1. A jet plane in straight horizontal flight passes over your head. When it is directly above you. The sound seems to come from a point behind the plane in a direction 30° from the vertical. The speed of the plane is:
   A. the same as the speed of sound
   B. half the speed of sound
   C. three-fifths the speed of sound
   D. 0.866 times the speed of sound

2. Velocity is defined as:
   A. rate of change of position with time
   B. position divided by time
   C. rate of change of acceleration with time
   D. a speeding up or slowing down
   E. change of position

3. A plane traveling north at 200m/s turns and then travels south at 200m/s. The change in its velocity is:
   A. zero
   B. 200m/s north
   C. 200m/s south
   D. 400m/s north
   E. 400m/s south

4. Which of the following is NOT an example of accelerated motion?
   A. Vertical component of projectile motion
   B. Circular motion at constant speed
   C. A swinging pendulum
   D. Earth's motion about sun
   E. Horizontal component of projectile motion

5. Two bodies are falling with negligible air resistance, side by side, above a horizontal plane. If one of the bodies is given an additional horizontal acceleration during its descent, it:
   A. strikes the plane at the same time as the other body
   B. strikes the plane earlier than the other body
   C. has the vertical component of its velocity altered
   D. has the vertical component of its acceleration altered
   E. follows a straight line path along the resultant acceleration vector

6. Identical guns fire identical bullets horizontally at the same speed from the same height above level planes, one on the Earth and one on the Moon. Which of the following three statements is/are true?
   I. The horizontal distance traveled by the bullet is greater for the Moon.
   II. The flight time is less for the bullet on the Earth.
III. The velocities of the bullets at impact are the same.
A. III only
B. I and II only
C. I and III only
D. II and III only
E. I, II, III

7. A stone is thrown horizontally and follows the path XYZ shown. The direction of the acceleration of the stone at point Y is:

A. ↓
B. →
C. ↙
D. ↘
E. ↑

Answer: A

8. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h. At what distance $d$ should it release a heavy bomb to hit the target X? Take $g = 10$ m/s$^2$.

A. 150m
B. 295m
C. 420m
D. 2,550m
E. 15,000m
9. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45°. With what speed was it thrown?

A. 14m/s
B. 20m/s
C. 28m/s
D. 32m/s
E. 40m/s

10. A toy racing car moves with constant speed around the circle shown below. When it is at point A its coordinates are x = 0, y = 3m and its velocity is (6m/s)i. When it is at point B its velocity and acceleration are:

A. -(6m/s)j and (12m/s²)i, respectively
B. (6m/s)i and -(12m/s²)i, respectively
C. (6m/s)j and (12m/s²)i, respectively
D. (6m/s)i and (2m/s²)j, respectively
E. (6m/s)j and 0, respectively

11. A Newton is the force:
   A. of gravity on a 1 kg body
   B. of gravity on a 1 g body
   C. that gives a 1 g body an acceleration of 1 cm/s²
   D. that gives a 1 kg body an acceleration of 1m/s²
   E. that gives a 1 kg body an acceleration of 9.8m/s²

12. The term “mass” refers to the same physical concept as:
   A. weight
   B. inertia
13. Acceleration is always in the direction:
   A. of the displacement
   B. of the initial velocity
   C. of the final velocity
   D. of the net force
   E. opposite to the frictional force

14. The block shown moves with constant velocity on a horizontal surface. Two of the forces on it are shown. A frictional force exerted by the surface is the only other horizontal force on the block. The frictional force is:
   A. 0
   B. 2N, leftward
   C. 2N, rightward
   D. slightly more than 2N, leftward
   E. slightly less than 2N, leftward

15. A constant force of 8.0 N is exerted for 4.0 s on a 16-kg object initially at rest. The change in speed of this object will be:
   A. 0.5m/s
   B. 2m/s
   C. 4m/s
   D. 8m/s
   E. 32m/s

16. An object rests on a horizontal frictionless surface. A horizontal force of magnitude F is applied. This force produces an acceleration:
   A. only if F is larger than the weight of the object
   B. only while the object suddenly changes from rest to motion
   C. always
   D. only if the inertia of the object decreases
   E. only if F is increasing

17. Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is:
18. Three books (X, Y, and Z) rest on a table. The weight of each book is indicated. The force of book Z on book Y is:

A. 0
B. 5N
C. 9N
D. 14N
E. 19N

19. Two blocks, weighing 250N and 350N, respectively, are connected by a string that passes over a massless pulley as shown. The tension in the string is:

A. 210N
B. 290N
C. 410N
D. 500N
E. 4900N
20. A 70-N block and a 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 35-N block is:

A. 1.6 m/s²  
B. 3.3 m/s²  
C. 49 m/s²  
D. 6.7 m/s²  
E. 9.8 m/s²

21. A forward horizontal force of 12N is used to pull a 240-N crate at constant velocity across a horizontal floor. The coefficient of friction is:
A. 0.5  
B. 0.05  
C. 2  
D. 0.2  
E. 20

22. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force P as shown. In the diagram f is the magnitude of the force of friction, N is the magnitude of the normal force, and Fg is the magnitude of the force of gravity. Which of the following must be true?

A. \( P = f \) and \( N = F_g \)  
B. \( P = f \) and \( N > F_g \)  
C. \( P > f \) and \( N < F_g \)  
D. \( P > f \) and \( N = F_g \)  
E. none of these

23. A block is first placed on its long side and then on its short side on the same inclined plane, as shown. The block slides down the plane on its short side but remains at rest on its long side. A possible explanation is:
A. the short side is smoother
B. the frictional force is less because the contact area is less
C. the center of gravity is higher in the second case
D. the normal force is less in the second case
E. the force of gravity is more nearly down the plane in the second case

24. Block A, with a mass of 50 kg, rests on a horizontal table top. The coefficient of static friction is 0.40. A horizontal string is attached to A and passes over a massless, frictionless pulley as shown. The smallest mass m_B of block B, attached to the dangling end, that will start A moving when it is attached to the other end of the string is:

- A. 20 kg
- B. 30 kg
- C. 40 kg
- D. 50 kg
- E. 70 kg

25. The system shown remains at rest. Each block weighs 20 N. The force of friction on the upper block is:

- A. 4N
- B. 8N
- C. 12N
- D. 16N
- E. 20N
26. An object of mass \( m \) and another object of mass \( 2m \) are each forced to move along a circle of radius 1.0m at a constant speed of 1.0m/s. The magnitudes of their accelerations are:
   A. equal
   B. in the ratio of \( \sqrt{2} : 1 \)
   C. in the ratio of 2 : 1
   D. in the ratio of 4 : 1
   E. zero

27. A giant wheel, 40m in diameter, is fitted with a cage and platform on which a man can stand. The wheel rotates at such a speed that when the cage is at \( X \) (as shown) the force exerted by the man on the platform is equal to his weight. The speed of the man is:
   A. 14m/s
   B. 20m/s
   C. 28m/s
   D. 80m/s
   E. 120m/s

28. The iron ball shown is being swung in a vertical circle at the end of a 0.7-m long string. How slowly can the ball go through its top position without having the string go slack?
   A. 1.3m/s
   B. 2.6m/s
   C. 3.9m/s
   D. 6.9m/s
   E. 9.8m/s

29. A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is \( g \). Select the correct combination of forces that act on her when she is at the top. In the table \( F_g = \) force of gravity, down; \( F_b = \) seat belt force, down; and \( F_s = \) seat force, up.

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<tr>
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<th>( F_g )</th>
<th>( F_b )</th>
<th>( F_s )</th>
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<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>( mg )</td>
<td>0</td>
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30. Which of the following five graphs is correct for a particle moving in a circle of radius $r$ at a constant speed of 10m/s?

Answer: E