The Open University of Sri Lanka
B.Sc./B.Ed. Degree Programme – Level 04
No Book Test (NBT) – 2021/2022
Applied Mathematics
ADU4301- Newtonian Mechanics
Duration : One Hour

Date : 12-02-2023 **Time : 10.30 a.m. – 11.30 a.m.**

Answer All Questions.

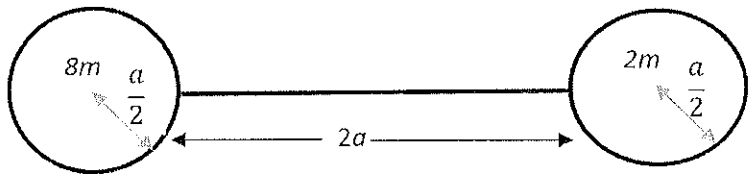
1. A rocket has total initial mass M. It propels itself by burning fuel and ejecting the burnt matter at a uniform rate with constant speed u relative to the rocket. The total mass of fuel in the rocket is initially $\frac{1}{2}M$, and the fuel is all burnt up after a time T. The rocket is launched from rest vertically upwards from the surface of the Earth. It may be assumed that the acceleration due to gravity remains constant throughout the flight of the rocket, and that air resistance is negligible. At time t, the speed of the rocket is v.

   (a) Show that, the equation of motion of the rocket is given by

   $$(2T - t)\frac{dv}{dt} = u - g(2T - t).$$

   (b) Hence find the speed of the rocket at the instant when all the fuel has been burnt.

2.



A model of a timing device in a clock consists of a uniform rod, of mass $3m$ and length $2a$, the ends of which are attached two uniform solid spheres, each of radius $\frac{a}{2}$ as shown in the figure. One sphere has mass $8m$ and the other has mass $2m$. The device rotates freely in a vertical plane abut a horizontal axis through the centre of the rod and perpendicular to it.

(a) Show that the moment of inertia of the system abut this axis is $\frac{49}{2}ma^2$.

(b) Find the period of small oscillations of the system about its position of stable equilibrium.
(You may assume that the moment of inertia of a uniform solid sphere of radius a and mass m, about an axis passing through the centre is $\frac{2}{5}ma^2$.