Sample of Problems

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Constant Velocity Problems

These problems have no acceleration and therefore the velocity **does not** change.

$$\vec{d} = \vec{v}t$$

Example:
A Car is travelling down the highway at a velocity of 90 km/hr. How far can it travel in 3.5hrs?

$v = 90 km/hr$
$t = 3.5 hr$

$d = v \cdot t$
$= (90)(3.5)$
$= 315 km$

Acceleration Problems

In these problems an object is accelerating at a constant rate. You must use the following equations to solve these problems.

$a \neq 0$

$$\vec{v}_{ave} = \frac{\vec{v}_f + \vec{v}_i}{2}$$

$$\vec{v}_f = \vec{v}_i + \vec{a}t$$

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

$$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$$

$$\vec{d} = \frac{\vec{v}_f + \vec{v}_i}{2}t$$

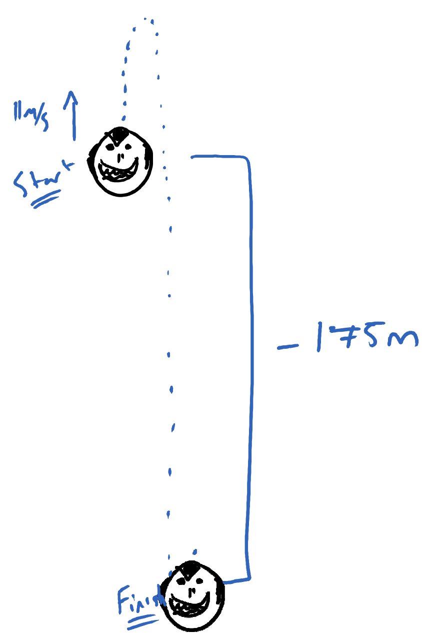
Draw a picture, list the variables you know and don't know. Then find the equations you need to use to solve the problem.

Example:
A spherical shark is thrown up in the air at 11m/s.

a) How high is the shark after 7.2 seconds?

→ $v_i = 11 m/s$
$v_f =$
→ $a = -9.8 m/s^2$
→ $t = 7.2 sec$
→ $d =$

$d = v_i t + \frac{1}{2}at^2$
$d = 11(7.2) - 4.9(7.2)^2$
$d = -174.8 m$
$d = -175 m$



b) At what times will the shark be 4m above its initial position.

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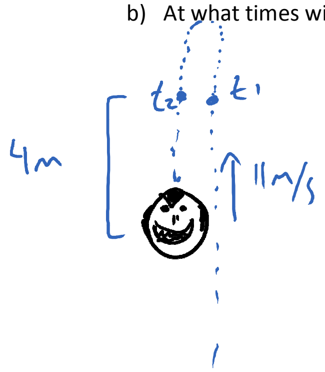


$v_i = 11 m/s$
$v_f =$
$a = -9.8 m/s^2$
$d = 4 m$
$t =$

$$d = v_i t + \frac{1}{2} a t^2$$
$$4 = 11t - 4.9t^2$$
$$4.9t^2 - 11t + 4 = 0$$
a b c

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$t = \frac{11 \pm \sqrt{(-11)^2 - 4(4.9)(4)}}{2(4.9)}$$
$$= \frac{11 \pm 6.53}{9.8}$$

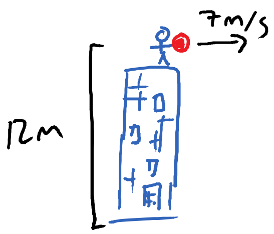
$$t_1 = \frac{11 + 6.53}{9.8} \qquad t_2 = \frac{11 - 6.53}{9.8}$$
$$t_1 = 1.79 sec \qquad t_2 = 0.456 sec$$

Projectile Motion - Basic

These problems use a combination of the previous. To solve these you must break up the motion into horizontal and vertical components. Then solve each by linking them together with time.

Example:

Mr. Mueller is throwing water balloons off a 12m building. He wants to hit a group of Claremont students. If the he throws the balloons with an initial horizontal velocity of 7m/s. Then where do the kids have to be for him to hit them?



Vertical
$v_i = 0 m/s$
$v_f =$
$a = -9.8 m/s^2$
$d_y = -12 m$
$t =$

$$d_y = v_i t + \frac{1}{2} a t^2$$
$$-12 = -4.9t^2$$
$$t^2 = \frac{12}{4.9}$$
$$t = \sqrt{\frac{12}{4.9}}$$
$$t = 1.56 sec$$

Horizontal
$d =$
$v = 7 m/s$
$t = 1.56 sec$

$$d = v \cdot t$$
$$= (7)(1.56)$$
$$d = 10.92 m$$

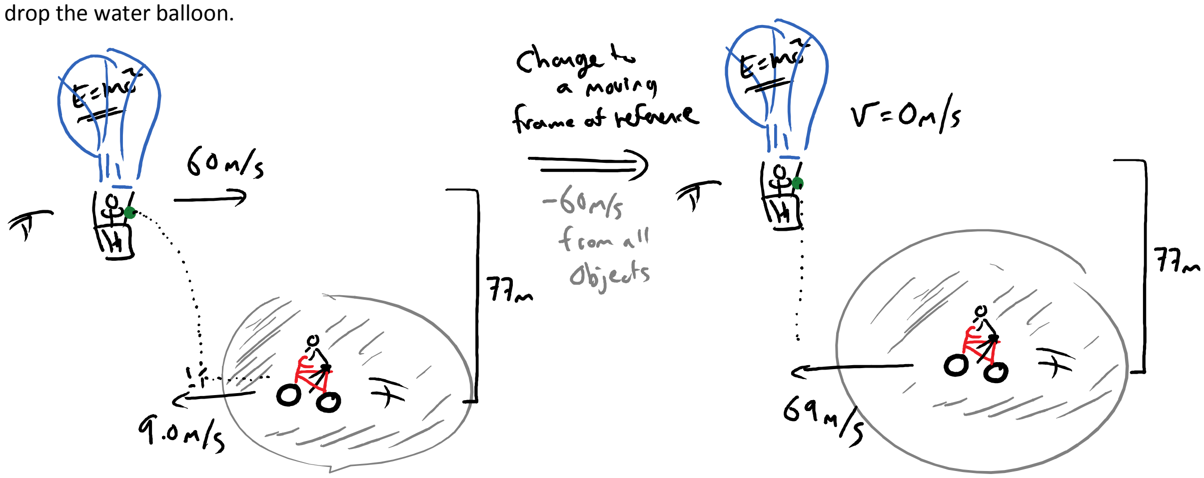
Relative Motion

Remember, we are on a planet that is orbiting around the sun at a rate of 108,000km/hr. We choose to create a frame of reference that is moving at this speed so that we do not have to include it in our calculations.

In these problems we will choose a frame of reference that is moving at a constant speed with one of the objects. This allows us to simplify the problem into one of the previous three.

Example:

Mr. Horncastle is flying across the sky at a speed of 60m/s. You are riding your bike towards him at a rate of 9.0m/s and you are 77m below him. He wants to drop a water balloon on you. When should he drop the water balloon.



Vertical balloon

$v_i = 0\,m/s$

$v_f =$

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

$d_y = -77\,m$

$t =$

$d = v_i t + \frac{1}{2}at^2$ (with $v_i = 0$)

$-77 = -4.9t^2$

$t = \sqrt{\frac{77}{4.9}}$

$t = 3.96\,sec$

Horizontal Bike

$v = 69\,m/s$ left

$t = 3.96\,sec$

$d_x =$

$d_x = v \cdot t$

$= (69)(3.96)$

$= 273.5\,m$

The bike needs to be 274 m away from the balloon