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

2. (2 pts) The value of \((3 \hat{i}) \cdot (4 \hat{j})\) is:
   - A. 0  
   - B. 5  
   - C. 7  
   - D. 12

3. (2 pts) In an attempt to go faster, all of the riders on a roller coaster carry a 20 pound weight with them. Neglecting air resistance and friction, what effect will the additional weight have on the maximum speed?
   - A. increase  
   - B. have no effect  
   - C. decrease  
   - D. undetermined - depends on the steepness of the hill

4. (2 pts) A hiker descends from the top of Rocky Top to the bottom of the mountain. During the hike, the work done by gravity on the hiker is:
   - A. positive and depends on the path taken  
   - B. negative and depends on the path taken  
   - C. positive and independent of the path taken  
   - D. negative and independent of the path taken  
   - E. zero

5. (2 pts) A 3 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. 4 m/s  
   - B. 8 m/s  
   - C. 24 m/s  
   - D. 72 m/s

6. (2 pts) A 10 gram bullet is fired horizontally with a velocity of +500 m/s at a 5.0 kg stationary block of wood resting on a table. What is the velocity of block if the bullet is rubber and bounces back with a speed of 300 m/s?
   - A. -1.6 m/s  
   - B. -1.0 m/s  
   - C. -0.4 m/s  
   - D. 0  
   - E. 0.4 m/s  
   - F. 1.0 m/s  
   - G. 1.6 m/s
7. (2 pts) Car 1 with mass $4m$ and speed of $v$ collides with Car 2 of mass $m$ that is initially at rest. If the collision is perfectly elastic, the speed of Car 2 after the collision is:
   
   A. $< 0$
   B. $0$
   C. $>0$ but less than $v$
   D. $v$
   E. $> v$

8. (2 pts) What is conserved during the collision in the ballistic pendulum?
   
   A. Energy
   B. Momentum
   C. Both energy and momentum
   D. Neither energy or momentum

9. (12 pts) An object is subjected to the force as shown in the force-displacement graph. The object starts from rest and is moving at 5 m/s after a displacement of 4 m. Determine the mass of the object.
10. (12 pts) A 1400 kg roller coaster crests a 22 m high hill with a speed of 7 m/s. The speed of the roller coaster at the bottom of the hill is 19 m/s. Determine the energy loss.

11. (12 pts) A 4 kg box is sliding up a ramp with an initial speed of 6 m/s. There is a constant friction force of 17 N. Determine the distance \(d\) the box slides up the ramp before coming to rest.
12. (12 pts) A spring (k = 360 lb/ft) is used to shoot a 30 lb box along a horizontal frictionless floor. Determine the force required to compress the spring so that the box has a speed of 22 ft/s when the spring is uncompressed.

13. (12 pts) A 2000 kg BMW is travelling at 42 m/s. It approaches a 1000 kg Mini Cooper going at 25 m/s in the same direction and strikes it in the rear. After the collision the BMW is traveling forward at 33 m/s. Determine the coefficient of restitution between the BMW and Mini.
14. (12 pts) A 40 kg cart is moving horizontally at 3 m/s when a 5 kg package is thrown onto the car as shown. After the package is on the cart, the cart is moving at 5 m/s. Determine the speed, $v$, of the package just before it hits the cart.

15. (12 pts) Two disks experience a perfectly elastic collision. Determine the velocity of the 4 kg disk after the collision in $\hat{i}\hat{j}$ notation.