DEPARTMENT OF PHYSICS
Indian Institute of Technology Kharagpur
Classical Mechanics-I
Assignment-4: Motion under central force-3

1. A ballistic missile is launched from earth's surface. If the angular range of the missile is 2ϕ, the physical distance between the launching point and point of impact is
   (a) $R_0\phi$
   (b) $2R_0\phi$
   (c) $4R_0\phi$
   (d) $6R_0\phi$

2. Areal velocity of central orbit is proportional to
   (a) Speed at any point of the orbit
   (b) Angular acceleration at any point of the orbit
   (c) Angular velocity at any point of the orbit
   (d) Angular momentum

3. If gravitational force between two bodies had been inversely proportional to the third power of the distance between them, find out the escape velocity at the surface of the earth.
   (i) $\sqrt{2gR}$
   (ii) $\sqrt{\frac{1}{2}gR}$
   (iii) $\sqrt{\frac{2}{3}gR}$
   (iv) $\sqrt{gR}$

4. A satellite moves in an elliptic path with the earth at one focus. At the perigee (nearest point) its speed is v and its distance from the centre of the earth is r . If $\epsilon = 0.5$, what is its speed at the apogee (farthest point)?
   (i) v
   (ii) $\frac{v}{2}$
   (iii) $\frac{v}{3}$
   (iv) $2v$

5. The greatest and least velocities of a certain planet in its orbit around the sun are 30.0 and 29.2 km/s. Find the eccentricity of the orbit.
   (i) 0.013
   (ii) 0.05
   (iii) 0.49
   (iv) 1.00

6. A binary star is formed when two stars bound by gravity move around a common centre of mass. Each component of a binary star has period of revolution about their centre of mass,

equal to 14.4 days and the velocity of each component of 220 km/s. Further, the orbit is nearly circular. Calculate the separation of the two components.
(i) $5.5 \times 10^{10}\ m$
(ii) $8.7 \times 10^{10}\ m$
(iii) $9.5 \times 10^{10}\ m$
(iv) $2.9 \times 10^{10}\ m$

7. If a satellite has its largest and smallest speeds given by v_{max} and v_{min}, respectively, and has time period equal to T and it moves on an elliptic path. Calculate the semi-major axis (a).
(i) $\frac{T}{2\pi}\sqrt{v_{max}\ v_{min}}$
(ii) $\frac{T}{2\pi}\sqrt[3]{v_{max}\ v_{min}}$
(iii) $\frac{2\pi}{T}\sqrt{v_{max}\ v_{min}}$
(iv) $\frac{2\pi}{T}\sqrt[3]{v_{max}\ v_{min}}$

8. A satellite of radius a revolves in a circular orbit about a planet of radius b with period T . If the shortest distance between their surfaces is c, the mass of the planet is
(i) $\frac{4\pi^2\ (a+b-c)^3}{GT^2}$
(ii) $\frac{4\pi^2\ (a+b+c)^3}{GT^2}$
(iii) $\frac{4\pi^2\ (a-b+c)^3}{GT^2}$
(iv) $\frac{4\pi^2\ (a+b+c)^3}{GT}$

9. Assuming that the earth is a sphere of radius 6400 km, with what velocity must a projectile be fired from the earths surface in order that its subsequent path be an ellipse with major axis equal to 80,000 km?
(i) $\sim$ 2 km/s
(ii) $\sim$ 5 km/s
(iii) $\sim$ 8 km/s
(iv) $\sim$ 10 km/s

10. A satellite has an elliptic orbit with the perigee (nearest point) of $r_p = 6570$ km and apogee (farthest point) at $r_a = 42{,}250$ km. The perigee velocitie was $v_p = 10.25$ km/s. Angular momentum of the satellite at apogee is approximately
(a) 55342.5 $Kg.m^2/sec$
(b) 87342.5 $Kg.m^2/sec$
(c) 67342.5 $Kg.m^2/sec$
(d) 97342.5 $Kg.m^2/sec$

End