Class	Register Number	Name

南洋女子中學校

Nanyang Girls' High School

End-of-Year Examination 2021
Secondary 4

PHYSICS
Paper 2

1 hour 45 minutes

Thursday 7 October **1100 – 1245**

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, register number and class 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.

Section A (40 marks)
Answer all questions.

Section B (30 marks)
Answer all questions including questions **12**, **13** and **14 Either** or **14 Or**.
Circle question **14 Either** or **14 Or** in the grid on the right to indicate which question you have answered.

INFORMATION FOR CANDIDATES
You are reminded that **all** quantitative answers should include appropriate units. The use of an approved scientific calculator is expected, where appropriate. Show all your working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

You are advised to spend no longer than **one hour** on Section A and no longer than **45 minutes** on Section B.

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

Take the acceleration due to gravity g (or gravitational field strength) to be 10 m s^{-2} (or 10 N kg^{-1}) near the Earth's surface.

Examiner's Use	
Paper 2 (70 marks)	
Section A	
1	
2	
3	
4	
5	
6	
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9	
10	
11	
Section B	
12	
13	
14 E	
14 O	
Total	

Paper 1 (30 marks)	

Overall
100

This document consists of **19** printed pages and **1** blank page.

Section A

Answer **all** questions in this section.

1 Two cars start from rest at the same point along a straight racetrack. Car A starts from rest and accelerates constantly. Car B accelerates rapidly for 3.0 s and then maintains a constant speed.

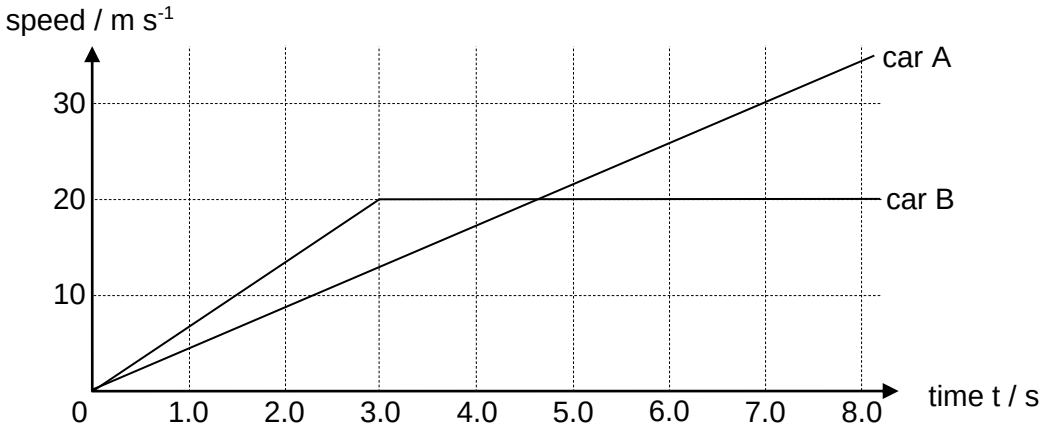

Fig. 1.1

(a) Determine the acceleration of car A.

acceleration of car A = ... [1]

(b) Calculate the time at which the two cars have the same speed.

time = ... [2]

(c) Given that the winning car crosses the finish line at t = 6.5 s, determine which car has won the race. Show all necessary calculations.

Car ..... has won the race. [3]

2 A mechanic wants to turn a nut by applying a 20 N force to a spanner as shown in Fig. 2.1.

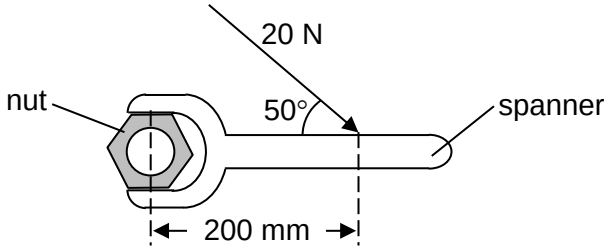

Fig. 2.1

(a) Determine the moment of the force applied by the mechanic.

moment of the force = ……..…… [1]

direction of the moment = ……..…… [1]

(b) State **one** way in which the mechanic could apply the same turning moment to the nut by using a smaller force.

……

……

…… [1]

3 Fig. 3.1 shows an iron cube and an aluminium cube.
The iron cube, of length 2.0 cm, has a density of 7.9 g cm^{-3}. The aluminium cube, of length 3.0 cm, has a density of 2.7 g cm^{-3}.

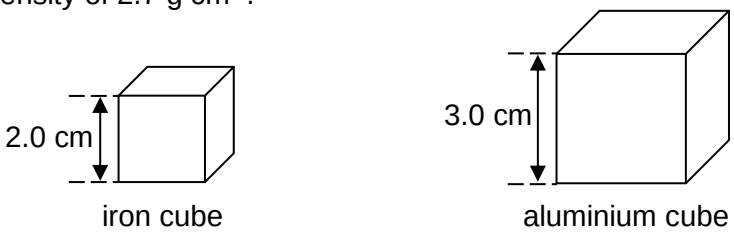

Fig. 3.1

The two cubes are melted to form an alloy. Calculate the density of this alloy.

density of alloy = …… [2]

4 A thin L-shaped tube traps a 150 mm length of air with a fixed length of mercury thread when it is held as shown in Fig. 4.1. The tube is sealed at one end and open to the atmosphere at the other.

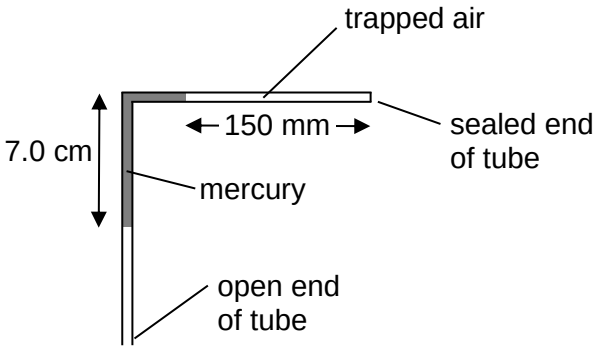

Fig. 4.1

(a) If atmospheric pressure is 76.0 cm Hg, calculate the pressure of the trapped air in cm Hg.

pressure of trapped air = ... [1]

The L-shaped tube is then rotated through 90º clockwise to the position shown in Fig. 4.2, such that the trapped air is reduced in length to 125 mm.

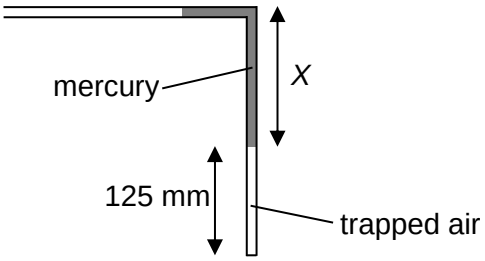

Fig. 4.2

(b) Calculate the length of mercury in the vertical tube, *X*, above the 125 mm of trapped air.

X = ... [2]

5 An optical fibre has an inner glass core surrounded by an outer glass cladding. Fig. 5.1 shows the path of a ray of light travelling along the fibre, striking the boundary between the core and the cladding at an angle θ.

The refractive indices of the core and the cladding are 1.60 and 1.10 respectively.

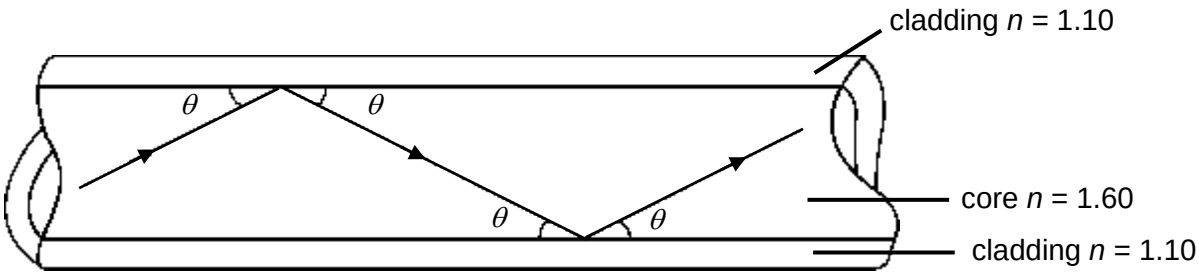

Fig. 5.1

(a) Explain the purpose of surrounding the glass core with the outer glass cladding shown in Fig. 5.1.

.....

.....

.....

.....

..... [2]

(b) State the angle of incidence of the light ray at the boundary between the core and the cladding if the angle θ is 35º.

angle of incidence = ... [1]

(c) Determine the maximum value of θ for which the light ray will remain within the inner glass core.

maximum angle of θ = ... [2]

6 A convex lens L forms an image I of a point object O placed on the principal axis, as shown in Fig. 6.1. The diagram is not drawn to scale.

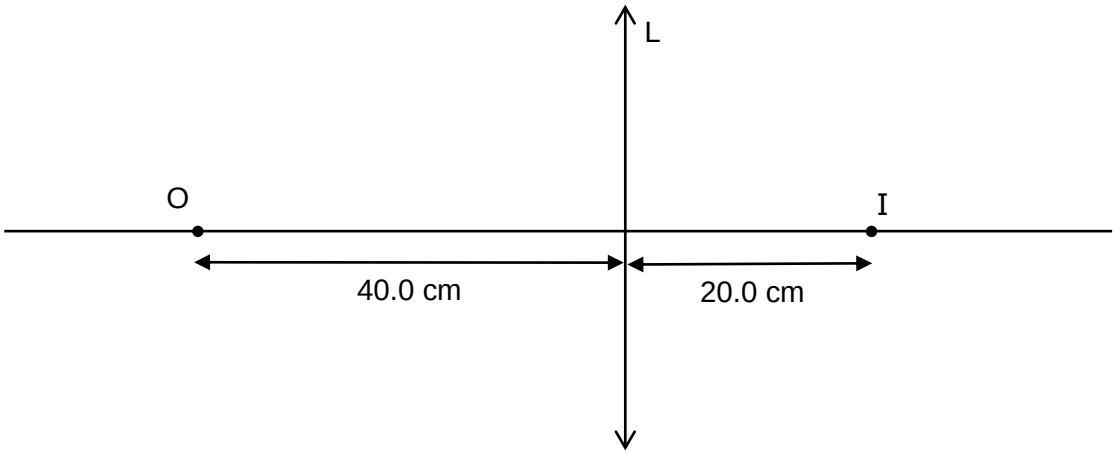

Fig. 6.1

(a) Calculate the focal length of the lens L.

focal length = ... [1]

(b) If the point object O is raised 5.0 cm vertically above the principal axis, determine the new position of the image. Show any working clearly.
Mark and label the position of this new image I' on Fig. 6.1. [2]

(c) If the object O on the principal axis (in Fig. 6.1) is moved a short distance further from the lens, state what would happen to the position of this image.

.....

..... [1]

7 The waves made by earthquakes are recorded by an instrument called a seismometer shown in Fig. 7.1.

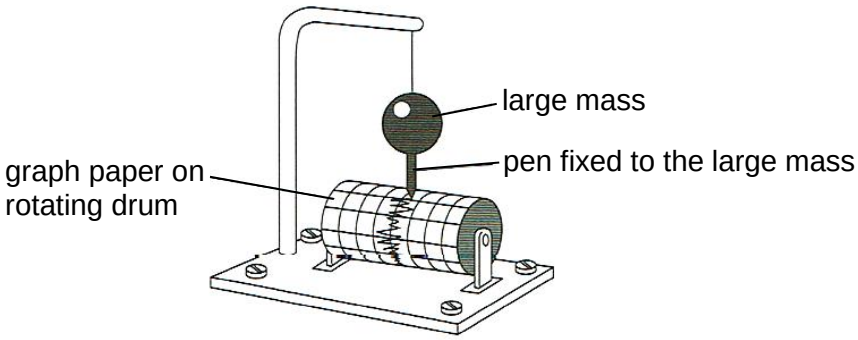

Fig. 7.1

Fig. 7.2. shows a trace of the waves recorded by the seismometer during an earthquake.

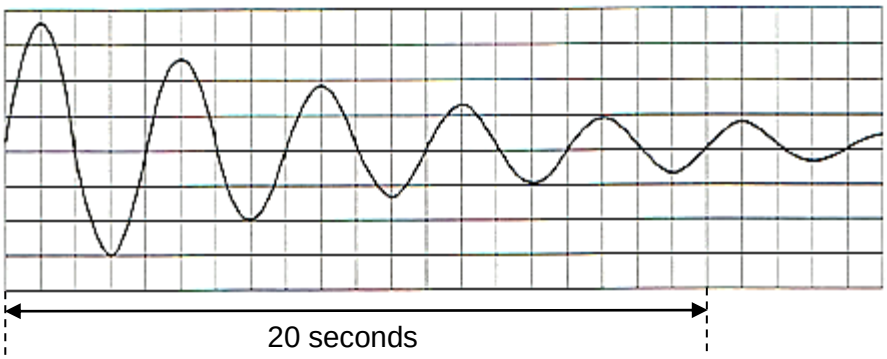

Fig. 7.2

(a) Describe any change in the wave shown in Fig. 7.2 during the 20 seconds.

..... [1]

(b) Calculate the frequency of the wave shown in Fig. 7.2.

frequency = ... [1]

8 Two identical metal spheres, X and Y, are given opposite charges of different magnitudes as shown in Fig. 8.1.

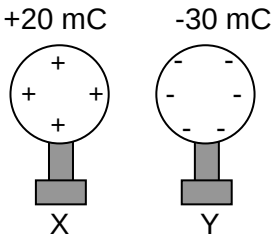

Fig. 8.1

A conducting wire is connected between the two spheres.

(a) State the direction in which electrons flow along the wire.

…… [1]

(b) State the final charge on sphere X.

…… [1]

(c) Given that the current in the connecting wire flows for 1.5 ms, calculate the average current that flows in the wire during this time.

average current = …… [2]

9 Fig. 9.1 shows a simplified circuit of a type of magnetic relay for turning on an electric motor connected to a high voltage power supply. Connected to this circuit are two metal strips A and B, made of a nickel-iron alloy, which can be easily magnetized.

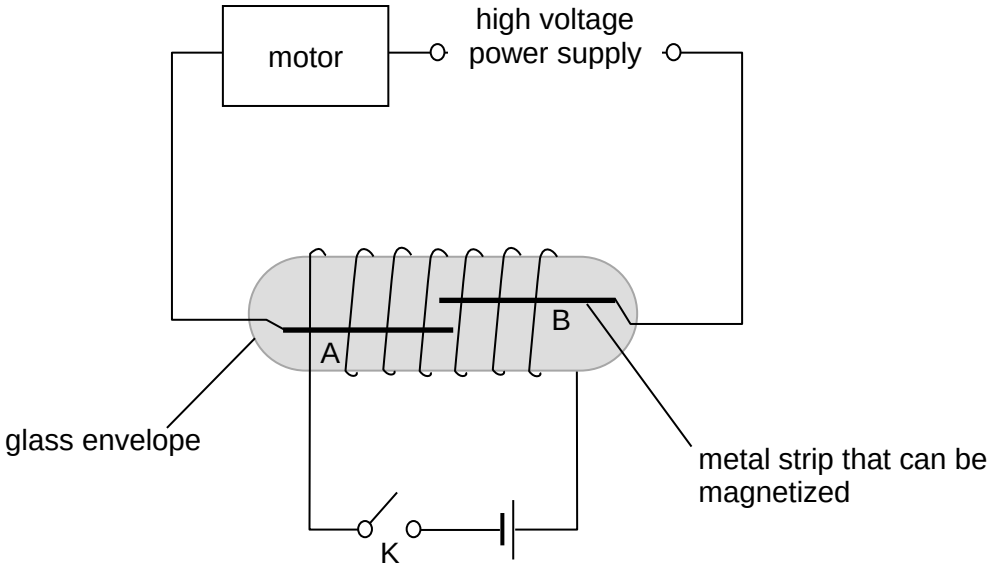

Fig. 9.1

A separate series circuit includes a cell, a switch K and a solenoid which surrounds a glass envelope. Inside the glass envelope are the strips A and B connected to the first circuit, as shown in Fig. 9.1. The solenoid does not have electrical contact with A and B.

(a) When the switch K is closed, describe and explain clearly what happens to the metal strips A and B.

.....

.....

.....

..... [2]

(b) On Fig. 9.1, label clearly the magnetic polarity of both ends of each of the strips A and B when the switch K is closed. [1]

(c) Explain how closing the switch K can be used to operate the motor.

.....

.....

..... [1]

10 Fig. 10.1 shows an electrical circuit with an ammeter and a voltmeter.

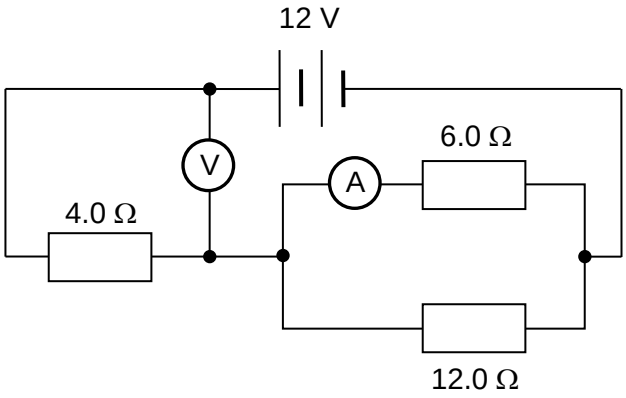

Fig. 10.1

(a) Calculate the effective resistance of this circuit.

effective resistance = …… [1]

(b) Determine the readings on the voltmeter and the ammeter.

voltmeter reading = …… [1]

ammeter reading = …… [1]

11 **(a)** Define *specific latent heat of fusion*.

.....

.....

..... [1]

(b) A lady really likes coffee, but on hot days, she doesn't want to drink a hot beverage. When she is served 200 cm^3 of coffee at 80 ºC in a well-insulated container, she adds ice to the coffee to obtain a final temperature of 30 ºC.

Calculate the mass of ice (at 0 ºC) she added to the hot coffee. Assume most physical properties of coffee are similar to those of water.

Given: density of water = 1.00 g cm^{-3}

specific latent heat of fusion of ice = 3.34 x 10^5J kg^{-1}

specific heat capacity of water = 4200 J $(kg\ K)^{-1}$

mass of ice = ……[3]

Section B

Answer all questions in this section.

Answer only one of the two alternative questions in **Question 14**.

12 **(a)** State the *principle of conservation of energy*.

……

……

…… [2]

A boy of mass 25 kg steps off the top of a wall and falls a distance *h* onto one end of a seesaw that is pivoted at its centre, shown in Fig. 12.1. A 1.5 kg ball is initially at rest at the other end of the seesaw. The boy lands on the spot P on the seesaw and the ball flies vertically upwards into the air.

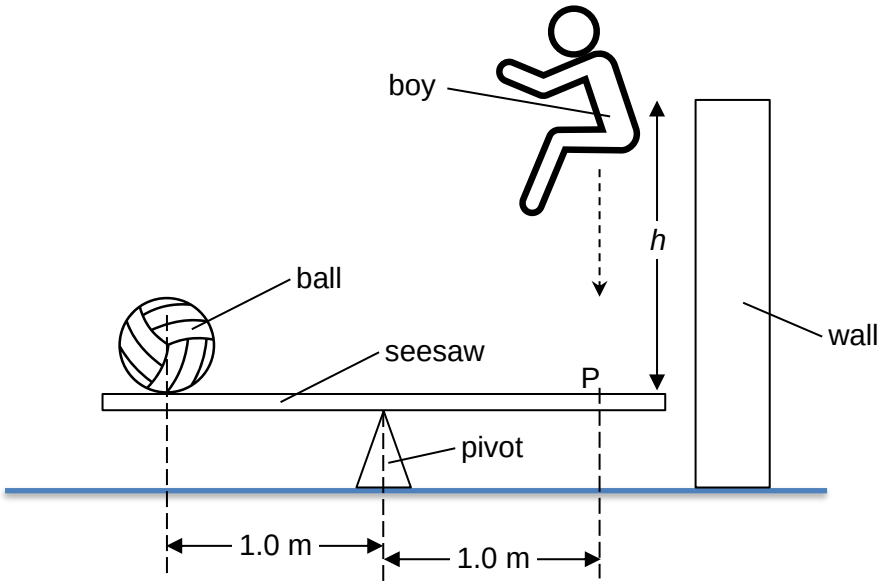

Fig. 12.1 (not drawn to scale)

(b) Given that the ball rises 14.0 m into the air, determine the gravitational potential energy gained by the ball.

gain in gravitational potential energy = …… [1]

(c) Hence or otherwise, calculate the initial speed of the ball when it just left the seesaw.

initial speed = …… [2]

(d) Apply the principle of conservation of energy to determine the minimum possible distance of *h* that the boy falls in Fig. 12.1.

h = …… [1]

(e) The actual height *h* the boy has fallen is 1.50 m. Determine the efficiency of the system shown in Fig. 12.1 in transferring energy from the falling boy to the ball for it to rise 14.0 m vertically in the air.

efficiency = …… [2]

(f) Suggest **one** way in which the boy could make the ball go higher than 14.0 m when he lands on the spot P. Explain your reasoning.

……

……

……

……

…… [2]

13 **(a)** Explain why ultrasound is not audible to humans in terms of known values of frequency.

.....

.....

.....[1]

(b) Fig. 13.1 shows the results of an experiment to measure the wavelength of sound in air at different frequencies.

wavelength / m	frequency / Hz
0.70	460
1.00	320
1.50	210
2.50	130
4.00	80

Fig. 13.1

(i) Plot a graph of wavelength against frequency using the grid in Fig. 13.2 below. [2]

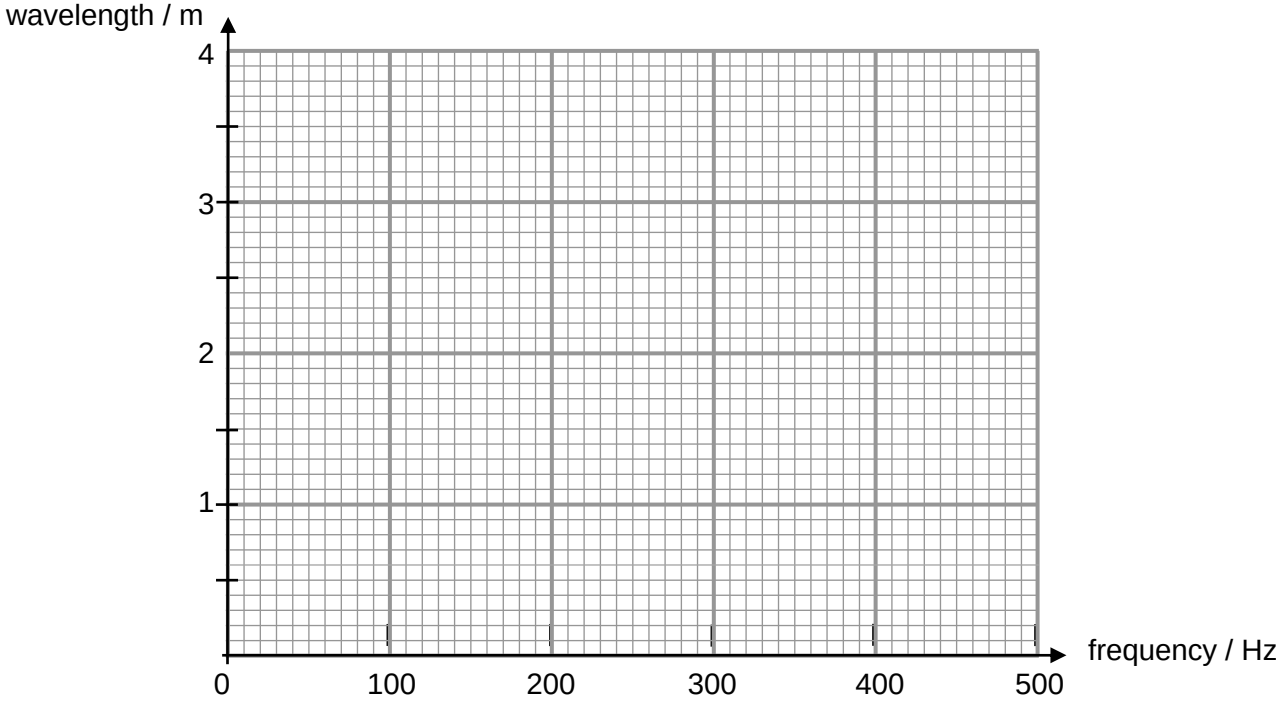

Fig. 13.2

(ii) From your graph, find the wavelength of sound with a frequency of 200 Hz.

wavelength = ... [1]

(iii) Hence, calculate the speed of sound in air.

speed of sound = ... [1]

(iv) Suggest how the speed of sound can be obtained accurately by plotting a different graph.

……

…….. [1]

(c) A geophysicist is searching for oil in a certain area. He sets off an explosive charge at the ground surface, and 0.40 s later, his detector receives an echo from a rock band in the Earth's crust as shown in Fig. 13.3 (not drawn to scale).

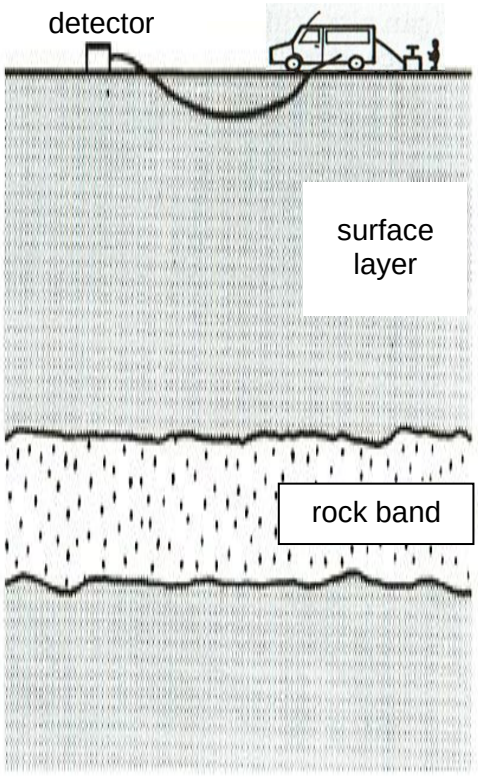

Fig. 13.3

(i) If the speed of sound waves through the surface layer is 4000 m s^{-1}, determine the depth of the top of the rock band from the ground surface.

depth of top of rock band = ... [2]

(ii) A second reflected pulse is detected 0.10 s later (after the first echo). Determine the thickness of this rock band. Assume the speed of sound underground remains unchanged.

thickness of rock band = ... [2]

14 EITHER

The variation of resistance of a thermistor R with temperature is shown in Fig. 14.1.

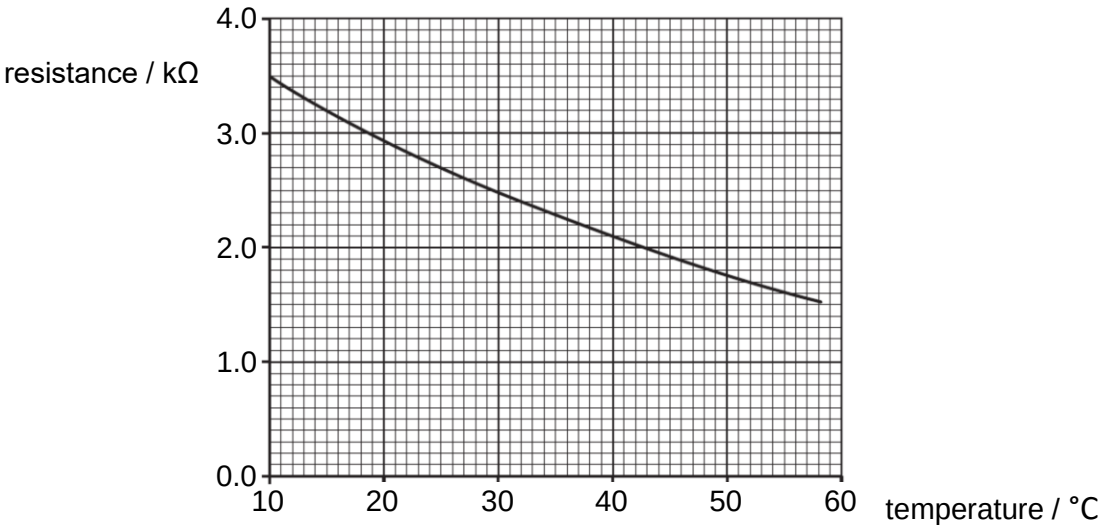

Fig. 14.1

(a) Describe how the resistance of the thermistor changes as the temperature increases.

…… [1]

(b) State the resistance of thermistor R when it is at 43 °C.

resistance of R = …… [1]

The thermistor R is connected to a 6.0 V battery, a voltmeter and a variable resistor X as shown in Fig. 14.2.

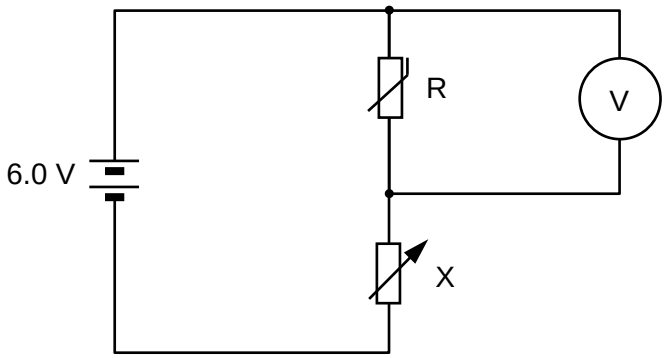

Fig. 14.2

(c) Given that the voltmeter reads 2.5 V at 43 °C, calculate the resistance of the variable resistor X.

resistance of X = …… [2]

(d) Calculate the current drawn from the battery when the circuit is at 43 °C.

current = …… [2]

(e) Calculate the electrical power supplied by the battery when the circuit is at 43 °C.

power = …… [2]

(f) The temperature of the circuit starts to increase.

State and explain, whether the resistance of the variable resistor X will need to be increased or decreased so as to maintain the voltmeter reading at 2.5 V.

……

……

……

……

……

…… [2]

14 OR

In Fig. 14.3, a coil is placed between the poles of two magnets. A voltage supply drives a current through the coil. The direction of the current in the coil is shown in Fig. 14.3.

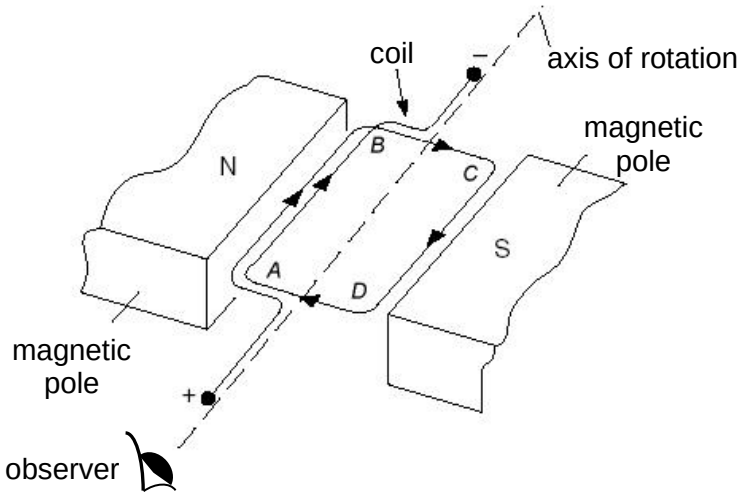

Fig. 14.3

(a) Draw two arrows to show the forces acting on the sides AB and CD of the coil at the moment shown in Fig. 14.3. [2]

(b) State how the direction of these forces in part **(a)** is determined.

…… [1]

(c) Describe and explain briefly the subsequent motion of the coil as viewed by the observer.

……

……

……

……

……

…… [3]

(d) Describe how the setup in Fig. 14.3 could be modified to work as a simple d.c. motor. Explain how this modification works.

……

……

……

……

……

…… [2]

(e) A student suggests that the coil of the working simple d.c. motor can be made to rotate at a higher speed by

1. increasing the number of turns in the coil and
2 by using a voltage supply with a higher voltage.

Suggest another way that can make the coil rotate at a higher speed. Explain how this works.

……

……

……

…… [2]

END OF PAPER

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