Name: Key

Chapter 3 Test 2015-2016

I. Multiple Choice: Select the one best answer for each question. Where g is used, assume it equals 10 m/s^2 and neglect air resistance for falling/moving objects.

1. For a symmetric projectile with an initial velocity of v_0, what other angle gives the same range as 60°?

   A) 5° **B) 30°** C) 45° D) 60° E) 75°

   Angles are complementary
   $\theta_1 + \theta_2 = 90°$

2. For a symmetric projectile with an initial velocity of v_0, what angle gives the greatest range?

   A) 5° B) 30° **C) 45°** D) 60° E) 75°

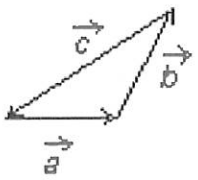
3. A projectile is shot vertically upward with a given initial velocity. It reaches a maximum height of 50.0 m. If, on a second shot, the initial velocity is tripled (i.e. 3X), then the projectile will reach a maximum height of:

   A) 75 m B) 100 m C) 150 m D) 200 m **E) 450 m**

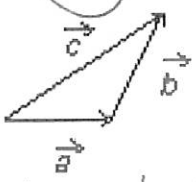
   $y_{MAX} = -\frac{v_{0y}^2}{2g} \Rightarrow y_{MAX} \sim v_{0y}^2$

4. The vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ are related by $\vec{C} = \vec{A} + \vec{B}$. Which diagram below illustrates this relationship?

   A)

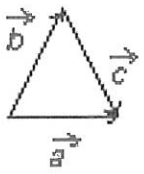
   

   B)

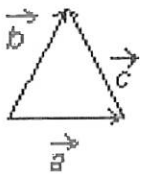
   

   Head-to-tail

   C)

   D)

5. A bird flies at a speed of 15 meters per second with respect to the ground and the wind is blowing at a speed of 5 m/s second with respect to the ground. [Note: The wind could be blowing with the bird, in the opposite direction of the bird or all other possible directions.] Which one of the speeds listed below is a possible net speed (i.e. vector sum) of the bird with respect to the ground?

   A) 3 m/s B) 5 m/s C) 9 m/s **D) 18 m/s** E) 25 m/s

   Min: $15 - 5 = 10 \frac{m}{s}$

   Max: $15 + 5 = 20 \frac{m}{s}$

For #6-11, the answers will be <, = or >, but you will mark A, B or C on your Scantron sheet. Assume no air friction for these projectiles and consider only the <u>speed</u> of the projectile (i.e. disregard the + and – signs).

A) < B) = C) >

C 6. v_B ___ v_{yA}

B 7. a_a ___ a_B

A 8. v_{yB} ___ v_{yC}

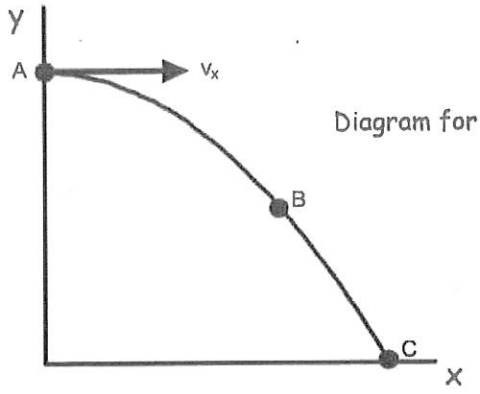


Diagram for #1-3

B 9. v_{xC} ___ v_{xD}

B 10. v_A ___ v_E

C 11. v_{yD} ___ v_{yB}

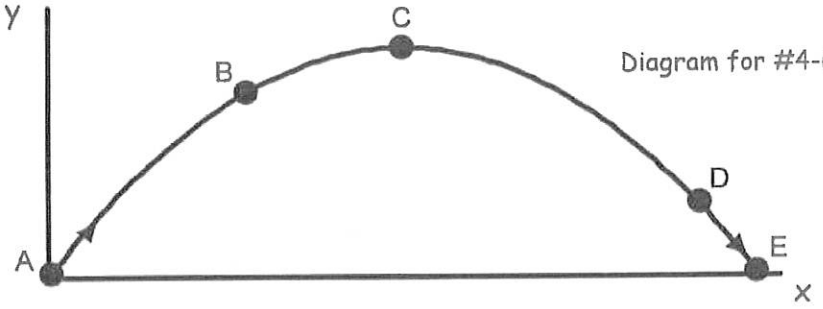


Diagram for #4-6

12. A vector has a component of 5 m in the +x direction and a component of 12 m in the +y direction. The magnitude of this vector is:

A) 13 m B) 15 m C) 17 m D) 60 m E) 169 m

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{5^2 + 12^2} = 13\,m$

13. A vector in the xy plane has an x-component of 14.0 and a y-component of 9.4. The angle it makes with the positive x axis is:

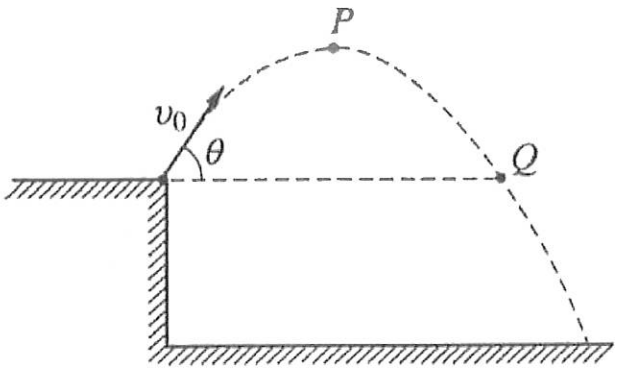
A) 26° B) 34° C) 45° D) 59° E) 66°

$\theta = \tan^{-1}\frac{y}{x} = \tan^{-1}\frac{9.4}{14.0} = 34°$

14. Which of the following <u>cannot</u> be a vector quantity?

A) velocity B) acceleration C) force D) temperature

Diagram for Questions 15 & 16



A rock is thrown from the edge of a cliff with an initial velocity v_0 at an angle θ with the horizontal as shown above. Point P is the highest point in the rock's trajectory and point Q is level with the starting point. Assume air resistance is negligible.

15. Which of the following correctly describes the horizontal and vertical speeds and the acceleration of the point at Point P?

	Horizontal Speed	Vertical Speed	Acceleration
A)	→ $v_0 \cos\theta$	→ 0	→ g
B)	0	→ 0	→ g
C)	→ $v_0 \cos\theta$	$v_0 \sin\theta$	→ g
D)	0	$v_0 \cos\theta$	→ g
E)	→ $v_0 \cos\theta$	→ 0	0

16. Which of the following correctly describes the horizontal and vertical speeds and the acceleration of the point at Point Q?

	Horizontal Speed	Vertical Speed	Acceleration
A)	$v_0 \cos\theta$	0	→ g
B)	0	0	→ g
C)	→ $v_0 \cos\theta$	→ $v_0 \sin\theta$	→ g
D)	0	$v_0 \cos\theta$	→ g
E)	$v_0 \cos\theta$	0	0

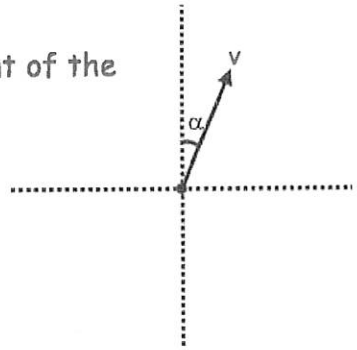
17. A bullet shot horizontally from a gun. At the same instant, another bullet is simply dropped from the same height. Neglecting air resistance, the bullet shot from the gun

A) strikes the ground much later than the dropped bullet.
B) never strikes the ground.
C) strikes the ground at the same time as the dropped bullet
D) travels in a straight line.
E) strikes the ground much sooner than the dropped bullet.

18. If θ is the angle with respect to the +x-axis, the y-component of the vector A is given by

A) $A \cos\theta$ B) $\mu A \cos\theta$ C) $A \sin\theta$ D) $mg - A \sin\theta$ E) $\tan^{-1}\theta$

19. Given the diagram to the right, what is the x-component of the vector v?



A) $V \sin\alpha$
B) $V \cos\alpha$
C) $V \tan\alpha$
D) $V \sin^{-1}\alpha$
E) $\sqrt{v_x^2 + v_y^2}$

II. Problems: Clearly show your work. Be neat. Use the correct number of significant figures and circle your answers. All answers must have units. Assume $g = 9.8\ m/s^2$.

1. A force vector $\vec{F}$ has a magnitude of 12.0 N and a direction of 290.0° with respect to the +x axis.
   A. Find the x-component of the force vector.
   B. Find the y-component of the force vector.

2. A position vector $\vec{r}$ has x- and y-components of $r_x = -6.50$ m and $r_y = 10.25$ m.
   A. Find the magnitude of the position vector.
   B. Find the direction with respect to the +x axis of the position vector.

3. A projectile is launched at ground level with an initial speed of 40.0 m/s at an angle of 58.0° above the horizontal. It strikes a target above the ground 4.60 seconds later. [Note: This is <u>not</u> a symmetric projectile.] Assume the projectile is launched at $x_0 = 0.00$ m and $y_0 = 0.00$ m.
   A. What is the x-position of the target?
   B. What is the y-position of the target?

4. A ball is kicked with an initial velocity of 16.0 m/s in the horizontal direction and 12.0 m/s in the vertical direction. [Note: This <u>is</u> a symmetric projectile.]
   A. What maximum height is attained by the ball?
   B. For how long does the ball remain in the air?
   C. What is the range of the ball (i.e. the horizontal distance traveled)?
   D. At what speed does the ball hit the ground?

5. A ball is thrown <u>horizontally</u> from the top of a 60.0-m building and lands 150.0 m from the base of the building. Ignore air resistance.
   A. How long is the ball in the air?
   B. What must have been the initial velocity?

6. A boat with a calm water speed of 10.0 m/s crosses a river 3.00×10^2 m wide. The boat keeps its bow pointed directly across the river, but drifts downstream because the river current is 3.00 m/s.
   A. Find the time needed to cross the river.
   B. Find the distance the boat drifts downstream.

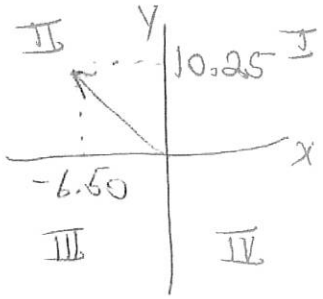
Physics 200 Chapter 3 Test
2015-2016

① $|\vec{F}| = 12.0\,N \quad \theta = 290.0^\circ$

A. $X = F\cos\theta = 12.0\,N \cos 290.0^\circ = \boxed{4.10\,N}$

B. $y = F\sin\theta = 12.0\,N \sin 290.0^\circ = \boxed{-11.3\,N}$

② $r_x = -6.50\,m \quad r_y = 10.25\,m$



A. $r = \sqrt{r_x^2 + r_y^2} = \sqrt{(-6.50\,m)^2 + (10.25\,m)^2}$

$= \boxed{12.1\,m}$

B. $\theta = \tan^{-1}\frac{10.25\,m}{-6.50\,m} + 180^\circ = -57.62 + 180^\circ = \boxed{122^\circ}$

↑ II Quadrant

③ $v_0 = 40.0\frac{m}{s} \quad \theta_0 = 58.0^\circ \quad t = 4.60\,s \quad x_0 = 0 \quad y_0 = 0$

A. $X = X_0 + v_{0x}t = 0 + \left(40.0\frac{m}{s}\cos 58.0^\circ\right)(4.60\,s)$

$= \boxed{97.5\,m}$

B $y = y_0 + v_{0y}t + \frac{1}{2}gt^2 = 0 + \left(40.0\frac{m}{s}\sin 58.0^\circ\right)(4.60\,s)$

$+ \frac{1}{2}\left(-9.80\frac{m}{s^2}\right)(4.60\,s)^2$

$= \boxed{52.4\,m}$

(4) $v_{0x} = 16.0\frac{m}{s}$ $v_{0y} = 12.0\frac{m}{s}$ $\Rightarrow v_0 = 20.0\frac{m}{s}$ $\theta = 36.87°$

A. $y_{MAX} = H = \frac{-v_{0y}^2}{2g} = \frac{-\left(12.0\frac{m}{s}\right)^2}{2\left(-9.80\frac{m}{s^2}\right)} = \boxed{7.35m}$

B. $t = \frac{-2v_{0y}}{g} = \frac{-2\left(12.0\frac{m}{s}\right)}{-9.80\frac{m}{s^2}} = \boxed{2.45s}$

C. $R = \frac{v_0^2 \sin 2\theta_0}{g} = \frac{\left(16.0^2 + 12.0^2\right)^2 \sin\left(2\left(\tan^{-1}\frac{12.0}{16.0}\right)\right)}{9.80\frac{m}{s^2}}$

$= \boxed{39.2m}$

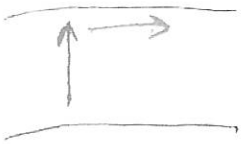
D. $v_{up} = v_{down} \Rightarrow v = \sqrt{\left(16.0\frac{m}{s}\right)^2 + \left(12.0\frac{m}{s}\right)^2} = \boxed{20.0\frac{m}{s}}$

(5) $y - y_0 = 60.0m$ $x - x_0 = 150.0m$

A. $y - y_0 = \cancel{v_{0y}^0 t} + \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2(y-y_0)}{g}} = \sqrt{\frac{2(60.0m)}{9.80\frac{m}{s^2}}} = \boxed{3.50s}$

B. $x - x_0 = v_{0x}t \Rightarrow v_{0x} = \frac{x-x_0}{t} = \frac{150.0m}{3.50s} = \boxed{42.9\frac{m}{s}}$

(6) $v_0 = 10.0\frac{m}{s}$ $v_c = 3.00\frac{m}{s}$ $y - y_0 = 3.00 \times 10^3 m$



A. $y - y_0 = v_{0y}t \Rightarrow t = \frac{y-y_0}{v_{0y}} = \frac{3.00 \times 10^3 m}{10.0\frac{m}{s}}$

$= \boxed{30.0s}$

B. $x - x_0 = v_{0x}t = \left(3.00\frac{m}{s}\right)(30.0s) = \boxed{90.0m}$