**PHYSICS 2204**
***Unit 1: Kinematics***
**Worksheet 10: Kinematics Equations**

**STUDENT NAME:**_____

In order to solve problems dealing with uniform acceleration of an object's motion there are five key equations we need to use.

| | Equation | Variable Not Found In Equation |
|---|---|---|
| **Equation 1** | $\vec{v}_2 = \vec{v}_1 + \vec{a}t$ | $\vec{d}$ |
| **Equation 2** | $\vec{v}_2{}^2 = \vec{v}_1{}^2 + 2\vec{a}\vec{d}$ | $t$ |
| **Equation 3** | $\vec{d} = \vec{v}_1 t + \frac{1}{2}\vec{a}t^2$ | $\vec{v}_2$ |
| **Equation 4** | $\vec{d} = \vec{v}_2 t - \frac{1}{2}\vec{a}t^2$ | $\vec{v}_1$ |
| **Equation 5** | $\vec{d} = \left(\frac{\vec{v}_2 + \vec{v}_1}{2}\right)t$ | $\vec{a}$ |

**The variables in the equation :**

$\vec{a}$ = Acceleration (m/s/s or m/s$^2$)

$\vec{v}_1$ = Initial velocity (m/s)

$\vec{v}_2$ = Final velocity (m/s)

$\vec{d}$ = Displacement (m)

t = Change in time (s)

**Some good problem solving steps:**

1) Read the question
2) Write the givens what you know (look for units) and what you want to know
3) Sketch a diagram if needed
4) Choose a formula(s)
5) Find the answer.
6) Don't forget to use the correct units
7) Ask if the answer reasonable

**Example 1:**

A boat moving at 2.0 m/s to the right accelerates to the right at 0.80 $m/s^2$ for 4.0s.

A) Calculate the final velocity of the boat.

B) Calculate the displacement for the 4.0 s interval

**Example 2**:

A car is coasting at 17 m/s (about 60 km/hr) when the driver accelerates at 5.3 $m/s^2$ for a distance of 25 m in a passing lane. What will be the speed after traveling the 25 m?

**Example 3**:

A bicycle crests the top of a hill moving at 3.0 m/s. While rolling down the hill the bike experiences an acceleration of 0.50 $m/s^2$. How long is the hill if the bike is moving at 5.0 m/s at the bottom?

**Example 4:**

A car travelling at 24 m/s can slow down at a rate of 8.0 $m/s^2$. If while driving this car you notice a child in the street 41 m in front of the car, can the car stop without hitting the child. Give mathematical evidence

**Example 5**:
Assuming that in question 4 your reaction time is 0.25 seconds, can the car still stop without hitting the child? Give mathematical evidence.

**Example 6:**

A car traveling at 22 m/s pulls into a passing lane and accelerates at 4.8 m/s2 to pass a slow vehicle. If the lane is 610 m long, how many seconds elapse before the car must pull back into the regular lane?

**PART A: MULTIPLE CHOICE**

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. How far does an object travel if it starts from rest and accelerates at 2.35 $m/s^2$ for 2.20 s?

   (A) 2.59 m
   (B) 5.17 m
   (C) 5.69 m
   (D) 11.4 m

2. How long does it take a car to accelerate from 20.0 m/s to 60.0 m/s at a rate of 8.5 $m/s^2$?

   (A) 0.11 s
   (B) 0.21 s
   (C) 4.7 s
   (D) 9.4 s

3. An object initially moving at 2.5 m/s accelerates at 1.5 $m/s^2$ for 3.2 s. What is its final speed?

   (A) 2.3 m/s
   (B) 4.8 m/s
   (C) 7.3 m/s
   (D) 9.5 m/s

4. What is the magnitude of the acceleration of an object that changes its velocity from 2.8 m/s to 6.4 m/s over a distance of 15 m?

   (A) 0.12 $m/s^2$
   (B) 0.24 $m/s^2$
   (C) 1.1 $m/s^2$
   (D) 2.2 $m/s^2$

5. A car starts from rest and accelerates uniformly at 6.6 $m/s^2$ for 10.0s . How far does it travel?

   (A) 33 m
   (B) 66 m
   (C) 330 m
   (D) 660 m

6. The driver of a car travelling at 25 m/s sees a moose ahead. He applies the brakes and the car slows down at a rate of 8.3 $m/s^2$ . If the driver's reaction time is 0.60 s, what is the total distance travelled from the time the driver sees the moose until the car stops?

(A) 14 m
(B) 15 m
(C) 38 m
(D) 53 m

7. An object accelerates at 2.2 $m/s^2$ for 3.0 s. If the final velocity of the object is 15 m/s, what was the initial velocity?

(A) 2.3 m/s
(B) 8.4 m/s
(C) 16 m/s
(D) 22 m/s

8. An object travels with uniform motion at 20 m/s for 10 s. What is the acceleration?

(A) 0 $m/s^2$
(B) 0.5 $m/s^2$
(C) 2 $m/s^2$
(D) 20 $m/s^2$

9. A skateboarder initially moving at 5.0 m/s [W] slows to a stop. Which is true regarding the skateboarder's motion?

| | **Displacement** | **Acceleration** |
|---|---|---|
| (A) | East | East |
| (B) | East | West |
| (C) | West | East |
| (D) | West | West |

10. An airplane lands with an initial speed of 120 m/s. The acceleration of the airplane as it comes to a stop is -11.6 $m/s^2$. How far does the airplane travel before stopping?

(A) 620 m
(B) 730 m
(C) 1200 m
(D) 1400 m

11. A cart initially moving at 4.5 m/s [E] accelerates at 1.1 $m/s^2$ [E]. What is the displacement of the cart when its velocity is 5.9 m/s [E]?

(A) 0.64 m/s [E]
(B) 6.6 m/s [E]
(C) 8.0 m/s [E]
(D) 25 m/s [E]

12. A car accelerates from rest at 3.0 $m/s^2$ for 5.0 s. What is its final velocity?

(A) 0.6 m/s
(B) 1.7 m/s
(C) 15 m/s
(D) 45 m/s

**PART B: LONG ANSWER**

1. A snowmobile on a frozen pond is moving at 15.0 m/s when the driver decides to pass a slow-moving sled. If the driver accelerates to a speed of 19.5 m/s in a time of 4.00 seconds then what was the acceleration?

2. Your friend is on a quad is moving at 14.0 m/s when you breeze by on your bike. Your friend accelerates at 2.0 $m/s^2$ for 3.0 seconds. How far does she travel during this time?

3. Corvette can accelerate during high speeds at about 2.0 $m/s^2$. At this rate how long does it take the car to accelerate from 80 km/h to 160 km/h?

4. A snowmobile with an initial speed of 5.6 m/s travels 24.0 m in 2.0 s. What final speed does it attain? Express your answer first in m/s and then in km/hr.

5. A motorcycle with an initial speed of 2.2 m/s accelerates at 3.6 $m/s^2$ and covers a distance of 12.0 m. What is its final speed?

6. A hockey puck initially travelling to the right at 34 m/s is slowed down by rough ice at a rate of 2.0 m/s/s. It moves for 7.2 s before finally coming to rest. How far did it travel?

7. A ski-doo moving at 12 m/s [W] accelerates at 6.0 $m/s^2$ [W]. How long will it take to experience a displacement of 63 m [W]?

8. A car moves at 12 m/s for 30.0 s. It then accelerates at 1.5 $m/s^2$ for 8.00 seconds. Finally, it continues on at this top speed for another 12.0 s. Calculate the net displacement during the whole time interval.

9. A police cruiser is travelling at 20.0 m/s when the officer spies a speeder. The cruiser accelerates at 3.0 $m/s^2$ for 5.0 seconds, at which time the speeder pulls over and starts thinking up excuses to try and get out of getting a ticket. The cruiser then slows to a stop at 5.0 $m/s^2$. How far does it go in the entire time?

10. The driver of a car travelling at 25 m/s suddenly sees the lights of a barrier 45 m ahead. It takes the driver 0.75 s to apply the brakes and the acceleration during braking is $-9.5\ m/s^2$. Calculate whether the car will hit the barrier. [4]

11. A car starts from rest and accelerates at $6.8\ m/s^2$ for a period of 3.1 s. The brakes are then applied and the car immediately slows to a stop at a rate of $-7.6\ m/s^2$. Calculate whether the car will hit a garbage can that is located 25 m ahead of the position where the brakes were applied. [4]

12. A car is travelling at a constant velocity of 28 m/s when the driver sees a moose 75 m ahead. The brakes are then applied, causing the car to accelerate at $-6.4\ m/s^2$. What was the maximum reaction time the driver had to apply the brakes and avoid hitting the moose? [5]