Name: _____ **Date:** _____

Escape Velocity or Bust: Kinetic Mastery for College Physics

Calculate orbital perturbations and non-linear trajectories to ensure your deep-space probe doesn't drift into the cosmic void.

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1. A particle moves along a path such that its position vector is given by r(t) = (ACos(ωt))i + (ASin(ωt))j. Which of the following best describes the relationship between the particle's velocity and acceleration vectors?

A. They are parallel and in the same direction.
B. They are parallel and in opposite directions.
C. They are mutually perpendicular at all times.
D. The angle between them varies sinusoidally with time.

2. In a frame of reference undergoing constant linear acceleration, the kinematic equations of motion for a projectile remain invariant compared to an inertial frame.

A. True
B. False

3. The time-dependent acceleration of a research submersible is defined by $a(v) = -kv^2$, where k is a constant and v is velocity. If the initial velocity is v_0 at t=0, the velocity as a function of time is v(t) = _____.

A. $v_0 / (1 + v_0kt)$
B. $v_0e^{(-kt)}$
C. $v_0 - kt^2$
D. $v_0 / (1 - v_0kt)$

4. Consider a projectile launched with velocity 'v' at an angle 'θ' on an inclined plane that itself makes an angle 'ϕ' with the horizontal. To maximize the range 'R' along the incline, what must be the relationship between θ and ϕ?

A. θ = 45°
B. θ = 45° + ϕ
C. θ = 45° + ϕ/2
D. θ = 90° - ϕ

5. The jerk of an object, defined as the third derivative of displacement with respect to time, must be zero for the standard kinematic equations (e.g., $\Delta x = v_0t + \frac{1}{2}at^2$) to be valid.

A. True
B. False

6. A particle moves such that its velocity is v = ks, where s is the distance covered and k is a positive constant. The acceleration of the particle is _____.

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A. $k^2/2$
B. ks
C. k^2
D. k/2

7. In polar coordinates (r, θ), the radial component of acceleration for a particle moving in a plane is given by which expression?

A. d^2r/dt^2
B. $d^2r/dt^2 - r(d\theta/dt)^2$
C. $d^2r/dt^2 + r(d\theta/dt)^2$
D. $2(dr/dt)(d\theta/dt) + r(d^2\theta/dt^2)$

8. If the velocity of a particle is zero at a given instant, the acceleration of that particle at that same instant must also be zero.

A. True
B. False

9. A relativistic particle moves with a velocity fraction 'β' of the speed of light. If its position is measured in frame S, how does the observed velocity change when transforming to frame S' moving at velocity 'v'? This requires the use of:

A. Galilean Transformation
B. Lorentz Velocity Addition
C. Euler-Lagrange Equations
D. Kepler's Second Law

10. A point moves along the curve $y = x^2/2$ with a constant speed 'v'. The magnitude of its acceleration at the origin (0,0) is _____.

A. v^2
B. v
C. 0
D. $v^2/2$