1. A 20 kg mass is fastened to a light spring \((k = 380 \text{ N/m})\) that passes over a massless, frictionless pulley. The mass is released from rest when the spring is in its unstretched equilibrium position. After the mass has dropped 0.40 m, what is its speed?
   a) 2.2 m/s  
   b) 2.5 m/s  
   c) 1.9 m/s  
   d) 1.5 m/s  
   e) 3.6 m/s

2. Two blocks are attached by a massless rope over a massless, frictionless pulley as shown. The coefficient of friction is \(\mu_s\). What is the minimal condition on \(m_2\) which will cause the \(m_1\) to move up the plane?
   a) \(m_2 > m_1 \sin \theta + \mu_s m_1 \cos \theta\)  
   b) \(m_2 > m_1 g \sin \theta + \mu_s m_1 g \cos \theta\)  
   c) \(m_2 > m_1 \sin \theta - \mu_s m_1 \cos \theta\)  
   d) \(m_2 > m_1 \cos \theta + \mu_s m_1 \sin \theta\)  
   e) \(m_2 > m_1 g \sin \theta - \mu_s m_1 g \cos \theta\)

3. A mass of 2 kg is in contact with a horizontal plane and is moving horizontally due to an external horizontal force of 6 N. The coefficient of kinetic friction between the mass and the plane is 0.25. What is the magnitude of the acceleration of the mass?
   a) 0.5 m/s^2  
   b) 20 m/s^2  
   c) 1.0 m/s^2  
   d) 60 m/s^2  
   e) 3.0 m/s^2

4. A 5.0 kg object is suspended by a string from the ceiling of an elevator that is accelerating upward at 2.6 m/s^2. What is the tension in the string?
   a) 49 N  
   b) 36 N  
   c) 62 N  
   d) 13 N  
   e) 52 N
5. Determine the angle between the directions of vector \( \vec{A} = 3.00\hat{i} + 1.00\hat{j} \) and vector \( \vec{B} = -3.00\hat{i} + 3.00\hat{j} \).
   a) 26.6°
   b) 30.0°
   c) 88.1°
   d) 117°
   e) 45.2°

6. For an object moving in a circular path at constant speed, which of the following is true?
   a) velocity is constant, acceleration is constant
   b) velocity is constant, acceleration is changing
   c) velocity is changing, acceleration is constant
   d) velocity is changing, acceleration is changing
   e) The average velocity has magnitude \(1/2\) of its maximum.

7. A particle moves at constant speed in a circular path. The instantaneous velocity and instantaneous acceleration vectors are:
   a) both tangent to the circular path
   b) both perpendicular to the circular path
   c) perpendicular to each other
   d) opposite to each other
   e) none of the above

8. An object moving at a constant speed goes at 10 revolutions per minute around a circle with a diameter of 4.0 m. What is the magnitude of the instantaneous acceleration of the particle?
   a) 2.2 m/s²
   b) 2.7 m/s²
   c) 3.3 m/s²
   d) 3.8 m/s²
   e) 2.9 m/s²
9. A box of mass \( m \) is pressed against (but not attached to) an ideal spring of force constant \( k \) and negligible mass, compressing the spring a distance \( x \). After it is released, the box slides up a frictionless incline as shown in the figure and eventually stops. If we repeat this experiment but instead compress the spring a distance \( 2x \)

a) the box will go up the incline twice as high as before.
b) just as it moves free of the spring, the box will be traveling twice as fast as before.
c) just as it moves free of the spring, the box will be traveling four times as fast as before.
d) just as it moves free of the spring, the box will have twice as much kinetic energy as before.
e) just before it is released, the box has twice as much elastic potential energy as before.

10. A sled of mass \( m \) is given a kick on a frozen pond. The kick imparts to it an initial speed \( v_i = 2.00 \text{ m/s} \). The coefficient of kinetic friction between the sled and the ice is \( \mu_k = 0.100 \). Using energy considerations, find the distance the sled moves before it stops.

a) 20.0 m  
b) 10.0 m  
c) 4.08 m  
d) 2.04 m  
e) 1.02 m

11. A force \( \vec{F} \) is applied to an object over a displacement \( \vec{s} \). If the angle between \( \vec{F} \) and \( \vec{s} \) is \( 130^\circ \), then the work done by this force is:

a) Positive  
b) Negative  
c) Zero  
d) Cannot be determined without knowing the magnitude of \( \vec{s} \).  
e) Cannot be determined without knowing the magnitude of \( \vec{F} \).
12. Tarzan, who has a mass of 73.0 kg, swings on a 7.00 m vine. When he gets to the lowest point of his path, he is moving at a speed of 6.32 m/s. What is the tension in the vine at this lowest point of his path?

   a) 360 N
   b) 1.51 kN
   c) 1.13 kN
   d) 417 N
   e) 2.23 kN

13. At what rate is the gravitational force doing work on a 2.0 kg projectile at an instant when the velocity of the projectile is 4.0 m/s directed 30° above the horizontal?

   a) +39 W
   b) -78 W
   c) -39 W
   d) +78 W
   e) +25 W

14. In your design for a tall building you have an elevator weighing 29.9 kN, including cable and maximum load. If you want your elevator to accelerate upwards at a rate of 1.00 m/s² to a maximum speed of 3.00 m/s, what is the minimum power output that your motor should have in order to pull the elevator cable as your design requires? (Assume no friction forces act on the moving elevator).

   a) 98.8 kW
   b) 89.6 kW
   c) 32.8 kW
   d) 29.9 kW
   e) It will depend on the number of floors the elevator travels.
15. A block of weight $w_{\text{block}} = 1520$ N sits on top of a horizontal surface and is connected to a hanging mass as shown. If the coefficients of kinetic and static friction between the block and the ramp are $\mu_k = 0.3$ and $\mu_s = 0.45$ respectively, what is the maximum possible weight of the hanging mass such that the blocks remain motionless.

a) 600 N  
b) 1898 N  
c) 456 N  
d) 684 N  
e) 769 N