Chapter 4: MOTION IN TWO AND THREE DIMENSIONS

1. 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

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

3. Which of the following is a scalar quantity?
   A. Speed
   B. Velocity
   C. Displacement
   D. Acceleration
   E. None of these

4. Which of the following is a vector quantity?
   A. Mass
   B. Density
   C. Speed
   D. Temperature
   E. None of these

5. 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

6. A particle goes from $x = -2\,\text{m}$, $y = 3\,\text{m}$, $z = 1\,\text{m}$ to $x = 3\,\text{m}$, $y = -1\,\text{m}$, $z = 4\,\text{m}$. Its displacement is:
   A. $(1\,\text{m})\,\hat{\text{i}} + (2\,\text{m})\,\hat{\text{j}} + (5\,\text{m})\,\hat{\text{k}}$
   B. $(5\,\text{m})\,\hat{\text{i}} - (4\,\text{m})\,\hat{\text{j}} + (3\,\text{m})\,\hat{\text{k}}$
   C. $-(5\,\text{m})\,\hat{\text{i}} + (4\,\text{m})\,\hat{\text{j}} - (3\,\text{m})\,\hat{\text{k}}$
   D. $-(1\,\text{m})\,\hat{\text{i}} - (2\,\text{m})\,\hat{\text{j}} - (5\,\text{m})\,\hat{\text{k}}$
   E. $-(5\,\text{m})\,\hat{\text{i}} - (2\,\text{m})\,\hat{\text{j}} + (3\,\text{m})\,\hat{\text{k}}$

7. A jet plane in straight horizontal □ight 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-□fths the speed of sound
   D. 0.866 times the speed of sound
   E. twice the speed of sound

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

9. 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

10. The velocity of a projectile equals its initial velocity added to:
    A. a constant horizontal velocity
    B. a constant vertical velocity
    C. a constantly increasing horizontal velocity
    D. a constantly increasing downward velocity
    E. a constant velocity directed at the target

11. A stone thrown from the top of a tall building follows a path that is:

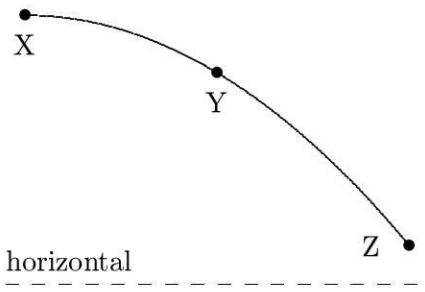
A. circular
B. made of two straight line segments
C. hyperbolic
D. parabolic
E. a straight line

12. 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 velocity 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

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

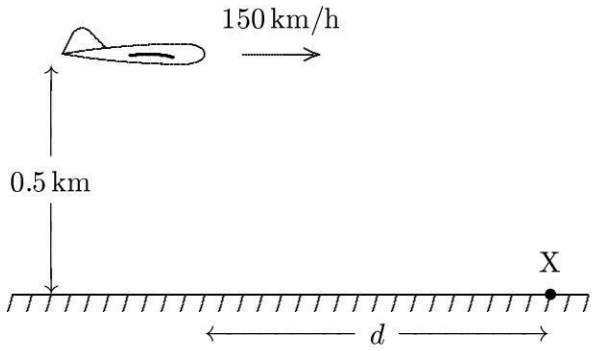


A. ↓
B. →
C. ↘
D. ↙
E. ↗

14. A bullet shot horizontally from a gun:
    A. strikes the ground much later than one dropped vertically from the same point at the same instant
    B. never strikes the ground
    C. strikes the ground at approximately the same time as one dropped vertically from the same point at the same instant
    D. travels in a straight line
    E. strikes the ground much sooner than one dropped from the same point at the same instant

15. A bomber flying in level flight with constant velocity releases a bomb before it is over the target. Neglecting air resistance, which one of the following is NOT true?
    A. The bomber is over the target when the bomb strikes
    B. The acceleration of the bomb is constant
    C. The horizontal velocity of the plane equals the vertical velocity of the bomb when it hits the target
    D. The bomb travels in a curved path
    E. The time of flight of the bomb is independent of the horizontal speed of the plane

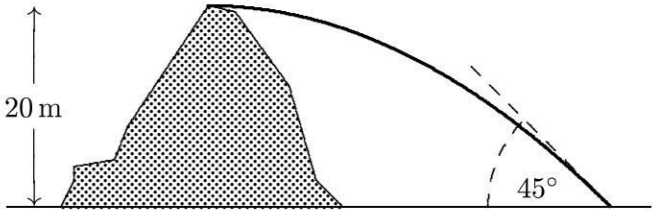
16. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h. At what distance d should it release a heavy bomb to hit the target X? Take $g = 10\,\text{m/s}^2$.



    A. 150 m
    B. 295 m
    C. 420 m
    D. 2550 m
    E. 15,000 m

17. An object is shot from the back of a railroad flatcar moving at 40 km/h on a straight horizontal road. The launcher is aimed upward, perpendicular to the bed of the flatcar. The object falls:
    A. in front of the flatcar
    B. behind the flatcar
    C. on the flatcar
    D. either behind or in front of the flatcar, depending on the initial speed of the object
    E. to the side of the flatcar

18. 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. 14 m/s
    B. 20 m/s
    C. 28 m/s
    D. 32 m/s
    E. 40 m/s

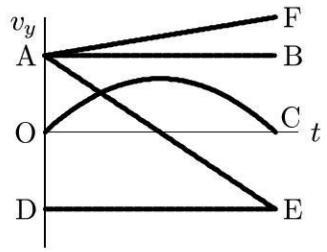
19. A stone is thrown outward from the top of a 59.4-m high cliff with an upward velocity component of 19.5 m/s. How long is stone in the air?
    A. 4.00 s
    B. 5.00 s
    C. 6.00 s
    D. 7.00 s
    E. 8.00 s

20. A large cannon is fired from ground level over level ground at an angle of 30° above the horizontal. The muzzle speed is 980 m/s. Neglecting air resistance, the projectile will travel what horizontal distance before striking the ground?
    A. 4.3 km
    B. 8.5 km
    C. 43 km
    D. 85 km
    E. 170 km

21. A boy on the edge of a vertical cliff 20 m high throws a stone horizontally outward with a speed of 20 m/s. It strikes the ground at what horizontal distance from the foot of the cliff? Use $g = 10\,\text{m/s}^2$.

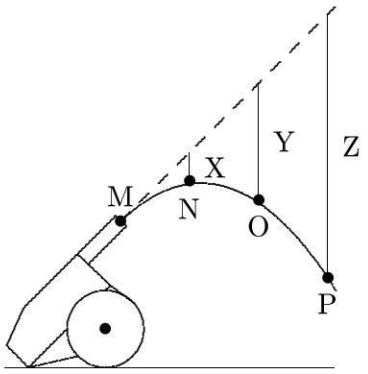
A. 10 m
B. 40 m
C. 50 m
D. $50\sqrt{5}$ m
E. none of these

22. Which of the curves on the graph below best represents the vertical component v_y of the velocity versus the time t for a projectile fired at an angle of 45° above the horizontal?



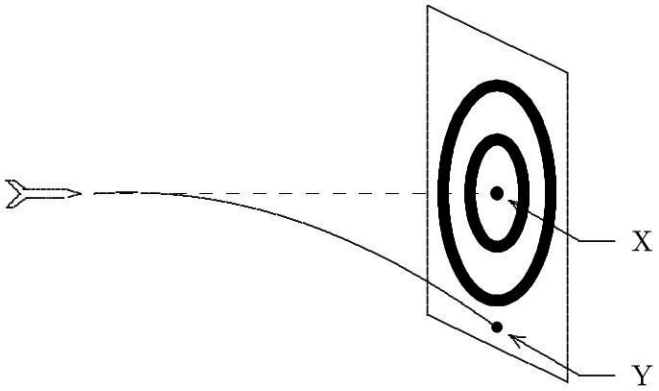
A. OC
B. DE
C. AB
D. AE
E. AF

23. A cannon fires a projectile as shown. The dashed line shows the trajectory in the absence of gravity; points MNOP correspond to the position of the projectile at one second intervals. If $g = 10\,\text{m/s}^2$, the lengths X,Y,Z are:



A. 5 m, 10 m, 15 m
B. 5 m, 20 m, 45 m
C. 10 m, 40 m, 90 m
D. 10 m, 20 m, 30 m
E. 0.2 m, 0.8 m, 1.8 m

24. A dart is thrown horizontally toward X at 20 m/s as shown. It hits Y 0.1 s later. The distance XY is:



A. 2 m
B. 1 m
C. 0.5 m
D. 0.1 m
E. 0.05 m