PHY2048 Exam 2

Fall 2019

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Abstract

This exam consists of 25 multiple choice questions. **You must record your answers on a Scantron sheet.** Don't record your answers on this print-out; I will not accept it as a submission. Fill out the Scantron sheet in with a pencil, not a pen. **Don't forget to include your name, the course, and exam number on the Scantron sheet.**

1. Two boxes are stacked, with box B placed on top of box A. If box A is pushed such that both boxes move with a decreasing speed, is there any friction on either box?

   (a) Kinetic friction on box A and no friction on box B

   (b) Kinetic friction on box A and static friction on box B

   (c) Kinetic friction on box A and kinetic friction on box B

   (d) Static friction on box A and kinetic friction on box B

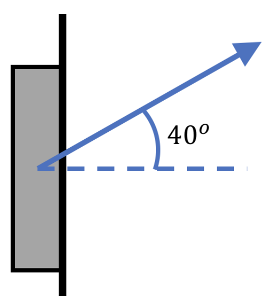


Figure 1: Problem 2

2. As shown in Figure 1 above, a 4kg object is pressed against a wall with a force of 50N, exerted at an angle 40^o above the horizontal. If the object remains at rest against the wall, what is the magnitude of friction acting on the object? Note that $\mu_s = 0.5$ and $\mu_k = 0.4$.

   (a) 7.9N

   (b) 15.3N

   (c) 17.5N

   (d) 20N

3. A 5kg box moves up an incline angle of 30^o with an initial speed of 20 m/s. If $\mu_k = 0.3$, what is the acceleration of the box as it moves up the ramp?

   (a) 1.5 m/s^2
   (b) 2.4 m/s^2
   (c) 5 m/s^2
   (d) 7.6 m/s^2

4. A 5kg box moves up an incline angle of 30^o with an initial speed of 20 m/s. If $\mu_k = 0.3$, what is the maximum height up the ramp reached by the box?

   (a) 0.7m
   (b) 1.3m
   (c) 13.2m
   (d) 26.3m

5. A 3kg mass hangs vertically from a spring with a force constant of 300 N/m. If the spring's natural length is 10cm, what is the mass' acceleration when the spring is stretched by 15cm?

   (a) 5 m/s^2 downward
   (b) 15 m/s^2 downward
   (c) 5 m/s^2 upward
   (d) 15 m/s^2 upward

6. A 2000kg car drives along a horizontal road at an initial speed of 15 m/s. While driving a distance of 1.2km, the car's engine does 70 kJ of work on the car. What is the speed of the car after traveling the 1.2km?

   (a) 8.8 m/s
   (b) 10.5 m/s
   (c) 12.5 m/s
   (d) 17.2 m/s

7. A 2000kg car drives along a horizontal road at an initial speed of 15 m/s. While driving a distance of 1.2km, the car's engine does 70 kJ of work on the car. If the engine's force on the car was constant over the 1.2km, what is the force produced by the engine?

   (a) 58.3 N, forward
   (b) 58.3 kN, forward
   (c) 58.3 N, backward
   (d) 58.3 kN, backward

8. A 4.6kg boxes slides down a 35^o incline, with $\mu_s = 0.5$ and $\mu_k = 0.3$. If the box slides a distance of 10cm down the incline's surface, how much work was done by friction?

   (a) -1.13J
   (b) 1.13J
   (c) -1.88J
   (d) 1.88J

9. A box slides up a curved ramp, slowing down as it gains height. As the box reaches the top of the ramp, the normal force will do work on the box that is:

   (a) Positive
   (b) Negative
   (c) Zero
   (d) Unable to determine without knowing the shape of the ramp

10. You need to load a box into the back of a truck. There are two possible paths to move the box: straight up from the ground to the truck, or along a ramp from the ground to the truck. Which path would require less work?

    (a) Straight up, because the distance is shorter
    (b) Along the ramp, because the force of gravity is reduced by the angle of the ramp
    (c) Both paths would require the same amount of work
    (d) Unable to determine without knowing more information

11. A 3kg mass is dropped from a height of 2.3m. If it hits the ground with a speed of 5 m/s, how much work was done by gravity?

    (a) 31.5J
    (b) -31.5J
    (c) 69J
    (d) -69J

12. Under what conditions is the energy of a system conserved?

    (a) If there are no conservative forces acting on the system
    (b) If conservative forces do no work on the system
    (c) If there are no nonconservative forces acting on the system
    (d) If nonconservative forces do no work on the system

13. True or false: If an object slides across a floor with a non-zero coefficient of friction μ_k, the energy of the object is conserved.

    (a) True
    (b) False

14. A 750g ball is held against a horizontal, 250 N/m spring compressed by 20cm. What speed will be the ball be fired at when the spring is released?
    (a) 0.72 m/s
    (b) 1.70 m/s
    (c) 2.50 m/s
    (d) 3.65 m/s

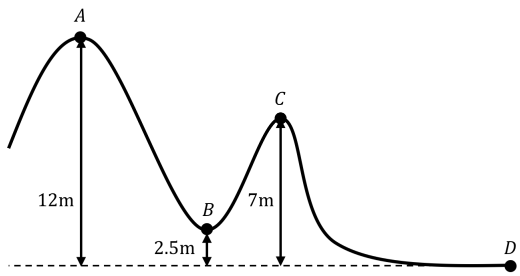


Figure 2: Problems 15 – 16

15. A 1000kg rollercoaster rides a track as shown in Figure 2. The rollercoaster begins by dropping from point A at rest. What would the coaster's speed be when it reaches point B?
    (a) 7.1 m/s
    (b) 13.8 m/s
    (c) 15.5 m/s
    (d) 17 m/s

16. A 1000kg rollercoaster rides a track as shown in Figure 2. The rollercoaster begins by dropping from point A at rest. If brakes are applied starting at point C, how much work must the brakes do in order to stop the coaster at point D?
    (a) 95,000J
    (b) $-95,000$J
    (c) 120,000J
    (d) $-120,000$J

17. Consider the potential energy function:

$$U(x) = 4x^3 - 3x + 5$$

    where each coefficient is assumed to have SI units. The equilibrium points associated with this potential energy are located at:
    (a) $x_1 = 0.25$m
    (b) $x_1 = 0.25$m, $x_2 = -0.25$m
    (c) $x_1 = 0.5$m
    (d) $x_1 = 0.5$m, $x_2 = -0.5$m

18. Consider the potential energy function:

$$U(x) = 4x^3 - 3x + 5$$

where each coefficient is assumed to have SI units. What is the force associated with this potential energy at $x = 0.4$m?

(a) 1.08N
(b) -1.08N
(c) 4.06N
(d) -4.06N

19. A 3.5kg ball bounces off a wall horizontally. If it hits the wall at 9 m/s, and leaves the wall at 5 m/s, what is the change in the ball's momentum?

(a) 14 Ns
(b) 17.5 Ns
(c) 31.5 Ns
(d) 49 Ns

20. Which of the following is an important consequence of Newton's third law?

(a) An object's momentum will only change if a force acts upon it
(b) The net internal force on any system is always zero
(c) The net external force on any system is always zero
(d) Momentum is always conserved

21. When is the momentum of a system conserved?

(a) Momentum is a conserved quantity, so it's always conserved
(b) Only during collisions
(c) Only if the net internal force on the system is zero
(d) Only if the net external force on the system is zero

22. Initially, a 1500kg car moves at 10 m/s to the right, while an 2200kg car moves at 7.5 m/s to the left. During the collision, the cars stick together. After the collision, in what direction do the cars move?

(a) To the left
(b) To the right
(c) It's stopped by the collision
(d) Unable to answer the question with the information given above

23. A 1700kg car moving at 25 m/s to the right hits a 2500kg truck moving at 10 m/s to the left. If the collision is elastic, what is the velocity of the car after the collision?

    (a) 16.7 m/s to the left
    (b) 16.7 m/s to the right
    (c) 18.3 m/s to the left
    (d) 18.3 m/s to the right

24. A 1700kg car moving at 25 m/s to the right hits a 2500kg truck moving at 10 m/s to the left. If the collision is elastic, what is the velocity of the truck after the collision?

    (a) 16.7 m/s to the left
    (b) 16.7 m/s to the right
    (c) 18.3 m/s to the left
    (d) 18.3 m/s to the right

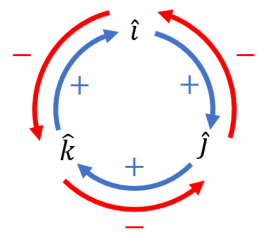
25. A 1700kg car moving at 25 m/s to the right hits a 2500kg truck moving at 10 m/s to the left. What is the maximum amount of heat that could be released during the collision?

    (a) 125 kJ
    (b) 531.2 kJ
    (c) 619.7 kJ
    (d) 656.2 kJ

<u>**FORMULA SHEET**</u>

- Vectors:

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$
$$= A_xB_x + A_yB_y + A_zB_z$$
$$\left|\vec{A}\times\vec{B}\right| = AB\sin\theta$$



- Kinematics:

$$g = 10\ \text{m/s}^2$$
$$\vec{v}_{av} = \frac{\Delta\vec{x}}{\Delta t};\quad \vec{v}(t) = \frac{d\vec{x}}{dt}$$
$$\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t};\quad \vec{a}(t) = \frac{d\vec{v}}{dt}$$
$$\Delta x = v_0t + \frac{1}{2}at^2$$
$$v = v_0 + at$$
$$v^2 = v_0^2 + 2a\Delta x$$

- Circular motion:

$$a_c = \frac{v^2}{r} = \omega^2 r$$
$$v = \omega r$$
$$\omega = \frac{2\pi}{T}$$

- Forces:

$$\sum\vec{F} = m\vec{a}$$
$$W = mg$$
$$F_{\text{sp}} = kx$$
$$f_{\text{s,max}} = \mu_s N$$
$$f_{\text{k}} = \mu_k N$$

- Work & Energy:

$$W = \vec{F} \cdot \Delta\vec{x} \quad \text{or} \quad W = \int \vec{F} \cdot d\vec{s}$$

$$W_{\text{tot}} = \Delta K$$

$$W_{\text{cons}} = -\Delta U$$

$$K = \frac{1}{2}mv^2$$

$$U_{\text{g}} = mgy$$

$$U_{\text{sp}} = \frac{1}{2}kx^2$$

$$K_i + U_i + W_{nc} = K_f + U_f \quad \text{(general energy equation)}$$

- Momentum & Collisions:

$$\vec{p} = m\vec{v}$$

$$J = \Delta\vec{p} = \int \vec{F}dt \quad \text{(impulse)}$$

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \quad or \quad \sum \vec{F}_{av} = \frac{\Delta\vec{p}}{\Delta t}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = (m_1 + m_2)\vec{v}_f \quad \text{(when objects stick together)}$$

$$\vec{v}_{1i} + \vec{v}_{1f} = \vec{v}_{2i} + \vec{v}_{2f} \quad \text{(elastic collisions)}$$