# TANJONG KATONG GIRLS' SCHOOL
# PRELIMINARY EXAMINATION
# SECONDARY FOUR EXPRESS

| | | | | | | |
|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | |
| CLASS | **4** | | | INDEX NUMBER | | |

## PHYSICS 6091/02

Paper 2

**14 August 2024**

**1 hour 45 minutes**

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

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

**Section A**
Answer **all** questions in the spaces provided.

**Section B**
Answer **one** question. Write your answers in the spaces provided.

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.

| For Examiner's Use | |
|---|---|
| **Section A** | |
| **Section B** | |
| **Total** | **/ 80** |

Setter : Mr Timothy Yeo

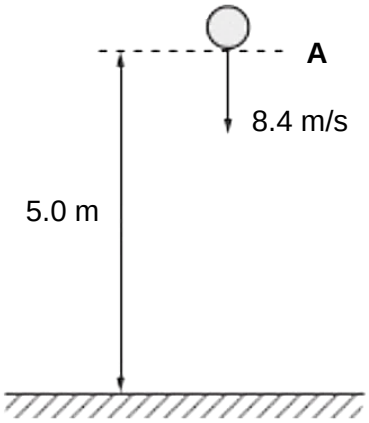
Markers : Ms Sultana Rahman, Mr Aloysius Goh, Mr David Chung

## Section A

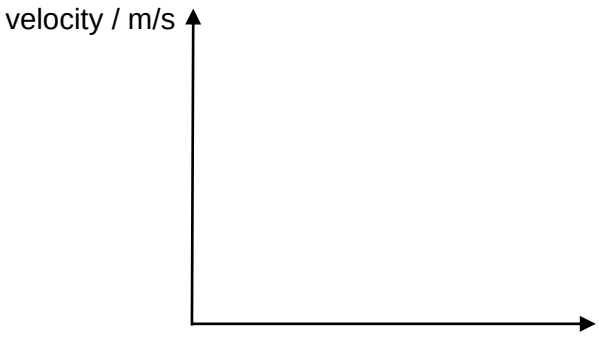
Answer **all** questions in this section in the spaces provided.

The total mark for this section is 70.

**1** A ball is thrown vertically down at a speed of 8.4 m/s from point **A** which is 5.0 m above the ground. Assuming that air resistance is negligible, the ball hits the ground at a speed of $v$ m/s after $t$ seconds.




**(a)** Sketch the velocity-time graph of the ball from the time it was thrown to when it hit the ground at $t$ seconds. Label all essential points.




[2]

**(b)** **(i)** Assuming acceleration due to gravity is 10 m/s$^2$, express $t$ in terms of $v$.

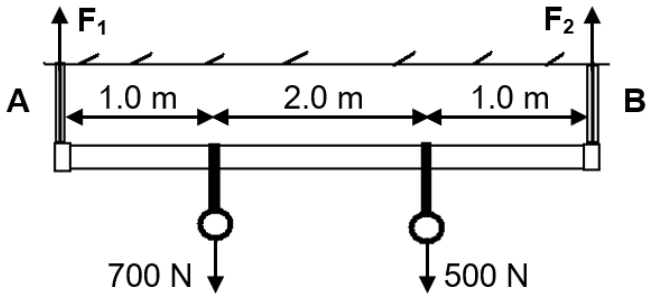
$t$ = ……[2]

**(ii)** Using your sketch in **(a)** and expression in **b(i)**, determine the speed, $v$ m/s, which the ball hits the ground.

$v$ = ..... [2]

[Total: 6]

**2** The diagram shows a section of a handrail attached to the ceiling of a train carriage. The handrail is light. A man and a lady hold onto the handles and exert downward forces of 700 N and 500 N respectively. The bar is held securely to the ceiling with supports **A** and **B**. The force acting on each support is $\mathbf{F_1}$ and $\mathbf{F_2}$ respectively.




**(a)** State the principle of moments.

……

……

……[2]

**(b)** **(i)** Taking moments about **A**, determine the value of $\mathbf{F_2}$.

$\mathbf{F_2}$ = …… [2]

**(ii)** Hence, find the value of $\mathbf{F_1}$.

$\mathbf{F_1}$ = …… [2]

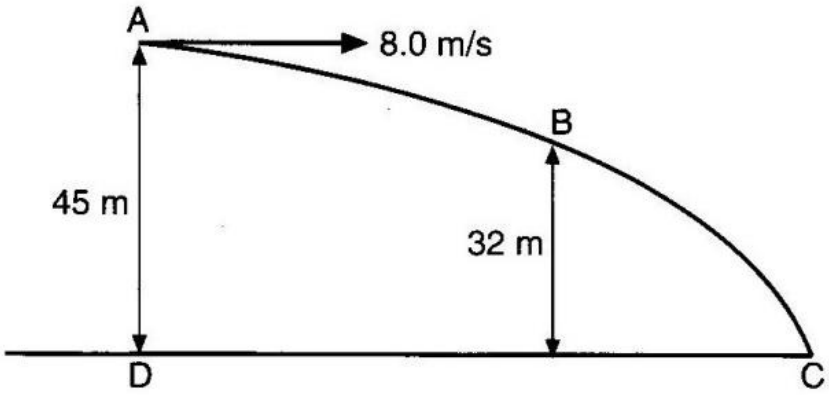
**(c)** A student boards the train and stands in between the man and lady. As there are only two handles, the student does not have any handle to hold onto.

Using your knowledge of stability, suggest one way how the student should stand on the train so that she does not fall over when it comes to a sudden stop at the next station.

……[1]

[Total: 7]

**3** A ball of mass 0.30 kg is projected horizontally with a speed of 8.0 m/s from the top of a building **AD** which is 45 m above the level ground **DC**. It moves in a parabolic path and hits the ground at **C**.




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

……

……

……[2]

**(b)** Calculate the energy of the ball at **A**.

energy = …… [2]

**(c)** Describe the energy transfer as the ball moves from **A** to **B**.

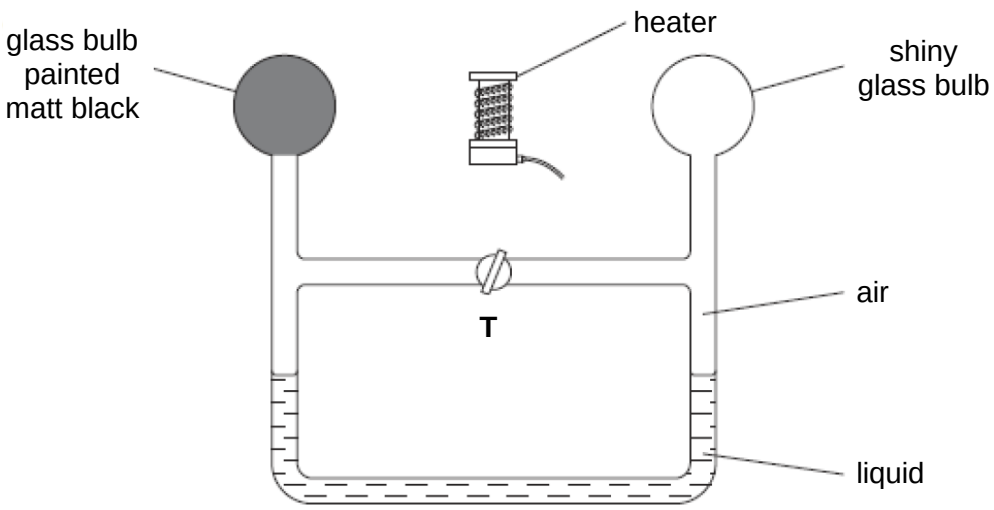
……

……

……[2]

[Total: 6]

**4** The figure shows a heater with two glass bulbs of different surfaces.




The heater is switched off at the start. Tap **T** is opened so that air on both sides of the thermometer have the same pressure. Tap **T** is then closed and the heater is switched on.

**(a)** On the figure, mark clearly the liquid levels on both sides of the thermometer after the heater has been switched on for a short time. [1]

**(b)** Explain your observation.

……

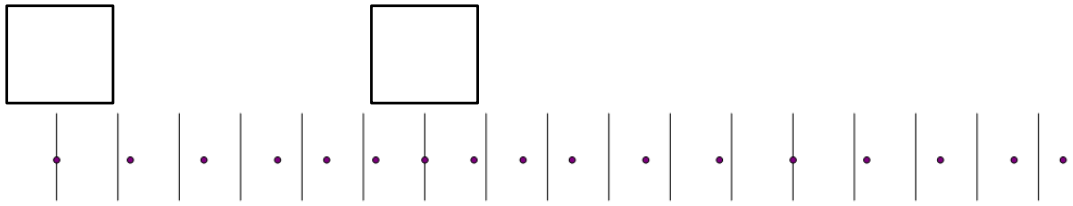
……

……

……...……...[3]

[Total: 4]

**5** The diagram, **drawn to scale**, shows the positions of particles at a particular instant when a longitudinal wave passes through. The dots represent the air particles and the lines represent the original undisturbed positions of the particles.



**(a)** **(i)** In the boxes provided, write down if the particle at that position is in a region of compression, **C**, or rarefaction, **R**. [1]

**(ii)** Mark on the figure the wavelength of the wave and label it as **λ**. [1]

**(iii)** State the magnitude of the wavelength.

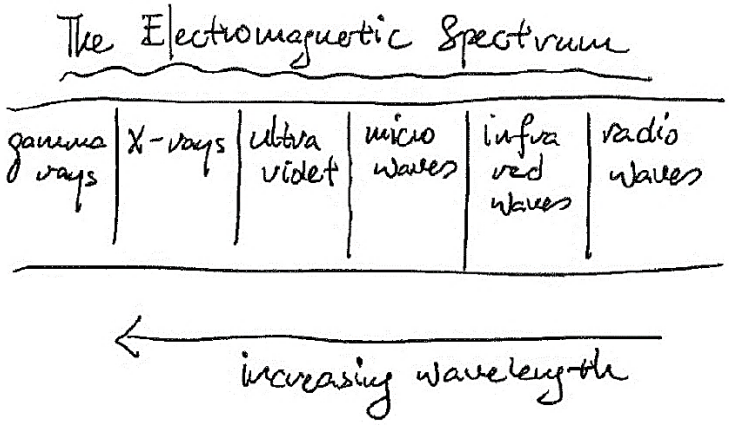
……..[1]

**(b)** Each particle oscillates 200 times per second about its original position. Calculate the speed of the longitudinal wave.

speed = …… [2]

[Total: 5]

**6** A page from a student's notebook is shown.




**(a)** Make corrections to two errors in the student's notes.

**1** ……..

**2** ……..[2]

**(b)** Describe the effect of extended gamma ray exposure on human cells.

……

……...……....[1]

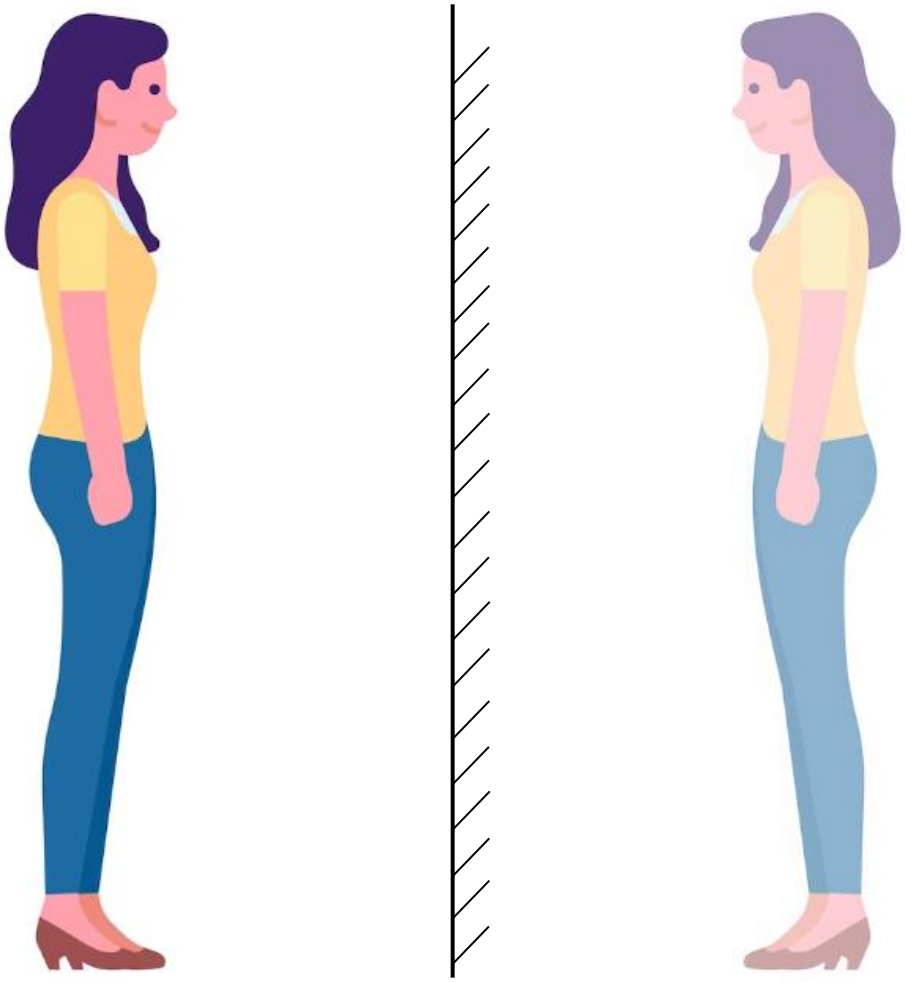
**(c)** State the changes, if any, to the speed and frequency of gamma rays when it penetrates the skin.

……

……...……....[2]

[Total: 5]

**7** A 1.60 m tall lady stands 0.50 m in front of a mirror to look at herself.



**(a)** Draw one light ray to show how the lady sees through the mirror

**(i)** the top of her head, and

**(ii)** her feet. [3]

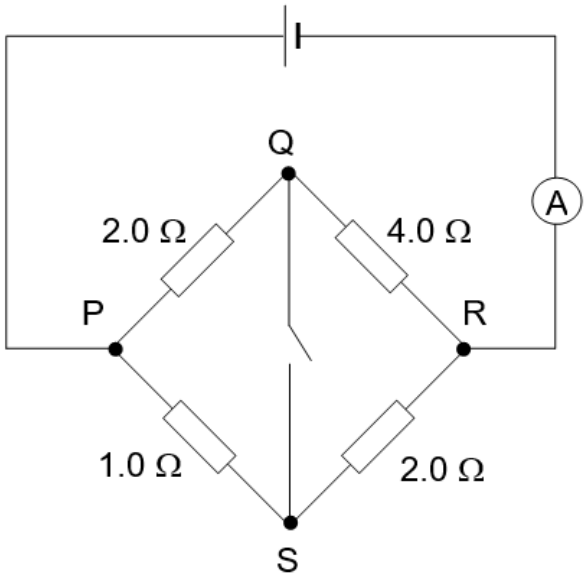
**(b)** Indicate on the diagram the minimum length of mirror, $l$, needed for the lady to see herself from the top of her head to her feet. [1]

**(c)** State two characteristics of the lady's image in the mirror.

……..……...[1]

[Total: 5]

**8** A circuit is connected to a battery of unknown e.m.f. The ammeter reads 3.0 A when the switch is opened.




**(a)** **(i)** Determine the e.m.f. of the battery.

e.m.f. = …… [2]

**(ii)** Calculate the current flowing in **PQR**.

current = …… [1]

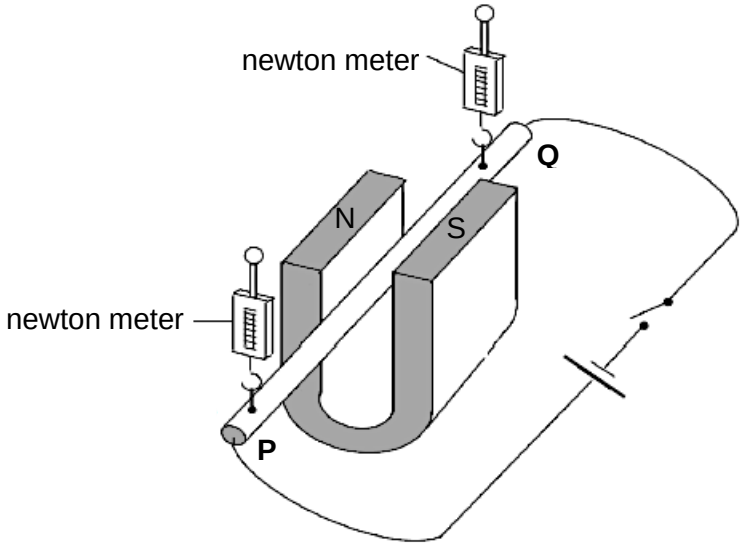
**(b)** The switch is now closed. State if current will flow along **QS**. Explain your answer.

……..……

……[2]

[Total: 5]

**9** A conducting rod **PQ** is suspended horizontally by two newton metres. The rod is placed inside the magnetic field of a U-shaped magnet.




**(a)** When the switch was closed, the readings on the newton meters changed.

State whether the readings on the newton meters increased or decreased. Explain your answer.

……

……

……

……

……[3]

**(b)** Describe how you can modify the set-up so that the change in the newton meter readings can be controlled.

……

……[2]

**(c)** If the battery is replaced by an a.c. source of frequency 0.50 Hz, describe the motion of the rod with respect to time when the switch is closed.

……

……[2]

[Total: 7]

**10** A manufacturing company melts aluminium rods in a furnace as part of its production process. Table 10.1 shows the specifications of the rods, and Table 10.2 shows how the temperature of the rods vary with time as they are placed in the furnace.

**Table 10.1**

| | |
|---|---|
| Dimensions (length x diameter) | 5.00 cm x 2.66 cm |
| Density of aluminium | 2.7 g/cm$^3$ |
| Specific heat capacity of aluminium | 880 J/kg°C |

**Table 10.2**

| Time / s | Temperature / °C |
|---|---|
| 0 | 0 |
| 200 | 240 |
| 400 | 460 |
| 600 | 650 |
| 800 | 650 |
| 1000 | 650 |
| 1200 | 920 |

**(a)** Calculate the mass of each aluminium rod. Leave your answer to the nearest gram.

mass = …… [2]

**(b)** Calculate the energy supplied to each rod between 0 s to 600 s.

energy supplied= …… [2]

**(c)** Using your understanding of the kinetic model of matter, describe the effect of heating on the amount of energy in the internal store of the aluminium rods from 600 – 1000 s.

……

……

……[2]

**(d)** The furnace has a power rating of 71.5 W. Given that the temperature of the aluminium rods only starts to increase after 1000 s, calculate the specific latent heat of fusion of aluminium.

specific latent heat of fusion = …… [2]

**(e)** An aluminium rod at 70 °C was taken out of the furnace and placed into 350 g of water to cool. The aluminium and water reached an equilibrium temperature of 30 °C.

Determine the initial temperature of the water, given that the specific heat capacity of water is 4200 J/kg°C.

initial temperature = …… [2]

[Total: 10]

**11** Carbon dating is a method used to estimate the age of organic matter. Living animals take in small amounts of carbon-14, a radioactive isotope of carbon, from their food. The amount of carbon-14 remaining in the bones of an animal's skeleton can be used to estimate its age.

Carbon-14 emits beta radiation and has a half-life of 5730 years.

**(a)** State what is meant by the following statements.

**(i)** Carbon-14 is an isotope of carbon.

……..

**(ii)** Carbon-14 has a half-life of 5730 years.

……..[2]

**(b)** Complete the decay equation for carbon-14.

$$^{14}_{6}\mathrm{C} = \,^{\cdots}_{\cdots}\mathrm{N} + \,^{\cdots}_{\cdots}e$$

[2]

**(c)** It is known that constant exposure to beta radiation is harmful to the body.

**(i)** Describe the effect of constant exposure to beta radiation on the human body.

……..

……..[1]

**(ii)** Write down one precaution that people working with beta radiation should take to reduce the risk to their health.

……..[1]

**(d)** A bone taken from an archaeological site was found to contain 5 units of carbon-14. An identical bone in a living animal contains 80 units of carbon-14. Determine the age of the bone.

age of bone = …… [2]

**(e)** A student reads about the archaeological finding on the news, and she concludes that the sediment that was built up on top of the bone over the years exerted pressure on the bone which in turn affected the nuclear decay.

Explain if you agree with the student.

……

……[2]

[Total: 10]

## Section B

Answer **one** question from this section in the spaces provided.

**12 (a)** A 750 g fish hanging from a spring balance is attached to the ceiling of a lift as shown in Fig 12.1. The reading on the spring balance is equal to the tension acting on the fish.

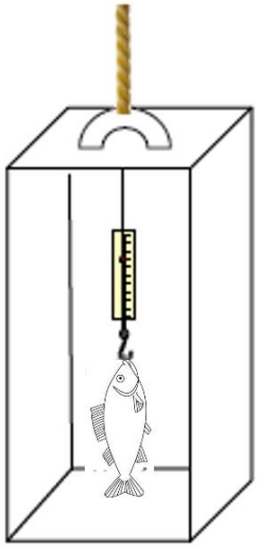


**Fig 12.1**

**(i)** Draw a free body diagram of the fish and label all forces acting on it.

[1]

**(ii)** State the reading on the spring balance when the lift is stationary.

……..[1]

**(iii)** Calculate the reading on the spring balance when the lift is accelerating up at 1.5 $m/s^2$.

reading = …… [2]

**(b)** An application of electromagnetic induction can be found in electric guitars. They sense vibrations in the steel strings using electric "pickups" which send electrical signals to the amplifier. Fig 12.1 shows the side view of a "pickup".

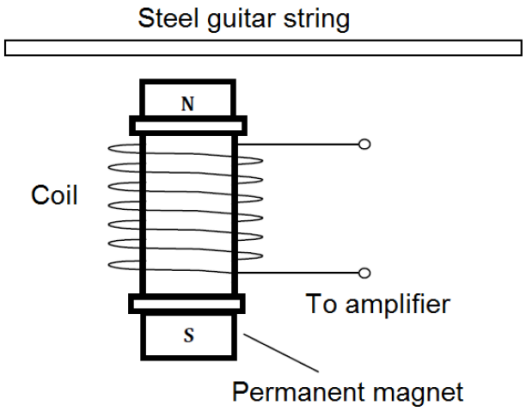



**Fig 12.1**

**(i)** On Fig 12.1, indicate the induced polarity on the side of the guitar string that is nearest to the permanent magnet. [1]

**(ii)** Using the idea of induced polarity in **(b)(i)**, explain how a current can be produced in the coil when the string vibrates.

……..

……..

……..

……..

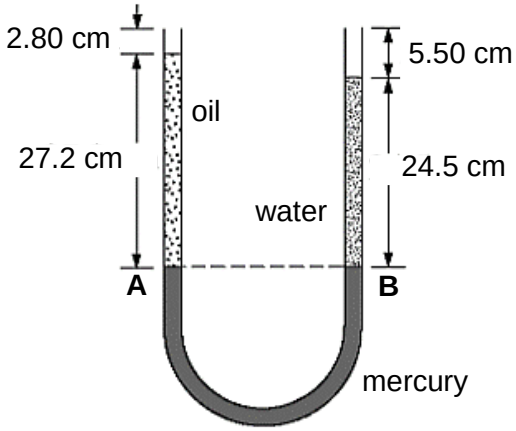
……..[4]

**(iii)** Suggest how the strength of the electrical signal can be increased without changing the strength of the magnet.

……..[1]

[Total: 10]

**13** **(a)** A U-tube glass with uniform cross sectional area of 0.80 $cm^2$ is used to determine the density of oil. The density of mercury and water are 13600 $kg/m^3$ and 1000 $kg/m^3$ respectively. The atmospheric pressure is taken to be 101000 Pa.



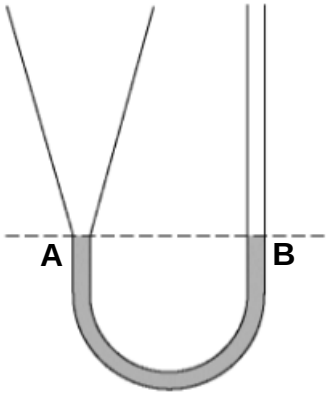

**(i)** Calculate the density of oil.

density = ..... [2]

**(ii)** Calculate the pressure at **B**.

pressure = ..... [1]

**(iii)** Another tube, identical to the U-tube except for a cone-shaped opening on the left, is filled with the same volume of mercury as in the previous set-up.




Oil and water are poured respectively into the left and right sides of the tube. The volume of water that is poured into this set-up is exactly the same as the previous one.

State and explain if the height of the oil in this set-up will be *equal, less than or greater than* the previous one in order to maintain the height of the mercury at **A** and **B**.

……..

……..

……..[2]

**(b)** When a negatively charged metal sphere with an insulated handle was brought near to an uncharged metal plate, the galvanometer showed a momentary deflection.

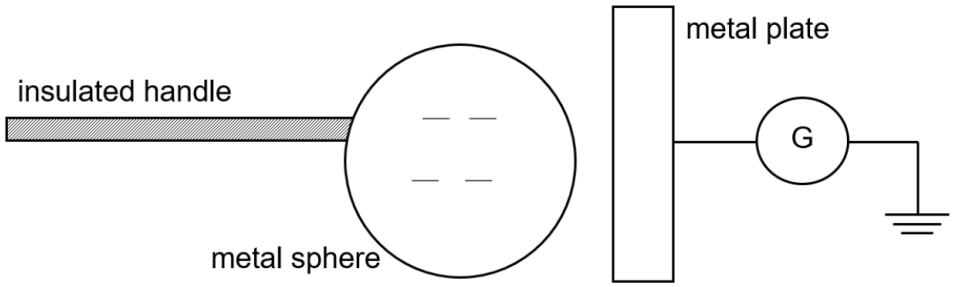



**Fig 13.1**

**(i)** Explain why there was a momentary deflection in the galvanometer when the metal sphere was brought near to the metal plate.

……..

……..

……..[2]

**(ii)** On Fig 13.1, draw the distribution of the charges on the metal plate after the deflection in the galvanometer. [1]

**(iii)** State and explain what will happen to the galvanometer if the metal sphere was held directly in a person's hand instead and brought near to the metal plate.

……..

……..

……..[2]

**-- END OF PAPER --**