# SIR ARTHUR LEWIS COMMUNITY COLLEGE

## ACADEMIC YEAR (2024/2025) – SEMESTER ONE

## END OF SEMESTER EXAMINATION

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|---|---|---|
| *COURSE CODE* | : | **PHY108** |
| *COURSE TITLE* | : | **Mechanics & Thermal Properties of Matter I** |
| *LECTURER(S)* | : | **Alexander Daniel** |
| *DATE* | : | **19th December 2024** |
| *TIME* | : | **1 p.m. – 3 p.m.** |
| *DURATION* | : | **2 Hours** |
| *STUDENT ID #* | : | _____ |

## GENERAL INFORMATION AND INSTRUCTIONS

- Students must sign **IN** and **OUT** on the examination class list.
- Write your ID number on the question paper.
- This paper has seven Questions.
- Answer a total of FIVE (5) questions, question 1 and any four (4) others.

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO**

Instructions: This paper has seven Questions. Answer a total of FIVE (5) questions, question 1 and any four (4) others.

1. (a) Why is the triple point of water used in the thermodynamic scale of temperature instead of the ice point? [2]

(b) The following readings were taken from a constant pressure gas thermometer in order to find a thermodynamic temperature T.

| Readings at temperature $T$ | | Readings at the triple point of water, $T_{Tr}$ | |
|---|---|---|---|
| Pressure, $P$ / Pa | Volume, $V$ / $c\text{m}^3$ | Pressure, $P$ / Pa | Volume $V$ / $c\text{m}^3$ |
| 100 000 | 503.30 | 100 000 | 398.53 |
| 50 000 | 1006.20 | 50 000 | 798.19 |
| 10 000 | 5031.50 | 10 000 | 3997.20 |

(i) Calculate the values of $\frac{(pV_T)}{(pV_{Tr})}$ for each of the three pressures in the table. [3]

(ii) Plot a graph of $\frac{(pV_T)}{(pV_{Tr})}$ against pressure for the readings of the gas. [4]

(iii) Use the graph to determine the thermodynamic temperature *T*. [4]

(c) What is the value of the temperature T on the Celsius scale? [2]

**Total = 15 marks**

2. (a) Define pressure. [2]

(b) State the SI base unit of

(i) volume, [1]

(ii) pressure. [2]

(c) The volume, V, of liquid that flows through a pipe in time, *t* is given by the equation, $\frac{V}{t} = \frac{\pi P r^4}{8Cl}$

where *P* is the pressure difference between the ends of the pipe of radius *r* and length *l*. The constant *C*, depends on the frictional effect of the liquid.

Determine the base unit of *C*. [5]

**Total = 10 marks**

3. (a) An athlete completes a 300 m lap round a track in 33.18 s. Determine:

(i) the average speed of the athlete, [1]

(ii) the average velocity of the athlete. [1]

(b) A boy jumps off a flat roof that is 2.4 m high. The initial velocity of the boy is 1.7 $\text{ms}^{-1}$ at an angle of 25° above the horizontal.

(i) State the horizontal and vertical components of the velocity. [2]

(ii) Calculate the time taken for the boy to reach the ground. [4]

(iii) How far horizontally from the truck does the boy land? [2]

**Total = 10 marks**

4. (a) State the principle of conservation of linear momentum. [2]

(b) A proton of mass $1.6 \times 10^{-27}$ kg is travelling with a velocity of $3.0 \times 10^{7}$ $ms^{-1}$ collides with a nucleus of an oxygen atom of mass $2.56 \times 10^{-26}$ kg (which may be assumed to be at rest initially). After the impact, the proton rebounds in the opposite direction with a velocity of $5.0 \times 10^{7}$ $ms^{-1}$.

(i) Determine the velocity of the nucleus after the impact. [4]

(ii) Make further calculations to determine whether the collision is elastic or not. [4]

**Total = 10 marks**

5. (a) State the conditions necessary for a body to be in equilibrium. [3]

(b) A block weighing 150 N hangs from a cord. It is pulled aside, as shown in figure 4, by a horizontal force F. Find the tension in the cord and the magnitude of F.

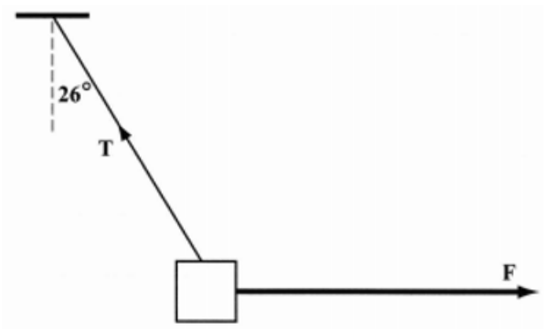


Figure 4 [7]

6. (a) An experiment is performed using the apparatus in Figure 1. A small disc of mass *m* on a frictionless table is attached to one end of a string. The string passes through a hole in the table and an attached narrow, vertical plastic tube. A disc of mass *M* is hung at the other end of the string. One student holding the tube makes the disc rotate in a horizontal circle of constant radius *r*, while another student measures the period *T*.

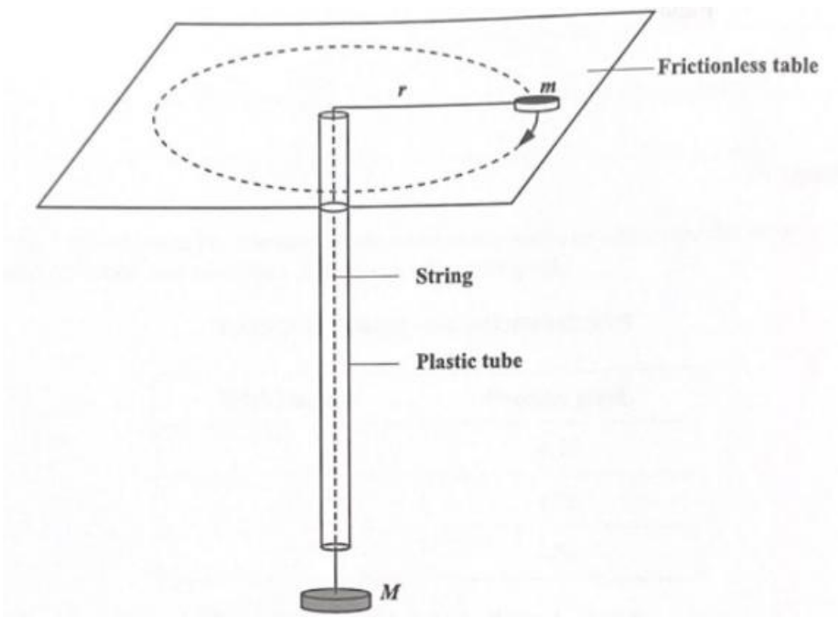


Figure 1. Experimental set-up

(i) State the TWO conditions that must be satisfied if a body is moving with uniform circular motion. [2]

(ii) Show that the relationship between the period, *T*, the radius *r*, and the masses, *m* and *M*, is given by the equation $T = 2\pi\sqrt{\frac{mr}{Mg}}$ [4]

(b) A rock of mass 140 kg rests on the surface of a planet of diameter $6.79 \times 10^6$ and a mass of $6.42 \times 10^{23}$ kg. What is the weight of the rock on the surface of the planet? [4]

**Total = 10 marks**

7. (a) Explain why the thermal conductivity in metal solids are usually much greater than the thermal conductivity of other solids. [3]

(b) Estimate the rate at which heat is radiated from the skin, if the skin's surface temperature is 37 ° C, the surface area is 0.40 $m^2$ and the emissivity 0.75. [7]