\[
\sin 30^\circ = \cos 60^\circ = 0.5 \\
\sin 60^\circ = \cos 30^\circ = 0.87
\]

1. “Whenever one object exerts a force on a second object, the second exerts an equal and opposite force on the first.” This is the definition of which Newton’s law of motion?

   (a) First  
   (b) Second 
   (c) Third  
   (d) Fourth

2. Newton’s second law can be expressed as:

   (a) \[
   \sum F = m \ddot{v}
   \]
   (b) \[
   \sum \vec{F} = m \vec{a}
   \]
   (c) \[
   \sum \vec{a} = m \vec{F}
   \]

3. A 0.1-kg baseball traveling 10 m/s strikes the catcher’s mitt, which, in bringing the ball to rest, recoils backward 0.5 m. What was the magnitude of the force applied by the ball on the glove?

   (a) 0  
   (b) 10 N  
   (c) 100 N  
   (d) none of these

**Questions 4-5.** Consider the forces \( \mathbf{F}_1 \) and \( \mathbf{F}_2 \) below:

4. What is the magnitude of the \( x \) component of the resulting force \( \mathbf{F}_1 + \mathbf{F}_2 \)?

   (a) 0  
   (b) 3.7 N  
   (c) 8.7 N  
   (d) 10 N

5. What is the magnitude of the \( y \) component of the resulting force \( \mathbf{F}_1 + \mathbf{F}_2 \)?

   (a) 0  
   (b) 3.7 N  
   (c) 8.7 N  
   (d) 10 N
Questions 6-7. Consider two boxes with masses \( m_1 = 1 \text{ kg} \) and \( m_2 = 2 \text{ kg} \) connected by a cord whose mass can be neglected. Assume there is no friction.

6. The acceleration of the system is:
   (a) 0 \hspace{1cm} (b) 1 \text{ m/s}^2 \hspace{1cm} (c) 3.27 \text{ m/s}^2 \hspace{1cm} (d) 9.8 \text{ m/s}^2

7. The tension in the cord is:
   (a) 0 \hspace{1cm} (b) 9.80 \text{ N} \hspace{1cm} (c) 13.07 \text{ N} \hspace{1cm} (d) 19.60 \text{ N}

Questions 8-9. A 10.0-kg box is pulled along a horizontal frictionless surface by a force \( F_p = 20.0 \text{ N} \) which is applied at a 30° angle with respect to the horizontal.

8. What is the acceleration of the box?
   (a) 0 \hspace{1cm} (b) 1.74 \text{ m/s}^2 \hspace{1cm} (c) 2 \text{ m/s}^2 \hspace{1cm} (d) none of these

9. The magnitude of the normal force on the box is:
   (a) 0 \hspace{1cm} (b) 88 \text{ N} \hspace{1cm} (c) 98 \text{ N} \hspace{1cm} (d) none of these

10. The force of friction is always oriented in the opposite direction from the direction of motion.
    (a) True \hspace{1cm} (b) False \hspace{1cm} (c) cannot be answered
Questions 11 – 13. Consider the system shown below: two boxes with masses $m_1=1$ kg and $m_2=2$ kg are connected by a cord running over a pulley. The coefficient of kinetic friction between box 1 and the table is 0.20. Neglect the mass of the cord and the pulley, and any friction in the pulley.

11. What is the acceleration of the system?
   (a) 0  (b) 0.6 g  (c) 1.5 g  (d) 3 g

12. What is the normal force on box $m_1$?
   (a) 0  (b) 1 N  (c) 9.8 N  (d) 19.6 N

13. What is the normal force on box $m_2$?
   (a) 0  (b) 1 N  (c) 9.8 N  (d) 19.6 N

Questions 14-15. Consider a box of mass $m$ moving along an incline with angle $\theta$. Coefficient of kinetic frictions is $\mu_k$.

14. The acceleration of the box is:
   (a) $g \sin \theta$  (b) $g(\sin \theta - \mu_k \cos \theta)$  (c) $g \cos \theta$  (d) $g(\cos \theta - \mu_k \sin \theta)$

15. The magnitude of friction force is:
   (a) $\mu_k m g \cos \theta$  (b) $\mu_k m g \sin \theta$  (c) $mg(\sin \theta - \mu_k \cos \theta)$
Questions 16 – 17. A box of mass \( m_1=10 \text{ kg} \) rest on a surface inclined at \( \theta = 30^\circ \) to the horizontal. It is connected by a lightweight cord, which passes over a massless and frictionless pulley, to a second box of mass \( m_2=10 \text{ kg} \), which hangs freely, as shown below. The coefficient of kinetic friction is \( \mu_k=0.1 \). Take \( g \approx 10 \text{ m/s}^2 \).

16. What is the acceleration of the system?

   (a) 0   (b) 1.03 m/s\(^2\)   (c) 2.07 m/s\(^2\)   (d) 4.13 m/s\(^2\)

17. What is the normal force on box \( m_1 \)?

   (a) 0   (b) 87 N   (c) 98 N   (d) 100 N

18. The net force on an object executing uniform circular motion is always oriented away from the center of the circle.

   (a) True   (b) False   (c) cannot be answered

Questions 19-20. A 0.1-kg ball on the end of a 1-m long cord (whose mass is negligible) is swung in a horizontal circle. The ball makes 1 revolution per second.

19. What is the centripetal acceleration of the ball?

   (a) 0   (b) 3.14 m/s\(^2\)   (c) 6.28 m/s\(^2\)   (d) 39.4 m/s\(^2\)

20. What is the magnitude of the net radial force on the ball?

   (a) 0   (b) 3.14 N   (c) 3.94 N   (d) 6.28 N