भारतीय प्रौद्योगिकी संस्थान पटना
INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 (Physics-I) **QUIZ-ONE (December 13, 2022)**

ROLL: NAME:

1. Consider a particle of mass m that feels only an angular force, such that $\vec{F} = mr\dot{\theta}$. Then,
   (a) $r = \sqrt{A + B\ln(r)}$, where, A and B are constants determined by initial conditions.
   (b) $r = A(1 + \frac{\tau}{r})$, where, A and τ are constants determined by initial conditions.
   (c) $r = Ae^{B\theta}$, where, A and B are constants determined by initial conditions.
   (d) $r = 0$, always.

2. A ball is thrown at speed v from zero height on level ground. Area under the trajectory is maximum when the ball is thrown at an angle (with the horizontal) of:
   (a) $\frac{3}{8}\pi$
   (b) $\frac{1}{3}\pi$
   (c) $\frac{1}{4}\pi$
   (d) $\frac{1}{5}\pi$

3. A ball is thrown straight upward so that it reaches a height h. It falls down and bounces repeatedly. After each bounce, it returns to a certain fraction 0.4 of its previous height. The average speed for the motion (tillthe ball reaches rest) is:
   (a) $\frac{2}{3}\sqrt{gh/2}$
   (b) $\frac{3}{4}\sqrt{gh/2}$
   (c) $\frac{4}{5}\sqrt{gh/2}$
   (d) $\frac{5}{6}\sqrt{gh/2}$

4. If $x_1(t)$ and $x_2(t)$ are solutions to $\ddot{x} = bx$,then $x_1(t) + x_2(t)$ is also a solution:

(a) TRUE

(b) FALSE

5. A particle of mass m moves under the influence of the potential $V(x) = \frac{a}{x^3} - \frac{b}{x}$ (where, $a > 0$ and $b > 0$). The frequency (ω) of small oscillations around the equilibrium point is:

   (a) $\sqrt{\frac{b^2}{8ma}}$

   (b) $\sqrt{\frac{b^3}{8ma^2}}$

   (c) $\sqrt{\frac{b^4}{8ma^3}}$

   (d) $\sqrt{\frac{b^5}{8ma^4}}$

6. A damped harmonic oscillator starting from rest has amplitude 4 cm after 100 oscillations. The first amplitude is 40 cm and its period is 2.3 s. The relaxation time is close to:

   (a) 90.9 s

   (b) 99.9 s

   (c) 109.9 s

   (d) 119.9 s

7. A particle of mass 2 kg oscillates along the x-axis according to the equation: $x = 0.2sin(5t - \frac{\pi}{6})$, where x is in meters and t is in seconds. The particle is acted upon by the maximum force when:

   (a) the particle is at its mean position.

   (b) the particle is at any of the extreme positions.

   (c) the particle is halfway between the mean position and any of the extreme positions.

   (d) none of the above.

8. The potential energy of a diatomic molecule (comprising two atoms separated by a distance r) is given by: $U(r) = \frac{A}{r^a} - \frac{B}{r^b}$, where, A, B, a and b are positive constants such that $a > b$. If r_0 is the equilibrium separation of the two atoms, the dissociation energy for such a diatomic molecule is given by:

   (a) $\frac{B}{r_0^b}(1 - \frac{b}{a})$.

   (b) $\frac{A}{r_0^a}(1 - \frac{b}{a})$.

   (c) $\frac{B}{r_0^a}(1 - \frac{b}{a})$.

   (d) $\frac{A}{r_0^b}(1 - \frac{b}{a})$.