Chapter 3

Motion in Two Dimensions

1. The position vector at t_i is r_i and the position vector at t_f is r_f. The average velocity of the particle during the time interval is

a. $\vec{\mathbf{v}} = \dfrac{\vec{\mathbf{r}}_i + \vec{\mathbf{r}}_f}{2}$

b. $\vec{\mathbf{v}} = \dfrac{\vec{\mathbf{r}}_i - \vec{\mathbf{r}}_f}{t_i - t_f}$

c. $\vec{\mathbf{v}} = \dfrac{\vec{\mathbf{r}}_f - \vec{\mathbf{r}}_i}{t_f - t_i}$

d. $\vec{\mathbf{v}} = \dfrac{\vec{\mathbf{r}}_f - \vec{\mathbf{r}}_i}{2}$

e. $\vec{\mathbf{v}} = \dfrac{\vec{\mathbf{r}}_i - \vec{\mathbf{r}}_f}{2}$

ANS: c

2. A particle moving in a circle about the origin travels with constant speed. How is its position vector oriented with respect to its velocity vector at each instant of time?

a. They are always perpendicular to each other.
b. They are always parallel to each other.
c. They are always anti-parallel to each other.
d. They are always collinear.
e. The velocity vector is always directed 45 degrees away from the position vector.

ANS: a

3. A synchronous satellite revolves around the Earth in a circular orbit.

a. Its acceleration is zero because its speed is constant.
b. Its acceleration is zero because its velocity is constant.
c. Its speed varies because its acceleration is constant.
d. Its speed is constant and its velocity is constant.
e. Its acceleration and its velocity are both not constant.

ANS: e

4. A simple pendulum is at the top of its arc as shown in the figure. The magnitude of its acceleration and its velocity are:

a. $|a| = 0,\ v = 0$
b. $|a| = 0,\ v = \text{maximum}$
c. $|a| = 9.8\ \text{m/s}^2,\ v = 0$
d. $|a| = 9.8\ \text{m/s}^2,\ v = \text{maximum}$
e. $|a| = 9.8\ \text{m/s}^2,\ v = 9.8\ \text{m/s}$

ANS: c

5. A car travels around a curve of radius 225 m with a speed of 15 m/s. What is the centripetal acceleration of the car in m/s^2?
a. 1
b. 2
c. 3
d. 4
e. 5

ANS: a

6. The acceleration of an object moving in a circle of 5 m radius at constant speed is $45\ \text{m/s}^2$. What is its speed in m/s?
a. 14
b. 15
c. 16
d. 17
e. 18

ANS: b

7. A stone is thrown straight down from the top of a building 30 m high. After it has fallen 10 m, what is its displacement in m if the origin is the top of the building and up is positive?
a. $-10\hat{\mathbf{j}}$
b. $0\hat{\mathbf{j}}$
c. $10\hat{\mathbf{j}}$
d. $20\hat{\mathbf{j}}$
e. $30\hat{\mathbf{j}}$

ANS: a

8. A stone is thrown straight down from the top of a building 30 m high. After it has fallen 10 m, what is its displacement in m if the origin is the earth's surface and up is positive?

a. $-10\hat{\mathbf{j}}$

b. $0\hat{\mathbf{j}}$

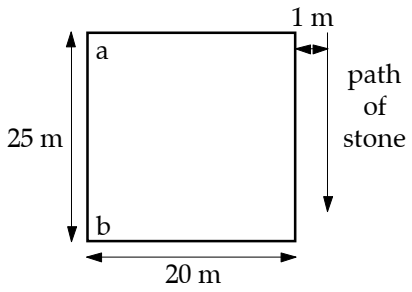
c. $10\hat{\mathbf{j}}$

d. $20\hat{\mathbf{j}}$

e. $30\hat{\mathbf{j}}$

ANS: a

9. A stone is dropped from the top of a 25 m high building. Its path is 1 m from the building as noted in the illustration. After it has fallen 15 m, what is its position in m if the origin is at point a and the upward direction is positive?



a. $21\hat{\mathbf{i}} + 15\hat{\mathbf{j}}$

b. $21\hat{\mathbf{i}} - 15\hat{\mathbf{j}}$

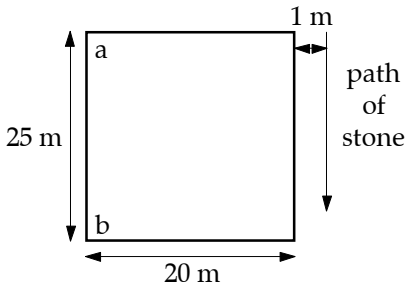
c. $20\hat{\mathbf{i}} - 10\hat{\mathbf{j}}$

d. $21\hat{\mathbf{i}} + 10\hat{\mathbf{j}}$

e. $26\hat{\mathbf{i}} - 10\hat{\mathbf{j}}$

ANS: b

10. A stone is dropped from the top of a 25 m high building. Its path is one m from the building as noted in the illustration. After it has fallen 15 m, what is its position in m if the origin is at point b and the upward direction is positive?



a. $21\hat{\mathbf{i}}+15\hat{\mathbf{j}}$
b. $21\hat{\mathbf{i}}-15\hat{\mathbf{j}}$
c. $20\hat{\mathbf{i}}-10\hat{\mathbf{j}}$
d. $21\hat{\mathbf{i}}+10\hat{\mathbf{j}}$
e. $21\hat{\mathbf{i}}-10\hat{\mathbf{j}}$

ANS: d

11. A stone is dropped from the top of a 25 m high building. What is its speed in m/s after it has fallen 5.0 m if its initial speed was zero?
a. 9.6
b. 9.7
c. 9.8
d. 9.9
e. 9.99

ANS: d

12. A projectile is fired horizontally from the top of a building 40 m high. Neglecting air resistance, what is the magnitude of the acceleration in the vertical direction in $\mathrm{m/s^2}$?
a. 0
b. 4.9
c. 9.8
d. 16
e. 32

ANS: c

13. A projectile is fired horizontally from the top of a building 40 m high. Neglecting air resistance, what is the magnitude of the acceleration in the horizontal direction in m/s^2?
a. 0
b. 4.9
c. 9.8
d. 16
e. 32

ANS: a

14. A projectile is fired horizontally from the top of a 50 m building. After 2 s, what do we know about its speed if we neglect air resistance?
a. Its speed decreases in the vertical direction.
b. Its speed increases in the vertical direction.
c. Its speed decreases in the horizontal direction.
d. Its speed increases in the horizontal direction.
e. It has only horizontal components.

ANS: b

15. A projectile is fired upward at 30° to the horizontal. What do we know about the horizontal component of the velocity if air resistance is neglected?
a. It remains constant.
b. It increases at a constant rate.
c. It decreases at a constant rate.
d. It increases exponentially.
e. It decreases exponentially.

ANS: a

16. A projectile is fired upward at 30° to the horizontal. If air resistance is neglected, what can we say about the magnitude of the vertical component of the velocity after the projectile reaches maximum height?
a. It remains constant.
b. It increases at a constant rate.
c. It decreases at a constant rate.
d. It increases exponentially.
e. It decreases exponentially.

ANS: b

17. A projectile is fired upward at 25° to the horizontal. What is known about the vertical component of the acceleration if air resistance is neglected?
a. It remains constant.
b. It increases at a constant rate.
c. It decreases at a constant rate.
d. It increases exponentially.
e. It decreases exponentially.

ANS: a

18. A woman throws a ball vertically upward while standing in a train car that is moving with constant velocity. A man inside the train observes the motion of the ball. What does he observe?
a. The ball moves in front of him in a parabolic arc.
b. The ball moves in front of him in a hyperbolic arc.
c. The ball remains stationary.
d. The ball moves straight up and straight down.
e. The ball moves in a circle.

ANS: d

19. A man throws a ball vertically upward while standing in a train car that is moving with constant velocity. A woman standing in the train station observes the motion of the ball. What does she observe?
a. The ball moves in front of her in a parabolic arc.
b. The ball moves in front of her in a hyperbolic arc.
c. The ball remains stationary.
d. The ball moves straight up, stops and comes down.
e. The ball moves in a circle.

ANS: a

20. A person standing in a train car moving with a constant velocity of $32\ \text{m/s}$ throws a ball vertically upwards. What is the magnitude of the ball's acceleration in m/s^2?
a. 9.8
b. 4.6
c. 0
d. 16
e. 32

ANS: a

21. A person standing in a train car that is accelerating forward at $3.3\ \text{m/s}^2$ has thrown a ball vertically upward. What is the magnitude $\left(\text{in } \text{m/s}^2\right)$ of the ball's acceleration relative to the train?

a. 9.8
b. 4.6
c. 13.1
d. 10.3
e. 6.5

ANS: d

22. A person standing in a train car that is accelerating forward at $3.3\ \text{m/s}^2$ has thrown a ball vertically upward. What is the magnitude $\left(\text{in } \text{m/s}^2\right)$ of the ball's acceleration relative to the Earth?

a. 9.8
b. 4.6
c. 13.1
d. 10.3
e. 6.5

ANS: a

23. A woman is driving an automobile in a straight line at constant speed. The acceleration of the automobile
a. is zero.
b. varies with time.
c. is 9.8 m/s^2.
d. is 4.9 m/s^2.
e. varies proportionally with time.

ANS: a

24. A man is driving an automobile in a circle at constant speed. The acceleration of the automobile
a. is zero.
b. has a constant magnitude.
c. has a constant direction.
d. is directed downwards.
e. is 9.8 m/s^2.

ANS: b

25. A rock is thrown from the point $x_0 = y_0 = 0$ with initial velocity components $v_{ox} = v_o \cos\theta$ and $v_{oy} = v_o \sin\theta$. What are the values of its x- and y-coordinates at maximum height when air resistance is neglected?
a. $\left(v_{ox},\ v_{oy}\right)$
b. $\left(v_{ox}t,\ v_{oy}t\right)$
c. $\left(x_o,\ y_o\right)$
d. $\left(v_{ox}t,\ t\left(v_{oy} - 4.9t\right)\right)$
e. $\left(v_{ox}t,\ t\left(v_{oy} + 4.9t\right)\right)$

ANS: d

26. What maximum height in meters is reached by a projectile fired on the moon with $v_{ox} = 3.0$ m/s and $v_{oy} = 4.0$ m/s? The gravitational acceleration on the moon is 1.6 m/s^2.
a. 0.50
b. 2.0
c. 3.0
d. 4.0
e. 5.0

ANS: e

27. If a body's initial position at time t_1 is $\vec{\mathbf{r}}_1 = 3\hat{\mathbf{i}} + 5\hat{\mathbf{j}}$ and its position at a later time t_2 is $\vec{\mathbf{r}}_2 = 6\hat{\mathbf{i}} + 9\hat{\mathbf{j}}$, its displacement between t_1 and t_2 is

a. $3\hat{\mathbf{i}} + 5\hat{\mathbf{j}}$.
b. $6\hat{\mathbf{i}} + 9\hat{\mathbf{j}}$.
c. $3\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$.
d. $-3\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$.
e. $3\hat{\mathbf{i}} - 4\hat{\mathbf{j}}$.

ANS: c

28. A particle's position is given as a function of time by $\vec{\mathbf{r}} = 2.0\hat{\mathbf{i}} + 3.0t^2\hat{\mathbf{j}}$, with r in meters. What is the particle's speed in m/s when $t = 2.0$ s?
a. 7.0
b. 8.0
c. 10
d. 12
e. 14

ANS: d

29. A particle's position is given as a function of time by $\vec{\mathbf{r}} = 2.0\hat{\mathbf{i}} + 3.0t^2\hat{\mathbf{j}}$, with r in meters. What is the particle's velocity in m/s when $t = 2.0$ s?
a. $7.0\mathbf{j}$
b. $8.0\mathbf{j}$
c. $10\mathbf{j}$
d. $12\mathbf{j}$
e. $14\mathbf{j}$

ANS: d

30. A particle's position is given as a function of time by $\vec{\mathbf{r}} = 2.0\hat{\mathbf{i}} + 3.0t^2\hat{\mathbf{j}}$, with r in meters. What is the particle's acceleration in m/s^2 when $t = 2.0$ s?
a. $2.0\hat{\mathbf{j}}$
b. $3.0\hat{\mathbf{j}}$
c. $4.0\hat{\mathbf{j}}$
d. $5.0\hat{\mathbf{j}}$
e. $6.0\hat{\mathbf{j}}$

ANS: e

31. The equation $\vec{\mathbf{r}} = 3.0\ \text{m/s}^2\, t\hat{\mathbf{i}} - 1.0\ \text{m/s}^2\, t^3\hat{\mathbf{j}}$, gives the position of a particle at times $t \geq t_0 = 0$. What is the magnitude of the particle's displacement from $\vec{\mathbf{r}} = 0$ when $t = 2.0$ s.
a. –2
b. 2
c. 8
d. 10
e. 12

ANS: d

32. The equation $\vec{\mathbf{r}} = 3.0\ \text{m/s}^2\, t\hat{\mathbf{i}} - 1.0\ \text{m/s}^2\, t^3\hat{\mathbf{j}}$, gives the position of a particle at times $t \geq t_0 = 0$. What is the magnitude of the particle's acceleration when $t = 2.0$ s.
a. $-12\hat{\mathbf{j}}$
b. $-9\hat{\mathbf{j}}$
c. $-6\hat{\mathbf{j}}$
d. $3\hat{\mathbf{i}} - 6\hat{\mathbf{j}}$
e. $3\hat{\mathbf{i}} - 12\hat{\mathbf{j}}$

ANS: a

33. If $\vec{\mathbf{r}}_o = 0$ m, $\vec{\mathbf{v}}_o = 3\hat{\mathbf{i}}$ m/s and $\vec{\mathbf{a}} = \hat{\mathbf{j}}\ \text{m/s}^2$, what is $\vec{\mathbf{r}}$ in m at $t = 2$ s?
a. $10\hat{\mathbf{j}}$
b. $6\hat{\mathbf{i}} + 2\hat{\mathbf{j}}$
c. $2\hat{\mathbf{i}} + 3\hat{\mathbf{j}}$
d. $4\hat{\mathbf{i}} + 6\hat{\mathbf{j}}$
e. $3\hat{\mathbf{i}}$

ANS: b

34. A ball moving at a speed of 2.0 m/s rolls off a horizontal table. If the table is 1.2 m high, how far does the ball travel horizontally in m before it strikes the floor?
a. 0.95
b. 0.97
c. 0.99
d. 1.00
e. 1.01

ANS: c

35. A particle moves with constant speed of 16 m/s in a circle of radius 4.0 m. What is its acceleration in m/s^2?
a. 8
b. 16
c. 32
d. 64
e. 128

ANS: d

36. A wheel of 0.50 m radius rotates at 15 rev/s. What is the acceleration at its outer rim in m/s^2?
a. 2.2×10^3
b. 3.3×10^2
c. 4.4×10^3
d. 5.5×10^2
e. 6.6×10^3

ANS: c

37. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 8.2 m/s^2. If its radial acceleration has a magnitude of 3.3 m/s^2, what is the magnitude of its tangential acceleration in m/s^2?
a. 8.8
b. 8.5
c. 7.7
d. 7.5
e. 7.3

ANS: d

38. The velocity of a particle at $t_o = 0$ is $v_o = \left(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}}\right)$ m/s. x_o and y_o are zero. When $t = 2$ s, $v = \left(8\hat{\mathbf{i}} - 5\hat{\mathbf{j}}\right)$ m/s. What is the acceleration of the particle in m/s^2?
a. $3\hat{\mathbf{i}} - 4\hat{\mathbf{j}}$
b. $4\hat{\mathbf{i}} - 3\hat{\mathbf{j}}$
c. $3\hat{\mathbf{i}} - 5\hat{\mathbf{j}}$
d. $-5\hat{\mathbf{j}}$
e. $2\hat{\mathbf{i}} + 3\hat{\mathbf{j}}$

ANS: a

39. A swimmer swims upstream in a river for 210 m and then swims 210 m downstream back to her starting point. If she swims at a constant rate of 1.1 m/s and the river has a constant speed of 0.40 m/s, how long did the round trip take in s?
a. 382
b. 280
c. 300
d. 600
e. 440

ANS: e

40. When crossing a 220 m wide river, a boat always moves at a right angle to the banks. If the boat's speed is 2.3 m/s and the stream's speed is 0.90 m/s, how far downstream in m from its starting point does the boat land?
a. 96
b. 95
c. 89
d. 86
e. 83

ANS: d

41. An observer notes that a swimmer is swimming upstream at 0.90 m/s and a second swimmer is swimming downstream moving at 1.5 m/s. If each swimmer is actually moving at 1.2 m/s with respect to the water, how fast is the stream flowing in m/s?
a. 0.10
b. 0.20
c. 0.30
d. 0.40
e. 0.50

ANS: c

42. A boat moves at right angles to the motion of a stream at 4 m/s. If the stream is moving at 3 m/s, what is the magnitude of the boat's velocity in m/s as observed by someone standing on the shore?
a. 1
b. 2
c. 3
d. 4
e. 5

ANS: e

43. A particle starts from the origin at $t = 0$ with a velocity of $8.0\hat{\mathbf{j}}$ m/s and moves in the xy plane with a constant acceleration of $\left(4.0\hat{\mathbf{i}} + 2.0\hat{\mathbf{j}}\right)$ m/s^2. At the instant the x coordinate of the particle is 29 m, what is the value of its y coordinate in m?
a. 35
b. 39
c. 45
d. 42
e. 20

ANS: c

44. At $t = 0$, a particle leaves the origin with a velocity of 9.0 m/s in the positive y direction and moves in the xy plane with a constant acceleration of $\left(2.0\hat{\mathbf{i}} - 4.0\hat{\mathbf{j}}\right)$ m/s^2. At the instant the x coordinate of the particle is 15 m, what is the speed of the particle in m/s?
a. 10
b. 16
c. 12
d. 14
e. 26

ANS: a

45. A particle starts from the origin at $t = 0$ with a velocity of $6.0\hat{\mathbf{i}}$ m/s and moves in the xy plane with a constant acceleration of $\left(-2.0\hat{\mathbf{i}} + 4.0\hat{\mathbf{j}}\right)$ m/s^2. At the instant the particle achieves its maximum positive x coordinate, how far is it from the origin in m?
a. 36
b. 20
c. 18
d. 27
e. 9.0

ANS: b

46. A particle leaves the origin with a velocity of 7.2 m/s in the positive y direction and moves in the xy plane with a constant acceleration of $\left(3.0\hat{\mathbf{i}} - 2.0\hat{\mathbf{j}}\right)$ m/s^2. At the instant the particle moves back across the x axis $(y = 0)$, what is the value of its x coordinate in m?
a. 65
b. 91
c. 54
d. 78
e. 86

ANS: d

47. At $t = 0$, a particle leaves the origin with a velocity of 5.0 m/s in the positive y direction. Its acceleration is given by $a = \left(3.0\hat{\mathbf{i}} - 2.0\hat{\mathbf{j}}\right)$ m/s^2. At the instant the particle reaches its maximum y coordinate, how far is the particle from the origin in m?
a. 11
b. 16
c. 22
d. 29
e. 19

ANS: a

48. A particle moves in the *xy* plane with a constant acceleration given by $\vec{\mathbf{a}} = -4\hat{\mathbf{j}}$ m/s^2. At $t = 0$ its position and velocity are $10\hat{\mathbf{i}}$ m and $\left(-2\hat{\mathbf{i}} + 8\hat{\mathbf{j}}\right)$ m/s. What is the distance in m from the origin to the particle at $t = 2$ s?

a. 6.4
b. 10
c. 8.9
d. 2.0
e. 6.2

ANS: b

49. A person is moving with constant velocity when
a. moving east at constant speed.
b. turning left at constant speed.
c. turning right at constant speed.
d. going from 20 m/s to 25 m/s while moving in a straight line.
e. moving in a straight line while slowing down.

ANS: a

50. When air resistance is neglected, the trajectory of a particle is a(an)
a. circle.
b. ellipse.
c. hyperbola.
d. parabola.
e. cycloid.

ANS: d

51. At the instant when a projectile has speed of magnitude v, v is equal to
a. $\sqrt{v_x^2 \cos^2\theta + v_y^2 \sin^2\theta}$.
b. $\sqrt{v_x^2 + v_y^2}$.
c. $v_x + v_y$.
d. $v_x \sin\theta + v_y \cos\theta$.
e. $v_x \cos\theta + v_y \sin\theta$.

ANS: b

52. When air resistance is neglected, the horizontal range, R, of a projectile on earth is $\frac{v_o^2 \sin 2\theta_o}{g}$. The moon's gravitational acceleration is $\frac{g}{6}$. The range, R_m, of this same projectile on the moon is

a. $\frac{6v_o^2 \sin 2\theta_o}{g}$.
b. $\frac{v_o^2 \sin 2\theta_o}{6g}$.
c. $\frac{2v_o^2 \sin 6\theta_o}{g}$.
d. $\frac{6v_o^2 \sin \theta_o}{2g}$.
e. $\frac{2v_o^6 \sin \theta_o}{g}$.

ANS: a

53. The point at which the velocity and acceleration of a projectile are perpendicular to one another occurs
a. when $v_x = 0$.
b. just before the projectile hits the ground.
c. when the projectile is at maximum height.
d. when the projectile is at half the maximum height.
e. at both times when $|v_y|$ is a maximum.

ANS: c

54. An object moves in a circle of radius 4.3 m with a constant speed of 3.1 m/s.
a. 0.72
b. 1.2
c. 1.4
d. 2.2
e. 7.4

ANS: d

55. If we ignore air resistance, a projectile fired from the ground at speed v_o reaches its maximum possible range when the angle between the initial velocity vector and the ground is:
a. 0°
b. 30°
c. 45°
d. 60°
e. 90°

ANS: c

56. While a tray on a cafeteria conveyor belt is moving forward at 3.2 cm/s, an ant on the tray moves a 4.2 cm distance backwards on the tray in 3.0 seconds. A student standing in front of the conveyor belt says the ant's velocity in m/s relative to the cafeteria is:
a. 1.4, forward.
b. 1.4, backward.
c. 1.8, forward.
d. 1.8, backward.
e. 3.2, forward.

ANS: c

57. While a tray on a cafeteria conveyor belt is moving forwards at 3.2 cm/s, an ant on the tray moves a 4.2 cm distance perpendicular to the tray's direction of motion in 3.0 seconds. A student standing in front of the conveyor belt says the ant's velocity in m/s at angle θ relative to the cafeteria and the forward direction is:
a. 1.4, 90°
b. 3.2, 24°
c. 3.2, 66°
d. 3.5, 24°
e. 3.5, 66°

ANS: d

58. An astronaut on the moon tosses a moon rock in the air while running forward at a constant speed of 3.2 m/s. The acceleration of gravity on the moon is 1.6 m/s^2. She catches the rock 4.0 seconds after it is thrown. The angle at which she threw the rock (relative to the forward direction and the surface of the moon) is:
a. 0°
b. 45°
c. 63°
d. 90°
e. 135°

ANS: b

59. A rotating cylinder ride in an amusement park is rotating at its maximum speed. The magnitude and direction of the acceleration of a person pressed against the wall are:
a. 0; 0
b. constant; constant
c. constant; changing direction constantly
d. changing constantly; constant
e. changing constantly; changing direction constantly

ANS: c

60. A group of students needs to cross a river in the shortest time. The water in the river flows downstream at a speed of 10 m/s. The boat has a maximum speed of 20 m/s. In what direction should the students head the boat?
a. downstream.
b. directly toward the opposite shore.
c. 27° away from downstream.
d. 63° away from downstream.
e. upstream.

ANS: b

61. Students entering a boat need to put the maximum distance possible between themselves and their pursuers in the shortest possible time. The water in the river flows downstream at a speed of 10 m/s. The boat has a maximum speed of 20 m/s. In what direction should the students head the boat?
a. downstream.
b. directly toward the opposite shore.
c. 27° away from downstream.
d. 63° away from downstream.
e. upstream.

ANS: a

62. Which of the following require(s) the presence of a constant force vector?
a. Projectile motion in a parabolic trajectory.
b. Motion along a straight line at constant acceleration.
c. Motion along a straight line at speed increasing at a constant rate.
d. All of the above.
e. None of the above.

ANS: d

63. A stone attached to a 2.00 m long string is whirled in a horizontal circle out in space where gravity can be neglected. If the centripetal acceleration cannot exceed 72 m/s^2 without breaking the string, the maximum tangential speed of the stone is:
a. $\frac{1}{6}$ m/s.
b. 12 m/s
c. 144 m/s
d. 8.5 m/s
e. 6 m/s

ANS: b

64. Josie throws a ball with a speed of 12 m/s at an angle of 60° to the ground. At the instant the ball is thrown her dog, standing beside her, heads for the ball. Ignore air resistance and any difference in height between the initial position of the ball and the dog's mouth. For the dog to catch the ball as it reaches her, the dog must run at a constant speed of:
a. 6.0 m/s
b. 11 m/s
c. 12 m/s
d. 21 m/s
e. 24 m/s

ANS: a

65. A juggler wants to throw a ball so that it spends 3.00 seconds in the air. Ignore air resistance. The ball must be thrown with a vertical component of velocity, in m/s, equal to:
a. 7.35
b. 11.0
c. 14.7
d. 22.0
e. 29.4

ANS: c

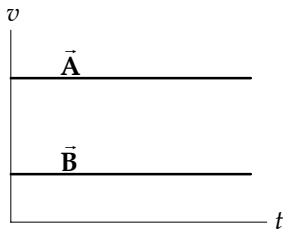
66. Pitching machines throw three balls into the air from ground level at the same time. Ball A is thrown at a speed of 50 m/s at an angle of 36.9° to the ground. Ball B is thrown at a speed of 37.5 m/s at an angle of 53.1° to the ground. Ball C is thrown at a speed of 30 m/s at an angle of 90° to the ground. In what order do the balls return to the ground?
a. A, B, C
b. C, B, A
c. C, A, B
d. A, C, B
e. They all return to the ground at the same time.

ANS: e

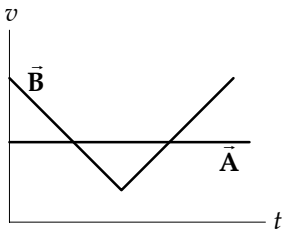
67. A man playing with a toy fish on a 3.0 m long string swings the fish so that it has an upward velocity of magnitude 4.0 m/s at the instant when the string is horizontal. What is the magnitude in m/s^2 of the total acceleration of the fish?
a. 4.0
b. 5.3
c. 9.8
d. 11.2
e. 15.1

ANS: d

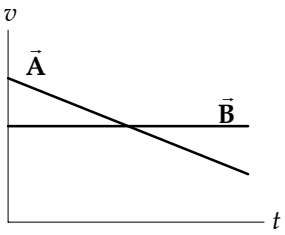
68. Car A and car B are both driving on a straight road. Car A comes from behind and passes car B at $t = 0$ s. It then comes from behind and passes car B again at a later time. For this to be able to happen the velocity versus time graphs of A and B must be those shown in:



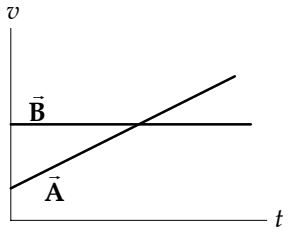
a.



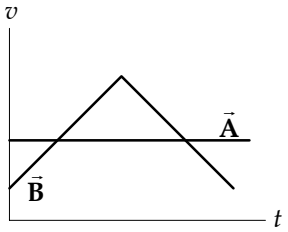
b.



c.



d.



e.

ANS: e

69. Starting from rest, a car travels around a circle of constant radius at constantly increasing speed. Its centripetal acceleration
a. is zero.
b. remains constant.
c. increases in direct proportion tot he increase in speed.
d. increases in direct proportion to the square of the speed.
e. cannot be defined unless it travels at constant speed.

ANS: d ✓

70. Donna wants to whirl a 0.64 kg stone on a string at the greatest possible speed, but the string will break if a force greater than 24 N is applied. If the maximum speed Donna can achieve is 3.0 m/s, how long should the string be?
a. 0.080 m
b. 0.16 m
c. 0.24 m
d. 0.32 m
e. 0.64 m

ANS: c ✓

71. When Rhonda releases the shot-put, it flies off at an initial speed of 10.0 m/s . If the distance from the center of her body to the shot-put is then 75.0 cm, what is the centripetal acceleration, in m/s^2 , of the shot-put at the instant of its release?
a. 0.133
b. 0.750
c. 1.33
d. 13.3
e. 133

ANS: e.

72. A passenger in a balloon-supported gondola releases a small ball while the gondola is rising at a speed of 5.0 m/s relative to the ground. A person who measures the ball's velocity at the instant of release will find that the ball's velocity relative to the ground at that instant is
a. 0 m/s .
b. 2.0 m/s , down.
c. 2.0 m/s , up.
d. 7.8 m/s , down.
e. 9.8 m/s , down.

ANS: c

73. A passenger in a balloon-supported gondola releases a small ball while the gondola is rising at a speed of 5.0 m/s relative to the ground. A person who measures the ball's acceleration at the instant of release will find that the ball's acceleration relative to the ground at that instant is
a. 0 m/s^2 .
b. 2.0 m/s^2 , down.
c. 2.0 m/s^2 , up.
d. 7.8 m/s^2 , down.
e. 9.8 m/s^2 , down.

ANS: e

74. While the gondola is rising at a speed of 2.0 m/s , a passenger in a balloon-supported gondola throws a small ball down at a speed of 5.0 m/s relative to his body . A person who measures the ball's velocity at the instant of release will find that the ball's velocity relative to the ground at that instant is
a. 2.0 m/s , up.
b. 3.0 m/s , down.
c. 3.0 m/s , up.
d. 5.0 m/s , down.
e. 12.8 m/s , down.

ANS: c

75. While the gondola is rising at a speed of 2.0 m/s , a passenger in a balloon-supported gondola throws a small ball up at a speed of 2.0 m/s relative to his body . A person who measures the ball's velocity at the instant of release will find that the ball's velocity relative to the ground at that instant is
a. 2.0 m/s , up.
b. 2.8 m/s , down.
c. 3.0 m/s , up.
d. 5.0 m/s , up.
e. 7.0 m/s , up.

ANS: e

76. A chef's dog, Banana Split, grabs a sausage and runs down the street at a speed of 5.00 m/s . The dog is 100 m distant when the chef starts in pursuit. The chef's best acceleration is 0.50 m/s^2 . How far away is the dog when the chef catches up to him?
a. 100 m.
b. 110 m.
c. 119 m.
d. 220 m.
e. The chef cannot catch the dog.

ANS: c

77. A chef's dog, Banana Split, grabs a sausage and runs down the street at a speed of 5.00 m/s . The dog is 100 m distant when the chef starts in pursuit. The chef's best acceleration is 0.50 m/s^2 . How many seconds does it take the chef to catch the dog?
a. 1.8 s
b. 10.0 s
c. 20.0 s
d. 21.8 s
e. The chef cannot catch the dog.

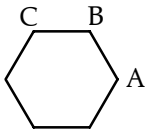
ANS: d

78. Sally is 1.92 km west of the town square and is driving east at 12.0 m/s . Astrid is 1.76 km south of the town square. What must Astrid's speed be if she is to drive north and arrive in the square at the same time as Sally?

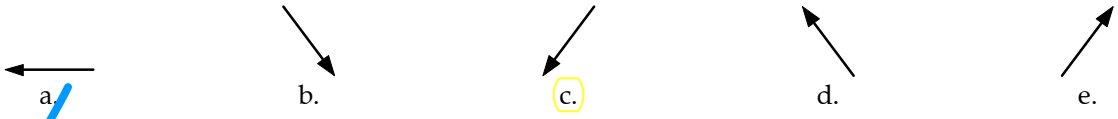
a. 6.0 m/s
b. 9.0 m/s
c. 10.0 m/s
d. 11.0 m/s
e. 12.0 m/s

ANS: **AU: Please provide missing information**

79. Newton approximated motion in a circle as a series of linear motions, as in the polygon below.

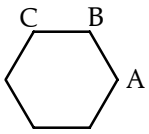


If we assume the particle moves at constant speed v_A from A to B, and at constant speed v_B from B to C, the direction of the change in velocity, $\Delta\vec{\mathbf{v}}$, at point B, is shown by the arrow in

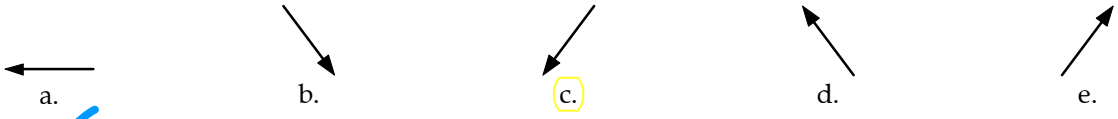


ANS: c

80. Newton approximated motion in a circle as a series of linear motions, as in the polygon below.



If we assume the particle moves at constant speed v_A from A to B, and at constant speed v_B from B to C, the direction of the acceleration, $\vec{\mathbf{a}}$, at point B, is shown by the arrow in



ANS: c