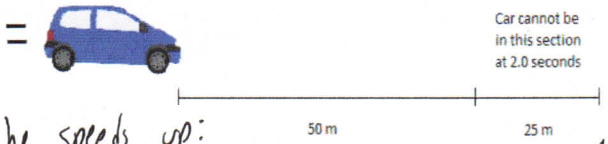


Name KEY

Worksheet #1

Acceleration + Projectiles

If he speeds up:

$\Delta x = \frac{1}{2}(6 m/s^2)(2s)^2 + (18 m/s)(2s)$

$\Delta x = 48 m < 75 m$

If he slows down → find when and where he stops

$0 = (-3)(t) + 18 m/s$

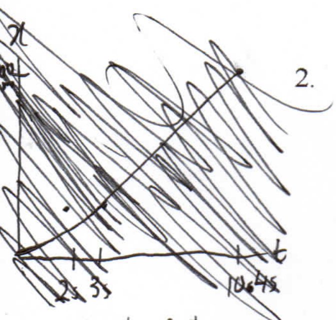
$t = 6 s$

$\Delta x = \frac{1}{2}(-3)(6s)^2 + (18)(6)$

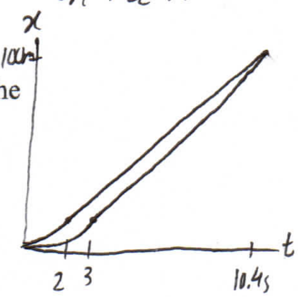
$\Delta x = 54 m$

In the intersection

1. Driving down the road at 18 m/s, an AP Physics student notices that the stoplight ahead has turned yellow… and will turn red in 2.0 seconds. The intersection starts exactly 50 m ahead of the car's current position and is 25 m in length (image above). To avoid a ticket, the student does not want to end up in the intersection at the time of t = 2.0 s. This car can speed up at 6 m/s^2 or slow down at 3 m/s^2. Can the student avoid the intersection? What should he/she do? Explain: He Can't Do Either!



2. In a 100-m race, accelerating uniformly, Laura takes 2.00s and Heather 3.00s to attain their maximum speeds, which they each maintain for the rest of the race. They cross the finish line simultaneously, both setting a world record of 10.4s.



   a. Draw a single position vs. time graph that tracks the motion of each runner.

   b. What is the maximum acceleration of each sprinter?

LAURA

split into two parts: accelerating and constant speed

$\Delta x = \frac{1}{2}at^2 + v_0 t$

$\Delta x = vt$

$v = at + v_0$

$100m = \frac{1}{2}(a)(2s)^2 + (a)(2s)(8.4s)$

$a = 5.3 m/s$

$v = (5.3 m/s^2)(2s) = 10.6 m/s$

$\Delta x = \frac{1}{2}(5.3 m/s^2)(2s)^2 + (10.6 m/s)(4s)$

$\Delta x = 53 m$

HEATHER

$100m = \frac{1}{2}(a)(3s^2) + (a)(3s)(7.4s)$

$a = 3.7 m/s$

$v = (3.7)(3) = 11.2 m/s$

$\Delta x = \frac{1}{2}(3.7)(3s)^2 + (11.2)(3s)$

$\Delta x = 50.25 m$

Laura [5.3] m/s^2 Heather [3.7] m/s^2

   c. What are their respective maximum speeds?

Laura [10.6] m/s Heather [11.2] m/s

   d. Which sprinter is ahead at the 6.00-s mark, and by how much?

Laura by [2.6] m

   e. What is the maximum distance by which Heather is behind Laura, and at what time does this occur?

[4.50] m at t = [3] s

When Heather is done accelerating, she is furthest behind Laura

3. A stone is thrown vertically upward. On its way up is passes point A with a speed v, and point B, 3.0 m higher than A, with speed ½v.

$v^2 = v_0^2 + 2a\Delta x$

$(\frac{1}{2}v)^2 = (v)^2 + 2(-9.8 m/s^2)(3m)$

$v = 8.85$

   a. Calculate the speed v.

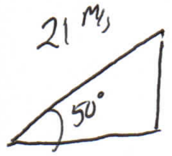
[8.85] m/s

   b. Calculate the maximum height reached by the stone above point B.

[1.0] m

$0 = (8.85)^2 + 2(-9.8 m/s^2)(\Delta x)$

$\Delta x = 1 m$



4. A placekicker must kick a football from a point 36.0 m (about 40 yards) from the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 21.0 m/s at an angle of 50.0° to the horizontal.

$36 = (21\cos 50)(t)$

$t = 2.67 s$

(a) By how much does the ball clear or fall short of clearing the crossbar?

$\Delta x = \frac{1}{2}(-9.8 m/s^2)(2.67 s)^2 + (21\sin 50)(2.67 s)$

+5.0 m

$\Delta x = 8.02 m$

$8.02 - 3.05 = 4.97 \approx 5 m$

(b) Does the ball approach the crossbar while still rising or while falling? Explain:

$0 = (-9.8 m/s^2)(t) + (21\sin 50)$

$t = 1.64 s$

1.64 s < 2.67 so ball already reached peak and is falling down.

5. Prove that the expression for the maximum range of a projectile in terms of only Vo, g and θ would be:

$$X_{MAX} = \frac{v_o^2 \sin(2\theta)}{g}$$

(a) What angle would produce the maximum range of a projectile? How can you tell just by using this equation?

$0 = \frac{1}{2}(-g)(t^2) + (V_o \sin\theta)(t)$

$\frac{1}{2} g t^2 = V_o \sin\theta\, t$

$t = \frac{2V_o \sin\theta}{g}$

$\Delta x = V t$

$V = V_o \cos\theta$

$$\Delta x = \left(\frac{2V_o \sin\theta}{g}\right)(V_o \cos\theta) = \frac{2V_o^2 \sin\theta\cos\theta}{g} = \boxed{\frac{2V_o^2 \sin 2\theta}{g}}$$

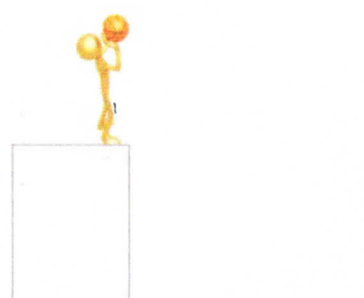
6. A student stands near the edge of a 383 m high cliff, shooting his basketball at a 40 degree angle above horizontal and with an initial velocity of 10.7 m/s.

(a) At what angle will it enter the water?

5.34 °

(b) At what velocity will it enter the water?

87.6 m/s



may vary a bit due to rounding

~~$-383 m = \frac{1}{2}(-9.8 m/s^2)(t^2) + (10.7\sin 40)(t)$~~

~~$t = 9.57 s$~~

$V^2 = (10.7\sin 40)^2 + 2(-9.8 m/s^2)(-383)$

$V_y = 86.914 m/s$

$V_x = 10.7\cos 40 = 8.197 m/s$

87.3 m/s