| Class | Register Number | Name |
|---|---|---|
| | | |

南洋女子中學校

Nanyang Girls' High School

# End-of-Year Examination 2022
# Secondary 4

## PHYSICS
**Paper 2 Theory**

**1 hour 45 minutes**

**Tuesday 11 October** **1015 – 1200**

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 **11**, **12** and **13 Either** or **13 Or**.
Circle question **13 E** or **13 O** 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 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Section B | |
| 11 | |
| 12 | |
| 13 E | |
| 13 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 A bob of mass 2.0 kg is suspended by a string at P. The bob is pulled to one side by a horizontal spring balance, as shown in Fig. 1.1. The string is now inclined at 40° from the vertical.

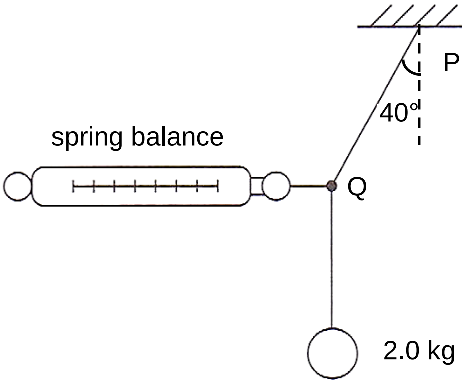


**Fig. 1.1**

**(a)** On Fig. 1.1, draw and label the direction of the tension acting at point Q along the string PQ. [1]

**(b)** In the space below, draw a scaled vector diagram to determine the magnitude of the tension in the string PQ. State the scale used.

scale ..............................

tension = .............................. [3]

**2** A uniform plank of length 2.00 m and mass 4.0 kg has markings at equal length intervals painted on it, as shown in Fig 2.1. The plank is supported by two trestles A and B, and a student of mass 52.0 kg stands on the plank.

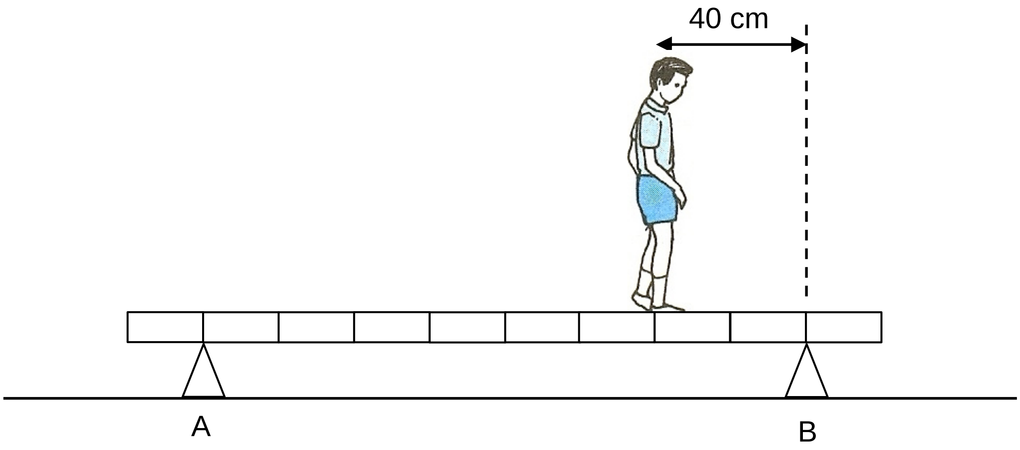


**Fig. 2.1**

**(a)** On Fig. 2.1, draw and label the weight of the plank. [1]

**(b)** Calculate the force exerted by trestle B on the plank.

force = ………………………… [2]

**(c)** Calculate the force exerted by trestle A on the plank.

force = ………………………… [1]

**[Turn over**

**3** A woman of mass 70 kg makes a bungee jump as shown in Fig. 3.1. She starts her jump from a bridge above a river. The unstretched length of the light elastic cord is 50 m. For this question, assume that air resistance and the height of the woman is negligible.

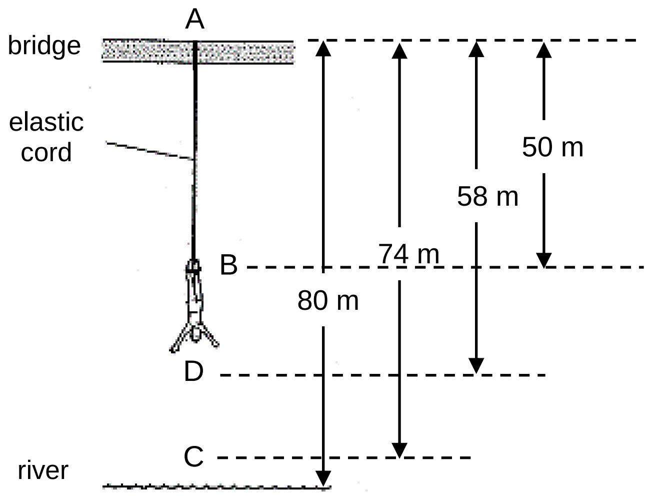


**Fig. 3.1 (not drawn to scale)**

At position A, she falls off the bridge from rest. From position B, the cord stretches. She comes to a momentary stop for the first time at position C before moving upwards. Position D is her final rest position.

**(a)** Determine her speed at position B.

speed = ………………………… [2]

**(b)** Determine the elastic potential energy of the cord when she is at position C.

energy = ………………………… [1]

**(c)** The elastic potential energy of the cord at position D is smaller than the value you have calculated in question **(b)**. Suggest a reason for this.

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

**4** Fig. 4.1 shows a partially inflated helium balloon leaving the ground to take scientific instruments high up in the atmosphere.

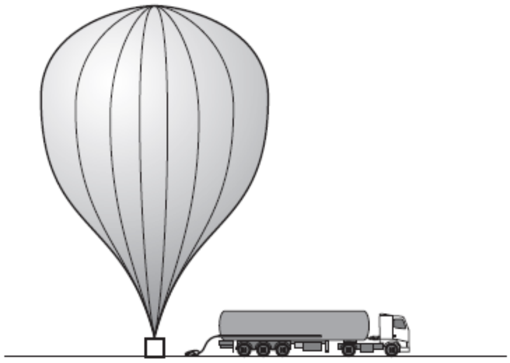

**Fig. 4.1**

A completely deflated balloon contains no gas. The helium to inflate it is stored in a very large cylinder at a pressure $3.0 \times 10^7$ Pa. Helium that occupies a volume of 20 $m^3$ in the cylinder is slowly released into the balloon until the pressure in the balloon is $1.0 \times 10^5$ Pa. The temperature of the helium remains constant. Assume the mass of the balloon to be negligible.

**(a)** Calculate the volume of the helium gas in the partially inflated balloon.

volume = ………………………… [2]

**(b)** As the partially inflated helium balloon rises up, the volume of the balloon increases due to lower atmospheric pressure at greater height. Assume the temperature of helium remains constant.

Applying the kinetic theory of matter and considering the helium molecules inside the balloon, explain why the pressure of the gas decreases as the balloon rises.

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

**5** Fig. 5.1 shows an object at O placed in front of a thin converging lens. The positions of the focal points of the lens are marked F.

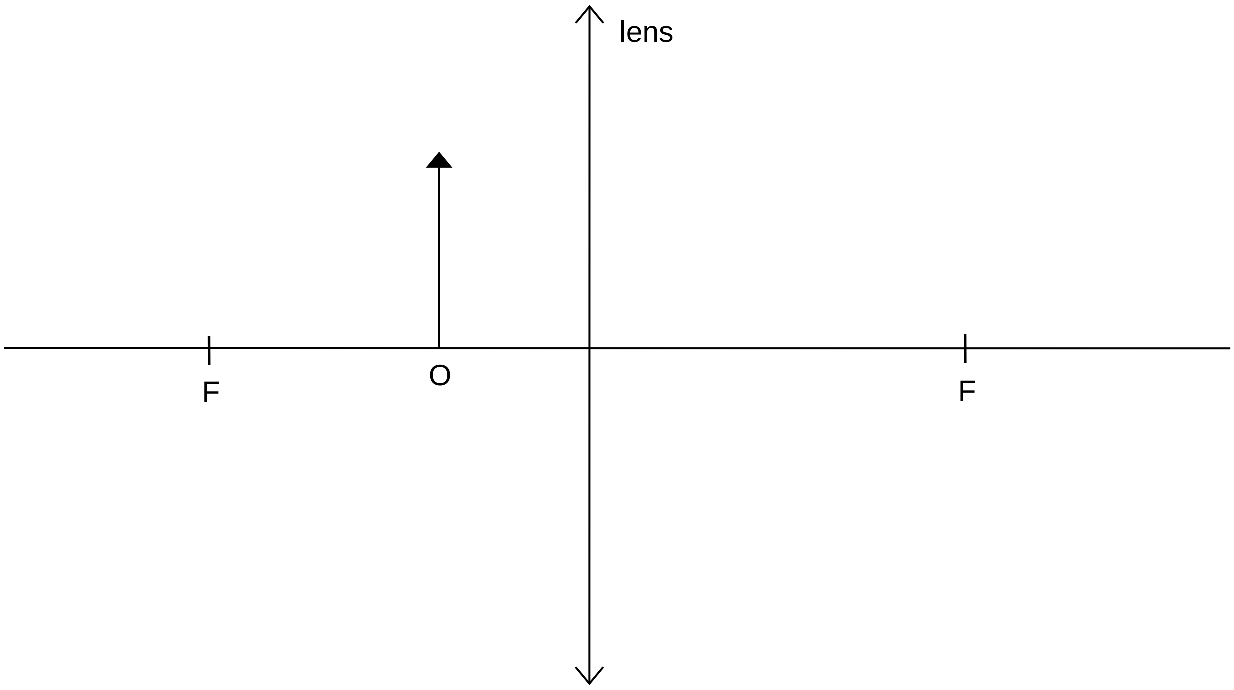


**Fig. 5.1**

**(a)** On Fig. 5.1, draw **two** rays from the tip of the object to find the position of its image. Label the foot of the image as **I**. [3]

**(b)** The lens is moved closer to the object. Describe one change to the image observed.

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

**6** A light uncharged conducting sphere R which is suspended on an insulating string is in contact with an uncharged metal sphere S. A positively charged sphere T is moved towards S as shown in the Fig. 6.1 below.

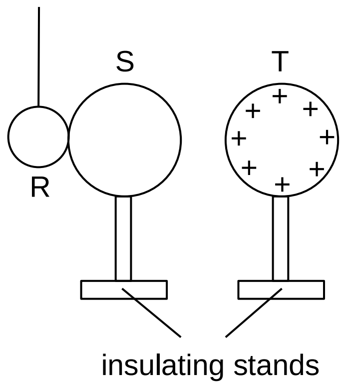


**Fig. 6.1**

**(a)** On Fig. 6.1, draw the charge distribution on R and S. [2]

**(b)** Sphere T is brought into contact with sphere S. Describe the movement of charges and explain what happens to sphere R.

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…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

**7** A resistance wire made from material X has a resistance of 5.0 Ω per metre.

**(a)** Determine the effective resistance when two pieces of wire made from material X, each 3.0 m long are connected in parallel.

effective resistance = ……………………… [2]

**(b)** If the diameter of the wire is 0.50 mm, calculate the resistivity of the material used to make the wire.

resistivity = ……………………… [2]

**[Turn over**

**8** Two lamps of ratings 30 W, 12 V and 50 W, 12 V are connected in series to a 12 V battery as shown in Fig 8.1.

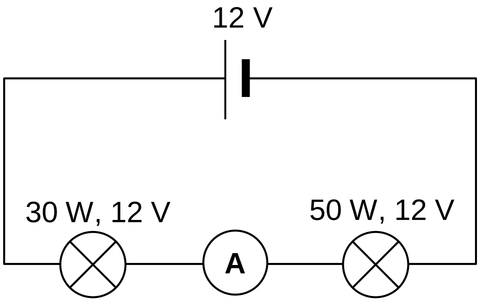


**Fig. 8.1**

**(a)** Explain why both lamps do not light up with normal brightness.

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...........................................................................................................

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

**(b)** Determine the current through the ammeter.

current = ..................... [2]

**(c)** Hence, or otherwise, determine the amount of electrical energy dissipated in the lamps if the above circuit is switched on for 5.0 minutes.

energy = ..................... [2]

**(d)** A rheostat is connected in parallel to the 50 W lamp.

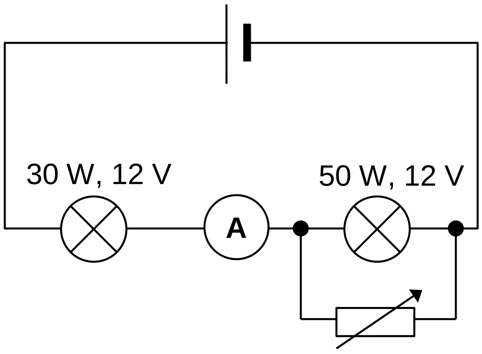


**Fig 8.2**

State what happens to the brightness of the 30 W lamp as the rheostat's resistance is reduced.

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

**9** Magnetic forces can be attractive or repulsive. When an unmagnetised iron pin is brought close to a permanent magnet, it is always attracted to the magnet. Explain why.

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

**10** Rice is a staple food eaten by Asians. In a family, 300 g of water is added to 200 g of rice for cooking in a 550 W rice cooker.

**(a)** Determine the time needed to raise the temperature of the rice and water mixture to 100 °C.
Assume the room temperature is 30 °C, the specific heat capacity of water is 4200 J $kg^{-1}$ $°C^{-1}$ and the specific heat capacity of the rice is 1000 J $kg^{-1}$ $°C^{-1}$.

time needed = ……………………….[2]

**(b)** State one assumption that you made when calculating your answer for **10(a)**.

…………………………………………………………………………………………………

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

**(c)** Suggest one way thermal energy can be transferred from the contents of the rice cooker to the environment if the lid of the rice cooker was accidentally left open.

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

## Section B

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

**11** A car in good condition is driven by an alert driver on a dry day at constant speed on a straight road. Upon becoming aware of a dangerous situation, the driver applies the brakes a short while later. After the brakes are applied, the car decelerates to a stop.

The performance of this car and the driver is tested for different initial speeds. The results of the tests are given in Fig. 11.1.

| Initial speed / m $s^{-1}$ | Reaction distance / m | Braking distance / m | Total distance / m |
|---|---|---|---|
| 5.0 | 4.0 | 2.1 | 6.1 |
| 10.0 | 8.0 | 8.3 | 16.3 |
| 15.0 | 12.0 | 19.0 | 31.0 |
| 20.0 | 16.0 | 33.0 | 49.0 |
| 25.0 | 20.0 | 52.0 | 72.0 |
| 30.0 | 24.0 | 75.0 | 99.0 |
| 35.0 | 28.0 | 102.0 | 130.0 |

**Fig. 11.1**

- Reaction time = time taken for the driver to become aware of a dangerous situation and apply the brakes
- Reaction distance = distance travelled by the car at constant speed during the driver's reaction time
- Braking time = time interval between the applying of brakes and the car coming to a stop
- Braking distance = distance travelled by the car after the brakes are applied

**(a)** The car has a mass of 1400 kg. Consider the case when the car was initially moving at 30.0 m $s^{-1}$.

**(i)** Calculate the reaction time of the test driver.

time = ………………………… [1]

**(ii)** Calculate the braking time for this car.

time = ………………………… [2]

**(iii)** Calculate the deceleration of the car.

deceleration = ………………………… [2]

**(iv)** Calculate the decelerating force on of the car when the car is braking.

force = ………………………… [1]

**(b)** Before the brakes are applied, the car moves at a constant speed even though the car's engine provides a forward driving force.

Compare the magnitudes of the resistive force and the forward driving force.

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

**(c)** The values in Fig. 11.1 show that the braking distance increases at an *increasing rate* with the initial speed of the car.

Suggest a reason for the above observation.

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

**(d)** The values in Fig. 11.1 were obtained from a car driven without any passenger and luggage.

Describe and explain how the braking distance would be affected if the car is carrying a full load of passengers and luggage.

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**12** A ripple tank has a lamp placed at the bottom, as shown in Fig. 12.1. At this instant, the water surface is level.

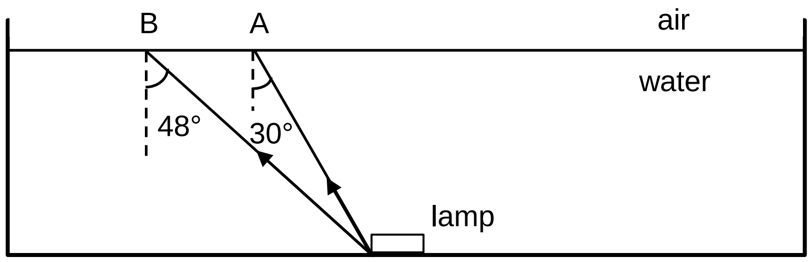


**Fig. 12.1 (not drawn to scale)**

**(a)** The critical angle for light travelling from water to air is 48°. Two rays from the lamp first strike the water surface at A and at B.

**(i)** Calculate the angle of refraction for the ray at A.

angle = ………………………… [2]

**(ii)** When viewed from above the tank, light from the lamp emerges only from a circular area on the water surface.

Explain why this happens.

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…………………………………………………………………………………………

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

**(b)** A straight rod connecting to a vibrating motor is placed on the water surface to produce plane waves. Fig. 12.2, drawn to scale, shows a side view of the waves produced at time $t$ = 0.0 s. It takes 4.0 s for the crest at C to reach E.

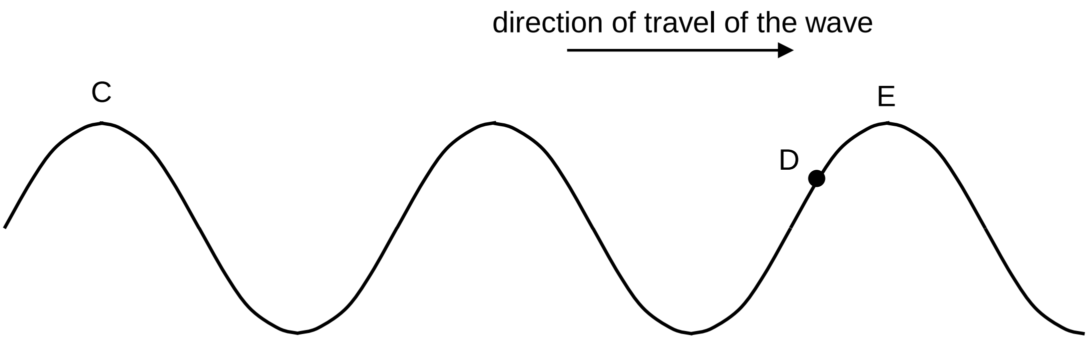


**Fig. 12.2 (drawn to scale)**

**(i)** Describe the movement of particle D for one complete cycle, starting from time $t$ = 0.0 s.

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……………………………………………………………………………………………

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

**(ii)** Determine the wavelength of this wave.

wavelength = ………………………… [1]

**(iii)** Determine the frequency of this wave.

frequency = ………………………… [1]

**(c)** A student demonstrates the sound produced by a tuning fork by connecting a microphone to a cathode-ray oscilloscope (c.r.o.) with the time-base switched on. The c.r.o. display is shown in Fig. 12.3.

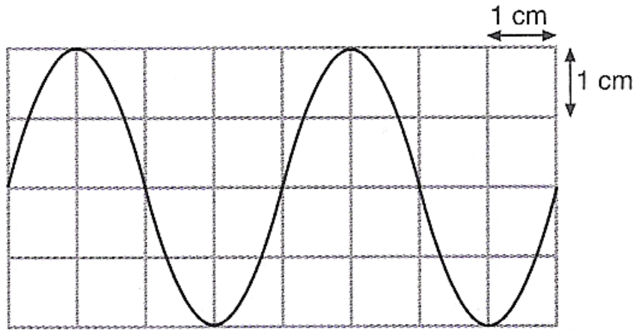


**Fig. 12.3 (not drawn to scale)**

Based on what she has learnt from Fig. 12.2 and what she now sees in Fig 12.3, she claims that the wavelength of this sound wave is 4 cm.

Explain why her claim is incorrect, and how this 4 cm measurement could be used to reveal another physical quantity related to that sound wave.

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

**13 EITHER**

Fig. 13.1 shows a d.c. motor connected to a battery and viewed by an observer at position P.

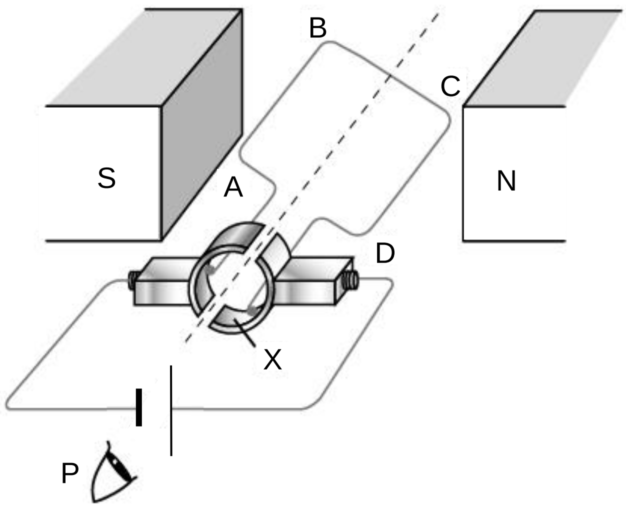


**Fig. 13.1**

**(a)** Determine the direction of rotation of the coil ABCD as viewed by the observer at P.

direction of rotation: ……………………….. [1]

**(b)** Name component X.

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

**(c)** State the function of component X.

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

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

**(d)** Suggest one modification to this d.c. motor to make coil ABCD spin faster.

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

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

**(e)** A student wants to study the electromotive force (e.m.f.) induced in the coil of wire as it rotates in the external magnetic field due to the magnets.

Describe clearly how she could modify the d.c. motor in Fig. 13.1 so that it becomes an a.c. generator which produces this e.m.f. as an output from the coil to be displayed on an oscilloscope (c.r.o.).

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

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

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

**(f)** After the student has done the correct modifications, the coil is rotated at a rate of 20 revolutions per second, and the output is displayed on a c.r.o. as shown in Fig. 13.2.

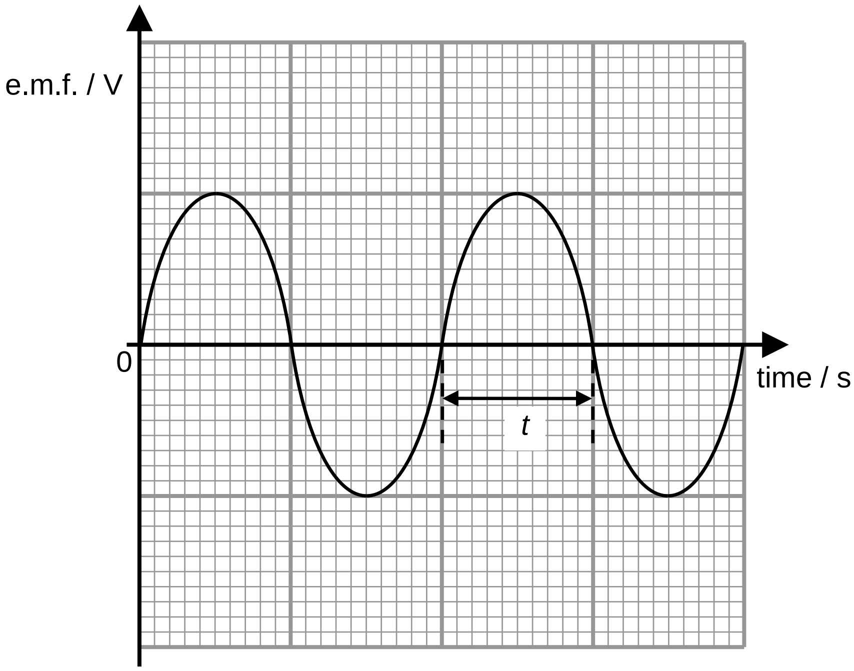


**Fig. 13.2**

**(i)** Determine the time interval *t* as shown in Fig. 13.2

time interval *t* = ……………………….. [2]

**(ii)** The speed of the coil is decreased to 10 revolutions per second. On Fig. 13.2, sketch the output as observed on the c.r.o.

[2]

**13** **OR**

**(a)** A solenoid made from thin wire, covered in plastic insulation is connected to a sensitive ammeter. Fig. 13.3 shows the N-pole of a steel magnet placed next to the solenoid. Point X and point Y are on the axis of the solenoid.

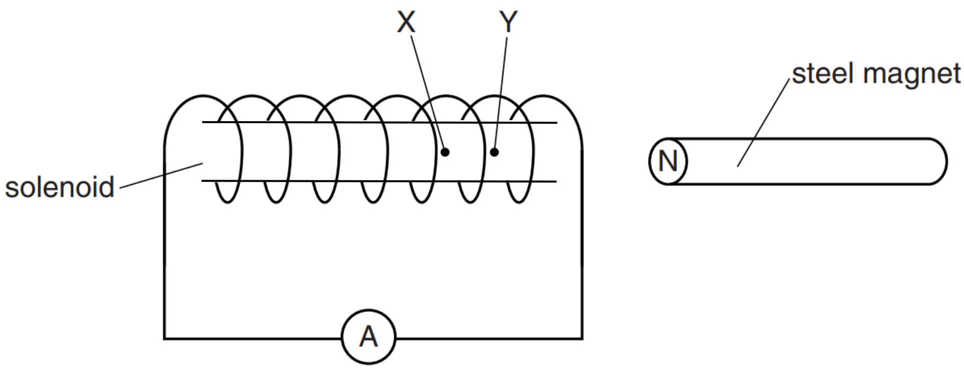


**Fig. 13.3**

In one experiment, the magnet in Fig. 13.3 is moved to the left and into the solenoid. The North pole of the magnet travels from Y to X at constant speed. As it moves, the ammeter shows a small deflection.

**(i)** Explain why there is a current in the solenoid when the magnet is moving.

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

**(ii)** On Fig. 13.3, indicate the direction of the current in the solenoid just before North-pole of the magnet enters the right end of the solenoid. [1]

**(iii)** As the North-pole of the magnet travels from Y to X in 0.16 s, the current shown on the ammeter is 0.055 mA. The charge carried by an electron is approximately $-1.6 \times 10^{-19}$ C.
Calculate the number of electrons passing through the solenoid as the North-pole of the magnet moves from Y to X.

number of electrons = ..................................[2]

**(b)** Fig 13.4 shows the basic structure of a transformer.

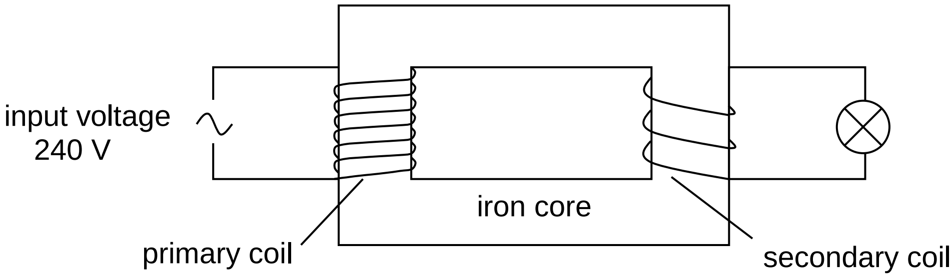


**Fig. 13.4**

An alternating voltage of 240 V is applied to the primary coil and a voltage is induced in the secondary coil.

**(i)** Explain why a direct current input cannot be used at the primary coil of the transformer.

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

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

**(ii)** The primary coil has 500 turns.

Determine the number of turns needed on the secondary coil to induce an output of 12.0 V.

number of turns = …………………………….[2]

**(iii)** The current in the secondary coil is 0.80 A.

Determine the current in the primary coil. Assume the transformer is 100% efficient.

current = …………………………….[2]

**END OF PAPER**

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