DEPARTMENT OF PHYSICS
Indian Institute of Technology Kharagpur
Classical Mechanics-I
Course: PH20007
Assignment-5: Assignment-5 (Moving coordinate system)

1. A particle of mass m moves under the action of a central force whose potential is $V(r) = kmr^3 (k > 0)$. For what angular momentum the orbit will be a circle of radius a about the origin
   (a) $\sqrt{3km}a^{5/2}$
   (b) $\sqrt{3k}ma^{3/2}$
   (c) $\sqrt{3mk}a^{5/2}$
   (d) $\sqrt{3mk}a^{3/2}$

2. The effective P.E. of a particle moving in a central force field is given by $V' = V(r) + \frac{l^2}{2mr^2}$. If the central potential is $\frac{1}{2}kr^2$, calculate the angular frequency (ω) for circular orbit
   (a) $\sqrt{\frac{m}{k}}$
   (a) $\sqrt{\frac{m}{2k}}$
   (a) $\sqrt{\frac{2m}{k}}$
   (d) $\sqrt{\frac{k}{m}}$

3. A particle moving in a central force field located at $r = 0$ describes the spiral $r = e^{-\theta}$. The law of force is
   (a) $\propto \frac{1}{r}$
   (b) $\propto \frac{1}{r^2}$
   (c) $\propto \frac{1}{r^3}$
   (d) $\propto \frac{1}{r^5}$

4. What will be the approximate time for one rotation for the plane of oscillation of the Foucault pendulum at 30° N latitude
   (a) 48 hr
   (b) 36 hr
   (c) 24 hr
   (d) 12 hr

5. What will be the horizontal component of the Coriolis force acting on a body of mass 1.5 kg moving northward with a horizontal velocity of 100 m/sec, at 30° N latitude on earth
   (a) 0.5 N along east
   (b) 0.0109 N along east
   (c) 0.9201 N along east
   (d) 0 N

6. Two separate Foucault pendulum experiments were set up on same longitude 10,466 km apart from each other. The plane of one pendulum was seen to rotate clockwise at a time period of 27.6 hrs. The plane of other pendulum was seen to rotate anticlockwise direction with time period 42.9 hrs. From this data, approximate radius of the earth is:
   (a) 6350 km
   (b) 6787 km
   (c) 6024 km
   (d) 6991 km

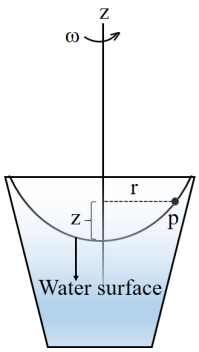
7. Given that earth rotates once every 23 hr 56 min around the axis from the North to South Pole, calculate the angular velocity, ω, of the earth
   (a) 7.29 $\times 10^{-3}$ rad/sec
   (b) 7.29 $\times 10^{-5}$ rad/sec
   (c) 51.21 $\times 10^{-5}$ rad/sec
   (d) 17.84 $\times 10^{-4}$ rad/sec

8. An iceberg of mass 5×10^5 tons near the North Pole moves west at the rate of 8 km/day. Neglecting the curvature of the earth, calculate the magnitude and direction of the Coriolis force
   (a) 6730 N and north
   (b) 6730 N and south
   (c) 6730 N and east
   (d) 6730 N and west

9. A train of mass 1000 tons moves in the latitude 60° north. Find the magnitude and direction of the lateral force that the train exerts on the rails if it moves with a velocity of 15 m/s
   (a) 2560 N and on the right rail
   (b) 2560 N and on the left rail
   (a) 1890 N and on the left rail
   (a) 1890 N and on the right rail

10. A bucket full of water spins with $\vec{\omega}$ about the axis as shown in the figure. The shape of the water surface is given by
   (a) $z = \frac{1}{2}\frac{\omega^2 r^2}{g}$
   (b) $z = \frac{1}{2}\frac{\omega^2 g^2}{r}$
   (c) $z = \frac{1}{2}\frac{\omega^3 r^2}{g^2}$
   (d) $z = \frac{1}{3}\frac{\omega^2 r^2}{g}$

End


z
ω
r
z
p
Water surface