DEPARTMENT OF PHYSICS
Indian Institute of Technology Kharagpur
Classical Mechanics-I
Course: PH20007
Assignment-2: Rocket motion and Motion under central force-1

1. A rocket set for vertical launching, weighs 50 kg and contains 450 kg of fuel. It can have a maximum exhaust velocity of 2 km/s. What should be the rate of consumption of fuel so that the rocket starts with an initial acceleration of 20 m/s^2
   (i) 1.45 kg/s
   (ii) 3.45 kg/s
   (iii) 5.45 kg/s
   (iv) 7.45 kg/s.

2. A rocket starting initially from rest, with u equal to 2.1 km/s and a mass loss per second equal to 1/60th of the initial mass, that in order to reach the escape velocity the ratio of the weight of the fuel to the weight of the empty rocket must be approximately
   (i) 275.
   (ii) 65.
   (iii) 860.
   (iv) 1120.

3. If a particle is moving under central force field then which one of the following is true
   (i) the particle moves in a straight line
   (ii) motion of the particle is confined in a plane
   (iii) angular momentum of the particle is conserved
   (iv) both (ii) and (iii) are true.

4. Which of the following condition is true if a particle is moving under central force field
   (i) $E >, < and = 0$ correspond to the path is an ellipse, a parabola and a hyperbola respectively
   (ii) $E >, < and = 0$ correspond to the path is a parabola, an ellipse and a hyperbola respectively
   (iii) $E >, < and = 0$ correspond to the path is a hyperbola, an ellipse, and a parabola respectively
   (iv) $E >, < and = 0$ correspond to the path is an an ellipse, a hyperbola and a parabola respectively.

5. A rocket has an initial mass of m and a burn rate of $\alpha = -\frac{dm}{dt}$ What is the minimum exhaust velocity that will allow the rocket to lift off immediately after firing (Ebook 2.60)

(i) $\frac{2mg}{\alpha}$
(ii) $\frac{2mg}{3\alpha}$
(iii) $\frac{mg}{\alpha}$
(iv) $\frac{mg}{2\alpha}$

6. A spherical rain drop falling under constant gravity and its radius at any instant t is given by $r = \frac{k}{\rho}t$. The rate of increase of its mass is proportional to the instantaneous surface area. The velocity (v) at any instant t is
(i) $\frac{1}{2}gt$
(ii) $\frac{1}{3}gt$
(iii) $\frac{1}{4}gt$
(iv) $\frac{1}{5}gt$

7. Consider the angular momentum of the system under central force field $\vec{L} = \vec{r} \times \vec{p}$. How does L change with time
(i) does not constant over time
(ii) proportional to acceleration
(iii) proportional to $\vec{r}$
(iv) does not change in time

8. $\vec{F} = \frac{r(r-1)}{(r^2+1)}\hat{r}$ represent a central force field. Which one of the following is true (spigel)
(i) it is attractive in nature
(ii) it is repulsive in nature
(iii) attractive if $0 < r < 1$ and repulsive if $r > 1$
(iv) repulsive if $0 < r < 1$ and attractive if $r > 1$

9. Which of the followings can be central force field
(i) $q\vec{v} \times \vec{B}$
(ii) $q\vec{E}$
(iii) frictional force
(iv) viscous force

10. The potential corresponding to the central force field $\vec{F} = (\frac{\alpha}{r^2} + \frac{\beta}{r^3})\hat{r}$
(i) 0
(ii) $\frac{\alpha}{r} + \frac{\beta}{r^2}$
(iii) $\frac{2\alpha}{r} + \frac{3\beta}{r^2}$
(iv) $\frac{\alpha}{r} + \frac{\beta}{2r^2}$