cost = ... [2]

(c) A student takes the lamp in **(b)** to school and connects it in a circuit using a 1.5 V cell, an ammeter and a voltmeter. The circuit is used to determine the resistance of the lamp.

(i) In the blank space, draw the circuit diagram of the circuit used to determine the resistance of the lamp.

[2]

(ii) The value of the resistance of the filament lamp in this circuit differs greatly from the value calculated in **(b)(ii)**.

State how the resistance value in this circuit differs and explain why it differs.

.....

.....

..... [2]

[Total: 15]

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