College Physics, 2e **(Knight)**
Chapter 3 Vectors and Motion in Two Dimensions

3.1 Quantitative

1) The components of vectors $\vec{\mathbf{B}}$ and $\vec{\mathbf{C}}$ are given as follows:

$\mathbf{B_x}$ = -9.2 $\mathbf{C_x}$ = -4.5
$\mathbf{B_y}$ = -6.1 $\mathbf{C_y}$ = + 4.3

The angle (less than 180 degrees) between vectors $\vec{\mathbf{B}}$ and $\vec{\mathbf{C}}$, in degrees, is closest to:
A) 77
B) 103
C) 10
D) 170
E) 84
Answer: A
Var: 50+

2) The magnitude of $\vec{\mathbf{A}}$ is 5.5. Vector $\vec{\mathbf{A}}$ lies in the second quadrant and forms an angle of 34 degrees with the y-axis. The components, $\mathbf{A_x}$ and $\mathbf{A_y}$, are closest to:
A) $\mathbf{A_x}$ = - 3.1, $\mathbf{A_y}$ = + 4.6
B) $\mathbf{A_x}$ = + 3.1, $\mathbf{A_y}$ = - 4.6
C) $\mathbf{A_x}$ = + 4.6, $\mathbf{A_y}$ = - 3.1
D) $\mathbf{A_x}$ = - 4.6, $\mathbf{A_y}$ = + 3.1
E) $\mathbf{A_x}$ = - 4.6, $\mathbf{A_y}$ = - 3.1
Answer: A
Var: 50+

3) A hiker walks 6.7 miles to the east in 5.1 hours then turns around and walks 1.1 miles to the west in 1.0 hours. What was her average velocity during the trip?
A) 0.92 mph
B) 1.3 mph
C) 1.2 mph
D) 3.9 mph
Answer: A
Var: 50+

4) Vector $\vec{\mathbf{A}}$ has length 4 units and directed to the north. Vector $\vec{\mathbf{B}}$ has length 9 units and is directed to the south. Calculate the magnitude and direction of $\vec{\mathbf{A}} + \vec{\mathbf{B}}$.
A) 5 units, south
B) 5 units, north
C) 13 units, north
D) 13 units, south
Answer: A
Var: 20

5) You walk 55 m to the north, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?
A) 87 m
B) 50 m
C) 94 m
D) 46 m
Answer: A
Var: 31

6) You walk 53 m to the north, then turn 60° to your right and walk another 45 m. Determine the direction of your displacement vector. Express your answer as an angle relative to east.
A) 63° N of E
B) 50° N of E
C) 57° N of E
D) 69° N of E
Answer: A
Var: 50+

7) Vector $\vec{\mathbf{A}}$ points to the north and has length A. Vector $\vec{\mathbf{B}}$ points to the east and has length B = 2.0 A. Find the magnitude of $\vec{\mathbf{C}} = 4\ \vec{\mathbf{A}} + \vec{\mathbf{B}}$ in terms of A.
A) 4.5A
B) 6A
C) 3.6A
D) 3.1A
Answer: A
Var: 50+

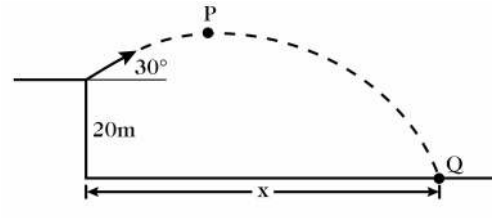
8) Vector $\vec{\mathbf{A}}$ points to the north and has length A. Vector $\vec{\mathbf{B}}$ points to the east and has length B = 2.5A. Find the direction of $\vec{\mathbf{C}} = 7.4\ \vec{\mathbf{A}} + \vec{\mathbf{B}}$. Express your answer as an angle relative to east.
A) 71° north of east
B) 19° north of east
C) 82° north of east
D) 60° north of east
Answer: A
Var: 50+

9) A rabbit trying to escape a fox runs north for 8.0 m, darts northwest for 1.0 m, then drops 1.0 m down a hole into its burrow. What is the magnitude of the net displacement of the rabbit?
A) 8.8 m
B) 8.1 m
C) 66 m
D) 10 m
Answer: A
Var: 50+

10) Karim rides his bike with velocity $\vec{\mathbf{v}}$ = (8.4 m/s, 25° north of east) for 10 minutes. How far to the north of his starting position does Karim end up?
A) 2100 m
B) 4600 m
C) 76 m
D) 36 m
Answer: A
Var: 50+

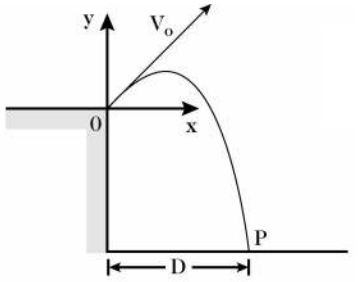
11) Jordan ran up the hill at 7.0 m/s. The horizontal component of Jordan's velocity vector was 1.8 m/s. What was the angle of the hill?
A) 75 degrees
B) 57 degrees
C) 33 degrees
D) 15 degrees
Answer: A
Var: 47

12) Jeff ran up the hill at 7.0 m/s. The horizontal component of Jeff's velocity vector was 5.1 m/s. What was the vertical component of Jeff's velocity?
A) 4.8 m/s
B) 4.3 m/s
C) 3.8 m/s
D) 3.4 m/s
Answer: A
Var: 50+



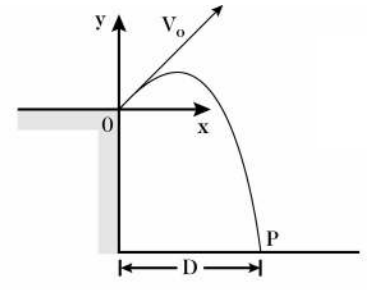
13) A projectile is fired from the origin (at y = 0 m) as shown in the figure. The initial velocity components are v_{ox} = 940 m/s and v_{oy} = 96 m/s. The projectile reaches maximum height at point P, then it falls and strikes the ground at point Q. In the figure, the y-coordinate of point P is closest to:
A) 470 m
B) 45,550 m
C) 45,080 m
D) 940 m
E) 90,160 m
Answer: A
Var: 1

14) A projectile is fired at time t = 0.0 s, from point 0 at the edge of a cliff, with initial velocity components of v_{ox} = 30 m/s and v_{oy} =300 m/s. The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 75.0 s.



In the figure, the horizontal distance D is closest to:
A) 2250 m
B) 2520 m
C) 2790 m
D) 3060 m
E) 3330 m
Answer: A
Var: 50+

15) A projectile is fired at time t = 0.0 s, from point 0 at the edge of a cliff, with initial velocity components of v_{ox} = 50 m/s and v_{oy} =200 m/s. The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 50.0 s.



In the figure, the y-coordinate of the projectile when its x-coordinate is 1000 m is closest to:
A) + 2040 m
B) 150 m
C) - 150 m
D) + 1240 m
E) + 600 m
Answer: A
Var: 50+

16) An apple falls straight down from an apple tree growing on a 20° slope. The apple hits the ground with a speed of 16.2 m/s. What is the component of the apple's impact velocity parallel to the ground?
A) 5.5 m/s
B) 8.7 m/s
C) 12 m/s
D) 15 m/s
Answer: A
Var: 50+

17) A rescue plane spots a survivor 132 m directly below and releases an emergency kit with a parachute. If the package descends at a constant vertical acceleration of 6.89 m/s^2 and the initial plane horizontal speed was 68.9 m/s, how far away from the survivor will it hit the waves?
A) 426 m
B) 2.64 km
C) 301 m
D) 446 m
Answer: A
Var: 50+

18) A boy throws a rock with an initial velocity of 3.13 m/s at 30.0° above the horizontal. How long does it take for the rock to reach the maximum height of its trajectory?
A) 0.160 s
B) 0.282 s
C) 0.313 s
D) 0.441 s
Answer: A
Var: 50+

19) A cat leaps to catch a bird. If the cat's jump was at 60.0° off the ground and its initial velocity was 2.74 m/s, what is the highest point of its trajectory?
A) 0.29 m
B) 0.58 m
C) 10.96 m
D) 0.19 m
Answer: A
Var: 50+

20) A football kicker is attempting a field goal from 44 m out. The ball is kicked and just clears the lower bar with a time of flight of 2.9 s. If the angle of the kick was 45°, what was the initial speed of the ball?
A) 21.5 m/s
B) 19.7 m/s
C) 2.2 m/s
D) 39 m/s
Answer: A
Var: 50+

21) A child is sitting on the outer edge of a merry-go-round that is 18 m in diameter. If the merry-go-round makes 8.3 rev/min, what is the velocity of the child in m/s?
A) 7.8 m/s
B) 15.6 m/s
C) 1.2 m/s
D) 5.5 m/s
Answer: A
Var: 50+

22) Two particles, A and B, are in uniform circular motion about a common center. The acceleration of particle A is 4.7 times that of particle B. Particle B takes 2.4 times as long for a rotation as particle A. The ratio of the radius of the motion of particle A to that of particle B is closest to:
A) 0.82
B) 2.0
C) 3.8
D) 0.51
E) 11
Answer: A
Var: 50+

23) An aircraft performs a maneuver called an aileron roll. During this maneuver, the plane turns like a screw as it maintains a straight flight path, by using its ailerons to set the wings in circular motion. If it takes the plane 35 s to complete the circle and each wing length is 4.6 m, what is the acceleration of the wing tip?
A) 0.15 m/s^2
B) 0.69 m/s^2
C) 6.7 m/s^2
D) 1.4 m/s^2
Answer: A
Var: 50+

24) A small boat is moving at a velocity of 3.35 m/s when it is accelerated by a river current perpendicular to the initial direction of motion. If the current acceleration is 0.750 m/s^2, what will the new velocity of the boat be after 33.5 s?
A) 25.3 m/s at 82.4° from initial direction of motion
B) 25.3 m/s at 7.59° from initial direction of motion
C) 640.1 m/s at 82.4° from initial direction of motion
D) 640.1 m/s at 7.59° from initial direction of motion
Answer: A
Var: 50+

25) A ship moving initially at 10.7 m/s due North, drifts due NE at the same speed. To correct the bearing, the captain accelerates the engine and turns the rudder NW. If the engines deliver a constant acceleration of 4.4 m/s^2, how long will it take to assume the original course again?
A) 2.4 s
B) 3.4 s
C) 1.7 s
D) 1.2 s
Answer: A
Var: 50+

26) A plane flying at 70.0 m/s suddenly stalls. If the acceleration during the stall is 9.8 m/s^2 directly downward, the stall lasts 5.0 s, and the plane was originally climbing at 25° to the horizontal, what is the velocity after the stall?
A) 66 m/s at -17°
B) 66 m/s at +17°
C) 80 m/s at -37°
D) 80 m/s at +37°
Answer: A
Var: 1

27) An electron moves with a horizontal velocity of 3.0×10^6 m/s as it enters a deflector inside a TV tube. The electron strikes the screen after traveling 17.0 cm horizontally and 40.0 cm vertically upward. What is the constant vertical acceleration provided by the deflector?
A) 2.5×10^{14} m/s^2
B) 8.3×10^2 m/s^2
C) 1.4×10^4 m/s^2
D) 1.2×10^{14} m/s^2
Answer: A
Var: 50+

28) A boat crosses a river at a constant engine speed of 8.0 cm/s under the influence of a constant perpendicular current acceleration of 0.060 m/s^2. How far off a straight course does it drift in 2.3 min?
A) 570 m
B) 0.16 m
C) 4.1 m
D) 1700 m
Answer: A
Var: 50+

29) A glider is tugged by an airplane at 81 m/s when it is released. If the original speed was along the horizontal and the glider is now under a constant acceleration of 2.4 m/s^2 at 1.1° below the horizontal due to air drag, how long will it take to reach the ground 5.7 km below?
A) 500 s
B) 250,000 s
C) 2.2 s
D) 4.8 s
Answer: A
Var: 50+

30) What is the maximum distance we can shoot a dart, provided our toy dart gun gives a maximum initial velocity of 2.78 m/s?
A) 0.79 m
B) 1.58 m
C) 1.39 m
D) More information needed
Answer: A
Var: 50+

31) A fisherman casts his bait into the river at an angle of 25°. As the line unravels, he notices that the bait and hook reach a maximum height of 3.9 m. What was the initial velocity he launched the bait with?
A) 21 m/s
B) 9.2 m/s
C) 10 m/s
D) 8.4 m/s
Answer: A
Var: 30

32) A hobby rocket reaches a height of 72.3 m and lands 111 m from the launch point. What was the angle of launch?
A) 69.0°
B) 67.4°
C) 22.6°
D) -44.8°
Answer: A
Var: 50+

33) A plane flies directly from city A to city B, which are separated by 2300 mi. From A to B, the plane flies into a 65 mi/h headwind. On the return trip from B to A, the wind velocity is unchanged. The trip from B to A takes 65 min less than the trip from A to B. What is the airspeed (assumed constant) of the plane?
A) 530 mi/h
B) 400 mi/h
C) 480 mi/h
D) 610 mi/h
Answer: A
Var: 31

34) You are taking a turn at 23.0 m/s on a ramp of radius 39.0 m. What is your acceleration?
A) 13.6 m/s^2
B) 0.590 m/s^2
C) 66.1 m/s^2
D) 1.70 m/s^2
Answer: A
Var: 50+

35) An aircraft performs a maneuver called an aileron roll. During this maneuver, the plane turns like a screw as it maintains a straight flight path, by using its ailerons to set the wings in circular motion. Due to structural strength, an airplane can only withstand an acceleration of 6.1 m/s^2 on its wing tips. If the wing span is 6.0 m, what is the shortest time it can make a full turn when it performs an aileron roll?
A) 4.4 s
B) 6.0 s
C) 0.70 s
D) 6.2 s
Answer: A
Var: 50+

3.2 True/False

1) The product of a vector by a scalar is a vector having the same direction of the original vector but a different magnitude.
Answer: FALSE
Var: 1

2) The magnitude of a vector cannot be smaller than the magnitude of any of its components.
Answer: TRUE
Var: 1

3) The magnitude of the resultant of two vectors must be greater than or equal to the magnitude of each of these vectors.
Answer: FALSE
Var: 1

4) The magnitude of the displacement vector from A to B can never be less than the distance from A to B, but it can be greater than that distance.
Answer: FALSE
Var: 1

5) The magnitude of the displacement vector of an object is equal to the distance that object has moved.
Answer: FALSE
Var: 1

6) The components of a vector will be the same no matter what coordinate system is used to express that vector.
Answer: FALSE
Var: 1

7) A grasshopper leaps into the air at a 62 degree angle above the horizontal. At its highest point, the grasshopper's velocity and acceleration are equal to zero.
Answer: FALSE
Var: 1

8) You throw a 5.0 kg stone from the top of a cliff with an initial vertical velocity of 8.0 m/s downward and an initial horizontal velocity of 7.0 m/s away from the cliff, and it feels no air resistance. After the stone is in the air but free of your hand, its acceleration remains constant at 9.8 m/s^2 downward but its speed changes.
Answer: TRUE
Var: 1

9) You can launch a projectile with a fixed initial speed but at any angle above the horizontal, and it feels no air resistance. The time for it to return to the ground does not depend on the angle at which you launch it.
Answer: FALSE
Var: 1

10) A ball is thrown at an angle above the horizontal from the top of a cliff and feels no air resistance. A runner at the base of the cliff moves horizontally so that she is always under the ball. In this runner's reference frame, the path of the ball is a straight line rather than a parabola.
Answer: TRUE
Var: 1

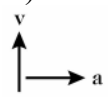
11) A football is kicked toward the goal posts and feels no air resistance. While it is in the air, the only force acting on it is 9.8 m/s^2 downward due to gravity.
Answer: FALSE
Var: 1

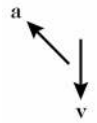
3.3 Conceptual

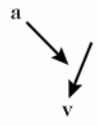
1) The sum of the two vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ is equal to zero. What can you conclude about $\vec{\mathbf{A}}$ and $\vec{\mathrm{B}}$?
Answer: The vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ have the same magnitude but are in opposite directions.
Var: 1

2) What is the minimum number of vectors (none of which have the same magnitude) for which it is theoretically possible that the sum of those vectors can be equal to zero?
Answer: It is possible with three (or more) vectors. Three is the minimum number for which the condition may be satisfied.
Var: 1

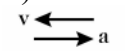
3) Which of the following is NOT a vector?
A) speed
B) acceleration
C) velocity
D) displacement
Answer: A
Var: 1

4) Shown here are the velocity and acceleration vectors for an object in several different types of motion. In which case is the object slowing down and turning to its right?
A)


B)


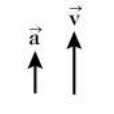
C)


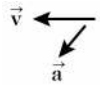
D)

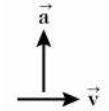

E)


Answer: B
Var: 1

5) Shown here are the velocity and acceleration vectors for an object in several different types of motion. In which case is the object's velocity changing while its speed is not changing?
A)


B)


C)


D)


E) None of these cases
Answer: D
Var: 1

6) Which of the following ideas is true about projectile motion with no air drag?
A) $v_x^2 + v_y^2 = \text{constant}$.
B) The acceleration is +g when the object is rising and -g when falling.
C) The velocity of the object is zero at the point of maximum elevation.
D) The trajectory will depend on the object's mass as well as its initial velocity and launch angle.
E) The horizontal motion is independent of the vertical motion.
Answer: E
Var: 1

7) Two bullets are fired simultaneously parallel to a horizontal plane. The bullets have different masses and different initial velocities. Which one will strike the plane first?
A) the fastest one
B) the slowest one
C) the heaviest one
D) the lightest one
E) They strike the plane at the same time.
Answer: E
Var: 1

8) Are projectiles subject to constant acceleration in two dimensions?
Answer: Yes, they are subject to the constant acceleration (g) along the vertical.
Var: 1

9) To achieve maximum range of a projectile, for a fixed initial velocity, on Earth we must launch it at 45°. If we were at the moon should we do the same?
Answer: Yes, only g will be different at the moon. Note that in this case the presence of the atmosphere is neglected.
Var: 1

10) If I throw a rock in a lake at 30° or 60° from horizontal, with the same initial speed, it will splash on the same spot. So what is the difference? Should we only consider angles from 0° to 45°?
Answer: The difference is that the one launched at 30° will travel a shorter arc, and thus it will splash in a shorter time span than the other. Consequently, the 60° launched rock will reach a higher elevation. You trade time of flight for altitude.
Var: 1

11) Bob and Biff throw identical rocks off a tall building at the same time. Bob throws his rock straight downward. Biff throws his rock downward and outward such that the angle between the initial velocity of the rock and the horizon is 30 degrees. Biff throws the rock with a speed twice that of Bob's rock. Which rock hits the ground first (assume the ground near the building is flat)?
A) They hit at the same time.
B) Bob's rock
C) Biff's rock
D) Impossible to determine
Answer: A
Var: 1