Class	Register Number	Name

南洋女子中學校

Nanyang Girls' High School

End-of-Year Examination 2023
Secondary 4

PHYSICS

Paper 2 Theory **1 hour 45 minutes**

Monday 9 Oct **0845 – 1030**

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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.
Do not use staples, paper clips, glue or correction tape/fluid.
Write your answers in the spaces provided on the question paper.

Section A (40 marks)
Answer **all** questions.

Section B (30 marks)
Answer **all** questions.
Question **13** has a choice of parts to answer: **13 *Either*** or **13 *Or*.**
Circle Question **13 Either** or **13 Or** in the grid on the right to indicate which question you have answered.

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 to be 10 m s^{-2} or gravitational field strength to be 10 N kg^{-1} near the Earth's surface.

Examiner's Use	
Paper 2 (70 marks)	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Section B	
11	
12	
13 Either	
13 Or	
Total	

Paper 1 (30 marks)	

Overall
100

This document consists of **22** printed pages.

Section A (40 marks)

Answer **all** questions in this section.

1 A boy standing on a building throws a stone vertically upwards.

Fig. 1.1 shows the variation of the velocity of the stone with time *t*. The stone leaves the boy's hand at t = 0 s and reaches the ground at the bottom of the building at t = 2.8 s.

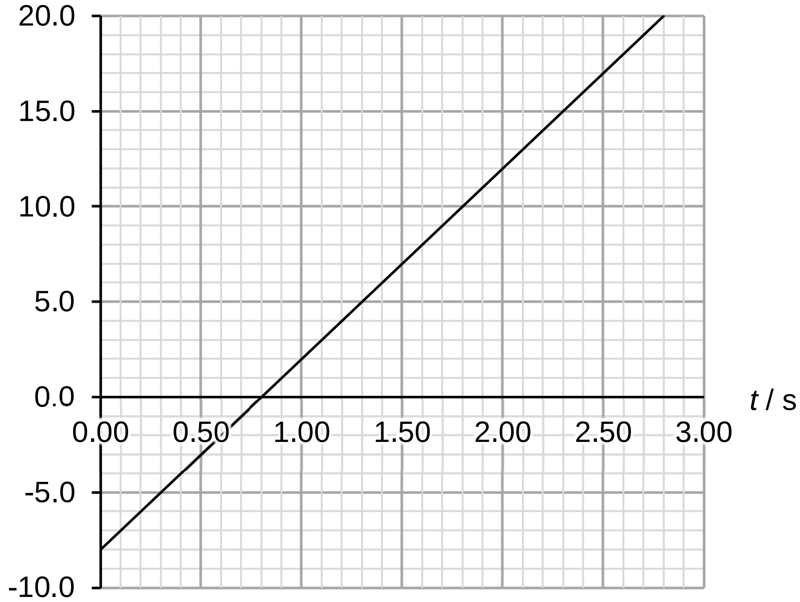

Fig 1.1

(a) **(i)** Distinguish between *velocity* and *speed*.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(ii) Calculate the change in velocity of the stone between t = 0 s and t = 2.8 s.

change in velocity = …………………….. [1]

(iii) Calculate the change in speed of the stone between t = 0 s and t = 2.8 s.

change in speed = …………………….. [1]

(b) The displacement of the stone is 0 m at t = 0 s. Taking this as the reference position,

(i) calculate the displacement of the stone at its maximum height,

displacement = …………………….. [1]

(ii) calculate the displacement of the stone when it reaches the ground.

displacement = …………………….. [2]

(iii) Hence, on the axes in Fig. 1.2, sketch the variation of the displacement of the stone with t from the instant the stone is at its maximum height until it reaches the ground.

Label all relevant values clearly. [2]

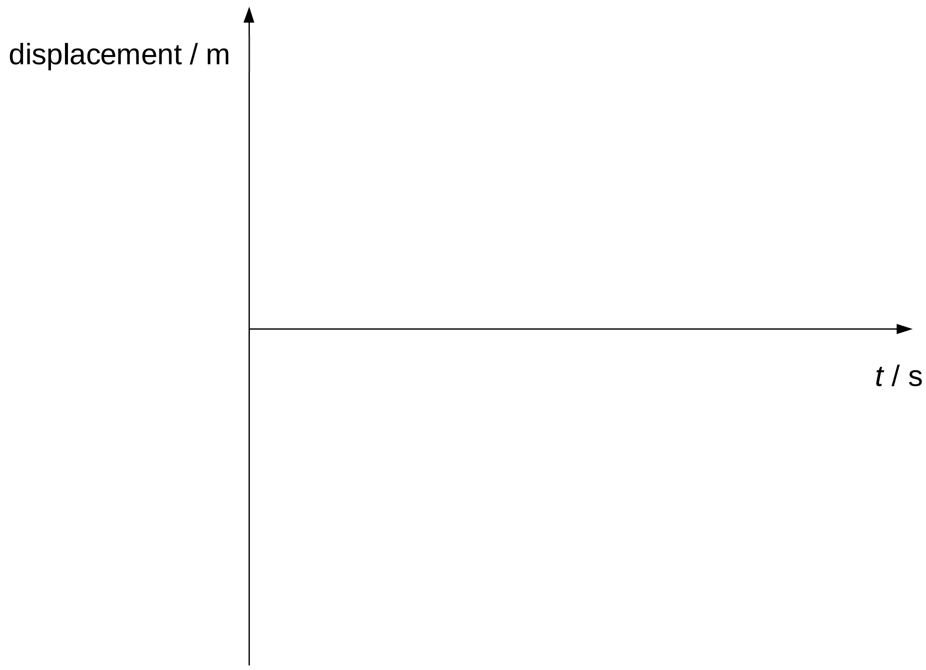

Fig. 1.2

2 A plank of mass 5.0 kg is held horizontally by supports A and B. Support A is 80 cm from the centre of gravity C of the plank and support B is 30 cm from C, as shown in Fig. 2.1.

A load of weight 25 N is placed at 60 cm from C.

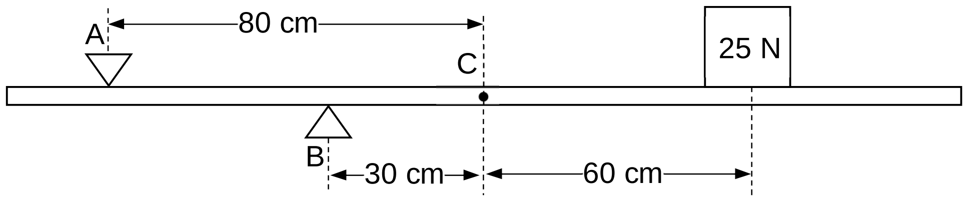

Fig 2.1

(a) State what is meant by [1]

(i) the *mass* of an object.

……………………………………………………………………………………………….........

(ii) the *weight* of an object.

……………………………………………………………………………………………….........

(b) Calculate the force exerted on the plank by support A.

force = …………………….. [2]

(c) Hence or otherwise, calculate the force exerted on the plank by support B.

force = …………………….. [1]

3 To determine the density of an unknown liquid X, a student measures its mass and volume. The readings are recorded in Table 3.1.

Table 3.1

volume of liquid X / cm^3	17.0
total mass of the measuring cylinder and liquid X / g	66.45
mass of the empty measuring cylinder / g	52.00

(a) Calculate the density of liquid X.

density = …………………….. [2]

(b) Fig. 3.1 shows an open U-shaped glass tube filled with water and liquid X.

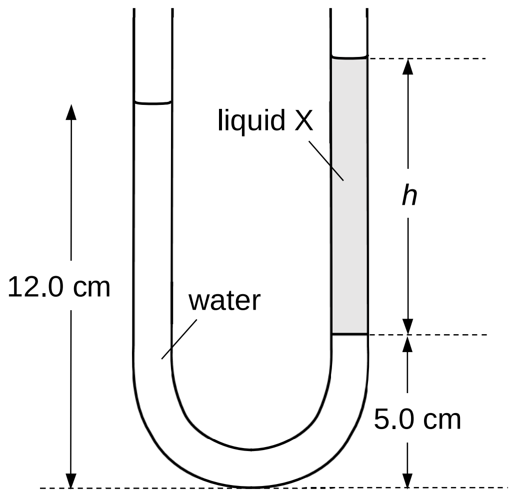

Fig. 3.1

The density of water is 1.0 g cm^{-3}.

Calculate the height h of the liquid X column.

height = …………………….. [2]

4 Fig. 4.1 shows a solar water heater which is mounted on top of a roof. Cold water from the bathroom inside the house is carried by the pipe to the roof and hot water produced is returned to the bathroom.

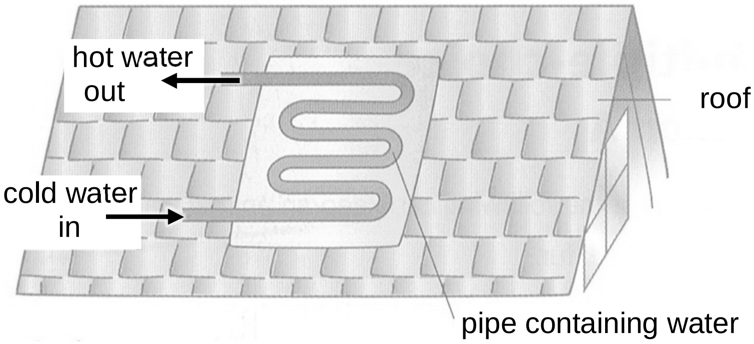

Fig. 4.1

(a) State the process by which thermal energy is transferred [1]

(i) from the Sun to the Earth: ……………………………………………….

(ii) through the pipe to the water: ……………………………………………….

(b) Explain why the pipe is painted in black.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

(c) Explain why copper is more suitable than plastic for making the pipe in Fig. 4.1.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

5 An espresso coffee machine injects 0.025 kg of steam at 100 °C into a cup of cold coffee of mass 150 g at 20 °C.

Given: specific heat capacity of the coffee used $= 5800\ \text{J kg}^{-1}\ °\text{C}^{-1}$
specific heat capacity of water $= 4200\ \text{J kg}^{-1}\ °\text{C}^{-1}$
specific latent heat of vaporisation of water $= 2.26 \times 10^{6}\ \text{J kg}^{-1}$

Determine the final temperature of the coffee.

final temperature = …………………….. [3]

6 An object is placed in front of a lens L.

Fig. 6.1 shows a light ray from the object refracted by L.

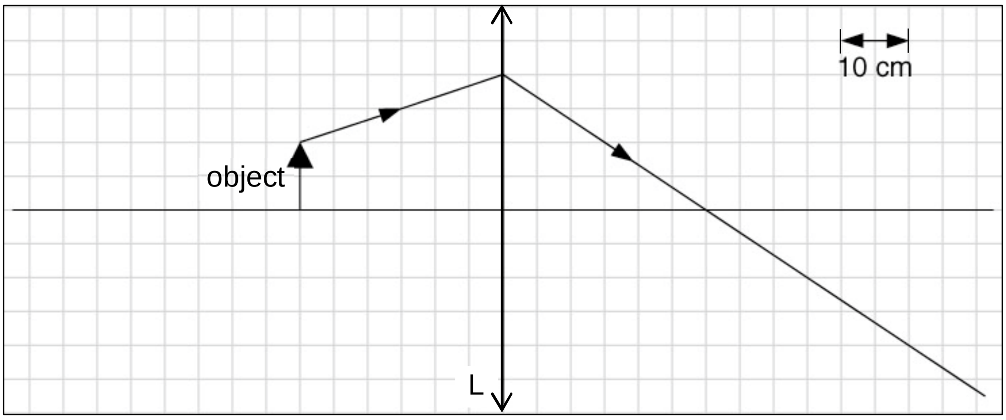

Fig. 6.1

(a) Determine the image distance.

image distance = …………………….. [1]

(b) Determine the focal length of the lens.

focal length = …………………….. [1]

7 **(a)** A car stops after travelling some distance. A net charge accumulates on the car tyres due to charging by rubbing (friction) with the road surface and also on the car body due to friction with air.

Fig. 7.1

As soon as the driver steps on the ground, he gets a mild electric shock when he touches the metal door of the car as shown in Fig. 7.1. Explain why this happens.

………

………

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

(b) The situation in Fig. 7.1 can be prevented by using a suitable material to make the car tyres. Suggest a property that this material must have.

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

8 An electric cable is made up of 24 thin strands of copper wire, as shown in Fig. 8.1 (not drawn with exact number of strands).

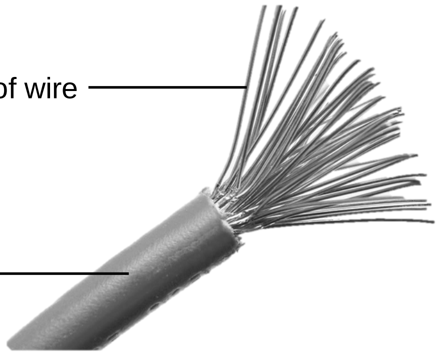

Fig. 8.1

Each strand has diameter 0.26 mm. Copper has resistivity of $1.7 \times 10^{-8}\ \Omega$ m.

Calculate

(a) the resistance of one strand of wire of length 1.0 m,

resistance of wire = …………………….. [2]

(b) the resistance of the cable of length 5.0 m.

resistance of cable = …………………….. [2]

9 An electric oven operates at a voltage of 220 V. It has a heating element with a resistance of 25 Ω.

(a) Calculate the rate of energy consumption of the oven.

rate of energy consumption = …………………….. [2]

(b) The cost of 1 kWh of electricity is 28 cents in Singapore. Calculate the total cost of electricity for operating the electric oven for 2.5 hours each day for a week.

total cost = …………………….. [2]

10 Fig. 10.1 shows part of an a.c. generator. A coil of wire ABCD is rotating steadily between the poles of two permanent magnets.

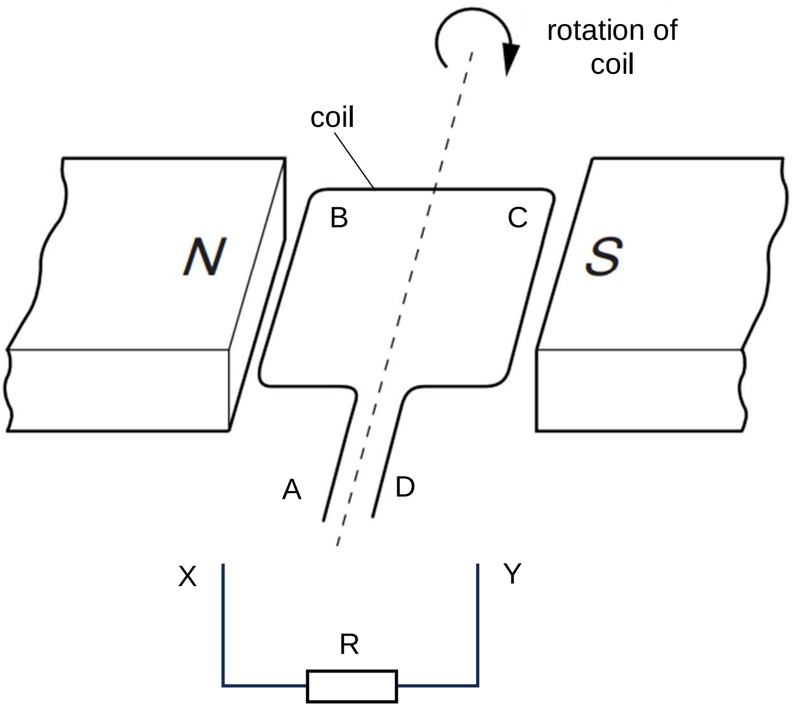

Fig. 10.1

The current generated in the coil is to pass through resistor R.

(a) State the components connected between the ends A and D of the coil and the connections X and Y.

.... [1]

(b) On Fig. 10.1, draw an arrow to indicate the direction of the current in section AB of the coil. Label the arrow *I*. [1]

(c) At time t = 0 s, the coil is in the horizontal plane as shown in Fig. 10.1.

The time T corresponds to one complete rotation of the coil.

On Fig. 10.2, sketch and label a graph to show the variation with t of the current through R from t = 0 s to t = T. [2]

Fig. 10.2

(d) State and explain any changes in the amplitude of the current in **(c)** if the frequency of rotation of the coil is halved.

………

………

……… [2]

Section B (30 marks)

Answer **all** questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 Earthquakes occur because of a sudden release of stored energy from the Earth. This energy has built up over long periods of time as a result of forces within the Earth. Most earthquakes take place along faults in the upper 40 km of the Earth's surface, when one side rapidly moves relative to the other side of the fault.

This sudden motion causes waves to radiate from their origin (called the focus) and travel through the Earth. It is these waves that can produce ground motion which people call an earthquake. Strong earthquake waves can cause great local damage and they can travel large distances.

Source: Adapted from an article in the Virtual Earthquake, Geology Labs On-Line, California State University (http://vcourseware5.calstatela.edu/VirtualEarthquake/VQuakeExecute.html)

(a) In Fig. 11.1, a student is demonstrating an earthquake wave with a slinky spring.

Fig. 11.1

Suggest what her hand and the spring represent.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

……………………………………………………………………………………………………… [2]

(b) *Earthquakes produce both longitudinal waves, known as P (primary) waves, and transverse waves, known as S (secondary) waves.*

State which type of earthquake wave the student is demonstrating in Fig. 11.1.

……………………………………………………………………………………………………… [1]

(c) State which wave property can be used to describe the 'strength' of an earthquake.

……………………………………………………………………………………………………… [1]

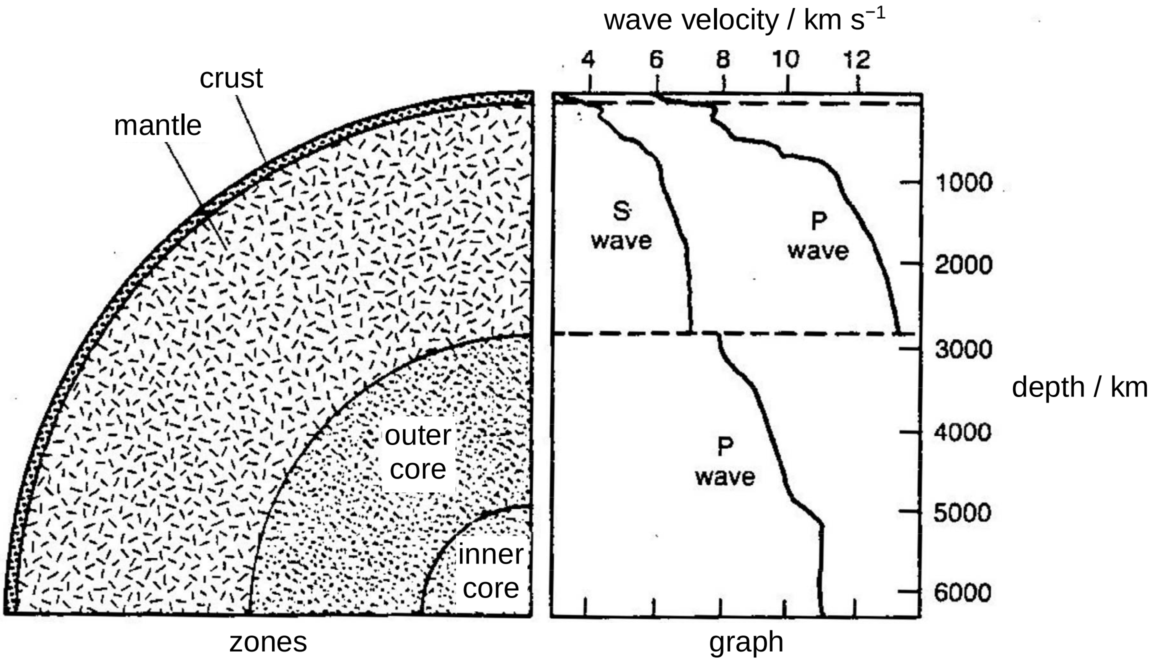

Fig. 11.2

Geologists have used the properties of P (primary) waves and S (secondary) waves to predict the composition of Earth's interior. They believe Earth consists of three main zones: the crust, the mantle, and the core. The core is believed to consist of a liquid outer core and a solid inner core. These are shown on the **left side** of Fig. 11.2.

P and S waves travel through different rock materials at different velocities, as shown in Fig. 11.2.

S waves cannot pass through molten, or liquid, rock. If Earth's composition were that of a uniform solid, the velocities of P and S waves would increase smoothly with depth. This is because increasing pressure beneath the surface increases the elastic properties of the rock, which in turn increases wave velocities. Because the interior rock composition is not uniform but changes with depth, earthquake velocity does not increase smoothly, as shown on the **right side** of Fig. 11.2.

Source: Adapted from Physics: Principles and Problems (Glencoe), p. 27-28, including Fig. 11.2.

Refer to Fig. 11.2.

(d) State the zone within Earth where the P-wave velocities range from about 6.0 to 7.5 km s^{-1}.

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

(e) Suppose P waves with the range of velocities in **(d)** are recorded during an earthquake. If these waves have a frequency of 5.0 Hz, calculate the range of the wavelengths.

range of wavelengths = ………………. to ………..……….. [2]

(f) Describe the change in velocities of P waves at the boundary of the mantle and core, from the mantle towards the core.

……

…… [1]

(g) Explain why S waves are not found in the solid inner core.

……

…… [1]

(h) Laboratory tests indicate that rocks such as peridotite (that are rich in the dense minerals olivine, pyroxene, and garnet) allow P-waves to travel at velocities greater than 8 km s^{-1}. State which zone is **not** likely to be made principally of peridotite.

…… [1]

12 When a driver steps on the accelerator of a car, the car experiences a forward driving force provided by the car engine.

The resistive forces acting on a car to oppose its motion are air resistance and friction, as shown in Fig. 12.1.

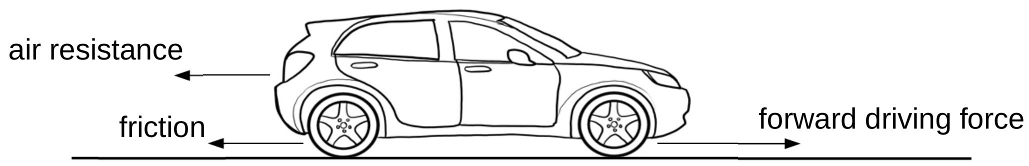

Fig. 12.1

(a) Fig. 12.2 shows a graph of the variation of the total resistive force that acts on the car with time *t*.

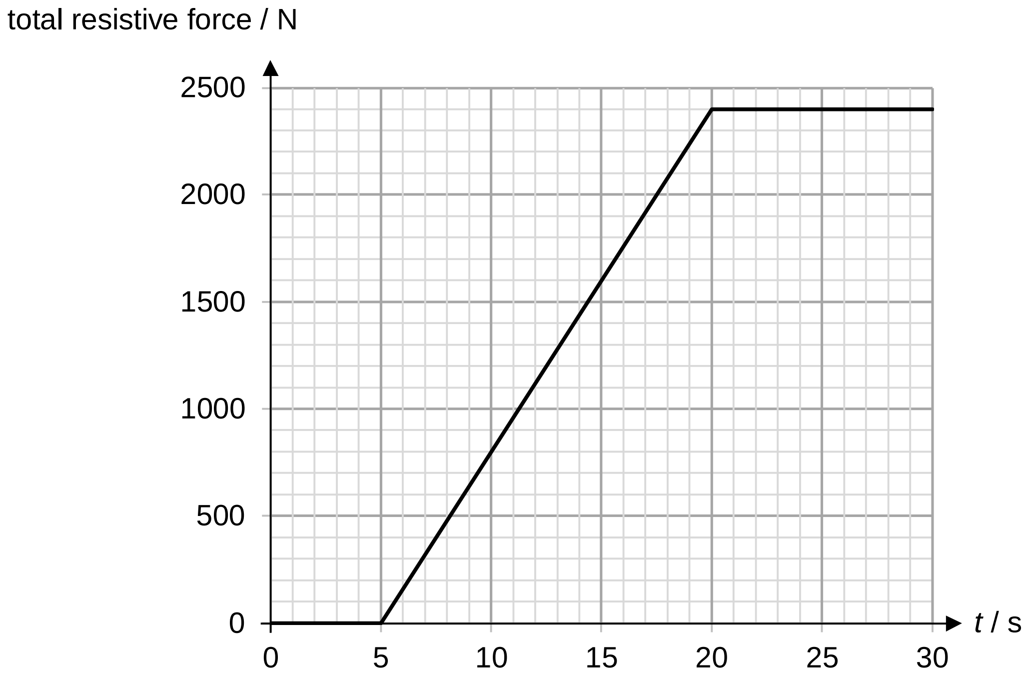

Fig. 12.2

At time t = 0 s, the car is at rest.

The driver steps on the accelerator at t = 5 s. From t = 5 s to t = 30 s, the driving force has a constant value of 2400 N.

The total mass of the car and the driver is 950 kg.

(i) Calculate the acceleration of the car at t = 15 s.

acceleration = …………………….. [2]

(ii) With reference to Newton's laws of motion, describe and explain the changes to the velocity of the car,

1. from t = 5 to t = 20 s,

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

2. from t = 20 s to t = 30 s.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) The car now travels with a constant speed of 20 m s^{-1}. The driving force has a constant value of 2700 N.

(i) Calculate the output power of the car engine when the car is travelling along a straight, horizontal road.

output power = …………………….. [2]

(ii) The car begins to travel up a slope.

State and explain whether any changes need to be made to the power of the car engine to maintain the speed of 20 m s^{-1}.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

13 EITHER

(a) Define *electromotive force* (e.m.f.) of a cell.

………

………

……… [1]

(b) A cell of e.m.f. 1.5 V is connected in series with a resistor of resistance 0.25 Ω and another resistor R, as shown in Fig. 13.1.

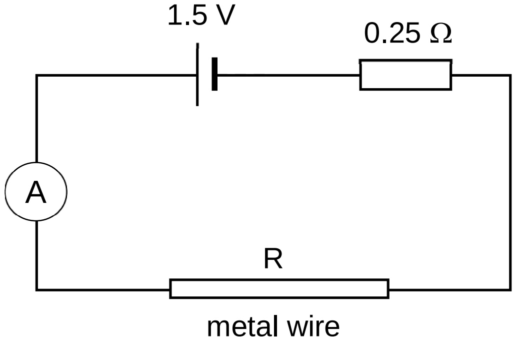

Fig. 13.1

The resistor R is made of a metal wire.

A current of 0.24 A passes through R for a time of 5.0 minutes.

(i) Calculate the charge that passes through the cell.

charge = …………………….. [2]

(ii) Calculate the total energy supplied by the cell in these 5.0 minutes.

energy = …………………….. [2]

(c) After 10 minutes, the ammeter reading changes due to a change in the resistance of resistor R.

State and explain the change in the ammeter reading.

……………………………………………………………………………………………………….

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

(d) Two identical cells of e.m.f. 1.5 V are connected in series with a fixed resistor of resistance 2000 Ω and a thermistor, as shown in Fig. 13.2.

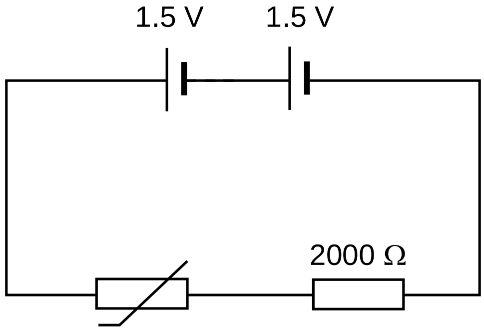

Fig. 13.2

The thermistor has resistance 4000 Ω at 0 °C and 1800 Ω at 20 °C.

(i) Determine the potential difference (p.d.) across the thermistor at 0 °C.

p.d. across the thermistor = …………………….. [2]

(ii) State and explain any change in the p.d. across the thermistor as its temperature rises above 0 °C.

…………………………………………………………………………………………….

…………………………………………………………………………………………….

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

[Turn over

13 **OR**

(a) Fig. 13.3 shows a solenoid connected in a circuit.

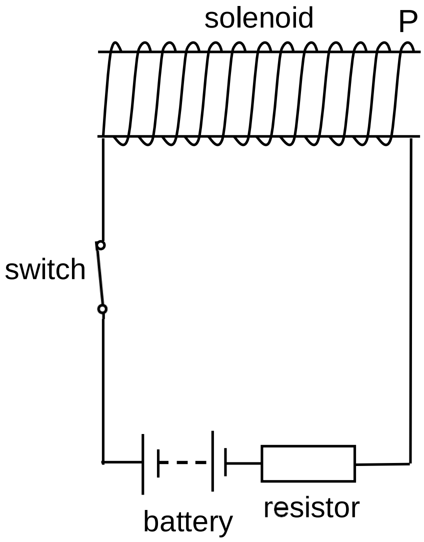

Fig. 13.3

(i) State the magnetic pole at point P of the solenoid.

…………………………… [1]

(ii) On Fig. 13.3, draw lines to show the pattern of the magnetic field inside and around the solenoid due to the current.

Indicate the direction of the magnetic field lines. [2]

(b) The switch is now opened.

A second coil connected to a sensitive galvanometer and a resistor R is placed next to the first solenoid as shown in Fig. 13.4.

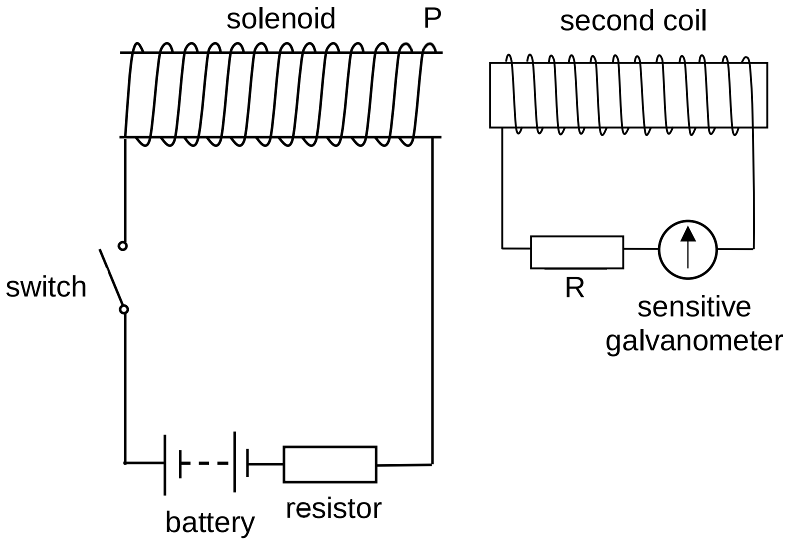

Fig. 13.4

When the switch is closed, the sensitive galvanometer shows a momentary deflection due to a momentary flow of current.

State and explain the **direction** of flow of this momentary current through resistor R.

……

……

……

……………………………………………………………………………………………………… [2]

(c) Fig. 13.5 shows a transformer.

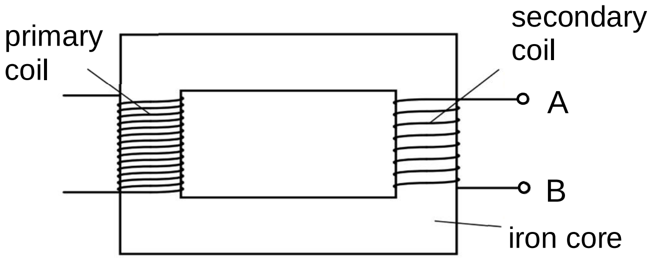

Fig. 13.5

An alternating voltage of 240 V is applied to the primary coil. The primary coil has 2000 turns of wire.

The voltage obtained between terminals A and B is 6.0 V.

(i) Calculate the number of turns in the secondary coil.

number of turns = …………………….. [2]

(ii) Two identical lamps rated 6.0 V, 18 W are connected in parallel across terminals A and B. The lamps glow with normal brightness.

1. Calculate the total power dissipated by both lamps.

power = …………………….. [1]

2. Hence, or otherwise, calculate the current in the primary coil. Assume that the transformer is 100% efficient.

current = …………………….. [2]

END OF PAPER