Practice Exam 2

Name: _____

- This exam consists of 8 conceptual questions (4 pts each) and 12 (5 pts each) quantitative questions. All questions are multiple choice.
- Show your work! For the quantitative questions I will award partial credit, but I can only do so if you clearly show your work. You must *convince* me you know what you're doing at least up until you get stuck. Clearly draw figures and free body diagrams where appropriate, list the (un)knowns of the problem, and explain your steps in writing. ***If no work or unclear work is shown for a quantitative question I will assume you just guessed and you will recieve no points.*** If you have a physical argument for your answer (as opposed to a calculation), that is okay, but state your argument.
- You may use only a copy of the standard equation sheet and your calculator. If I see your phone, laptop, or notes I will take your exam and you will receive a zero. If your calculator allows you to save equations/notes in memory using that feature is considered cheating and you will recieve a zero.
- You can use the full time (2 periods) to complete this exam.
- Use $g = 9.81\text{m/s}^2$ for the acceleration due to gravity.

Honor Pledge: Please write out and sign the following honor pledge. "The Naval Service I am a part of is bound by honor and integrity. I will not compromise our values by giving or receiving unauthorized help on this exam."

Answers

Write your answers here. For quantitative questions show your work in the space provided under each question.

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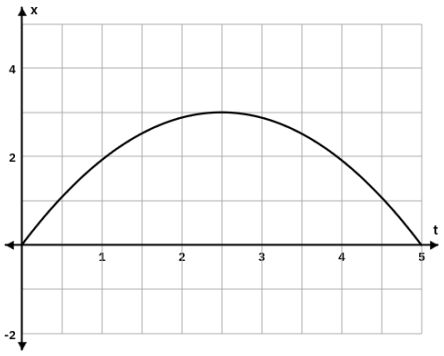
Conceptual Questions

1. Consider an object moving in one dimension with the following position vs. time plot.



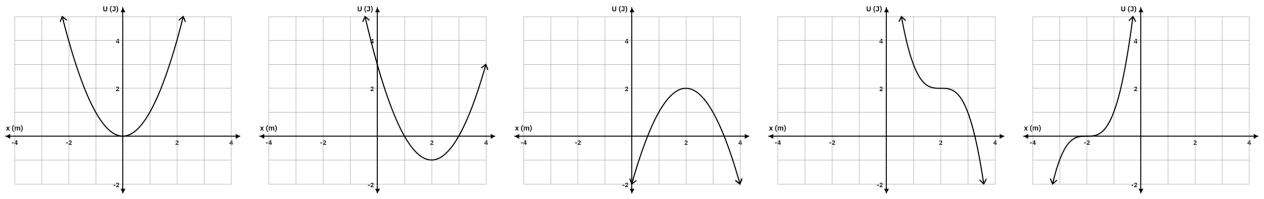
Which of the following is FALSE for the pictured time interval?

   A. The velocity is in the negative direction when $t > 2.5$ s.
   B. The object is moving in the positive direction at $x = 1.0$ s.
   C. The kinetic energy of the object is zero at $t = 2.5$ s.
   D. A conservative force would have done no work on the object during the interval $0 \leq t \leq 5$.
   E. The kinetic energy of the object is zero at $t = 0.0$ s and $t = 5.0$ s.

2. A large truck collides head-on with a small compact car. During the collision:
   A. The truck exerts a greater amount of force on the car than the car exerts on the truck.
   B. The car exerts a greater amount of force on the truck than the truck exerts on the car.
   C. Neither exerts a force on the other, the car gets smashed simply because it gets in the way of the truck.
   D. The truck exerts a force on the car but the car does not exert a force on the truck.
   E. The truck exerts the same amount of force on the car as the car exerts on the truck

3. Suppose a point object is at a stable equilibrium at $x = 2.0$ m. Which of the following could be the potential energy function $U(x)$ for this object?

A. B. C. D. E.



4. Two midshipmen of the same weight race to the top of a hill. Midshipman A picks a steeper path, since it is shorter. Midshipman B picks a longer, gently sloped path up the hill, since they can run faster on a shallower slope. Which of the following is TRUE?
   A. Midshipman B gains more gravitational potential energy than Midshipman A.
   B. Midshipman B gains less gravitational potential energy than Midshipman A.
   C. Midshipman B gains the same gravitational potential energy than Midshipman A.
   D. To compare the gravitational potential energies, we must know the height of the hill.
   E. To compare the gravitational potential energies, we must know the lengths of the two paths.

5. Two steel balls collide elastically. Which of the following is FALSE?
   A. Kinetic energy is conserved during the collision.
   B. In the center of mass reference frame, both balls have the same velocity before and after the collision.

C. Momentum is conserved during the collision.

D. If the balls have the same mass, and, initially, are moving towards one another with equal speeds in opposite directions, the center of mass of the system is constant for the entire collision process.

E. If the balls have the same mass, and one of the balls is at rest before the collision, one of the balls will be at rest after the collision.

6. Two objects, one of mass m and one of mass $2m$, are dropped from a height h at the same time. Which of the following is TRUE? Assume no air resistance.

A. The momentum of the objects is conserved as they fall.

B. The object of mass $2m$ will hit the ground first.

C. The kinetic energy of the objects just before they hit the ground are equal.

D. The speed of the objects just before they hit the ground are equal.

E. The potential energy of the objects just before they are dropped are equal.

7. A child is riding a merry-go-round turning at constant angular velocity. During the ride they move from the outer edge of the merry-go-round to a point halfway between the edge and the center. What happens to their linear speed?

A. It doubles.

B. It halves.

C. It stays the same

D. It quadruples.

E. It decreases, but to know how much we would need to know the moment of inertia of the merry-go-round

8. Starting simultaneously from rest, a coin and a hoop roll without slipping down an incline. Which of the following is TRUE?

A. The hoop reaches the bottom first.

B. The coin reaches the bottom first.

C. The hoop and the coin reach the bottom at the same time.

D. The race to the bottom depends on their relative masses.

E. The race to the bottom depends on their relative diameters.

Quantitative Questions

9. From ground level, a rock is thrown straight up with a speed of 12 m/s. If air resistance is negligible, the maximum height reached by the rock is

A. 7.3 m

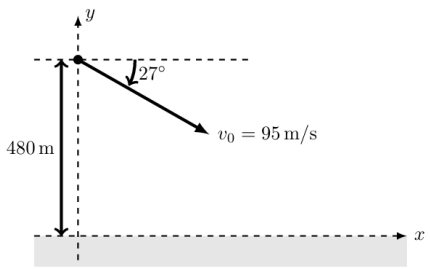
B. 15 m

C. 8.9 m

D. 11 m

E. 13 m

10. A bomb is dropped from an airplane diving with a speed of 95 m/s at an angle of 27° below the horizontal. If the bomb leaves the plane with the same velocity as the plane at a height of 480 m above the ground, where does the projectile land? See the picture below. Assume air resistance is negligible.



A. $x = 1300$ m
B. $x = 190$ m
C. $x = 400$ m
D. $x = 940$ m
E. $x = 540$ m

11. A block sits on an incline with an angle of 30° from the horizontal. What is the minimum coefficient of static friction between the block and incline be such that the block will not slide?

A. 0.50
B. 0.58
C. 0.86
D. 1.73
E. Not enough information given.

The next two problems concern the following situation: A 10kg block is moving across a horizontal frictionless with velocity $v = +2.0$ m/s when an applied force on the block is initiated and held constant. The applied force has a magnitude of 15 N and it is directed at an angle of 45° above the $-x$ axis.

12. After 2 m of sliding what is the work done by the applied force?

A. $-15\sqrt{2}$ J
B. $+15\sqrt{2}$ J
C. -30 J
D. $-30\sqrt{2}$ J
E. 20 J

13. What must the net work done on the object be to bring it to rest?

    A. -20 J
    B. $-15\sqrt{2}$ J
    C. 0 J
    D. $+15\sqrt{2}$ J
    E. +20 J

14. Suppose the net force acting on an object is given as a function of position by $F(x) = 10e^{-x}$. Which of the following is the potential energy function for this object given that the potential energy at $x = 0$ is zero (i.e. $U(0) = 0$).

    A. $U(x) = 5x^2$
    B. $U(x) = 10e^{x}$
    C. $U(x) = 10e^{-x}$
    D. $U(x) = 10e^{-2x} - 10$
    E. $U(x) = 10e^{-x} - 10$

15. Two steel balls, each of mass $m = 0.2$ kg roll down a track towards one another, from rest at initial heights of $h_1 = 0.5$ m and $h_2 = 0.75$ m, respectively, as pictured below. Suppose the two objects collide elastically. How high back up the track will the ball initially at height h_2 go? Assume friction and air resistance are negligible.

    A. 0.25 m
    B. 0.5 m
    C. 0.75 m
    D. 1.25 m
    E. 1.5 m

16. A pinball machine launches a ball of 0.08 kg via a spring with spring constant $k = 60$ N/m. If the ball leaves the spring with a speed of 1.2 m/s, by what distance x must the spring have been compressed?

    A. 1.6 cm

    B. 2.2 cm

    C. 4.4 cm

    D. 6.8 cm

    E. 9.1 cm

17. A shell traveling with speed v_0 exactly horizontally and due north explodes into two equal-mass fragments. It is observed that just after the explosion one fragment is traveling vertically upwards with speed v_0. What is the magnitude of the velocity of the other fragment?

    A. 0

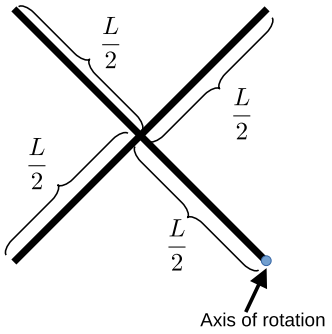
    B. $\frac{v_0}{2}$

    C. v_0

    D. $\sqrt{5}v_0$

    E. $5v_0$

18. Consider an object made of two orthogonal long, thin rods each of length L, joined at their center, as pictured below. What is the moment of inertia about an axis of rotation at the end of one of the rods? Suppose the object has a total mass M which is uniformly distributed.



    A. $\frac{1}{12}ML^2$

    B. $\frac{1}{6}ML^2$

    C. $\frac{1}{2}ML^2$

    D. $\frac{2}{3}ML^2$

    E. ML^2

19. A record player is unplugged and the disc slows to a stop from an initial angular velocity of 78 revolutions per minute with a constant angular acceleration in 12 seconds. What is the magnitude of this angular acceleration?

    A. 0.11 rad/s

    B. 0.68 rad/s

    C. 1.2 rad/s

    D. 2.4 rad/s

    E. 6.5 rad/s

20. The right side of a seesaw is instantaneously angled at 40° above the horizontal. On the left side a 48 kg point mass sits 1.3 m from the pivot. On the right, a 39 kg point mass sits 1.7m from the pivot. The plank's mass is negligible. What is the magnitude of the net torque on the seesaw at this instant?

    A. 2.5 N· m

    B. 2.98 N· m

    C. 3.9 N· m

    D. 99 N· m

    E. 130 N· m

21. **Bonus** [up to 5 points]: A rotating, steel chain in free fall will tend to twist and turn until it is all straight and rotating as a rigid body. Given that angular momentum is given by $L = I\omega$ and (rotational) kinetic energy is given by $K = \frac{1}{2}I\omega^2 = \frac{L^2}{2I}$, argue that

    (a) internal friction between links of the chain acting to dissipate kinetic energy; and

    (b) conservation of angular momentum

    can explain this phenomenon.