Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	CANDIDATE NUMBER

4817102122

PHYSICS **5054/21**

Paper 2 Theory **May/June 2016**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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. Answer only one of the two alternative parts in Question 9.

Section B
Answer any **two** questions.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **20** printed pages.

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Section A

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

Answer only one of the two alternative parts in **Question 9**.

1 A sky-diver jumps from a stationary balloon. His initial downwards acceleration is $10\,m/s^2$.

Fig. 1.1 shows the directions of the air resistance and the weight of the sky-diver.

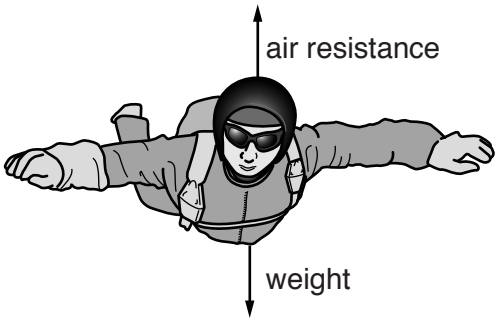


Fig. 1.1

The mass of the sky-diver is 60 kg and his weight is 600 N.

(a) Explain, using ideas about the forces, why his initial downwards acceleration is $10\,m/s^2$.

.....

.....

.....

.....

.....[2]

(b) When the parachute opens, the sky-diver experiences an upward acceleration for a short time.

Explain why.

.....

.....

.....[1]

(c) The total force of air resistance on the sky-diver and open parachute changes with their speed, as shown in Fig. 1.2.

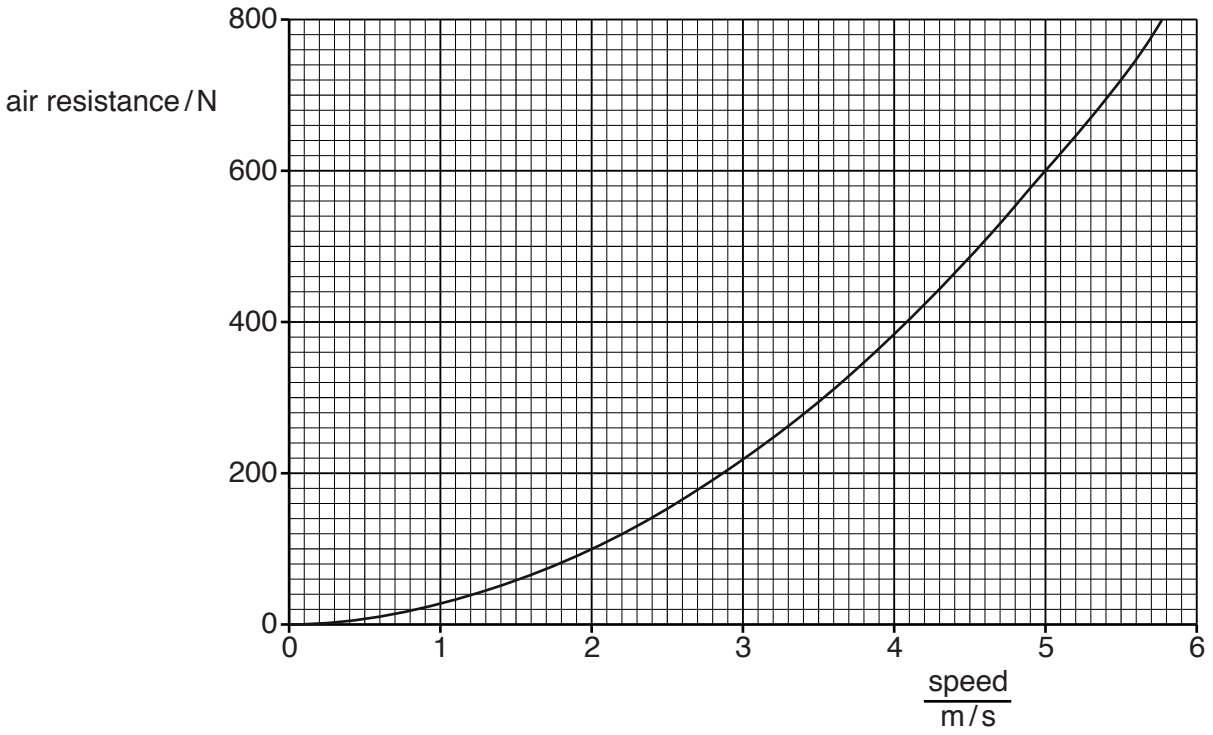


Fig. 1.2

After the parachute opens, the sky-diver slows down to a terminal velocity.

The weight of the sky-diver is 600 N.

(i) Using Fig. 1.2, determine the terminal velocity of the sky-diver.

terminal velocity = ...[1]

(ii) Calculate the resultant force on the sky-diver when his speed is 5.5 m / s.

resultant force = ...[1]

2 A student hangs various masses from the end of a spring and determines the extension produced. Fig. 2.1 shows the spring hanging vertically on its own and with an unknown mass X at one end.

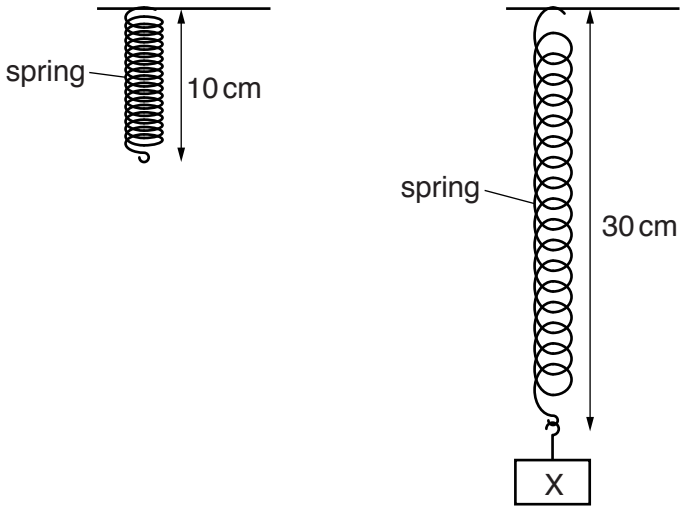


Fig. 2.1 (not to scale)

(a) The student plots a graph of the extension of the spring against the mass hanging on the spring. Fig. 2.2 shows the student's graph.

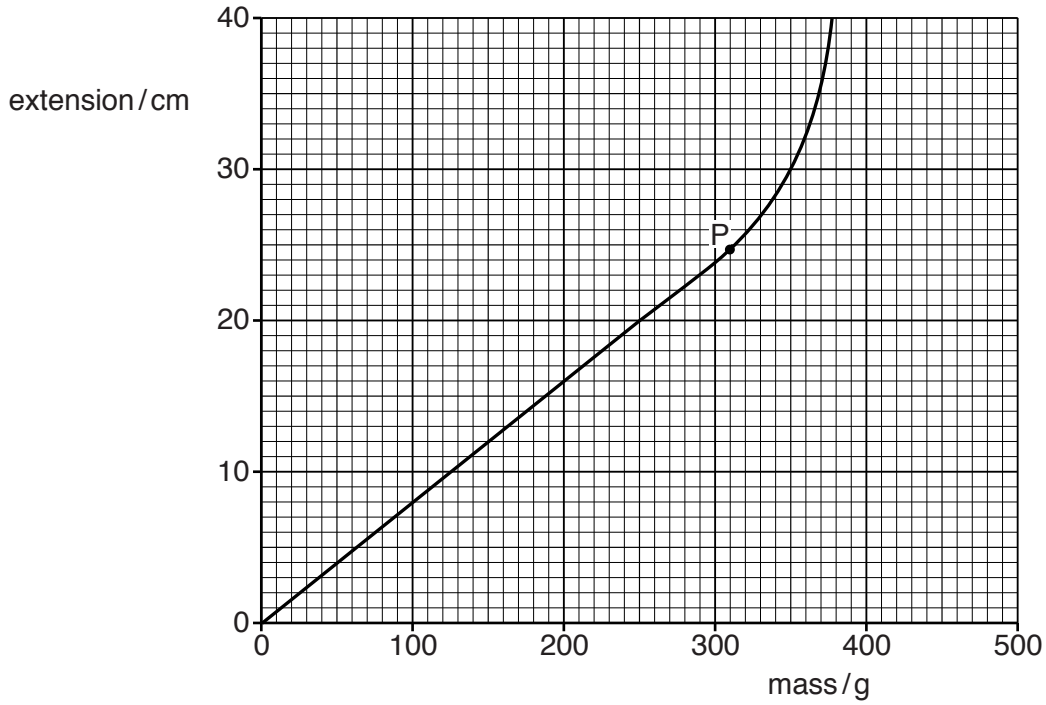


Fig. 2.2

(i) At point P on the graph, the line begins to curve.

State the name of point P.

.....[1]

(ii) Using Fig. 2.1 and Fig. 2.2, determine the mass X.

mass = ... [1]

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

Calculate the weight of X.

weight = ... [1]

(b) An identical spring is used with the original spring, as shown in Fig. 2.3.

Together they support the mass X.

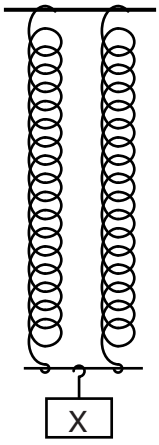


Fig. 2.3 (not to scale)

State and explain how the extension in Fig. 2.3 compares with the extension in Fig. 2.1.

.....

.....

.....

.....[2]

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3 Fig. 3.1 shows a thin sheet of plastic. A student tries to measure the thickness of the sheet with a ruler, but the sheet is too thin to measure accurately.

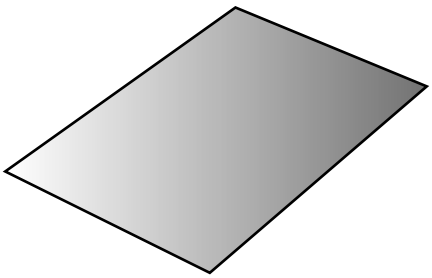


Fig. 3.1 (not to scale)

The student measures the mass of the sheet and obtains the value 0.12 g.

(a) (i) State what is meant by *mass*.

.....

.....[1]

(ii) The student is told that the density of the plastic is 0.91 g/cm^3.

Calculate the volume of the plastic sheet.

volume = ...[2]

(iii) The student measures the length and width of the sheet. The readings obtained are:

length of sheet = 3.0 cm
width of sheet = 2.0 cm

Calculate the thickness of the sheet.

thickness = ... [2]

(b) State a measuring instrument that can be used to measure the thickness of the sheet accurately.

.....[1]

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4 **(a)** Equal volumes of air, copper and water are heated from 20 °C to 80 °C. They expand by different amounts.

Draw a line from each box on the left-hand side to show which expands the most and which expands the least.

expands the most	air
	copper
expands the least	water

[1]

(b) Fig. 4.1 shows a mercury thermometer.

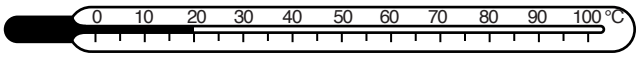


Fig. 4.1

This thermometer has a suitable range for use in laboratory experiments, but has a low sensitivity for some experiments.

(i) With reference to this thermometer, describe what is meant by

1. *range*,

.....

.....

.....[1]

2. *low sensitivity*.

.....

.....

.....[1]

(ii) State one change in the design of a thermometer that increases its sensitivity.

.....

.....[1]

5 **(a)** Light is a transverse wave. The direction of vibration is perpendicular to the direction of transfer of the energy.

Complete the table of Fig. 5.1 to show the direction of vibration and the type of wave associated with a sound wave and with a wave on the surface of water in a ripple tank.

wave	direction of vibration	type of wave
light	perpendicular to the direction of transfer of the energy	transverse
sound		
water		

[2]

Fig. 5.1

(b) A wave travels along a rope. Fig. 5.2 shows how the height of one point on the rope varies with time as the wave passes.

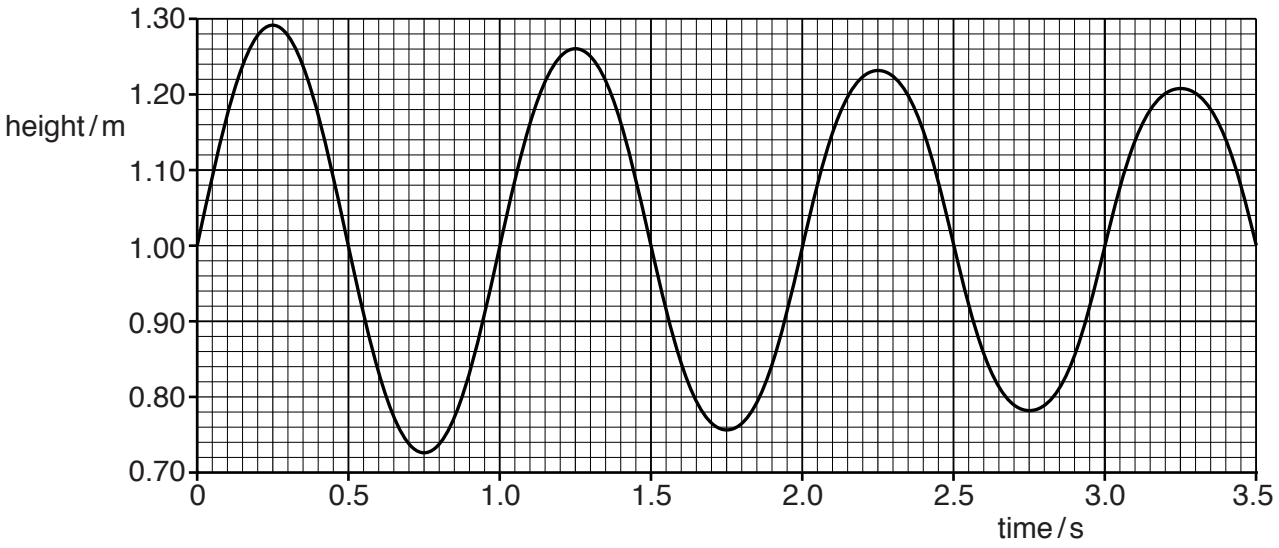


Fig. 5.2

(i) Determine the amplitude of the vibration at time = 0.25 s.

.....[1]

(ii) Describe how the graph shows that the frequency of the wave is constant.

.....

.....[1]

6 **(a)** Explain what is meant by *critical angle*.

.....

.....

.....

.....[2]

(b) Diamonds are attractive because of their ability to reflect light. The critical angle for diamond in air is 24°.

(i) Calculate the refractive index of diamond.

refractive index = ...[2]

(ii) Fig. 6.1 shows two diamonds of different shapes. A ray of light enters each diamond, as shown.

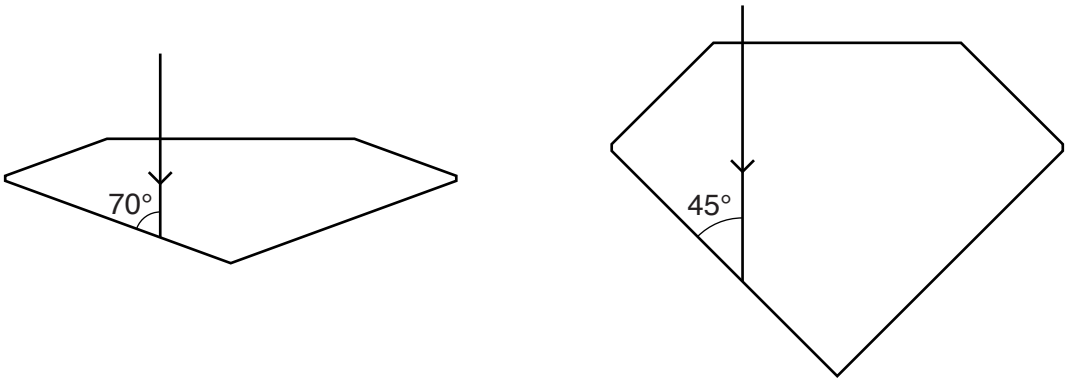


Fig. 6.1

On Fig. 6.1 continue the path of each ray of light until it emerges into the air. [3]

7 Fig. 7.1 shows part of a loudspeaker. A coil is attached to a paper cone and is suspended freely within a cylindrical magnet.

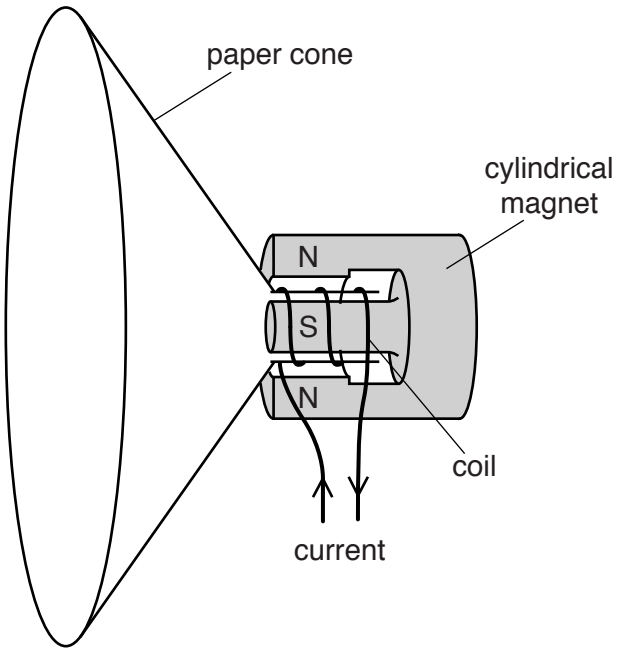


Fig. 7.1

(a) Explain why a current in the coil causes the paper cone to move.

.....

.....

.....

.....[2]

(b) Describe and explain the movement of the cone when there is an alternating current in the coil.

.....

.....

.....[2]

(c) The loudspeaker produces sound of frequency 500 Hz. The speed of sound is 320 m/s. Calculate the wavelength of the sound produced.

wavelength = ...[2]

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8 Fig. 8.1 shows a circuit that contains a battery, a fixed resistor of resistance 1000 Ω and a variable resistor R.

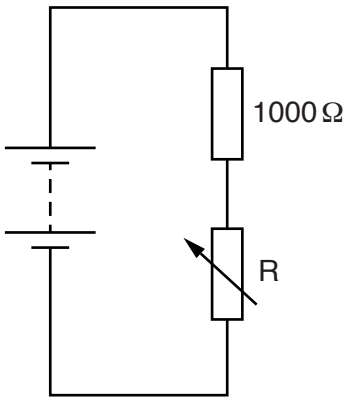


Fig. 8.1

(a) (i) State the relationship between the current I_B in the battery, the current I_1 in the fixed resistor and the current I_2 in the variable resistor.

.....

.....[1]

(ii) State an equation that relates the potential difference (p.d.) V_B across the battery, the p.d. V_1 across the fixed resistor and the p.d. V_2 across the variable resistor.

.....

.....[1]

(b) The p.d. across the battery is 9.0 V. The resistance of R is set at 500 Ω.

Calculate the current in R.

current = ...[2]

9 EITHER

Fig. 9.1 shows a cathode-ray oscilloscope (c.r.o.). An alternating voltage supply is applied to the input and the trace produced is shown.

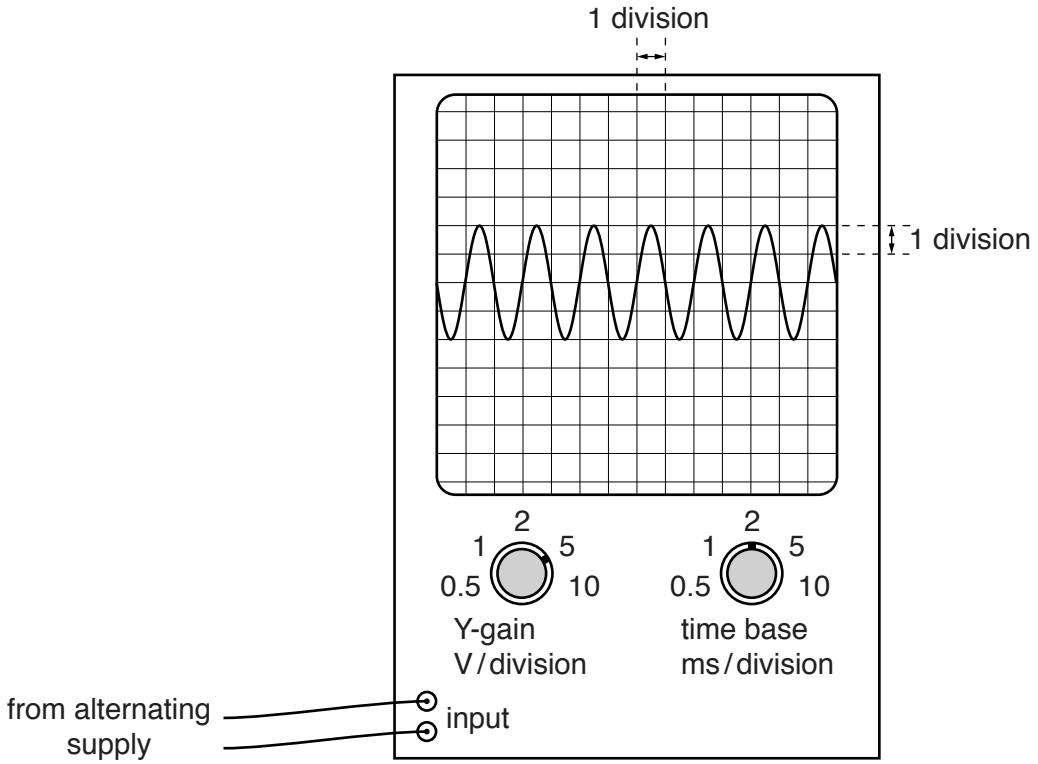


Fig. 9.1

(a) Use Fig. 9.1 to determine the maximum voltage of the supply.

voltage = ... [2]

(b) Describe how the trace on the screen and the controls on the c.r.o. are used to measure the time between any two points on the trace.

.....

.....

.....

.....[2]

OR

The circuit diagram shown in Fig. 9.2 uses an LDR as the sensor in an automatic night light.

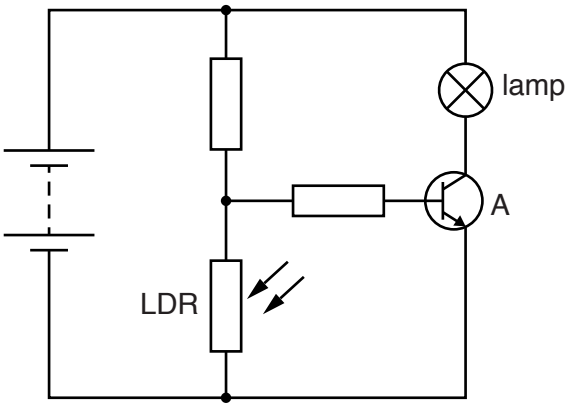


Fig. 9.2

When it gets dark, the lamp turns on.

(a) State the name of component A.

.....[1]

(b) Explain why the lamp turns on when it gets dark.

.....

.....

.....

.....

.....

.....[3]

Section B

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

10 (a) (i) State what is meant by *melting point*.

.....

.....[2]

(ii) The temperature of a liquid is between its melting point and its boiling point.

Using ideas about molecules, describe the changes that occur when the liquid evaporates.

.....

.....

.....

.....

.....[3]

(b) The boiling point of nitrogen is –196 °C.

Liquid nitrogen, below its boiling point, is stored in a vacuum flask, as shown in Fig. 10.1.

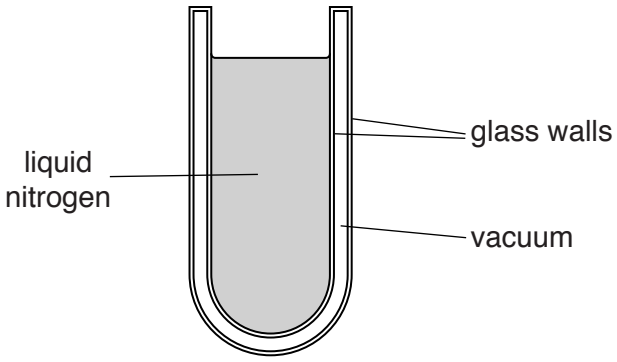


Fig. 10.1

The flask has two glass walls with a vacuum between them.

(i) Suggest where, in the apparatus shown in Fig. 10.1, evaporation occurs.

.....[1]

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(ii) State and explain the advantage of having a vacuum between the two glass walls.

.....

.....

.....

.....

.....[3]

(c) The liquid nitrogen reaches –196 °C, its boiling point. A small piece of metal at 20 °C is lowered slowly into the liquid nitrogen.

Bubbles form within the liquid nitrogen as it boils.

(i) State what is inside the bubbles.

.....[1]

(ii) The small piece of metal has a mass of 50 g. When it is lowered into the liquid nitrogen, the metal cools to –196 °C.

The specific heat capacity of the metal is 0.39 J / (g °C).
The specific latent heat of vaporisation of nitrogen is 200 J / g.

Calculate

1. the thermal energy (heat) lost from the metal as it cools,

thermal energy = ... [3]

2. the mass of nitrogen that boils away.

mass = ... [2]

11 (a) Induced currents can be formed in a coil of wire by electromagnetic induction.

(i) Describe how to demonstrate the formation of an induced current in a coil of wire.

Sketch and label a diagram of the arrangement of the apparatus.

.....

.....

.....[3]

(ii) State two changes to the apparatus that increase the induced current.

1. .....

2. .....
[2]

(iii) The direction of the induced current is determined by Lenz's Law.

1. State Lenz's Law.

.....

.....

.....[2]

2. Describe how Lenz's Law applies in the experiment you described in **(a)(i)**.

.....

.....

.....

.....

.....[2]

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(b) An electrical generator supplies power to a distant factory.

(i) The factory receives 500 kW of electrical power at a voltage of 33 kV.

Calculate

1. the current in the wires supplying the power,

current = ...[2]

2. the electrical energy supplied to the factory in one hour.

energy = ...[2]

(ii) The 33 kV voltage supplied to the factory is very high.

Transmitting electrical energy at high voltage reduces energy losses in the transmission lines.

Explain why.

.....

.....

.....

.....

.....[2]

12 The overall stopping distance of a cyclist is made up of two parts, as shown in Fig. 12.1:

- the distance the cyclist travels during the reaction time of the cyclist (the thinking distance)
- the distance the cyclist travels after the brakes are applied (the braking distance)

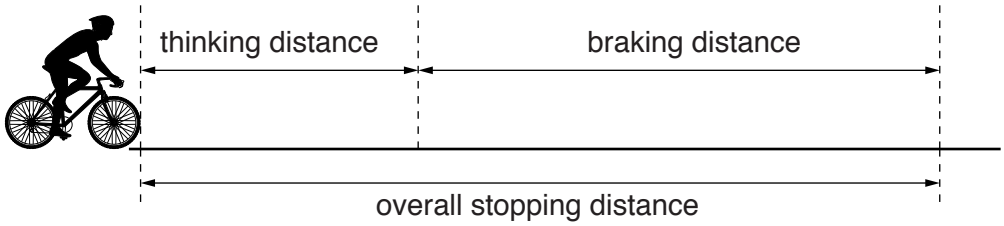


Fig. 12.1 (not to scale)

(a) State the energy change that occurs during braking.

.....

.....[2]

(b) A ball rolls in front of a cyclist at time $t = 0$ and the cyclist brakes and comes to rest.

Fig. 12.2 shows the speed-time graph for the cyclist.

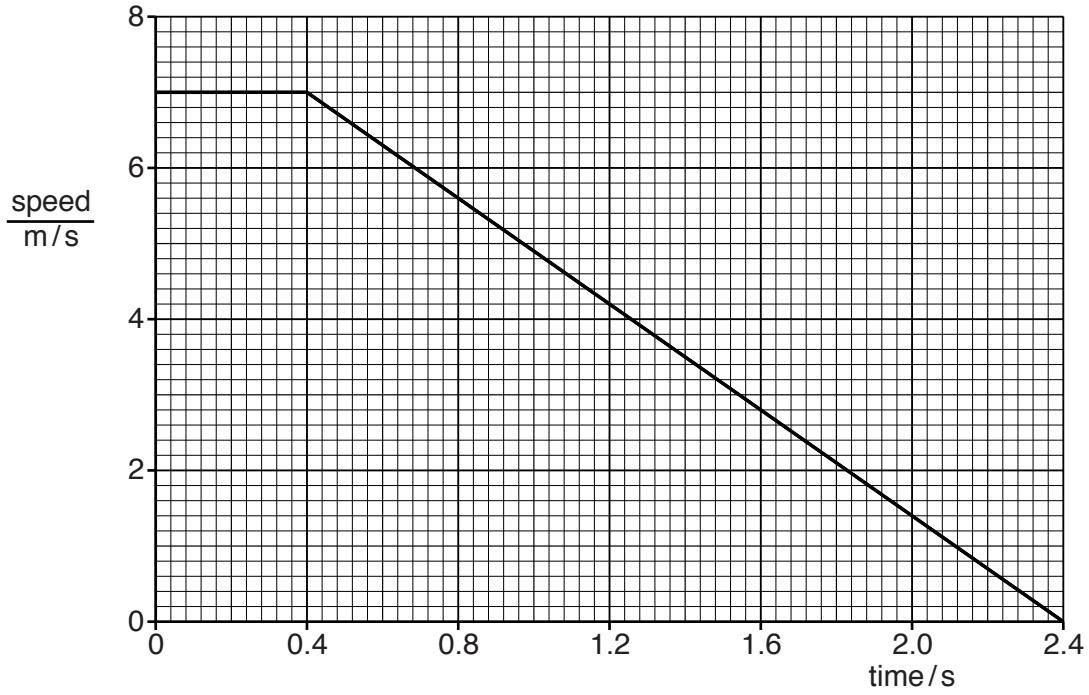


Fig. 12.2

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(i) Using Fig. 12.2, determine the reaction time of the cyclist.

reaction time = ...[1]

(ii) Using Fig. 12.2, calculate the thinking distance.

thinking distance = ...[2]

(iii) State how the braking distance is found using Fig. 12.2.

.....

.....[1]

(iv) On another occasion, the same cyclist travels at an initial speed of 5.0 m/s. A ball rolls in front of the cycle at time $t = 0$.

The cyclist has the same reaction time and the deceleration of the cycle is the same as in Fig. 12.2.

On Fig. 12.2 draw the new speed-time graph for the cyclist. [2]

(v) The braking distance is longer when the cyclist stops on a wet road.

Explain why.

.....

.....

.....

.....

.....

.....[3]

Please turn over for Question 12(c).

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(c) Fig. 12.3 shows the hydraulic braking system of the cycle.

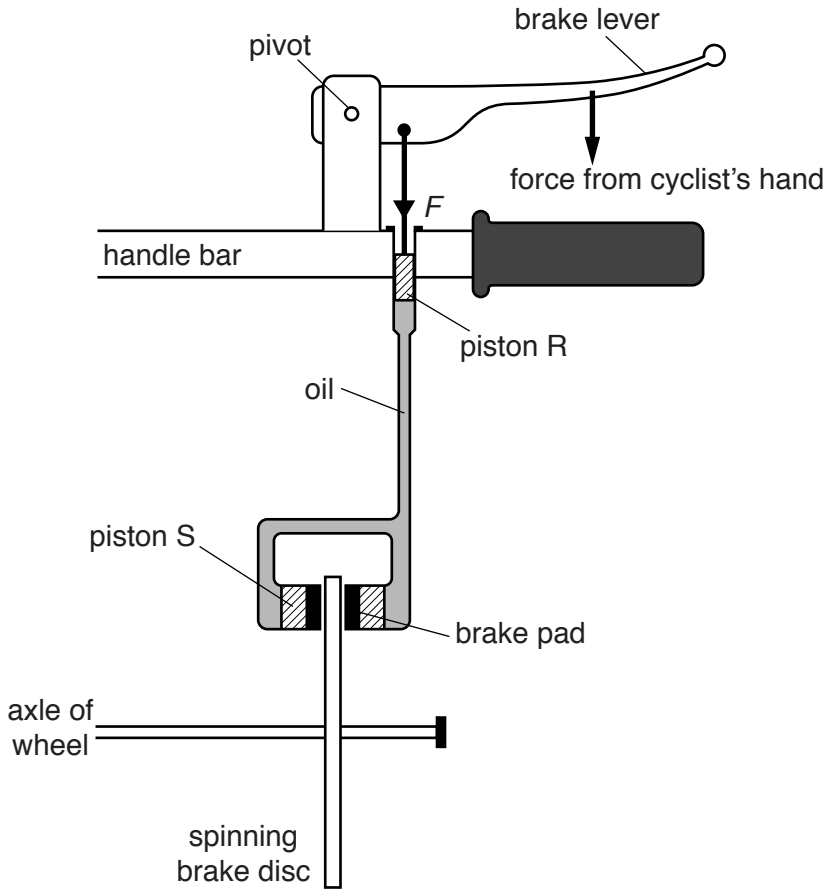


Fig. 12.3 (not to scale)

(i) The cyclist applies a force on the brake lever. This increases the pressure in the oil by 1.2×10^6 Pa.

The cross-sectional area of piston R is 5.0×10^{-5} m^2.

Calculate the force *F* applied by the brake lever to piston R.

F = ... [2]

(ii) The force applied to each of the brake pads is larger than *F*.

Explain why.

.....

.....

.....[2]