RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
First Year – Semester I Examination – April / May 2015

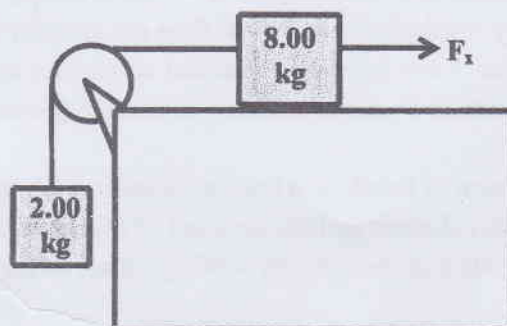**PHY 1201 – General & Thermal Physics**

<u>Answer **All** Questions.</u>   <u>Time allowed: **Two hours**</u>

Gravitational field intensity, $g = 9.8 \text{ N kg}^{-1}$.

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1. In the system shown in the following figure, a horizontal force F_x acts on the 8.00 kg mass. The horizontal surface is frictionless.


   a. For what values of F_x does the 2.00 kg mass accelerate upward?   (10 Marks)
   b. For what values of F_x is the tension in the cord zero?   (05 Marks)
   c. Plot the acceleration of the 8.00 kg mass versus F_x. (Include the values of F_x from -100 N to 100 N in 20 N steps)   (05 Marks)
   d. If the force F_x is removed from the setup, find the tension in the cord. (05 Marks)

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2. An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough that any person inside is held up against the wall when the floor drops away as shown in the following figure. The coefficient of the static friction between person and wall is μ_s, and the radius of the cylinder is **R**,
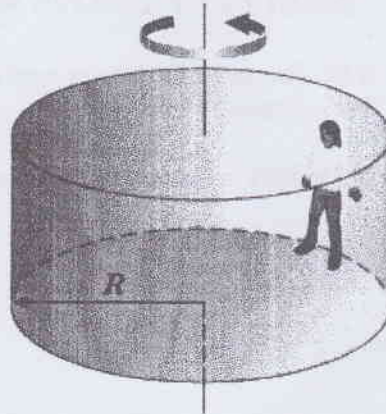
a. Show that the minimum period of revolution necessary to keep the person from falling is $T = \left(\frac{4\Pi^2 R \mu_s}{g}\right)^{\frac{1}{2}}$ (5 Marks)

b. Obtain a numerical value for **T** if **R** = 4.00 m and μ_s = 0.400   (5 Marks)

c. How many revolutions per minute does the cylinder make?   (5 Marks)

d. If the cylinder was initially at rest and accelerates at 0.5 rad/s^2, when should they remove the floor from the cylinder, so that the person would not fall down?
   (5 Marks)

e. If the moment of inertia of a hollow cylinder is given by $I = MR^2$, where M is the mass of the cylinder, find the moment of inertia of the above system with man on the edge. (Mass of the cylinder = 40 kg , Mass of the man = 50 kg)   (5 Marks)

3. Consider a steady flow of fluid inside a uniform cylinder with radius **R** and length **L**.
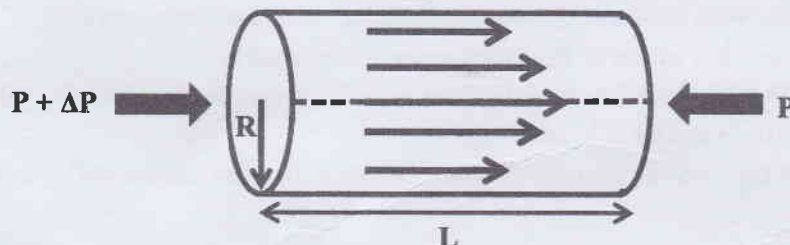

If the pressure difference across the tube is ΔP, and the viscose force opposing the motion is $F = \eta A \frac{dv}{dr}$, where η is the viscosity of the fluid and **A** is the surface area of the fluid,

a. Show that the vertical fluid velocity profile is given by $V(r) = \frac{\Delta P}{4\eta l}\left[R^2 - r^2\right]$.

(5 Marks)

b. Sketch the variation of vertical fluid velocity as a function of radius (**r**).   (5 Marks)

Oil flows in a pipe with a 100 mm diameter and Reynold number of 250. The dynamic viscosity of the oil is 0.018 N s/m^2 and the density is 900 kg/m^3. Find,

c. the velocity of the fluid   (5 Marks)
d. the average flow rate of the fluid   (5 Marks)
e. the pressure drop per meter length   (5 Marks)

4. Following is a Pressure – volume diagram (P-V diagram) of a cyclic heat engine.
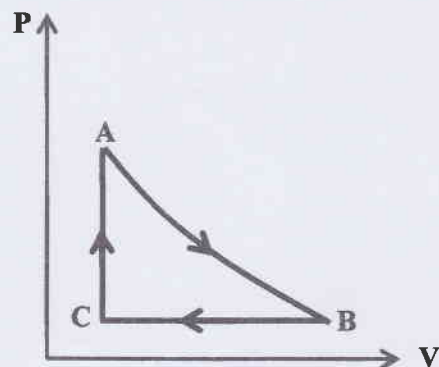
Part I
a. Identify the Isothermal, Isovolumetric and Isobaric processes on above diagram.

(3 Marks)

b. Using the second law of the thermodynamics (Q = ΔE + W), show that in an **Isovolumetric** process the energy added to the system (Q) is equal to the change in internal energy of the system (ΔE).   (5 Marks)
c. Giving appropriate reasons explain why the energy added to the system is equal to the work done in an **Isothermal** process.   (5 Marks)

Part II

d. Plot the Maxwell-Boltzmann distribution of molecular velocities in an ideal gas.

(5 Marks)

e. Mark the most probable velocity, root mean square velocity and the average velocity of gas molecules on above graph.   (5 Marks)
f. What is the term "**mean free path**" means in a gas.   (2 Marks)

Useful Equations,

$$Q = \frac{\Pi r^4}{8\eta l}\Delta P, \qquad R = \frac{v\rho D}{\eta}$$