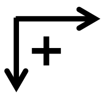
Name ________ **KEY** __________

Kinematics Review Problems (Ignore air resistance unless noted and show your work clearly)

1. A steel projectile is shot horizontally (right) at 20.0 m/s from the top of a 49.0 m high tower. How far from the base of the tower does it hit the ground?

Draw picture



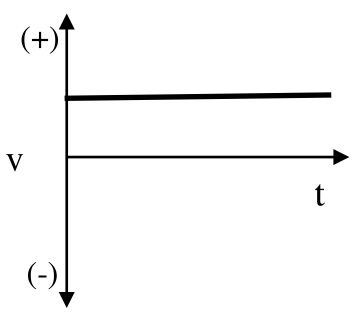
Constant V	**Constant Acceleration**
$V_x = 20.0$ m/s	$V_{yi} = 0.0$ m/s
$\Delta X = ?$	$\Delta Y = 49.0$ m
$\Delta t = ?$	$g = 10$ m/s^2
	$\Delta t = ?$

$$\Delta Y = V_{yi}\,\Delta t + \tfrac{1}{2}\, g\, \Delta t^2$$
$$\Delta Y = \tfrac{1}{2}\, g\, \Delta t^2$$

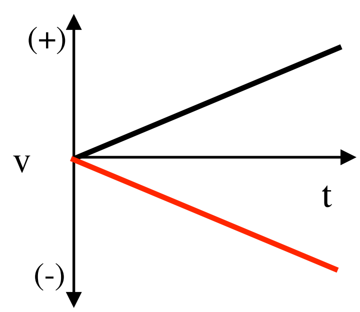
$$\Delta t = \sqrt{\frac{2 * \Delta Y}{g}} \qquad \Delta t = \sqrt{\frac{2 * 49.0\ m}{10\ \frac{m}{s^2}}} \qquad \boxed{\Delta t = 3.13\ s}$$

$$\Delta x = V_X \Delta t \qquad \Delta x = 20.0\frac{m}{s} * 3.13\ s \qquad \Delta x = 62.6\ m$$

1a. Sketch the **horizontal velocity-time** graph for the projectile:



1b. Sketch the **vertical velocity-time** graph for the projectile:



If down is positive

If up is positive

1c. Draw and label PROPERLY the FBD for the projectile at each of the following locations:

at the instant it leaves the tower

F_g or
F_{Earth} or
mg or
Gravity

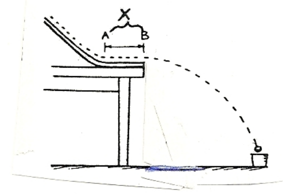
half-way down to the base

F_g

at the instant before it hits the ground

F_g

2. Assume that a marble rolled horizontally off a 1.6 m high desk with an initial horizontal velocity of 0.98 m/s as shown. How far out from the base of the desk will the marble land? (Show formulas and work)



Constant V

$V_x = 0.98$ m/s
$\Delta X = ?$
$\Delta t = ?$

Constant Acceleration

$V_{yi} = 0.0$ m/s
$\Delta Y = 1.6$ m
$g = 10$ m/s^2
$\Delta t = ?$

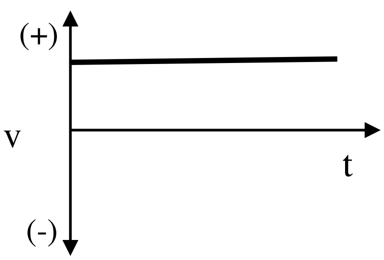
$$\Delta Y = V_{yi}\,\Delta t + ½\, g\, \Delta t^2$$

$$\Delta Y = \frac{1}{2} g \Delta t^2$$

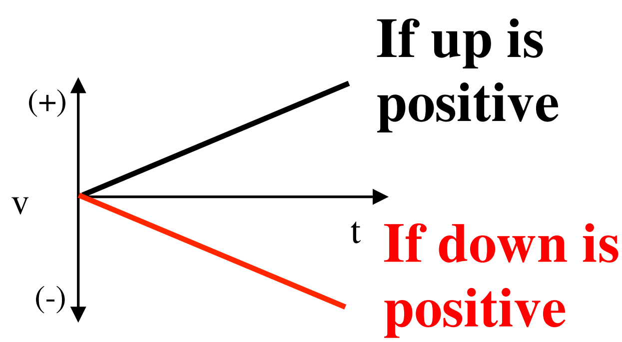
$$\Delta t = \sqrt{\frac{2 * \Delta Y}{g}}$$

$$\Delta t = \sqrt{\frac{2 * 1.6\ m}{10\ \frac{m}{s^2}}} = 0.566\ s$$

2a. Sketch the **horizontal velocity-time** graph for the marble:



2b. Sketch the **vertical velocity-time** graph for the marble:



2c. Describe in words and numerically what happens to the horizontal velocity as the marble continues on its path.

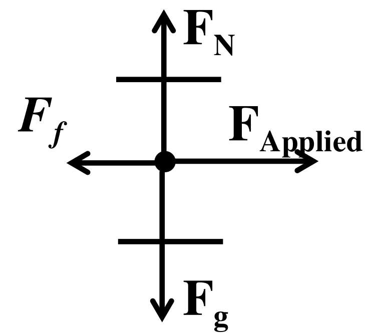
Since there is no acceleration in the X-direction the velocity will not change. $V_x = 0.98$ m/s at the start and the end of the problem.

2d. Describe in words and numerically what happens to the vertical velocity as the marble continues on its path.

As the marble falls it is accelerated by the Force of Gravity at a rate of 10 m/s^2. It is launched horizontally so the initial Velocity in the Y direction is 0.0 m/s. It's speed will increase 10 m/s every second.

$V_{yf} = V_{yi} + a * t$ $\qquad$ $V_{yf} = 0.0\frac{m}{s} + 10\frac{m}{s^2} * 0.566\ s$ $\qquad$ $V_{yf} = 5.66\ m/s$

3a. Tori is attempting to push her 28.0-kg Labrador Retriever across the wooden floor by applying a horizontal force of 250 N and accelerates him to the right. The coefficient of friction between the dog and the floor is 0.68. On the dot, draw a FBD for the dog as he is being pushed across the floor and be sure to label PROPERLY.



3b. Calculate the normal force acting on the dog

$$F_{net} = ma$$
$$F_N - F_g = 0$$
$$F_N = F_g$$
$$F_N = mg = 28.0 \text{ kg} * 10 \text{ N/kg}$$
$$F_N = 280 \text{ N}$$

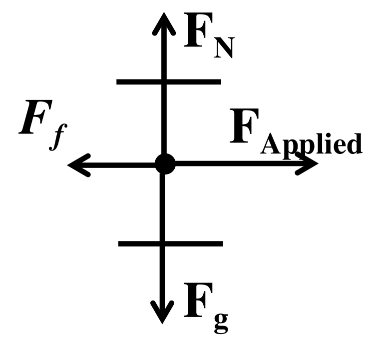
3c. Calculate the force of friction acting on the dog

$$F_f = \mu F_N$$
$$F_f = 0.68 * 280 \text{ N}$$
$$F_f = 190.4 \text{ N}$$

3d. Calculate the acceleration of the dog, showing formulas and work.

$$F_{net} = ma$$
$$F_{Applied} - F_f = ma$$
$$a = \frac{(F_{Applied} - F_f)}{m}$$
$$a = \frac{(250\ N - 190.4\ N)}{28.0\ kg}$$
$$a = 2.13\ \frac{N}{kg}$$

4a. Laura Inertia (58.0 kg) is running through the cafeteria when she slips on some mashed potatoes and falls to the floor. (Let that be a lesson for Laura!) Laura lands in a puddle of milk and her friend quickly pushes her out of the way with a force of 305 N so she doesn't get any more embarrassed. The coefficient of friction between Laura and the *milky* floor is 0.45. Draw a FBD for Laura as she is being pushed across the floor and accelerating to the right.
Be sure to label all forces PROPERLY.



4b. Calculate Laura's normal force

$$F_{net} = ma$$
$$F_N - F_g = 0$$
$$F_N = F_g$$
$$F_N = mg = 58.0 \text{ kg} * 10 \text{ N/kg}$$
$$F_N = 580 \text{ N}$$

4c. Calculate the force of friction acting on Laura.

$$F_f = \mu F_N$$
$$F_f = 0.45 * 580 \text{ N}$$
$$F_f = 261 \text{ N}$$

4d. Calculate the acceleration of the Laura.

$$F_{net} = ma$$
$$F_{Applied} - F_f = ma$$
$$a = \frac{(F_{Applied} - F_f)}{m}$$
$$a = \frac{(305\,N - 261\,N)}{58.0\,kg}$$
$$a = 0.76\,\frac{N}{kg}$$