00444

The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc / B. Ed Degree Programme

Department	: Physics
Level	: 03
Name of the Examination	: Final Examination
Course Code and Title	: **PHU3300 - General and Thermal Physics**
Academic Year	: 2023/2024
Date	: 2023-10-13
Time	: 9.30 am – 11.30 am
Duration	: 02 hours

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 06 questions in 04 pages.
3. Answer any **04** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Draw fully labelled diagrams where necessary.
6. Relevant log tables are provided where necessary.
7. Having any unauthorized documents/ mobile phones in your possession is a punishable offense.
8. Use blue or black ink to answer the questions.
9. Circle the number of the questions you answered in the front cover of your answer script.
10. Clearly state your index number in your answer script.

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Department of Physics
The Open University of Sri Lanka
Bachelor of Science Degree Program
Level 3
PHU3300- General and Thermal Physics
Final Examination – 2023/2024

Duration - two hours (2 hrs.)

Date: 13.10.2023 **Time: 9.30am - 11.30am**

ANSWER FOUR QUESTIONS ONLY

1.(a) A student is asked to determine the coefficient of viscosity of an oil at room temperature by dropping a steel ball into a long cylinder filled with the oil. The student used the following expression to determine the coefficient of viscosity of oil when it is moving in the oil.

$$V = \frac{2r^2}{9\eta}(\rho_b - \rho_o)g$$

Derive the above expression and name the symbols in the expression. **(5 Marks)**

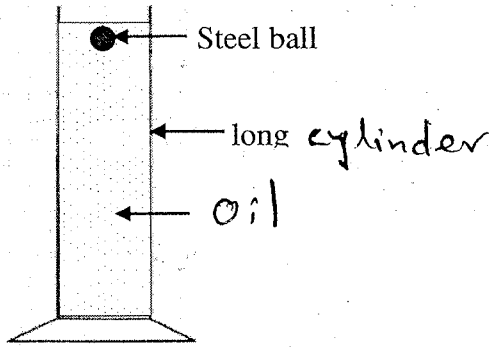

Figure 01

(i) Experimental setup is shown in the figure 01 to determine viscosity of the oil in the laboratory. Write down an experimental procedure to determine viscosity of the oil in the laboratory using he graphical method and you should include the following points to your answer.

(10 Marks)

- List any additional **apparatus** required,(stating the quantities to be measured)
- Explanation about selection of measuring instrument for **two** of these quantities
- **Independent and dependent** variables
- Explain how the data collected will be used to find the viscosity
- Write down the few details about an **error evaluation.**

(b) (i) Write down the Newtons law of viscosity. **(4 Marks)**

(ii)A viscos medium with coefficient of viscosity 0.85 Nsm^{-2} is inserted between two rectangular plates separated by 0.6 mm and cross-sectional area $15x10^4$ mm^2. Calculate the viscous force to move the top plate with a velocity of 1.2 ms^{-1}. **(6 Marks)**

2. (a) (i) Define coefficient of surface tension of a liquid and discuss the molecular theory of surface tension. **(4 Marks)**

(ii)What do you understand by angle of contact of the liquid? On what factors does it depend? **(4 Marks)**

(iii) Explain the relationship between the surface energy and coefficient of surface tension of liquid. **(4 Marks)**

(b) A U-shaped frame consists of a sliding rod connecting its two arms (Figure 2). It is dipped in a soap solution and then placed horizontally. The mass of the sliding rod is 100 g. The coefficient of surface tension of soap solution (T) is 0.05 Nm^{-1} & length of sliding rod is 20 cm. If the sliding rod starts from rest at t = 0, find the velocity of rod when t = 5 s. Assume that there are no frictional forces.

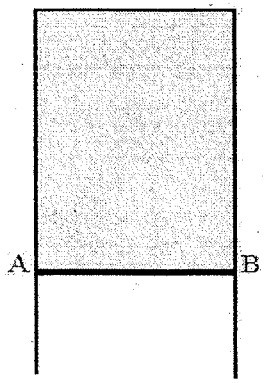

Figure 2 **(7 Marks)**

(c) A square shape glass plate of 10 cm long and 1mm thick is suspended vertically with the lower edge horizontal on one arm of a balance and counterpoised so that the beam is horizontal. When the glass is allowed to touch the surface of a soap solution, an additional mass of 0.72 g must be added to the other pan to keep the beam horizontal. Find the surface tension of the liquid. ($g = 9.8\ m\ s^{-2}$) **(6 marks)**

3. (a) State and Explain Hooke's law of elasticity. **(4 Marks)**

(b) Explain the properties of (i) elasticity of materials and (ii) plasticity of materials. **(4 Marks)**

(c)A rope climber of mass 100 kg has a rope of length 3m and 2 cm in diameter attached to him for safety. The other end of the rope is attached to a ridge on rock face and the climber can be treated like a point mass.

The climber falls freely vertically downwards until the rope is stretched as shown in figure 3. The potential energy is stored in the rope as the rope extends to a maximum of 1.5 mm.
By considering the energy converted to other forms is negligible, complete Parts (i) to (iv) using maximum extension of the rope.

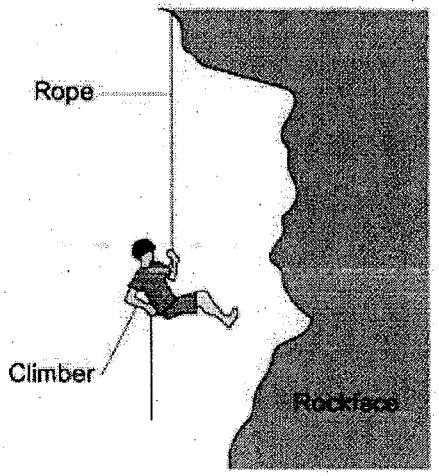

Figure 3

(i) Derive an expression for energy stored in the sting with the extension (e). **(4 Marks)**
Calculate
(ii) the tension of the rope. **(3 Marks)**
(iii) the stress of the rope. **(4 Marks)**
(iv) the Strain of the rope. **(3 Marks)**
(v) Hence calculate the Young's modulus of the material of the rope. **(3 Marks)**

4. (a) (i) What is the equation of continuity of fluid ? **(4 Marks)**

(ii)Water flows through a pipe of an internal diameter of 20 cm at the speed of 1m s^{-1}. What should be the diameter of the nozzle if the water is to emerge at the speed of 4m s^{-1}? **(6 Marks)**

(b) (i)Write down Bernoulli's Principle of fluid dynamics? **(4 Marks)**

(ii) Describe two practical applications of Bernoulli's principle. **(4 Marks)**

(iii) Air is streaming over horizontal wings of an airplane such that its speed is 120 ms^{-1} at the upper surface and 90 ms^{-1} at the lower surface. If the wing is 10 m long and 2 m wide and density of air is 1.3 kgm^{-3}. Determine dynamic lift excreted on wings (in Newton) .

(7 Marks)

5. Write down Kepler's laws of planetary motion around the sun. **(6 Marks)**

(a) A planet of mass **m** is in a circular orbit around a star of mass **M**. Use the equation of Newton's law of gravitation and your knowledge of circular motion to show that the relationship between the orbital period T of the planet and its orbital radius r is, $T^2 \alpha r^3$. **(4 Marks)**

(b) A satellite moves in a circular orbit of radius $16x\ 10^3$ km from the center of the Earth. The radius of the earth = 6400 km and gravitational field intensity on the earth surface is 10 ms^{-2}.

(i) State one of the main benefits of satellites on mankind. **(2 Marks)**

(ii) Calculate the gravitational field strength g at the radius of $16x10^3$ km **(4 Marks)**

(iii) Calculate the period of the orbiting satellite. **(4 Marks)**

(c) (i)What is Geo-Stationary satellite around the earth? **(2 Marks)**

(ii) Determine the radius of a Geo-Stationary satellite. **(3 Marks)**

6. Discuss the differences between the ideal gas and real gas. **(4 Marks)**

As shown in Figure 4 an ideal gas is confined in a cylinder by a movable frictionless piston.

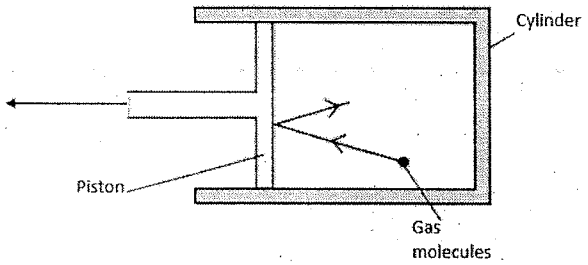

Figure 4

At the temperature of 310 K, the pressure is 3.3×10^5 Pa and volume is 1.8×10^{-3} m^3 of the gas. The value of the gas constant in SI unit is 8.3J mol^{-1} K^{-1}.

Show that the number of gas molecules in the cylinder is 1.4×10^{23}. **(4 Marks)**

(a) Write down the assumptions of kinetic theory of gases. **(4 Marks)**

(b) Derive an expression for the kinetic energy of ideal gas molecule. **(4 Marks)**

(c) Use kinetic theory to explain why the temperature of the gas decrease when the piston is moved so that the gas expands, **(3 Marks)**

(d) The gas expands so that its volume increases to 2.4×10^{-3} m^3 at a pressure of 2.3×10^5 Pa and a temperature of 288 K, as shown in Figure 5.

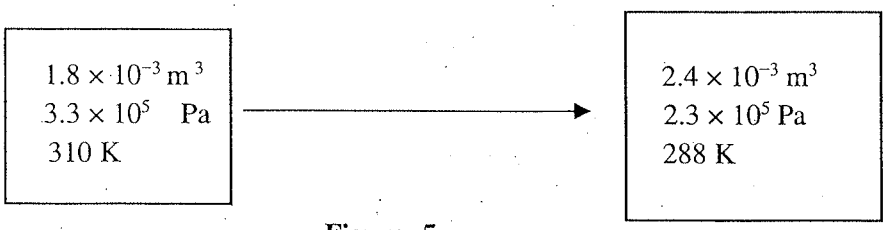

Figure 5

Determine the kinetic energy of a gas molecule at the initial and final temperature of the system. Boltzmann constant K= 1.3×10^{-23} J/K. **(6 Marks)**

- The End -