SINGAPORE CHINESE GIRLS' SCHOOL
END-OF-YEAR EXAMINATION 2024
YEAR FOUR
INTEGRATED PROGRAMME

CANDIDATE NAME

CLASS

REGISTER NUMBER

PHYSICS

PAPER 2

Wednesday **2 October 2024** **1 Hour 45 mins**

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Section A

Answer **all** questions.

Section B

Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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

Take g = 10 ms^{-2} or 10 Nkg^{-1} unless stated otherwise.

For Examiner's Use	
Section A	**70**
Section B	**10**
Total	**80**

SECTION A

Answer all the questions in this section.

1 A man standing in a hot air balloon released a ping pong ball as the balloon accelerated upwards at 2.0 m/s^2. The upward speed of the balloon is 2.0 m/s at the moment the ping pong ball is released. The ping pong ball has the same velocity as the balloon when it is released. Fig. 1.1 shows how the velocities of the hot air balloon and the ping pong ball vary with time.

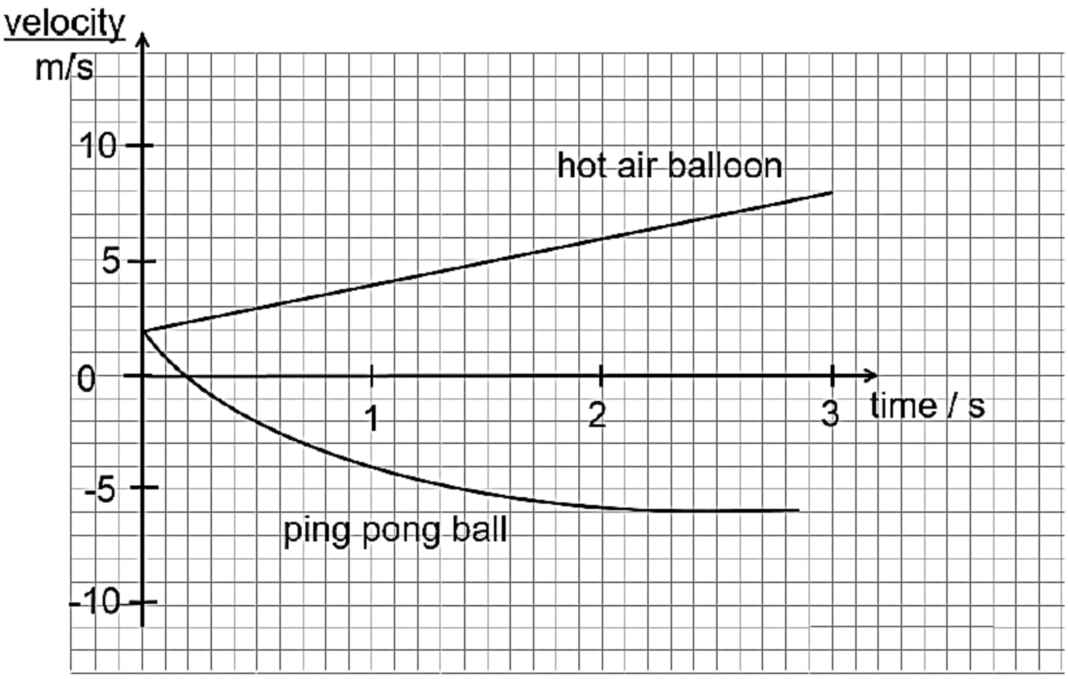


Fig. 1.1

(a) Explain why the acceleration of the ping pong ball at its maximum height is 10 m/s^2.

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

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

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

(b) Describe the motion of the ping pong ball from the moment it is released until it reaches terminal velocity.

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

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

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

(c) Calculate the average velocity of the hot air balloon from $t = 0$ to $t = 3.0$ s.

Average velocity of hot air balloon = …………………….. [3]

[Total : 7 m]

2 Fig. 2.1 shows how the speed of a rocket SpaceX varies with time as it enters the gravitational field of a new Planet Y with negligible atmosphere.

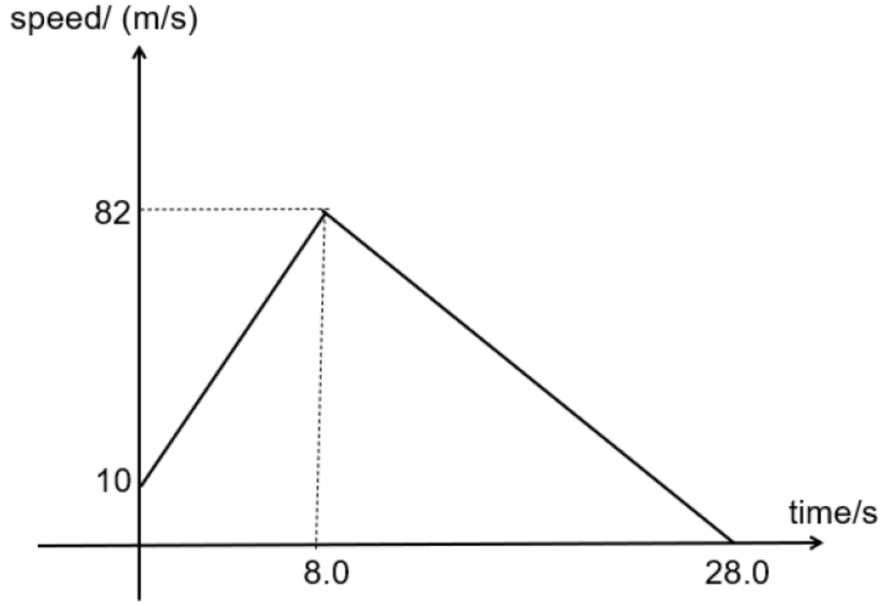


Fig. 2.1 (not to scale)

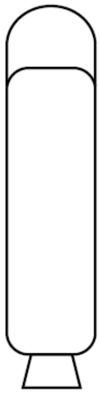
SpaceX has a total mass of 1.8×10^6 kg. Once it enters the atmosphere of Planet Y, it undergoes free fall for 8.0 s before its engine fires a continuous thrust to bring it to a gentle upright landing on the surface of Planet Y.

(a) Calculate the weight of SpaceX on Planet Y.

Weight = ……………………….. [2]

(b) At 8.0 s, a significant amount of liquid oxygen fuel undergoes combustion in the rocket engine to produce a constant thrust, *T*, to decrease the rocket's speed of descent.

(i) On Fig. 2.2, draw and label all the forces acting on SpaceX during its descent. You may ignore air resistance. [2]



.

Fig. 2.2

(ii) 1. Write an equation relating the forces in Fig. 2.2.

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

2. Calculate the magnitude of the thrust, *T*.

Thrust = ……………………………….. [2]

(iii) The thrust produced by the engine is uniform throughout the descent. Explain why the deceleration from t = 8.0 s to t = 28.0 s increases in reality.

………………………………………………………………………………………………

………………………………………………………………………………………………

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

[Total : 8 m]

3 In a tourist attraction, a lift, powered by a motor, is used to carry tourists up and down a mine shaft. The set up is shown in Fig. 3.1.

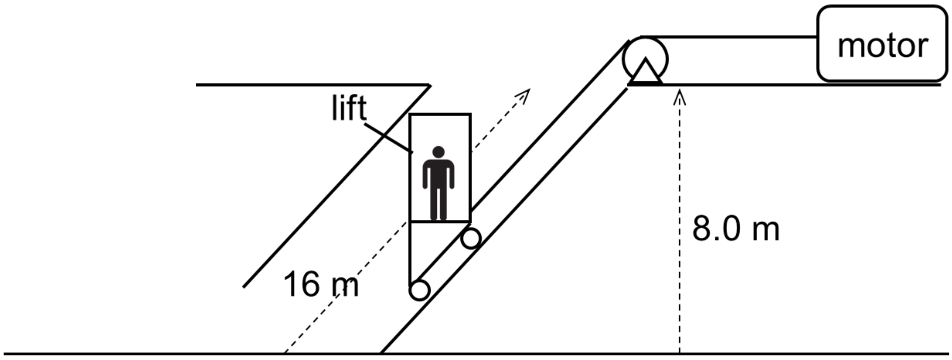


Fig. 3.1

The vertical distance travelled by the lift is 8.0 m and the lift travels at an average constant speed of 0.40 m/s along the 16 m mine shaft. The total mass of a fully loaded lift is 800 kg. Work done against friction along the 16 m shaft is 16 000 J.

(a) Calculate the gain in gravitational potential energy when the lift travels from the bottom to the top of the mine shaft.

gain in GPE = ... [2]

(b) The efficiency of the motor is 80%. Calculate the energy required by the motor each time it brings the lift up the shaft.

energy required = ... [1]

(c) Calculate the rate at which energy is done by the motor.

power = ... [2]

[Total : 5 m]

4 A piece of stiff cardboard is stuck to a plank of wood by means of two sticky-tape "hinges". This is shown in Fig. 4.1.

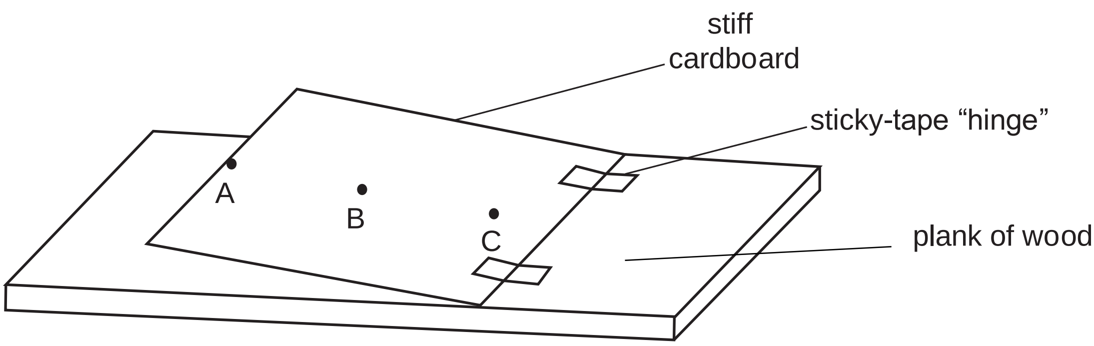


Fig. 4.1

(a) The cardboard is lifted as shown, using a force applied either at A or B or C.

(i) On Fig. 4.1, draw the force at the position where its value will be as small as possible. State the angle between the force and the cardboard. Indicate this angle clearly on Fig. 4.1.

Angle = ………………………… [1]

(ii) Explain why the position you have chosen in **(a)(i)** results in the smallest force.

....

....[1]

(b) Initially, the cardboard is flat on the plank of wood. A box of matches is placed on it. The cardboard is then slowly raised at the left hand edge, as shown in Fig. 4.2.

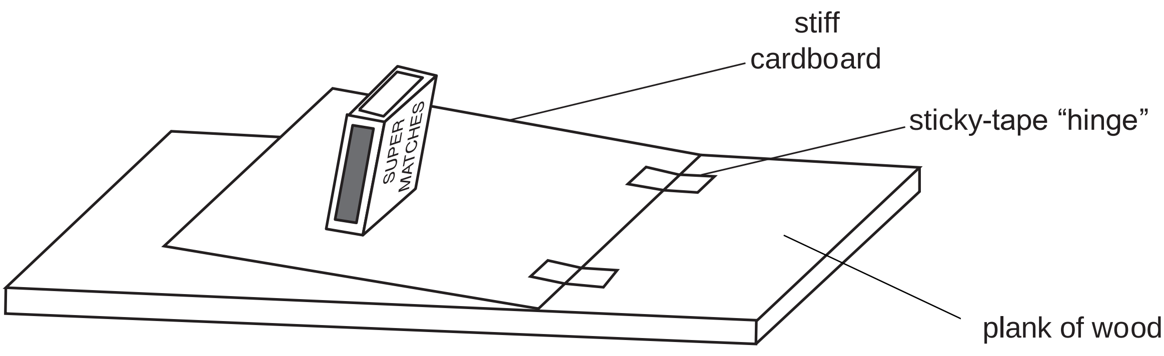


Fig. 4.2

By means of a labelled diagram, explain the position of the matchbox when it is about to topple.

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

....

……... [2]

(c) The box of matches is opened, as shown in Fig. 4.3. The procedure in **(b)** is repeated.

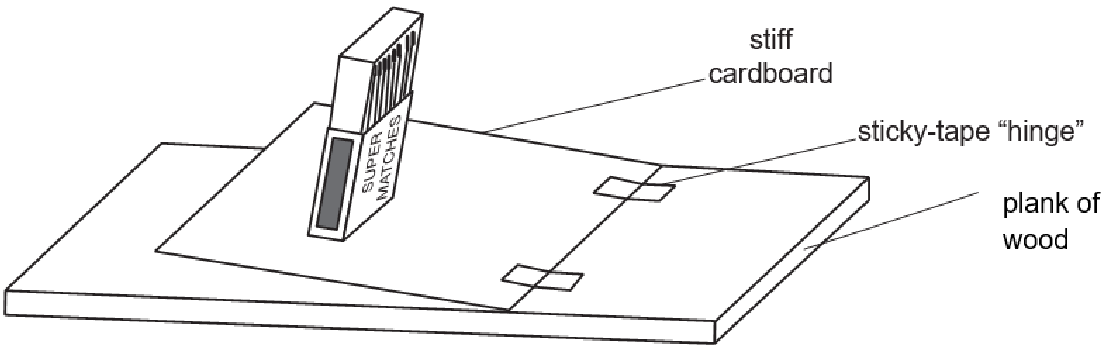


Fig. 4.3

Is the angle through which the cardboard can be lifted before the box of matches falls greater, the same or less than the angle before the box of matches falls in Fig. 4.2? Explain.

Angle is …....................... the angle before the box of matches falls in Fig. 4.2.

Explanation

....

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

[Total : 6 m]

5 A student uses a pump to inflate a bicycle tyre.

Fig. 5.1 shows the pump and the tyre.

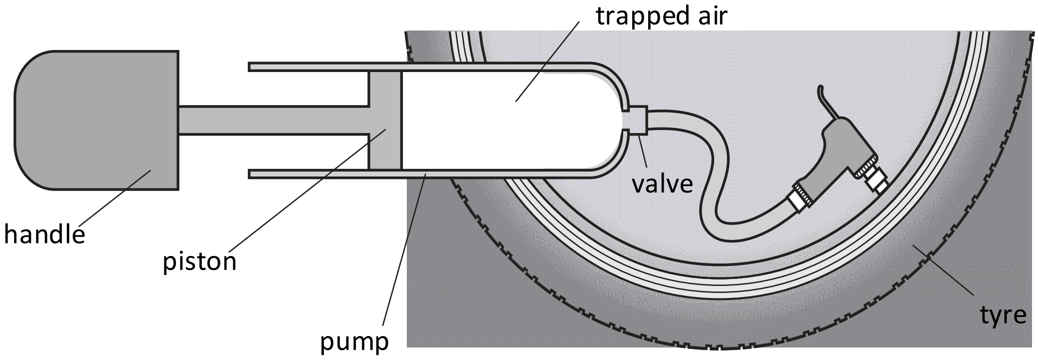


Fig. 5.1 (not to scale)

(a) The pressure of the trapped air in the pump is 3.8×10^5 Pa and the cross-sectional area of the piston is 6.1×10^{-4} m^2.

(i) Calculate the force exerted on the piston by the trapped air in the pump.

force = ... [2]

(ii) The student pushes the handle to the right and the piston forces the trapped air into the tyre. The force exerted by the student is less than the value in **(a)(i)**.

Suggest one reason why.

....

.... [1]

(b) The temperature of the air in the pump remains constant as the handle moves to the right.

Explain, in terms of its molecules, why the pressure of a gas increases when its volume is decreased at constant temperature.

....

....

....

.... [2]

[Total : 5 m]

6 Fig. 6.1 shows a hot water tank that contains two electric heaters X and Y.

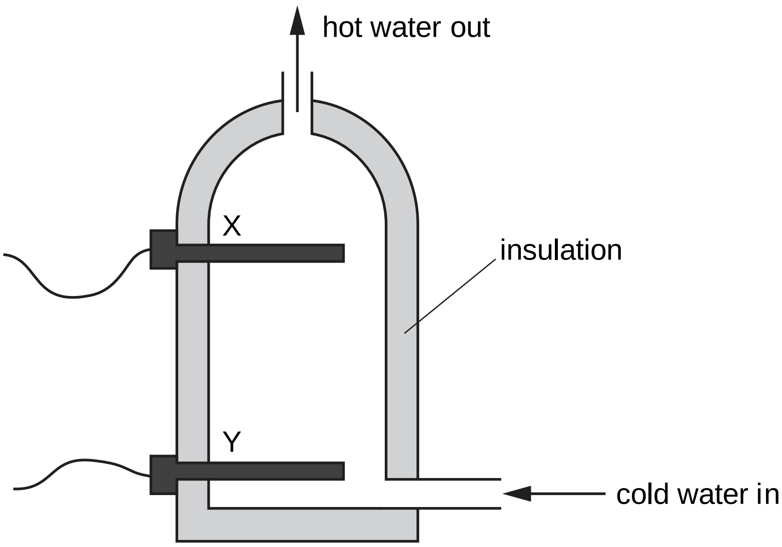


Fig. 6.1

Heater X is used during the daytime but heater Y is only used at night when electricity is cheaper.

(a) The tank is full of cold water and X is switched on.

The temperature of **all** the water above X increases very quickly but the temperature of the water below X increases much more slowly.

(i) Explain, in terms of molecules, how all the water above X increases in temperature quickly.

....

....

....

....

.... [3]

(ii) Heater Y remains switched off. Explain, in terms of molecules, why the temperature of the water below heater X increases much more slowly than the temperature of the water above heater X.

....

....

....

.... [2]

(b) The hot water tank is covered in a thick layer of insulating material. The material is a plastic that contains a large number of small pockets of trapped air.

Explain, in terms of molecules, why this material is a good insulator.

....

....

....

.... [2]

[Total : 7 m]

7 Fig. 7.1 shows a type of electric door lock.

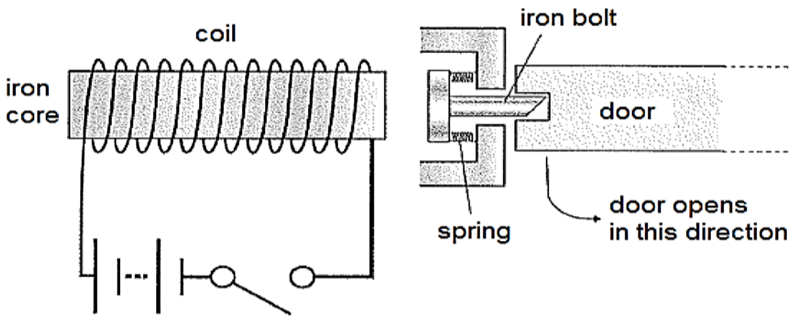


Fig. 7.1

The lock is closed when the position of the iron bolt is as shown in Fig. 7.1.

(a) Explain how closing the switch in the circuit allows the door to be opened.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(b) The door's iron bolt is changed and a thicker piece of iron is used. When the switch is closed, the lock remains closed.

(i) Without changing the bolt, suggest two changes that could be made in order to open the lock.

1 …………………………………………………………………………………

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

(ii) Explain one of the changes suggested in **(b)(i)**.

…………………………………………………………………………………

………………………………………………………………………………… [1]

(c) A student suggests removing the iron core. Explain how this affects the opening of the door.

…………………………………………………………………………………………..

…………………………………………………………………………………………...

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

[Total : 6 m]

8 One method of making sandpaper is by passing a roll of paper through nylon friction pads. An aerosol sprays positively charged fine droplets of glue onto the paper, spreading it evenly on the surface of the paper. The resulting sticky paper is then pressed over a flat table covered with sand grains.

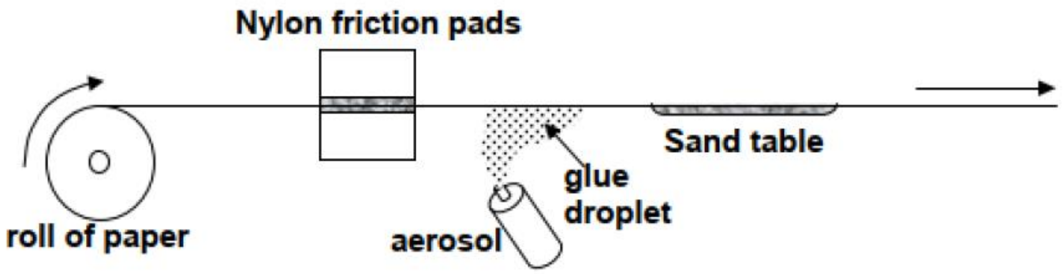


Fig. 8.1

(a) (i) Explain how the paper becomes negatively charged after it passes through the nylon friction pads.

……………………………………………………………………………………..

……………………………………………………………………………………..

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

(ii) Explain how this method allows the glue droplets to spread out and stick to the paper easily.

……………………………………………………………………………………..

……………………………………………………………………………………..

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

(b) Draw in Fig. 8.2 the electric field pattern between two identical glue droplets. [2]

Fig. 8.2

[Total : 6 m]

9 Fig. 9.1 below shows an a.c. generator being used to light a small filament bulb.

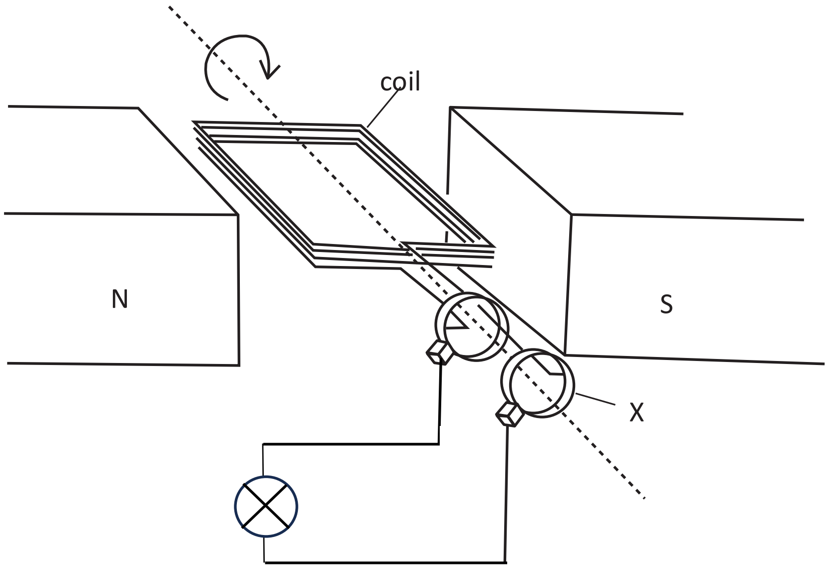


Fig. 9.1

When the coil is rotated slowly, the bulb blinks.

(a) Explain why the bulb blinks.

....

....

....

.... [2]

(b) State the purpose the component labelled X in Fig. 9.1.

....

.... [1]

(c) At the instant shown in the Fig. 9.1, indicate clearly

(i) the direction of the induced current in the coil and the external circuit. [1]

(ii) the direction of the forces on both sides of the coil due to the induced current in the coil. [1]

(d) Fig. 9.2 shows the variation of current flowing through the bulb as the generator coil is rotated at 20 Hz.

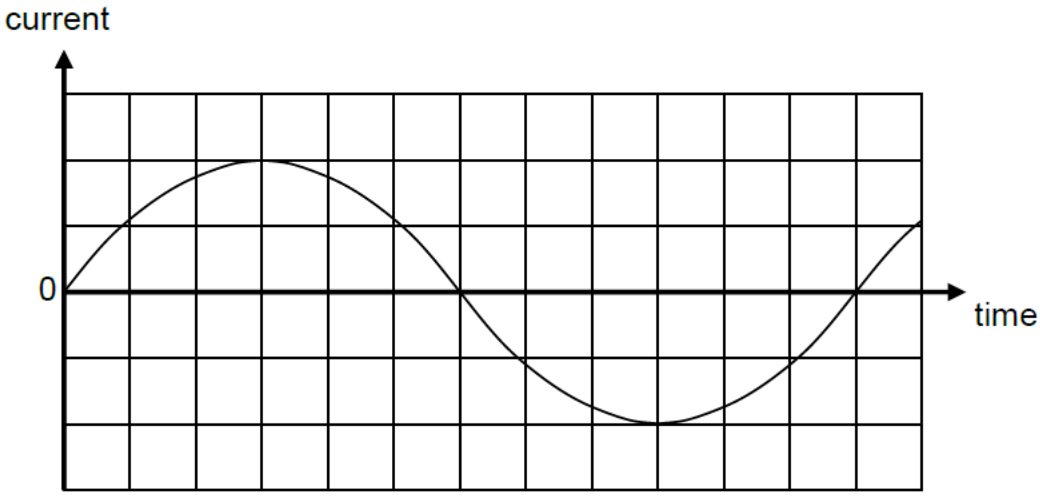


Fig. 9.2

On Fig. 9.2, draw the output from the same generator when the rate of rotation of the coil is increased to 30 Hz. [2]

[Total : 7 m]

10 (a) Both sound and ultrasound are longitudinal waves.

Describe what is meant by *longitudinal*.

....

....

.... [2]

(b) Fig. 10.1 shows an ultrasound cleaner being used to clean jewellery.

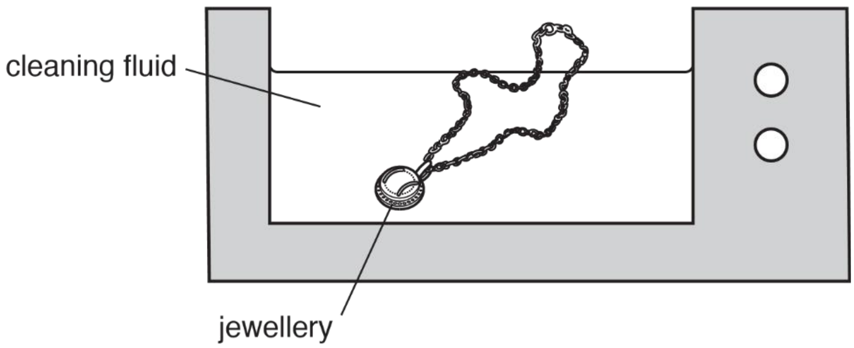


Fig. 10.1

The jewellery is lowered into the cleaning fluid and ultrasound waves of frequency 42 000 Hz are produced in the fluid.

(i) The speed of ultrasound in the fluid is 1500 m / s.

Calculate the wavelength of the ultrasound in the fluid.

wavelength = ... [2]

(ii) Describe how the ultrasound cleans the jewellery.

....

....

....

.... [2]

[Total : 6 m]

11 Radon-222 is an isotope of radon which undergoes a series of radioactive decays.

Fig. 11.1 is a diagram showing the proton number (atomic number) and nucleon number (mass number) of nuclei involved in the series of decays.

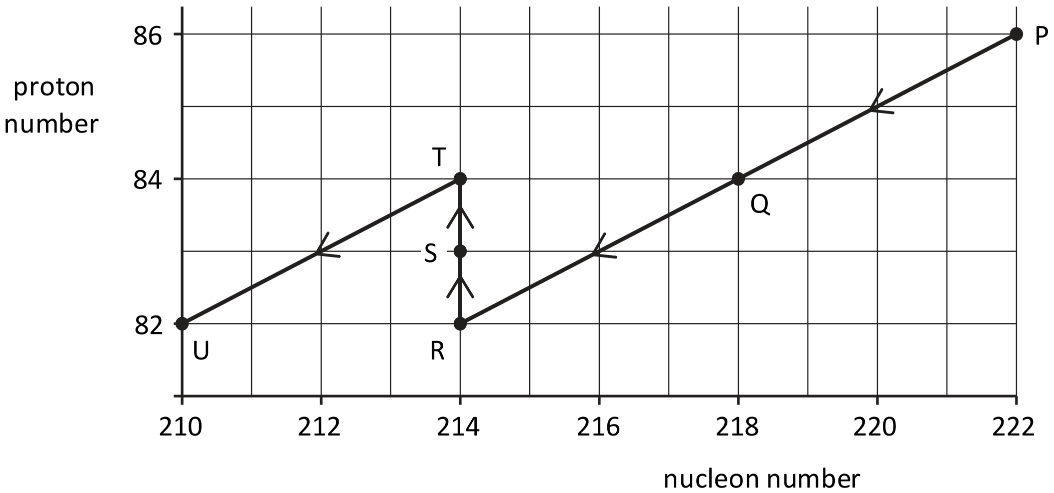


Fig. 11.1

The point P represents a nucleus of radon-222.

Starting at P, a nucleus of radon-222 decays to Q; then from Q to R; then from R to S; then from S to T; and finally from T to U.

(a) **(i)** State two points on Fig. 11.1 which represent isotopes of the same element.

.... [1]

(ii) Different isotopes of the same element have different atomic compositions.

State how the composition of their atoms is different.

....

.... [1]

(b) A nucleus of radon-222 emits an alpha-particle as it decays.

(i) The radioactive decay of a single nucleus is random.

Explain what is meant by the *random* radioactive decay of a nucleus.

....

....

.... [1]

(ii) When a nucleus of radon-222 emits an alpha-particle (α), it decays to an isotope of polonium (Po).

Complete the decay equation below for this decay.

.... Rn $\rightarrow$ .... Po + ... α

[2]

(c) **(i)** State the name of the particle emitted as a nucleus of R decays to a nucleus of S.

.... [1]

(ii) Describe the change in the composition of a nucleus of R as it decays to a nucleus of S.

....

....

....[1]

[Total : 7 m]

SECTION B

Answer ONE QUESTION ONLY.

EITHER

12 The variation with temperature of the resistance *R* of a thermistor is shown in Fig. 12.1.

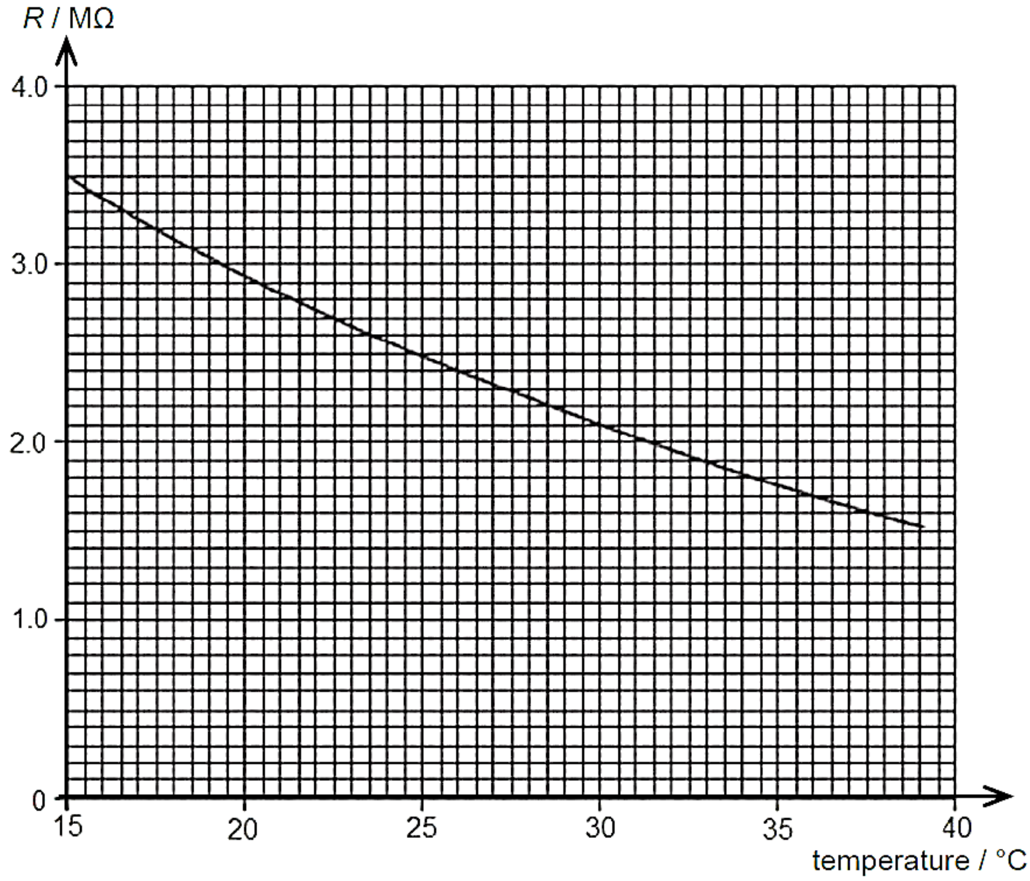


Fig. 12.1

Fig. 12.2 shows an electric circuit.

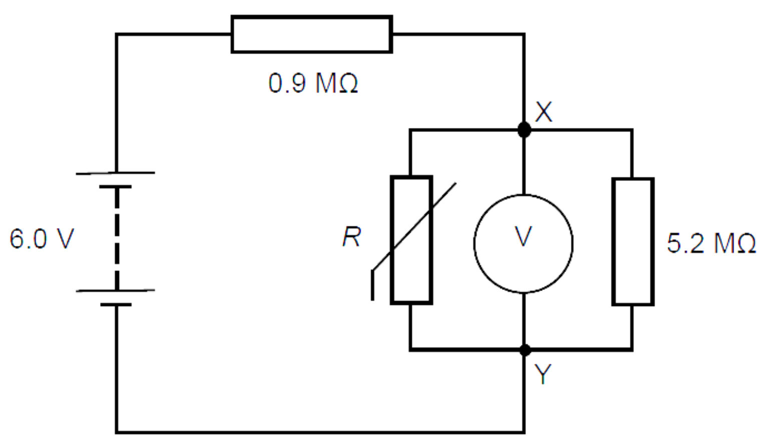


Fig. 12.2

The *electromotive force* of the battery is 6.0 V. The *potential difference* measured by the voltmeter is 4.0 V.

(a) Explain the difference between the words in italics.

……………………………………………………………………………………………

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

(b) Determine

(i) the total resistance between points X and Y,

total resistance = ……………….. [1]

(ii) the temperature of the thermistor using Fig. 12.1.

temperature of the thermistor = …………………… [3]

(c) Explain how the voltmeter reading varies when the temperature decreases.

………………………………………………………………………………………...

………………………………………………………………………………………...

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

(d) A lamp is rated at 50 W and is designed to be used with a 230 V supply.

(i) Calculate the resistance of the lamp.

Resistance of the lamp = ………………………… [1]

(ii) A room is lit by three of these lamps connected in parallel.

The lamps are lit for an average time of 3.6 hours a day for a year.
Electricity costs $0.29 / kWh.

Calculate the cost of using these lamps for a year.

Cost of using these lamps for a year = …………………………… [2]

[Total : 10 m]

OR

12 Fig. 12.3 shows a boiling liquid at its boiling point, trapped in a cylinder by a piston.

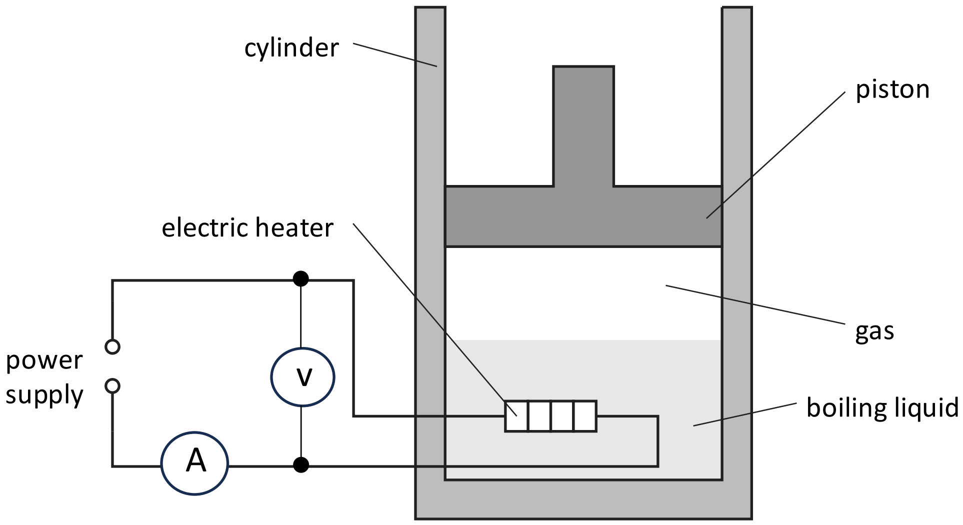


Fig. 12.3

There is an electric heater in the liquid which is connected to a power supply. The thermal energy produced by the heater gradually turns the boiling liquid into a gas.

(a) State what is meant by *boiling point*.

....

....[1]

(b) Explain, in terms of molecules, why it is necessary to supply energy in order to turn a liquid at its boiling point into a gas.

....

....

....

.... [2]

(c) The current in the heater is 2.0 A and the p.d. across it is 6.0 V.

(i) Calculate the power of the heater.

power = ... [1]

(ii) Calculate the thermal energy supplied to the liquid by the heater in 1.0 minute.

energy = ... [1]

(iii) The specific latent heat of vaporisation of the liquid is 9.0×10^5 J / kg.

Calculate the mass of liquid that vaporises every minute.

mass = ... [2]

(d) (i) The piston is free to move in the cylinder. As the liquid boils, the piston is pushed upwards in the cylinder at a constant speed. The volume occupied by the gas just above the liquid increases.

Discuss whether the upward force on the piston change as the piston moves upwards at a constant speed.

....

....

....

.... [2]

(ii) Explain, using ideas of molecules, how this upward force kept the piston moving upwards at a constant speed.

....

....

....[1]

END OF PAPER

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