Worksheet 1.8

Motion Equations; X-direction only

1. Write down the four main equations that describe motion in the x-direction.

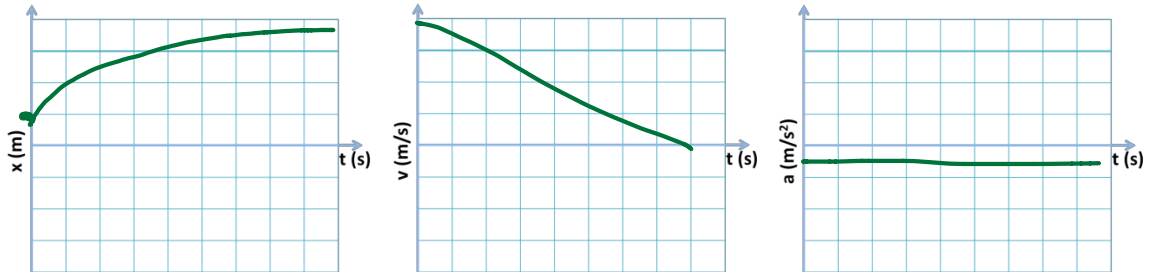
$v_f = at + v_i$

$x_f = \frac{1}{2}at^2 + vt + x_i$

$v_f^2 = v_i^2 + 2a\Delta x$

$\Delta x = \frac{t}{2}(v_f + v_i)$

2. A hockey puck leaves a player's stick from a position of x = 2 m with a velocity of 25 m/s and moves across the ice with a constant deceleration of 0.5 m/s^2 due to friction from the ice. Draw x vs t, v vs t, and a vs t graphs that describe this situation. Make sure to label your axis.



What is v_o? 25 m/s What is x_o? 2m What is a? $-.5\ m/s^2$

3. Rewrite the equations from (1) for this system by substituting in the variables provided.

$v_f = (-.5)t + 25 m/s$

$x_f = \frac{1}{2}(-.5)t^2 + 25t + 2$

$v_f^2 = 25^2 + 2(-.5)(x_f - 2)$

$(x_f - 2) = \frac{t}{2}(v_f + 25)$

4. What is the velocity of the puck at 1 second?

$v_f = -.5(1) + 25 = 24.5 m/s$

5. What is the position of the puck at 1 second?

$x_f = \frac{1}{2}(-.5)(1^2) + 25(1) + 2 = -.25 + 25 + 2 = 26.75 m$

6. How long does it take for the puck to reach the goal that is 5 meters away?

$7 = \frac{1}{2}(-.5)(t^2) + 25t + 2 \quad t = .2 sec$

$0 = -.25t^2 + 25 - 5$

7. How fast is the puck traveling when it reaches the goal?

$v_f = -.5(.12) + 25 = 24.94 m/s$

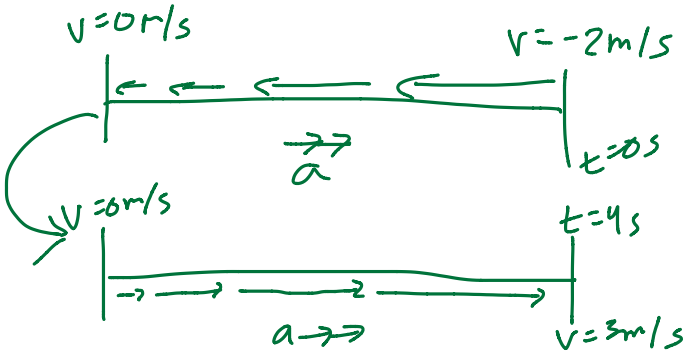
Draw a motion diagram and x vs t, v vs t, and a vs t graphs for each of the following word problems in addition to answering the questions.

8. A gust of wind hits a beach ball already moving with a velocity of 2 m/s to the west. The wind hits the ball for 4 seconds and then stops. When the wind stops, the ball is moving 3 m/s to the east. What was the acceleration of the ball due to the wind?

$v_f = at + v_i$

$3 = a(4) - 2$

$a = \frac{5}{4}\ m/s^2$



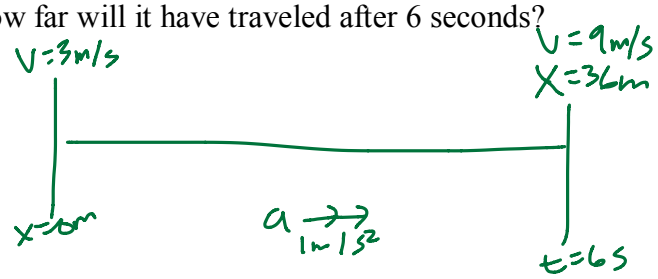
9. If a ball initially started at x = 0 m with an eastward velocity of 3 m/s and an acceleration of 1 m/s^2 to the east, how far will it have traveled after 6 seconds?

$x_i = 0m$

$v_i = 3m/s$

$a = 1m/s^2$

$t_f = 6s$



$v_f = (1)(6) + 3 = 9\ m/s$

$x_f = \frac{1}{2}(6^2) + 3(6) + 0 = 36m$

(-18, -18)

10. What is the acceleration of a tennis ball if initially it comes toward the player's racquet at 20 m/s, and it leaves in the opposite direction at 24 m/s? A high-speed camera indicates the time of impact of 4.0 ms.

$v_i = 20m/s$

$v_f = -24m/s$

$t_f = .004s$

$a?$

$-24 = a(.004) + 20$

$-44 = .004a$

$a = -1000\ m/s^2$

11. A motorcyclist is traveling 10 m/s is 200 m behind a car at traveling at a steady 20 m/s. How fast must the motorcyclist accelerate in order to pass the car in 5 seconds?

(M) $v_i = 10 m/s$ $t_f = 5s$
$x_i = -200m$

(C) $v_f = v_i = 20 m/s$ $t_f = 5s$
$x_i = 0m$

$x_{f(M)} = x_{f(C)}$

$\frac{a}{2}(5^2) + 10(5) - 200 = \frac{0}{2}(5^2) + 20(5) + 0$

$12.5a - 150 = 100$
$12.5a = 250$
$a = 20 m/s^2$

12. A car moving with a velocity of 20 m/s requires 3 m to stop. What is the acceleration of the car while stopping? How far would a car traveling at 40 m/s need to stop assuming the same rate of acceleration as the first car?

$v_i = 20 m/s$
$x_f = 3m$
$v_f = 0$
$0^2 = 20^2 + 2a(3)$
$-400 = 6a$
$a = 66.7 m/s^2$

$0^2 = 40^2 + 2(-66.7)(\Delta x)$
$-1600 = -133.4 \Delta x$
$\Delta x = 12m$
$12m = x_f - 0$
$x_f = 12m$