RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science in Applied Sciences
First Year - Semester I Examination – July / Aug 2023

PHY 1201 – GENERAL PHYSICS

Time: Two (02) hours

Answer All Questions
Unless otherwise specified, symbols have their usual meaning.
A non-programmable calculator is permitted.

Acceleration due to gravity, $g = 9.81\ \text{ms}^{-2}$

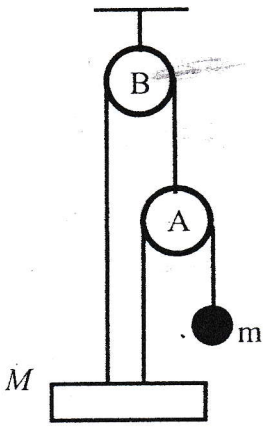
Universal gravitational force constant, $G = 6.67 \times 10^{-11}\ \text{Nm}^2\text{kg}^{-2}$

Mass of the Earth, $M_E = 5.98 \times 10^{24}\ \text{kg}$

Radius of the Earth, $R_E = 6.37 \times 10^{6}\ \text{m}$

1.

a) A heavy bar of mass M is suspended as shown by means of strings from a system of pulleys. The pulley A of mass m_A is movable and the pulley B of mass m_B is fixed. The particle of mass m is attached to the end of the string passing over the pulley A.



i. Draw free body diagrams of masses m and M and pulleys A, B, separately by showing all the forces acting on them. (04 marks)

ii. If the system is in equilibrium, obtain an expression for the mass m. Consider that the acceleration due to gravity is g. (06 marks)

b) i. State the law of conservation of linear momentum. (02 marks)

ii. An open lorry of mass 12000 kg travels along a straight horizontal road on a heavily raining day. The friction of the road is negligibly small. The rain water falls vertically downwards. The lorry contains no water initially and it moves with a velocity of 5 ms^{-1}. When the lorry travels a certain distance, 1000 kg of rain water is collected in the lorry. After that, What is the speed of the lorry? (03 marks)

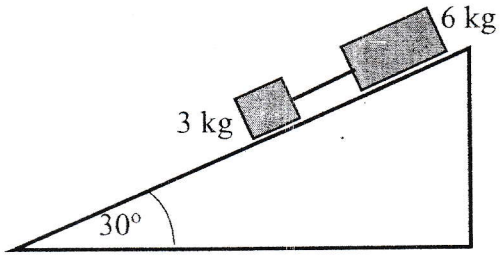
2.

a) i. Plot the variation of the frictional force on an object with the magnitude of the external force acting on it.

(02 marks)

ii. Two cubes connected by a light inextensible string are places on an inclined fixed plane as shown in the figure below. The coefficient of friction between the larger cube and the surface is 0.5 and that between the smaller cube and the surface is 0.25. Calculate the common acceleration of the system of objects and the tension of the string when the system is in motion.

(08 marks)



b) i. Write down the expression of the escape velocity of an object. (01 marks)

ii. Calculate the escape velocity from the Earth for an 8000 kg spacecraft, and determine the kinetic energy it must have at the Earth's surface in order to move infinitely far away from the Earth.

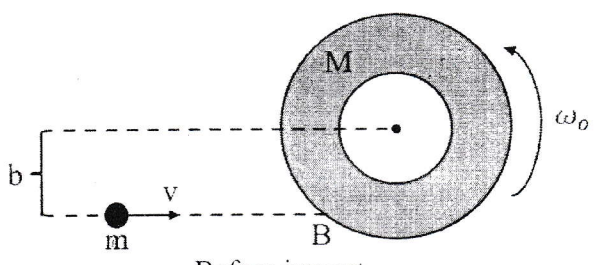
(04 marks)

3. a) Write down the parallel axes theorem and perpendicular axes theorem of moment of inertia.

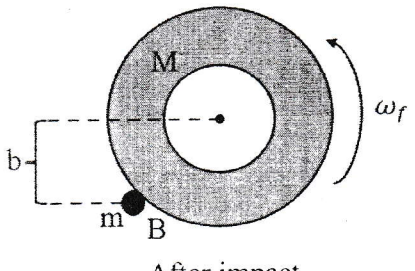
(04 marks)

b) State the law of conservation of angular momentum. (02 marks)

c) Consider the annular (ring-shaped) disc of mass M with outer radius R and inner radius $R/2$ which is rotating with a uniform angular speed ω_o on a smooth horizontal surface such that the axis of rotation is vertical. A small particle of mass $m = 0.2\,M$ moves towards the disc with a constant velocity v and sticks at the point B on the disc as shown in the figure, where $b = \frac{3}{4}R$. The moment of inertia of the annular disc about an axis passing through the center is $\frac{5}{8}MR^2$.



Before impact



After impact

i. What is the angular momentum of the system before impact, about the rotational axis passing through the center of the annular disc?

(02 marks)

ii. Write an expression for the angular momentum of the system just after impact.

(02 marks)

iii. Find the angular velocity (ω_f) of the system just after the impact.

(05 marks)

4)

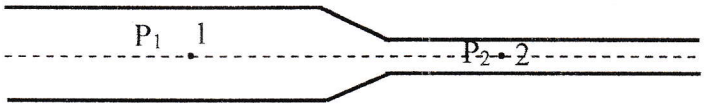
b) Briefly explain two applications of Bernoulli's principle in real life. (06 marks)

b) Write down the expression for the coefficient of viscosity. (02 marks)

c) Water runs through a pipe with cross sectional area 0.4 m^2 with a velocity of 6 ms^{-1}. Assuming that water behave as an ideal fluid, find the velocity of the water when the pipe narrows down to a cross sectional area of 0.3 m^2.

(02 marks)

d) The horizontal constricted pipe known as a *venture tube* can be used to measure the flow speed of a fluid of which the compressibility is negligible.



Show that the velocity at point 2 is given by, $V_2 = A_1\sqrt{\frac{2(P_2-P_1)}{\rho(A_2^2-A_1^2)}}$.

Where, A_1 – area inside the tube at point 1
A_2 – area inside the tube at point 2
P_1 – pressure at point 1
P_2 – pressure at point 2

(05 marks)

End.