PHYS 201 F2023 Equations Sheet (may be teared & re-stapled) Name: Answer Key

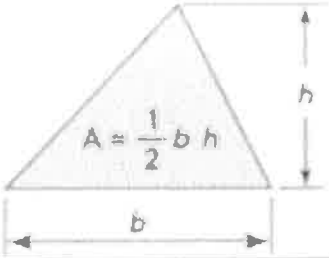
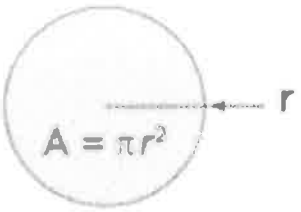
1. Equations of kinematics:

1.	2.	3.	4.	5.
$x = \bar{v}\,t$	$x = \frac{1}{2}(v_0 + v)t$	$v = v_0 + at$	$x = v_0 t + \frac{1}{2}at^2$	$v^2 = v_0^2 + 2ax$

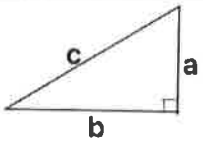
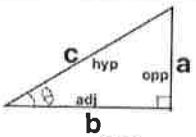
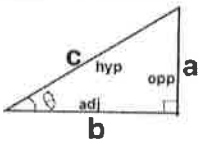
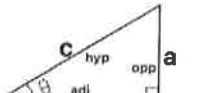
Acceleration due to gravity = g = 9.8 m/s^2, down

2. Conversion factors:
1 H = 3600 s, 1 Mile = 1608 m, 1 inch = 2.54 cm, 1 foot = 12 inch, 1 m = 3.281 ft.
1 m = 100 cm, 1 cm = 10 mm, 1 m = 1000 mm, 1 km = 1000 m

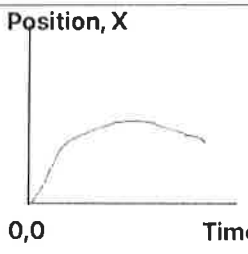
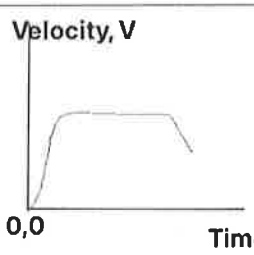
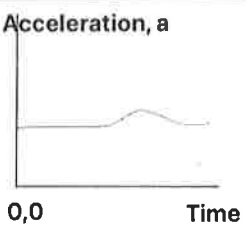
3. Areas:

Rectangle	Triangle	Circle
 Area of rectangle = *Length X Width*	 $A = \frac{1}{2} b\,h$	 $A = \pi r^2$

4. Pythagorean theorem and Trigonometry:

Pythagorean Theorem	*sin θ*	*cos θ*	*tan θ*	Components of a vector:
 $c^2 = b^2 + a^2$	 $Sin\,\theta = \frac{opp}{hyp} = \frac{a}{c}$	 $Cos\,\theta = \frac{adj}{hyp} = \frac{b}{c}$	 $Tan\,\theta = \frac{opp}{adj} = \frac{a}{b}$	Adjacent component = Cos Opposite component = Sin

5. Graphical analysis of motion:

			
Slope	Velocity	Acceleration	XXXXXXXXXXXXXX
Area	XXXXXXXXXXXX	Displacement	Change in Velocity

6. Addition of velocities: $\overrightarrow{V_{PG}} = \overrightarrow{V_{PT}} + \overrightarrow{V_{TG}}$

PHYS 201 Fall 2023 Test #1 Name: Answer key

A. Select the correct answer for the following multiple choice questions and write your answer in the line next to the question number.

f 1. In 2019, the SI base unit mole was re-defined using this fundamental constant:

a. Planck constant.
b. Elementary charge.
c. Hyperfine transition frequency of the cesium 133 atom.
d. Boltzmann constant.
e. Speed of light in vacuum.
f. Avogadro constant.

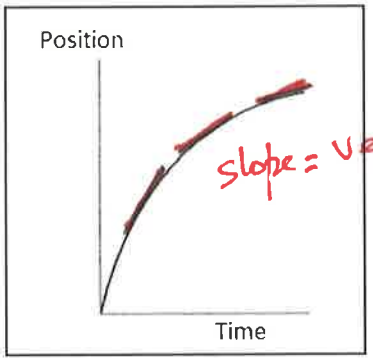
a 2. What is the SI base unit for temperature?
a. K b. ^{0}F c. ^{0}C d. ^{0}K e. F f. C

b 3. Which one of the following is a SI derived unit?
a. kg b. m^3 c. mol d. A e. m f. cm/s

e 4. Which one of the following is a scalar?
a. displacement b. acceleration c. velocity d. weight e. distance

a 5. What is the angle between the vectors 2**A** and 3**A** when they are drawn from a common origin?
a. 0^0 b. 90^0 c. 180^0 d. 270^0 e. 360^0

b 6. For the motion described in the graph, decide whether the moving object is
a) accelerating
b) decelerating
c) moving at a constant velocity
d) moving at a constant speed

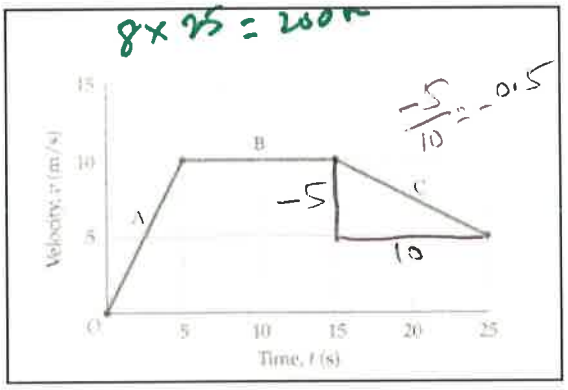


d 7. Velocity is defined as,
b 8. Acceleration is defined as,
Answers for 7 & 8
a. Rate at which the speed changes
b. Rate at which the velocity changes
c. Rate at which the distance changes
d. Rate at which the displacement changes

d 9. Speeding tickets are issued using the,
a. average speed b. average velocity c. average acceleration
d. instantaneous speed e. instantaneous velocity f. instantaneous acceleration

b 10. Which pair of the following physical quantities are zero at the highest point of the trajectory of a two-dimensional projectile motion?
a. horizontal velocity and vertical velocity
b. horizontal acceleration and vertical velocity
c. vertical acceleration and vertical velocity
d. horizontal velocity and horizontal acceleration

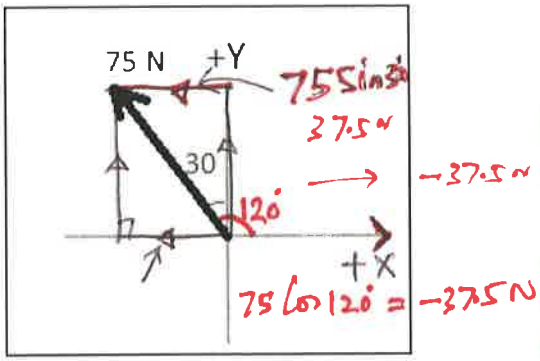
11-13) Deal with the one-dimensional motion of a race, duration of 25 s, where the velocity is graphed as a function of time, shown on the right.



b 11. What is the instantaneous velocity of the runner at 5 s?
a. 5 m/s b. 10 m/s c. 7.5 m/s d. -7.5 m/s

d 12. What is the instantaneous acceleration of the runner at 20 s?
a. 0 m/s^2 b. 2.0 m/s^2 c. 0.5 m/s^2 d. -0.5 m/s^2 e. -2 m/s^2

d 13. How far is the race?
a. 25 m b. 50 m c. 100 m d. 200 m e. 250 m

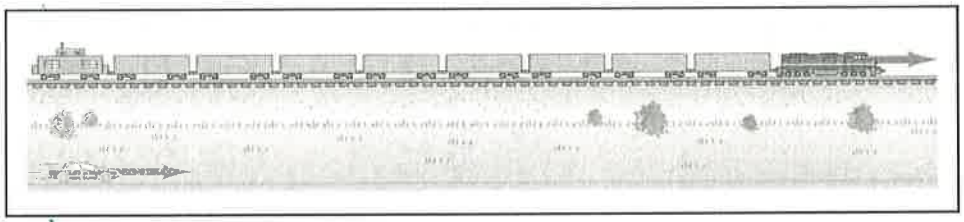


C 14. What is the +X component of the force 75N shown in the diagram, which is in the 2nd quadrant and makes 30^0 with the +Y axis?
a. 37.5 N b. 65 N c. -37.5 N
d. -65 N e. 75N f. -75 N

C 15. A ball (I) is rolled along the surface of a table and leaves the edge horizontally. At the same instant the ball I leaves the table, a second ball (II) is dropped from rest at the edge of the table. In the absence of air resistance, which ball will strike the ground first?
a. I b. II c. both will strike at the same time

b 16. In the above question which ball will have the lower speed at the ground level?
a. I b. II c. both will have the same speed

17-18) A car traveling at 35 m/s overtakes a 150 m long train traveling in the same direction on a track parallel to the road. The velocity of the train is 30 m/s, eastward.



b 17. What is the velocity of the car relative to the train?
a. 65 m/s eastward b. 5 m/s eastward c. 35 m/s eastward
d. 65 m/s westward e. 5 m/s westward f. 30 m/s eastward

d 18. How long does it take the car to pass the train?
a. 2.3 s b. 4.3 s c. 5.0 s d. 30 s e. 300 s

B. Equations of Kinematics for constant acceleration are given below:

1.	2.	3.	4.	5.
$x = \bar{v}\,t$	$x = \frac{1}{2}(v_0 + v)t$	$v = v_0 + at$	$x = v_0 t + \frac{1}{2}at^2$	$v^2 = v_0^2 + 2ax$

1. Derive the 4th kinematic equation using the kinematic equations 2 & 3.

$x = \frac{1}{2}(v_0 + v)t$

$x = \frac{1}{2}(v_0 + v_0 + at)t$

$x = \frac{1}{2}(2v_0 + at)t$

$x = (v_0 + \frac{1}{2}at)t$

$x = v_0 t + \frac{1}{2}at^2$

2. A car traveling at 18 m/s hits a bridge abutment. A passenger in the car moves forward a distance of 0.95 m, while being brought to rest by an inflated air bag. Determine the deceleration of the passenger?

deceleration = 170.5 m/s²

$v_0 = 18$ m/s, $a = ?$, $v = 0$, $x = 0.95$ m

$v^2 = v_0^2 + 2ax$

$0 = 18^2 + 2a(0.95)$

$0 = 324 + 1.9a$

$1.9a = -324$

$a = \frac{-324}{1.9} = -170.5$ m/s²

3. A ball is shot vertically upward from the ground. It goes up and returns to the ground in 12 s. Ignore air resistance.

a. Determine the initial velocity of the ball?

↑ $y = 0$, $t = 12$ s, $a_y = -9.8$ m/s², $v_0 = ?$

$y = v_0 t + \frac{1}{2}at$

$0 = v_0 * 12 + \frac{1}{2}(-9.8)(12^2)$

$0 = 12v_0 - 705.6$ → $v_0 = \frac{705.6}{12} = 58.8$ m/s

b. What is the maximum height reached by the ball?

$t = 6$ s

$v_0 = 58.8$ m/s

$y = ?$

$a_y = -9.8$ m/s²

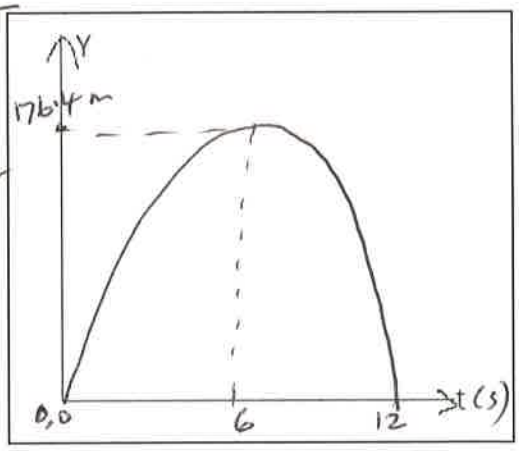
$y = v_0 t + \frac{1}{2}a_y t^2$

$y = 58.8 \times 6 + \frac{1}{2}(-9.8)6^2$

$y = 352.8 - 176.4$

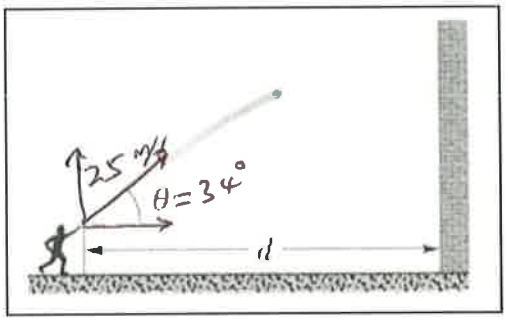
$y = 176.4$ m

c. Plot the vertical displacement (y) versus t for the ball inside the box.



1.	2.	3.	4.	5.
$y = \overline{v_y}\, t$ $x = \overline{v_x}\, t$	$y = \frac{1}{2}(v_{0y} + v_y)t$	$v_y = v_{0y} + a_y t$	$y = v_{0y}t + \frac{1}{2}a_y t^2$	$v_y{}^2 = v_{0y}^2 + 2a_y y$

C. A ball is thrown toward a wall at speed 25.0 m/s and at angle $\theta = 34.0^0$ above the horizontal as shown below. The wall is at a horizontal distance $d = 32.0$ m from the release point of the ball.



(a) Determine the horizontal and vertical components of the initial velocity. V_{ox} V_{oy}

$V_{ox} = 25 \cos 34^\circ = 20.7$ m/s

$V_{oy} = 25 \sin 34^\circ = 14$ m/s

(b) How much time the ball takes to hit the wall?

X ⟶ $a_x = 0$

$V_{ox} = 20.7$ m/s $\quad x = V_{ox}t + \frac{1}{2}a_x t^2$

$x = 32$ m $\quad 32 = 20.7t + 0$

$t = ?$ $\quad t = \frac{32}{20.7} = 1.55$ s

$t = 1.55$ s

(c) How far above the release point does the ball hit the wall?

↑ $y = ?$

$t = 1.55$ s $\quad y = V_{oy}t + \frac{1}{2}a_y t^2$

$V_{oy} = 14$ m/s $\quad y = 14 \times 1.55 + \frac{1}{2}(-9.8)(1.55)^2$

$a_y = -9.8$ m/s^2 $\quad y = 21.7 - 11.7 = 10$ m

$y = 10$ m

(d) What are the (1) horizontal and (2) vertical components of its velocity as it hits the wall?

$V_x = V_{ox} + a_x t \rightarrow V_x = V_{ox} = 20.7$ m/s ($a_x = 0$)

$V_y = V_{oy} + a_y t$

$V_y = 14 - 9.8 \times 1.55$

$V_y = 14 - 15.19 = -1.2$ m/s

$V_{ox} = 20.7$ m/s

$V_y = -1.2$ m/s ↓

(e) When it hits, has it passed the highest point on its trajectory? Explain your answer.

It has passed the highest point, since V_y is negative.

$V_y = -1.2$ m/s ↓ ⟶ It is going down.