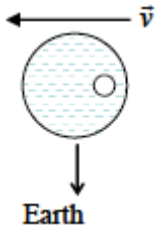
Multiple choice questions (Select one answer in each question.)

1. An object of mass *m* is attached to a spring. The restoring force of the spring is $F = -yx^3$, where *x* is the displacement. The oscillation period now depends on the oscillation amplitude. Supposed the object is initially at rest. If the initial displacement is *D*, then its period is *t*. If the initial displacement is 2*D*, find the period. (Hint: dimensional analysis.)

   A. 8*t* B. 2*t* C. *t* D. *t*/2 E. *t*/8

2. A small air bubble is inside a drop of water residing in a space station on an orbit around Earth. The direction to Earth is downwards and the space station is moving to the left relative to Earth, as shown. The air bubble will _____ relative to the water drop.



   A. move to the left B. move the right C. move up
   D. move down E. not move

3. Ball A was dropped from the top of a tall building. At the same instant and from the same height ball B was thrown straight downward. Neglecting the effects of air friction, compare their accelerations while they were falling.
   A. Their accelerations are equal.
   B. Ball A has the greater acceleration.
   C. Ball B has the greater acceleration.
   D. It is impossible to tell since their accelerations vary greatly.
   E. None of the above.

4. Two objects, A and B, accelerated from rest at the same uniform rate. Object B accelerated for a distance twice as long distance A. Compare to Object A, Object B was moving _____.
   A. Twice as fast.
   B. 1.414 times as fast
   C. Three times as fast.
   D. Four times as fast.
   E. None of the above.

5. A light string is wound around the rim of a yo-yo of mass m and radius r. One end of the string is held by a person. When the yo-yo is released from rest, it falls and rotates at a linear acceleration of $0.8g$. What is the tension in the string?
   A. 0
   B. $0.2\,mg$
   C. $0.4\,mg$
   D. $0.8\,mg$
   E. mg

6. Two balls of masses m, M and speeds v_1, v_2 and collide at a right angle. The maximum amount of kinetic energy loss due to inelastic collision is ____.
   A. $\frac{1}{2}(mv_1^2 + Mv_2^2)$
   B. $\frac{1}{2}\frac{mM}{m+M}(v_1^2 + v_2^2)$
   C. $\frac{1}{2}\frac{1}{m+M}(m^2v_1^2 + M^2v_2^2)$
   D. $\frac{1}{2}\frac{mM}{m+M}(v_1 + v_2)^2$
   E. None of the above

7. A car of mass m is slipping down a slope of inclination angle θ at a constant acceleration a. The static friction coefficient between the wheels and the slope is μ. What is the friction force between the wheels and the slope?
   A. $\mu mg\cos\theta$
   B. μmg
   C. $mg(\sin\theta - \mu)$
   D. $m(g - a)$
   E. $mg\sin\theta - ma$

8. A wheel of weight W and radius 0.8m is placed against a 0.3m height rectangular block fixed on the ground. The wheel has an axle of radius 0.1m. A force F is applied tangentially to the top of the axle to lift the wheel. The minimum value of F is:
    A. $1.05W$
    B. $0.86W$
    C. $0.69W$
    D. $0.32W$
    E. $2.45W$

9. An object is released from rest and falls a distance h during the first second of time. How far will it fall during the next second of time?
    A. h
    B. $2h$
    C. $3h$
    D. $4h$
    E. h^2

10. A uniform disk, a thin hoop, and a uniform sphere, all with the same mass and same outer radius, are each free to rotate about a fixed axis through its center. Assume the hoop is connected to the rotation axis by light spokes. With the objects starting from rest, identical forces are simultaneously applied to the rims. Rank the objects according to their kinetic energies after a given time t, from least to greatest.
    A. Disk, hoop, sphere
    B. Sphere, disk, hoop
    C. Hoop, sphere, disk
    D. Disk, sphere, hoop
    E. Hoop, disk, sphere