1. If $\theta = 40^\circ$ and the tension in string 2 is 30 N, determine $M$.

   - a) 3.4 kg
   - b) 3.6 kg
   - c) 2.6 kg
   - d) 4.9 kg
   - e) 7.5 kg

2. Two forces are the only forces acting on a 3.0-kg object which moves with an acceleration of 3.0m/s$^2$ in the positive y direction. If one of the forces acts in the positive x direction and has a magnitude of 8.0 N, what is the magnitude of the other force?

   $\sum F_x = m a_x = \left(3 \times 10^{-3}\right)\left(3 \times 10^{-2}\right) = \theta N$

   - a) 12 N
   - b) 14 N
   - c) 16 N
   - d) 18 N
   - e) 22 N

3. A heavy weight is supported by two cables that exert tensions of magnitude $T_1$ and $T_2$. Which statement is correct?

   - a) $T_1 = T_2$
   - b) $T_{1y} = T_{2y}$
   - c) $T_1 > T_2$
   - d) $T_1 < T_2$
   - e) We need the mass of the box in order to determine the correct answer.

4. In order to jump off the floor, the floor must exert a force on you

   - a) in the direction of and equal to your weight.
   - b) opposite to and equal to your weight.
   - c) in the direction of and less than your weight.
   - d) opposite to and less than your weight.
   - e) opposite to and greater than your weight.
5. A stunt pilot weighing 0.70 kN performs a vertical circular dive of radius 0.80 km. At the bottom of the dive, the pilot has a speed of 0.20 km/s which at that instant is not changing. What force does the plane exert on the pilot?

\[\sum F = m\frac{v^2}{R}\]

\[F_p - F_g = m\frac{v^2}{R}\]

- a) 3.6 kN up
- b) 4.3 kN up
- c) 2.9 kN down
- d) 2.9 kN up
- e) 5.8 kN down

6. An object attached to the end of a string swings in a vertical circle \((R = 1.2 \text{ m})\), as shown. At an instant when \(\theta = 30^\circ\), the speed of the object is 5.1 m/s and the tension in the string has a magnitude of 20 N. What is the mass of the object?

\[\sum F = m\frac{v^2}{R}\]

\[\theta = \theta_0 + \theta = 60^\circ\]

- a) 2.0 kg
- b) 1.5 kg
- c) 1.8 kg
- d) 1.2 kg
- e) 0.80 kg

7. When a car goes around a circular curve on a level road without slipping,

- a) no frictional force is needed because the car simply follows the road.
- b) the frictional force of the road on the car increases when the car’s speed decreases.
- c) the frictional force of the road on the car increases when the car’s speed increases.
- d) the frictional force of the road on the car increases when the car moves to the outside of the curve.
- e) there is no net frictional force because the road and the car exert equal and opposite forces on each other.
8. What is the net force on a 10-kg solid steel sphere falling in air at terminal speed?  
   a) 980 N  
   b) 200 N  
   c) 98 N  
   d) 49 N  
   e) Some value other than those given above.

9. A constant force of 15 N in the negative y direction acts on a particle as it moves from the origin to the point \(-2.5\hat{i} + 3\hat{j} + \hat{k}\) m. How much work is done by the given force during this displacement?  
   a) +45 J  
   b) -45 J  
   c) +30 J  
   d) -30 J  
   e) +75 J

10. The horizontal surface on which the block slides is frictionless. The speed of the block before it touches the spring is 6.0 m/s. How fast is the block moving at the instant the spring has been compressed 15 cm?  
    k = 2.0 kN/m  
    
    \[ E_g = \frac{1}{2}mv^2 \]  
    \[ \frac{1}{2}mv^2 = \frac{1}{2}kv^2 + \frac{1}{2}m \nu_f^2 \]  
    \[ \nu_f = 3.7 \text{ m/s} \]
11. In a contest, two tractors, starting from rest, pull two identical blocks of stone the same distance over identical surfaces. The coefficients of static and kinetic friction, respectively are: $\mu_s = 0.60$, $\mu_k = 0.50$. If block A is moving twice as fast as block B when it crosses the finish line. Which statement is correct?

   a) When they cross the finish line, Block A has twice as much kinetic energy as block B.
   b) Friction forces do twice as much work on Block B than on Block A.
   c) Friction forces do 4 times as much work on Block B than on Block A.
   d) The work done by the tractor pulling block A is four times the work done by the tractor pulling Block B.
   e) The total work done on block A is four times the work done on block B.

$$\sqrt{\text{Total}} = \frac{1}{2}mv^2$$

12. If the scalar (dot) product of two vectors is negative, it means that

   a) there was a calculator error.
   b) the angle between the vectors is less than 90 degrees.
   c) the angle between the vectors is 90 degrees.
   d) the angle between the vectors is greater than 270 degrees.
   e) the angle between the vectors is between 90 and 180 degrees.

13. A champion athlete can produce one horsepower (746 W) for a short period of time. If a 70-kg athlete were to bicycle to the summit of a 500-m high mountain while expending power at this rate, she would have used at least ______ J of energy.

   a) 746
   b) $3.43 \times 10^5$
   c) $3.73 \times 10^5$
   d) $7.46 \times 10^5$
   e) $2.61 \times 10^7$
14. Two equal masses are raised at constant velocity by ropes that run over pulleys, as shown below. Mass B is raised twice as fast as mass A. The magnitudes of the forces are \( F_A \) and \( F_B \), while the power supplied is respectively \( P_A \) and \( P_B \). Which statement is correct?

\[
\begin{align*}
\rho & = F \cdot \gamma / t \\
\gamma_B & = \gamma_A \\
\gamma_B & = 2\gamma_A \\
\rho_B & = 2\rho_A
\end{align*}
\]

(a) \( F_B = F_A; P_B = P_A \).
(b) \( F_B = F_A; P_B = 2P_A \).
(c) \( F_B = 2F_A; P_B = P_A \).
(d) \( F_B = 2F_A; P_B = 2P_A \).
(e) \( P_A = F_A; P_B = F_B \).

15. A block is pushed across a horizontal surface by the force shown. If the coefficient of kinetic friction between the block and the surface is 0.30, \( F = 20 \, \text{N}, \theta = 30^\circ \), and \( M = 3.0 \, \text{kg} \), what is the magnitude of the acceleration of the block?

\[
\begin{align*}
\mathbf{F}_x & = F \cos \theta \\
\mathbf{F}_y & = F \sin \theta \\
\sum \mathbf{F}_x & = 0 = M_0 + F - N \\
N & = M_0 + F_y = 3 \times 9.4 \, \text{N} \\
\sum \mathbf{F}_y & = ma_0 = \mathbf{F}_y - \mathbf{F} - F \cos \theta = -a_0 N \\
a & = 1.8 \, \text{m/s}^2
\end{align*}
\]