Name: _______________

Learning Intention

- Learn to solve problems involving displacement and velocity under constant acceleration due to gravity

Notes

1. The acceleration due to gravity is $-9.81\ m/s^2$ [up] = $9.81\ m/s^2$ [down]
2. A mean person decides to throw a rock straight up from the Lions Gate Bridge. There is a kayak directly below, 111 m [down]. The rock is thrown at an initial velocity of 15.0 m/s [up], and there is no friction or drag force.
   a. How long does it take for the rock to reach its maximum height?
   b. What maximum height above the bridge does the rock reach?
   c. How long does it take for the rock to reach the bridge?
   d. What is the velocity of the rock when it reaches the bridge?
   e. How long does it take for the rock to hit the kayak below?
   f. What is the velocity of the rock when it hits the kayak?

2a. At max. height, $\vec{v}_y = 0$ (y direction velocity)

Initial $\vec{v}_y = 15.0\ m/s$

Given $\vec{a}_y = -9.81\ m/s^2$

$$\vec{v}_{1y} = \vec{v}_{0y} + \vec{a}_y \times t$$

$$t = \frac{\vec{v}_{1y} - \vec{v}_{0y}}{\vec{a}_y} = \frac{0\ m/s - 15.0\ m/s}{-9.81\ m/s^2} = 1.53\ s$$

b. Find $\vec{d}$

$$\vec{v}_1^{\,2} = v_0^2 + 2\vec{a}\vec{d}$$

$$\vec{d} = \frac{\vec{v}_1^{\,2} - \vec{v}_0^{\,2}}{2\vec{a}} = \frac{0 - (15\ m/s)^2}{2(-9.81\ m/s^2)} = 11.468\ m = 11.5\ m\ [up]$$

See over →

2.c. Back at the bridge, $\vec{d} = 0$

$$\vec{d} = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

$$0 = (15\ m/s) \times t + \frac{1}{2}(-9.81\ m/s^2)\ t^2$$

$$0 = t\left[15\ m/s + -4.905\ m/s^2 \times t\right]$$

$t = 0$

$$15\ m/s - 4.905\ m/s^2 \times t = 0$$

$$t = \frac{15\ m/s}{4.905\ m/s^2} = 3.06\ s$$

d. $\vec{v}_1^{\,2} = \vec{v}_0^{\,2} + 2\vec{a}\vec{d}$

$$\vec{v}_1^{\,2} = (15\ m/s)^2 + 2(-9.81\ m/s^2)(0\ m)$$

$$\vec{v}_1^{\,2} = (15\ m/s)^2 + 0$$

$\vec{v}_1 = +15\ m/s$ or $\vec{v}_1 = -15\ m/s$

doesn't make sense

$\vec{v}_1 = -15.0\ m/s$ [up] $= 15.0\ m/s$ [down]

2\. e. At the Kayak, $\vec{d} = -111\text{ m}$ [up]

$$\vec{d} = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

$$-111\text{ m} = (15\text{ m/s})t + \frac{1}{2}(-9.81\text{ m/s}^2)t^2$$

$$-111\text{ m} = (15\text{ m/s})t + -4.905\text{ m/s}^2 \times t^2$$

$$\underbrace{4.905\text{ m/s}^2}_{A} \times t^2 + \underbrace{-15\text{ m/s}}_{B} \times t + \underbrace{-111\text{ m}}_{C} = 0$$

$$t = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A} = \frac{-(-15) \pm \sqrt{(-15)^2 - 4(4.905)(-111)}}{2(4.905)}$$

$t = 6.53\text{ s}$ or $t = -3.47\text{ s}$

doesn't make sense

f. $\vec{v}_1 = \vec{v}_0 + \vec{a}t = (15\text{ m/s}) + (-9.81\text{ m/s}^2)(6.53\text{ s}) = -49.018\text{ m/s}$

$\vec{v}_1 = -49.0\text{ m/s}$ [up] $= 49.0\text{ m/s}$ [down]

g. Graph the acceleration, velocity, and displacement of the rock, from t=0 seconds until it hits the kayak. t = 6.53 s   30 squares wide, 22 squares tall