Name: ____________________________  Section: _____________

Instructions:

• Put name and section on exam and on equation sheet.
• Do not open the test until you are told to do so.
• Write your final answer in the box provided
• If you finish with less than 5 minutes remaining, please stay seated until the exam is over.
• Stop work immediately when time is over; pass exams to the aisle; stay seated until all exams are collected. Working after time is over results in an automatic 10 point deduction.
• Turn in your equation sheet with your examination

Guidelines:

• Assume 3 significant figures for all given numbers unless otherwise stated
• Show all of your work – no work, no credit
• Include units for all answers
• Include directions for all vectors

<table>
<thead>
<tr>
<th>Time</th>
<th>111 Front</th>
<th>111 Back</th>
<th>Est 209</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:10</td>
<td>S1a Tyler</td>
<td>S1b Taylor</td>
<td>S1c Rachel</td>
</tr>
<tr>
<td>12:40</td>
<td>S2a Tyler</td>
<td>S2b Taylor</td>
<td>S2c Rachel</td>
</tr>
<tr>
<td>2:10</td>
<td>S3a Tyler</td>
<td>S3b Taylor</td>
<td>S3c Rachel</td>
</tr>
</tbody>
</table>
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
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.

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.
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.

\[ \mu_k = \frac{F_{friction}}{F_{normal}} \]

\[ F_{friction} = mgsin(\theta) \]

\[ F_{normal} = mgcos(\theta) \]

\[ \mu_k = \frac{mg \sin(\theta)}{mg \cos(\theta)} = \tan(\theta) \]

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?

\[ F_{top} = F_{equilibrium} = mgh \]

\[ k \Delta x = mgh \]

\[ \Delta x = \frac{mgh}{k} \]

\[ \Delta x = \frac{(3 \text{ lb})(9.0 \text{ ft})}{60 \text{ lb/ft}} = 0.45 \text{ ft} \]

\[ \Delta x = \frac{(3 \text{ lb})(9.0 \text{ ft})}{110 \text{ lb/ft}} = 0.02727 \text{ ft} \]

\[ \Delta x = 0.45 \text{ ft} - 0.02727 \text{ ft} = 0.42273 \text{ ft} \]
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.

Coefficient of restitution:

$$e = \frac{v_{1f} - v_{2f}}{v_{1i} - v_{2i}}$$

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)

$$v_{1f} = \frac{(m_1 + m_2) v_{1i} + m_2 v_{2i}}{m_1 + m_2}$$

$$v_{1f} = \frac{(40 + 5) 3 + 5 \cdot 8}{40 + 5}$$

$$v_{1f} = \frac{125}{45}$$

$$v_{1f} = 2.78 \text{ m/s}$$

Direction: Right