Name: KEY

Date: _____ Block: _____

Horizontally Launched Projectile Problems

1) Dylan and Sophia are walking along Bluebird Lake on a perfectly calm day. Dylan, determined to impress Sophia by his ability to skip rocks, picks up the flattest rock he can find and gives it a sidearm launch from the edge of the water. The rock acquires a completely horizontal velocity of 26 m/s from a height of 0.45 m above the water surface.

a. How much time does it take the rock to fall to the water surface?

b. How far from the edge of the water does the rock travel before it makes its first skip?

$V_{ix} = 26\ m/s$

$\Delta x_y = -.45m$

$a = g = -9.8\ m/s^2$

$V_{iy} = 0\ m/s$

$t = ?$

$\Delta x_x = ?$

a) $\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$

$-.45 = \frac{1}{2}(-9.8)t^2 + 0$

$-.45 = -4.9t^2$

$.092 = t^2$

$t = .305$

b) $\Delta x_x = V_x t$

$= (26)(.30)$

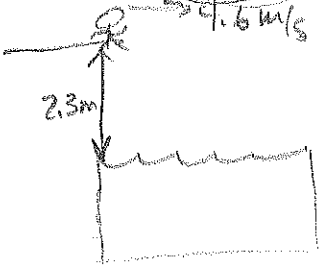
$\Delta x_x = 7.88m$

2) In an effort to create a cannonball-style splash, eight-year old Matthew runs off the edge of the board of the high dive at 4.6 m/s and falls 2.3 m to the water below.

a. Determine the time for Matthew to fall the 2.3 m to the water.

b. What horizontal distance from the edge of the board will Matthew plunge into the water?

c. With what speed does Matthew enter the water?



$V_{ix} = 4.6\ m/s$

$\Delta x_y = -2.3\ m$

$a = g = -9.8\ m/s^2$

$V_{iy} = 0\ m/s$

$t = ?$

$\Delta x_x = ?$

$V_{fy} = ?$

a) $\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$

$-2.3 = \frac{1}{2}(-9.8)t^2 + 0t$

$\frac{-2.3}{-4.9} = \frac{-4.9t^2}{-4.9} + 0$

$.469 = t^2$

$.68s = t$

b) $\Delta x_x = V_x t$

$= (4.6)(.68)$

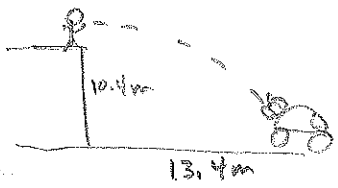
$\Delta x_x = 3.15m$

c) $V_{fy} = at + V_{iy}$

$= (-9.8)(.68) + 0$

$V_{fy} = 6.664\ m/s$

3) Ima Peode wishes to throw a 2.8-kg pumpkin horizontally off the top of the school roof in order to hit a car. The car is parked a distance of 13.4 m away from the base of the building below the point where Ima is standing. The building's roof is 10.4 m high. Assuming no air resistance, with what horizontal speed must Ima toss the pumpkin in order to hit the car.



$\Delta x_y = -10.4m$

$a = g = -9.8\ m/s^2$

$V_{iy} = 0\ m/s$

$t = ?$

$\Delta x_x = 13.4m$

$\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$

$-10.4 = \frac{1}{2}(-9.8)t^2 + 0t$

$-10.4 = -4.9t^2 + 0$

$2.122 = t^2$

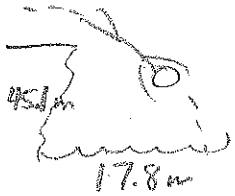
$t = 1.46s$

$V_x = \frac{\Delta x_x}{t}$

$V_x = \frac{13.4m}{1.46s}$

$V_x = 9.20\ m/s$

4) The La Quebrada Cliff Divers provide daily entertainment for the crowds at Acapulco, Mexico. As a group of professional high divers, they dive off the cliff of La Quebrada and fall 45.1 m (148 feet) to the water below. More an act of bravery, the cliff divers must time their dive so that they hit the water when the crest of an incoming wave arrived. Determine the speed with which Pedro must run off the cliff in order to land in the water a horizontal dist of 17.8 m from the edge of the cliff.

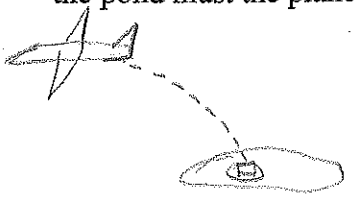


$\Delta x_y = -45.1\text{ m}$
$a = g = -9.8\text{ m/s}^2$
$v_{iy} = 0\text{ m/s}$
$t = ?$
$\Delta x_x = 17.8\text{m}$

$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$-45.1 = \frac{1}{2}(-9.8)t^2 + 0t$
$-45.1 = -4.9t^2 + 0$
$9.2 = t^2$
$3.03\text{ s} = t$

$v_x = \frac{\Delta x_x}{t}$
$v_x = \frac{17.8\text{ m}}{3.03\text{ s}}$
$v_x = 5.87\text{ m/s}$

5) An emergency relief plane is dropping a care package from a plane to a group of medical personnel working for a relief agency in an African village. The package is designed to land in a small lake, inflate an attached raft upon impact and finally resurface with the raft side down. The plane will be moving horizontally with a ground speed of 59.1 m/s. The package will be dropped a horizontal distance of 521 m from the intended target location. At what altitude above the pond must the plane be flying in order to successfully accomplish this feat?



$\Delta x_x = 521\text{m}$
$v_x = 59.1\text{ m/s}$
$t = ?$

$v_x = \frac{\Delta x_x}{t}$
$\frac{\Delta x_x}{v_x} = t = \frac{521\text{m}}{59.1\text{m/s}} = 8.82\text{s}$

$\Delta x_y = ?$
$a = g = -9.8\text{ m/s}^2$
$v_{iy} = 0\text{ m/s}$
$t = 8.82\text{s}$

$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$= \frac{1}{2}(-9.8)(8.82)^2 + 0(8.82)$
$= (-4.9)(77.71) + 0$
$\Delta x_y = -380.8\text{ m}$
so
height $= +380.8\text{m}$

6) The Choo Choo Restaurant in DesPlaines, IL is a 50's style diner, which is notorious for the delivery of food from the kitchen to the dining room by an O-scale model train. Dinner baskets filled with hot dogs, hamburgers, French fries and the like are mounted to the tops of flatbed train cars and transported to table tops. On Matthew's fifth birthday, a French fry rolled off the top of the pile on a tight turn moving at a speed of 1.25 m/s and fell to the floor.

a. Determine the time for the French fry to fall 113 cm from the top of the pile to the floor.
b. Determine the horizontal displacement of the fry from the edge of the track.
c. Determine the speed of the French fry upon striking the floor.

a) $\Delta x_y = 113\text{cm} = 1.13\text{m}$
$a = g = -9.8\text{ m/s}^2$
$v_{iy} = 0\text{ m/s}$
$t = ?$
$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$-1.13 = \frac{1}{2}(-9.8)t^2 + 0t$
$-1.13 = -4.9t^2$
$.231 = t^2$
$.48\text{s} = t$

b) $\Delta x_x = ?$
$v_x = 1.25\text{m/s}$
$t = .48\text{s}$
$\Delta x_x = v_x t$
$= (1.25)(.48)$
$\Delta x_x = .6\text{m}$

c) $\Delta x_y = -1.13\text{m}$
$v_{iy} = 0\text{m/s}$
$a = g = -9.8\text{m/s}^2$
$v_{fy} = ?$
$v_{fy}^2 = v_{iy}^2 + 2a\Delta x_y$
$v_{fy}^2 = 0^2 + 2(-9.8)(-1.13)$
$\sqrt{v_{fy}^2} = \sqrt{22.148}$
$v_{fy} = 4.71\text{ m/s}$

) Aaron Agin and Bud Derfenger are lab partners who last year earned a reputation for breaking beakers, spilling acid, mixing the wrong chemicals, breaking thermometers and accidentally lighting Sophia's hair on fire with a Bunsen burner. And now to the delight of the physics class, the teacher has made the mistake of allowing them to partner again In a recent lab, which utilized expensive tracks and carts, Aaron and Bud lived up to their reputation. Despite strong warnings from the teacher, they allowed a cart to roll off the track and then off the table with a speed of 208 cm/s. The crash of the cart to the floor a horizontal distance of 96.3 cm from the table's edge turned the entire classroom silent. Use this information to determine the height of the lab tables in the lab. (HINT: change cm into m first)

$\Delta x_x = 96.3\text{cm} \left|\frac{1\text{m}}{100\text{cm}}\right. = .963\text{m}$

$V_x = \frac{208\text{cm}}{1\text{s}} \left|\frac{1\text{m}}{100\text{cm}}\right. = 2.08\text{m/s}$

$V_x = \frac{\Delta x_x}{t}$ $\quad \Delta x_x = V_x t = \frac{.963\text{m}}{2.08\text{m/s}}$

$t = .463\text{s}$

$\Delta x_y = ?$
$a = g = -9.8\text{m/s}^2$
$V_{iy} = 0\text{m/s}$
$t = .463\text{s}$

$\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$
$= \frac{1}{2}(-9.8)(.463)^2 + 0$
$= -4.9(.214)$

$\Delta x_y = -1.05\text{m}$
so
height $= +1.05\text{m}$

8) A stone is thrown horizontally at 15 m/s from the top of a cliff 44 m high.
a. How far from the base of the cliff does the stone hit the ground?
b. How fast is it moving the instant before it hits the ground?

a)
$\Delta x_y = 44\text{m}$
$a = g = -9.8\text{m/s}^2$
$V_{iy} = 0\text{m/s}$
$t = ?$
$V_x = 15\text{m/s}$

$\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$
$-44 = \frac{1}{2}(-9.8)t^2 + 0t$
$-44 = -4.9t^2$
$8.98 = t^2$
$3\text{s} = t$

$\Delta x_x = V_x t$
$= (15)(3)$
$\Delta x_x = 45\text{m}$

b) $V_{fy}^2 = V_{iy}^2 + 2a\Delta x_y$
$V_{fy}^2 = 0^2 + 2(-9.8)(-44)$
$\sqrt{V_{fy}^2} = \sqrt{862.4}$
$V_{fy} = 29.4\text{m/s}$

9) A steel ball rolls with constant velocity across a tabletop 0.950 m high. It rolls off and hits the ground 0.352 m from the edge of the table. How fast was the ball rolling?

$\Delta x_y = .95\text{m}$
$a = g = -9.8\text{m/s}^2$
$V_{iy} = 0\text{m/s}$
$t = ?$
$\Delta x_x = .352\text{m}$

$\Delta x_y = \frac{1}{2}at^2 + V_{iy}t$
$-.95 = \frac{1}{2}(-9.8)t^2 + 0t$
$-.95 = -4.9t^2 + 0$
$\sqrt{.194} = \sqrt{t^2}$
$.44\text{s} = t$

$V_x = \frac{\Delta x_x}{t}$
$= \frac{.352}{.44}$
$V_x = .8\text{m/s}$

10) A coin rolls along the top of a 1.33 m high desk with a constant velocity. It reaches the edge of the desk and hits the ground 0.25 m from the edge of the desk. What was the velocity of the coin as it rolled across the desk?

$\Delta x_y = 1.33\text{m}$
$a = g = -9.8\ \text{m/s}^2$
$v_{iy} = 0\ \text{m/s}$
$t = ?$
$\Delta x_x = .25\text{m}$
$v_x = ?$

$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$-1.33 = \frac{1}{2}(-9.8)t^2 + 0t$
$-1.33 = -4.9t^2$
$.27 = t^2$
$.52\text{s} = t$

$v_x = \frac{\Delta x_x}{t}$
$= \frac{.25}{.52}$
$v_x = .48\ \text{m/s}$

11) Billy Joe stands on the Talahatchee Bridge kicking stones into the water below. If Billy Joe kicks a stone with a horizontal velocity of 3.50 m/s and it lands in the water a horizontal distance of 5.40 m from where he is standing, what is the height of the bridge? If the stone had been kicked harder, how would this affect the time it would take to fall?

$v_x = 3.5\ \text{m/s}$
$\Delta x_x = 5.40\text{m}$
$t = ?$

$\frac{\Delta x_x}{v_x} = \frac{v_x t}{v_x} = \frac{5.40}{3.5} = 1.54\text{s}$

$\Delta x_y = ?$
$a = g = -9.8\ \text{m/s}^2$
$v_{iy} = 0\ \text{m/s}$
$t = 1.54\text{s}$

$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$\Delta x_y = \frac{1}{2}(-9.8)(1.54)^2 + 0(1.54)$
$= (-4.9)(2.38) + 0$
$\Delta x_y = -11.66\text{ m}$
so
height = 11.66m

12) You accidentally throw your car keys horizontally at 8.0 m/s from a cliff 64 m high. How far from the base of the cliff should you look for the keys?

$\Delta x_y = -64\text{m}$
$a = g = -9.8\ \text{m/s}^2$
$v_{iy} = 0\ \text{m/s}$
$t = ?$
$v_x = 8\ \text{m/s}$

$\Delta x_y = \frac{1}{2}at^2 + v_{iy}t$
$-64 = \frac{1}{2}(-9.8)t^2 + 0t$
$-64 = -4.9t^2$
$13.06 = t^2$
$3.61\text{s} = t$

$\Delta x_x = v_x t$
$= (8)(3.61)$
$\Delta x_x = 28.9\text{m}$