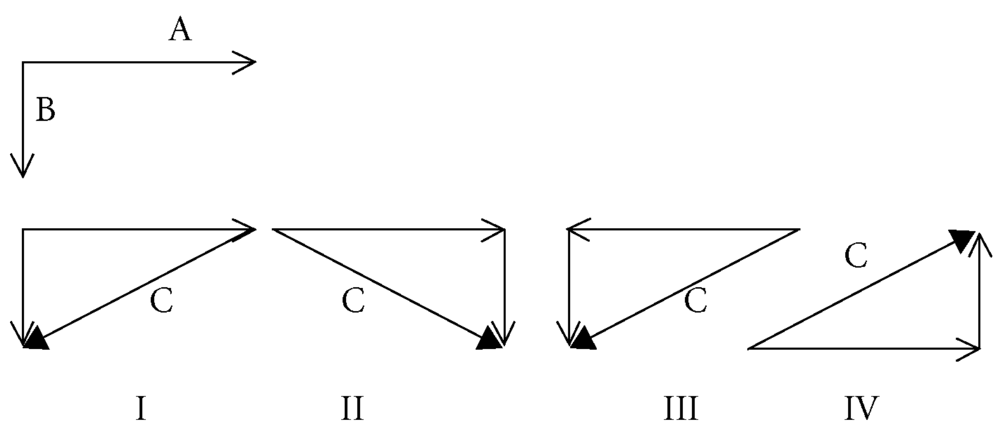
Projectile Motion Practice Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is a physical quantity that has a magnitude but no direction?
a. vector
b. scalar
c. resultant
d. frame of reference

____ 2. Identify the following quantities as scalar or vector: the speed of a snail, the time it takes to run a mile, the free-fall acceleration.
a. vector, scalar, scalar
b. scalar, scalar, vector
c. vector, scalar, vector
d. scalar, vector, vector



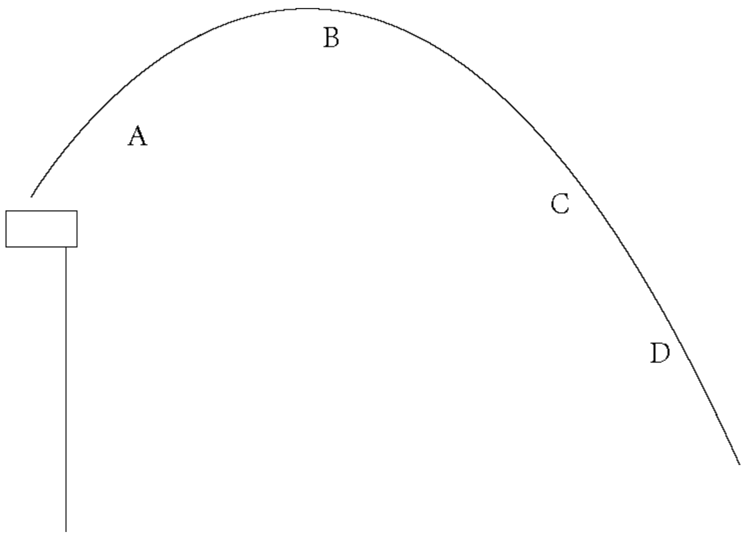
____ 3. In the figure above, which diagram represents the vector subtraction **C** = **A**–**B**?
a. I
b. II
c. III
d. IV

____ 4. In a coordinate system, a vector is oriented at angle θ with respect to the *x*-axis. The *y* component of the vector equals the vector's magnitude multiplied by which trigonometric function?
a. cos θ
b. cot θ
c. sin θ
d. tan θ

____ 5. Find the resultant of these two vectors: 2.00×10^2 units due east and 4.00×10^2 units 30.0° north of west.
a. 300 units, 29.8° north of west
b. 581 units, 20.1° north of east
c. 546 units, 59.3° north of west
d. 248 units, 53.9° north of west

____ 6. Which of the following is *not* an example of projectile motion?
a. a volleyball served over a net
b. a baseball hit by a bat
c. a hot-air balloon drifting toward Earth
d. a long jumper in action

____ 7. Which of the following does *not* exhibit parabolic motion?
a. a frog jumping from land into water
b. a basketball thrown to a hoop
c. a flat piece of paper released from a window
d. a baseball thrown to home plate



The figure above shows the path of a ball tossed from a building. Air resistance is ignored.

____ 8. In the figure above, the horizontal component of the ball's velocity at A is
a. zero.
b. equal to the vertical component of the ball's velocity at C.
c. equal in magnitude but opposite in direction to the horizontal component of the ball's velocity at D.
d. equal to the horizontal component of its initial velocity.

____ 9. A jet moving at 500.0 km/h due east is in a region where the wind is moving at 120.0 km/h in a direction 30.00° north of east. What is the speed of the aircraft relative to the ground?
a. 620.2 km/h
b. 606.9 km/h
c. 588.7 km/h
d. 511.3 km/h

Problem

10. A duck waddles 2.5 m east and 6.0 m north. What are the magnitude and direction of the duck's displacement with respect to its original position?

11. A skateboarder rolls 25.0 m down a hill that descends at an angle of 20.0° with the horizontal. Find the horizontal and vertical components of the skateboarder's displacement.

12. What is the magnitude of the resultant displacement of a dog looking for its bone in the yard if the dog first heads 55.0° north of west for 10.0 m and then turns and heads west for 5.00 m?

13. An hockey puck travels 2.00 m at 10.0° east of south before ricocheting 2.50 m at 75.0° north of east. What is the puck's resultant displacement?

14. A stone is thrown at an angle of 30.0° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stopwatch measures the stone's trajectory time from the top of the cliff to the bottom at 5.60 s. What is the height of the cliff? (Assume no air resistance and that $a_y = -g = -9.81\ \text{m/s}^2$.)

Projectile Motion Practice Test
Answer Section

MULTIPLE CHOICE

1.	ANS: B	PTS: 1	DIF: I	OBJ: 3-1.1
2.	ANS: B	PTS: 1	DIF: II	OBJ: 3-1.1
3.	ANS: D	PTS: 1	DIF: I	OBJ: 3-1.2
4.	ANS: C	PTS: 1	DIF: I	OBJ: 3-2.3

5. ANS: D

Given

$\mathbf{d_1}$ = 2.00×10^2 units east

$\mathbf{d_2}$ = 4.00×10^2 units 30.0° north of west

Solution

Measuring direction with respect to *x* = (east),

$$\Delta x_1 = 2.00 \times 10^2 \text{ units}$$

$$\Delta y_1 = 0$$

$$\Delta x_2 = d_2 \cos\theta = (4.00 \times 10^2 \text{ units})(\cos\ 150.0°) = -3.46 \times 10^2 \text{ units}$$

$$\Delta y_2 = d_2 \sin\theta = (4.00 \times 10^2 \text{ units})(\sin\ 150.0°) = 2.00 \times 10^2 \text{ units}$$

$$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = (2.00 \times 10^2 \text{ units}) + (-3.46 \times 10^2 \text{ units}) = -1.46 \times 10^2 \text{ units}$$

$$\Delta y_{tot} = \Delta y_1 + \Delta y_2 = 0 + (2.00 \times 10^2 \text{ units}) = 2.00 \times 10^2 \text{ units}$$

$$d^2 = (\Delta x_{tot})^2 + (\Delta y_{tot})^2$$

$$d = \sqrt{(\Delta x_{tot})^2 + (\Delta y_{tot})^2} = \sqrt{(-1.46 \times 10^2 \text{ units})^2 + (2.00 \times 10^2 \text{ units})^2}$$

$$d = 2.48 \times 10^2 \text{ units}$$

$$\theta = \tan^{-1}\left(\frac{\Delta y_{tot}}{\Delta x_{tot}}\right) = \tan^{-1}\left(\frac{2.00 \times 10^2 \text{ units}}{-1.46 \times 10^2 \text{units}}\right) = -53.9°$$

$$\mathbf{d} = 2.48 \times 10^2 \text{ units, } 53.9° \text{north of west}$$

	PTS: 1	DIF: IIIB	OBJ: 3-2.4	
6.	ANS: C	PTS: 1	DIF: I	OBJ: 3-3.1
7.	ANS: C	PTS: 1	DIF: I	OBJ: 3-3.2
8.	ANS: D	PTS: 1	DIF: II	OBJ: 3-3.2

9. ANS: B

Given

$\mathbf{v_{pa}}$ = velocity of plane relative to the air = 500.0 km/h east

$\mathbf{v_{ag}}$ = velocity of air relative to the ground = 120.0 km/h 30.00° north of east

Solution

$v_{ag,x} = v_{ag}\cos\theta = (120.0\text{ km/h})(\cos 30.00°) = 103.9\text{ km/h}$

$v_{ag,y} = v_{ag}\sin\theta = (120.0\text{ km/h})(\sin 30.00°) = 60.00\text{ km/h}$

$v_{pg,x} = v_{pa} + v_{ag,x} = 500.0\text{ km/h} + 103.9\text{ km/h} = 603.9\text{ km/h}$

$v_{pg,y} = 60.00\text{ km/h}$

$v_{pg} = \sqrt{(v_{pg,x})^2 + (v_{pg,y})^2} = \sqrt{(603.9\text{ km/h})^2 + (60.00\text{ km/h})^2} = 606.9\text{ km/h}$

PTS: 1 DIF: IIIB OBJ: 3-4.2

PROBLEM

10. ANS:
6.5 m at 67° north of east

Given
$\mathbf{d_1}$ = 2.5 m east
$\mathbf{d_2}$ = 6.0 m north

Solution

$\Delta x = d_1 = 2.5\text{ m}$

$\Delta y = d_2 = 6.0\text{ m}$

$d^2 = \Delta x^2 + \Delta y^2$

$d = \sqrt{\Delta x^2 + \Delta y^2} = \sqrt{(2.5\text{ m})^2 + (6.0\text{ m})^2} = 6.5\text{ m}$

$\theta = \tan^{-1}\left(\frac{\Delta y}{\Delta x}\right) = \tan^{-1}\left(\frac{6.0\text{ m}}{2.5\text{ m}}\right) = 67°$

$\mathbf{d}$ = 6.5 m at 67° north of east

PTS: 1 DIF: IIIB OBJ: 3-2.2

11. ANS:
d_x = 23.5 m; d_y = –8.55 m

Given
d = 25.0 m, θ = 20.0°

Solution

$d_x = d\cos\theta = (25.0\text{ m})(\cos 20.0°) = 23.5\text{ m}$

$d_y = d\sin\theta = (25.0\text{ m})(\sin 20.0°) = 8.55\text{ m}$

PTS: 1 DIF: IIIB OBJ: 3-2.3

12. ANS:

13.5 m

Given
$\mathbf{d_1}$ = 10.0 m at 55.0° north of west
$\mathbf{d_2}$ = 5.00 m west

d_1 = 10.0 m θ_1 = 55.0°
d_2 = 5.0 m θ_2 = 0.0°

Solution

$$\Delta x_1 = d_1 \cos\theta_1 = (10.0\text{ m})(\cos 55.0°) = 5.74\text{ m}$$

$$\Delta y_1 = d_1 \sin\theta_1 = (10.0\text{ m})(\sin 55.0°) = 8.20\text{ m}$$

$$\Delta x_2 = 5.00\text{ m}$$

$$\Delta y_2 = 0.00\text{ m}$$

$$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = 5.74\text{ m} + 5.00\text{ m} = 10.74\text{ m}$$

$$\Delta y_{tot} = \Delta y_1 + \Delta y_2 = 8.20\text{ m} + 0.00\text{ m} = 8.20\text{ m}$$

$$d^2 = (\Delta x_{tot})^2 + (\Delta y_{tot})^2$$

$$d = \sqrt{(\Delta x_{tot})^2 + (\Delta y_{tot})^2} = \sqrt{(10.74\text{ m})^2 + (8.20\text{ m})^2} = 13.5\text{ m}$$

PTS: 1 DIF: IIIB OBJ: 3-2.4

13. ANS:
1.09 m at 24° north of east

Given
d_1 = 2.00 m θ_1 = 10.0° east of south
d_2 = 2.50 m θ_2 = 75.0° north of east

Solution

$$\Delta x_1 = d_1 \sin\theta_1 = (2.00)(\sin 10.0°) = 0.347\text{ m}$$

$$\Delta y_1 = d_1 \cos\theta_1 = (2.00\text{ m})(\cos 10.0°) = 1.97\text{ m}$$

$$\Delta x_2 = d_2 \cos\theta_2 = (2.50\text{ m})(\cos 75.0°) = 0.647\text{ m}$$

$$\Delta y_2 = d_2 \sin\theta_2 = (2.50\text{ m})(\sin 75.0°) = 2.41\text{ m}$$

$$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = 0.347\text{ m} + 0.647\text{ m} = 0.994\text{ m}$$

$$\Delta y_{tot} = \Delta y_1 + \Delta y_2 = -1.97\text{ m} + 2.41\text{ m} = 0.44\text{ m}$$

$$d = \sqrt{(\Delta x_{tot})^2 + (\Delta y_{tot})^2} = \sqrt{(0.994\text{ m})^2 + (0.44\text{ m})^2} = 1.09\text{ m}$$

$$\theta = \tan^{-1}\left(\frac{0.44\text{ m}}{0.994\text{ m}}\right) = 24°$$

d = 1.09 m at 24° north of east

PTS: 1 DIF: IIIC OBJ: 3-2.4

14. ANS:
120 m

Given
$\mathbf{v_i}$ = 12 m/s at 30.0° above the horizontal
Δt = 5.60 s
g = 9.81 m/s^2

Solution
$v_{i,y} = v_i \sin\theta = (12 \text{ m/s})(\sin 30.0°) = 6.0 \text{ m/s}$

$\Delta y = v_{i,y}\Delta t + \frac{1}{2} a_y(\Delta t)^2 = (6.0 \text{ m/s})(5.60 \text{ s}) + \frac{1}{2}(-9.81 \text{ m/s}^2)(5.60 \text{ s})^2$

$\Delta y = 34 \text{ m} - 154 \text{ m} = -120 \text{ m}$

$h = 120 \text{ m}$

PTS: 1 DIF: IIIB OBJ: 3-3.3