1. (2 pts) A 20 lb box is pulled a distance of 5 ft along a level floor with a horizontal force of 10 lb and a constant friction force of 4 lb. How much work is done by friction?
   A. -100 ft-lb
   B. -50 ft-lb
   C. -20 ft-lb
   D. 0

2. (2 pts) The value of \((3\hat{i} - 2\hat{j}) \cdot (4\hat{j})\) is:
   A. 0
   B. \((12\hat{i} - 8\hat{j})\)
   C. -8
   D. 4

3. (2 pts) A cart starting from rest rolls down a hill and has a speed of 4 m/s at the bottom. If the cart had an initial speed of 3 m/s, what would it speed at the bottom be?
   A. 4 m/s
   B. 5 m/s
   C. 7 m/s
   D. 25 m/s

4. (2 pts) A 4 kg object is initially at rest. It then receives an impulse of 24 N-s. After the impulse, the object has a speed of:
   A. 0 m/s
   B. 6 m/s
   C. 59 m/s
   D. 96 m/s

5. (2 pts) Which of the items below is NOT represented by a vector?
   A. Force
   B. Impulse
   C. Power
   D. Momentum

6. (2 pts) You are given a value with units of HP-hrs. What does this value represent?
   A. Energy
   B. Power
   C. Efficiency
   D. Momentum
   E. Impulse

7. (2 pts) A motor is 75% efficient and used to do 400 J of work. How much energy does the motor consume?
   A. 0 J
   B. 300 J
   C. 400 J
   D. 533 J

8. (3 pts) What is the x velocity of the top disc after the collision shown in the diagram below?
   A. -3 m/s
   B. -1.5 m/s
   C. 0 m/s
   D. +2.5 m/s
   E. +5 m/s

9. (3 pts) What is the y velocity of the bottom disc after the collision shown in the diagram above?
   A. -3 m/s
   B. -1.5 m/s
   C. 0 m/s
   D. +2.5 m/s
   E. +5 m/s
   
   Like billiard balls hitting. all momentums transferred
   Bottom ball stops
10. (10 pts) An object is subjected to a varying force as shown in the force-time graph. The object starts with a speed of 2 m/s and is moving at 11 m/s after 2 seconds. Determine the mass of the object.

\[ \text{Imp} = \Delta P \Rightarrow \text{area} = m(v_f - v_0) \]

\[ \text{Similar triangles} \quad F \cdot t = 12 \text{ N} \cdot \text{sec} \]

\[ \frac{1}{2} \left( 12 \text{ N} \right) \left( 2 \text{ sec} \right) = m (11 \text{ m/s}) - m (2 \text{ m/s}) \]

\[ 2m = 1.33 \text{ kg} \]

**Common Answers**

-5 Fix d 4 C.O.E

-1 Taking area as 12N(2) = 24

-3 More

1F Area

Wrong

Using work with correct area 

\[ m = 2.17 \text{ kg} \]

-2 Using area as 48N\( \cdot \)s

\[ m = 5.33 \text{ kg} \]

11. (14 pts) A 1400 kg roller coaster starts from rest at the bottom of a hill. Its speed at the top of the 22 m high hill is of 7 m/s. Determine the average power required to get the coaster up the hill in 11 seconds.

\[ 30000 \text{ J/s} = 41 \text{ HP} \]

\[ v = 7 \text{ m/s} \]

\[ h = 22 \text{ m} \]

\[ v_0 = 0 \]

\[ \Delta t = 11 \text{ sec} \]

**Common Answers**

-3 Don't include high term

Answer = 3118.18 \text{ Watts}

-4 Forget \( \frac{1}{2}mv^2 \) term

Answer = 2746.8 \text{ W}

\[ W = \frac{1}{2}mv^2 + W = U_g + W \]

\[ W = mgh + \frac{1}{2}mv^2 \]

\[ W = (1400 \text{ kg})(9.81 \text{ m/s}^2)(22 \text{ m}) \]

\[ + \frac{1}{2} (1400 \text{ kg})(7 \text{ m/s})^2 \]

\[ = 336448 \text{ J} \]

\[ P = \frac{W}{t} = \frac{336448 \text{ J}}{11 \text{ sec}} \]

\[ P = 30586 \text{ J/s} \]

\[ = 41 \text{ HP} \]

30586 \text{ kwh / 1 HP day}
12. (14 pts) A 4 kg box is sliding down a ramp with an initial speed of 6 m/s and travels 4.2 m before coming to rest on the ramp. Determine \( \mu_k \) for the system.

\[
F = \frac{1}{2}mu_0^2 + mg h_0 = F \cdot d
\]

\[
\frac{1}{2} (4)(6)^2 + (4)(4.2 \sin 18) = F (4.2)
\]

\[
F = 29.27 \text{ N}
\]

\[
F = \mu_k N \to -4 \text{ for not doing}
\]

\[
\mu_k = \frac{29.27 \text{ N}}{37.32 \text{ N}} = 0.784
\]

13. (14 pts) Two springs are arranged as shown. The bottom spring is compressed 0.8 ft and a 3 lb box is placed on it. The top spring is initially uncompressed. The bottom spring is released, the box shoots up, and is stopped by the top spring. What is the maximum compression of the top spring?

\[
0.475 \text{ ft}
\]
14. (14 pts) A 2.0 kg basketball moving at 4.2 m/s to the right directly collides with a 1.2 kg volleyball moving at 8.1 m/s to the left. After the collision the basketball is moving to the left at 1.2 m/s. Determine the coefficient of restitution between the two balls.

\[ e = \frac{0.171}{1.2 - (-8.1)} = 0.171 \]

15. (14 pts) A 40 kg cart is moving horizontally when a 5 kg package is thrown onto the cart as shown. Determine the velocity of the system after the cart catches the package. (use right or left for the direction of the velocity)

\[ \text{COM} \quad e = 0 \quad v_c' = v_c = v' \]

\[ m_c v_c + m_p v_p = (m_c + m_p) v' \]

\[ (40)(-3) + 5(8 \cos 37^\circ) = (40 + 5) v' \]

\[ v' = 1.96 \text{ m/s} \text{ left or } -1.96 \text{ m/s} \text{ right} \]

-2 missing direction
-3 missing \( \cos(37^\circ) \)
-1 missing direction, but have some sort of coordinates drawn