12 − 7

$u = 25\ m/s \qquad a = -3\ m/s^2$

From the 1st law : $v = u + at$

$$v = 25 + (-3)(4)$$

$$= \cancel{42}\ 13\ m/s$$

Displacement ?

$s = ut + \frac{1}{2}at^2$ ✓ since we have u, t, and a

$v^2 = u^2 + 2as$ ✗ can also be used since we have a, u, and we just calculated v for t = 4.

$$s = 25(4) + \frac{1}{2}(-3)(4)^2 = 100 - \cancel{3}24 = 76\ m.$$

To stop the car means $v = 0$.

Which law ?

$$v = u + at$$

$$0 = 25 + (-3)t$$

$$t = \frac{25}{3} = 8.33\ s.$$

Note that this is 8.33 s from beginning of motion. Students, rework and find time to stop after ~~spee~~ ~~traveamen~~ t = 4.

12-1

$u = 35 \; m/s$

$V = 10 \; m/s$

$t = 15 \; s$

1st Equation : $v = u + at$

$10 = 35 + a(15)$

$a = \frac{10 - 35}{15} = -1.66 \; m/s^2$

The negetive value acceleration implies deceleration

12-2

So first the ball will travel upwards until it stops.

$V = 0 \; , \; u = 15 \; m/s$

Once in flight upwards, the ball is being decelerated due to the effect of gravity

$v = u - gt \Rightarrow 0 = 15 - 9.81 t \Rightarrow t = \frac{15}{9.81} = 1.529 \; s.$

We can use second law or third law to calculate the distance travelled in this time.

3rd law: $v^2 = u^2 + 2as$

$$s = \frac{v^2 - u^2}{2a} = \frac{0 - 15^2}{2(-9.81)} = 11.46 \text{ m}$$

The next phase of the flight is to fall back from the 'stop' position to the original position. This time however since the ball is falling 'down' the acceleration due to gravity is applied as a positive value.

From 2nd law: $s = ut + \frac{1}{2}at^2$

$11.46 = (0)t + \frac{1}{2} \cdot 9.81 t^2$ → solve for t using quadratic

OR:

From 3rd law: $v^2 = (0)^2 + 2(9.81)(11.46)$

$v = \sqrt{224.8452} = 14.99$ m/s.

So how long of free fall to get here?

1st law: $v = u + at$

$$t = \frac{v - u}{a} = \frac{14.99 - 0}{9.81} = 1.528$$

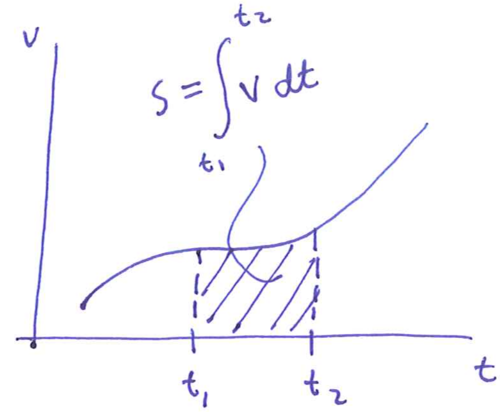
So total time of flight = $1.53 + 1.53 = 3.06$ s ~~2.6843 s~~.

Please note that I intentionally took us on a convoluted path to the solution in order to demonstrate the applications of the equations.

12-3

$$v = 4t - 3t^2$$

$$v = \frac{ds}{dt} = 4t - 3t^2$$



$$ds = (4t - 3t^2)\,dt$$

$$\int_0^s ds = \int_0^4 (4t - 3t^2)\,dt$$

$$s = \left[4\frac{t^2}{2} - 3\frac{t^3}{3}\right]_0^4$$

$$= \left[4\frac{(4)^2}{2} - 3\frac{(4)^3}{3}\right] - \left[4\frac{(0)^2}{2} - 3\frac{(0)^3}{3}\right]$$

$$= 32 - 64$$

$$= -32 \text{ m}$$ in other words 32 m in the opposite direction

12 – 10

Car A:

At what distance from start does it reach reaches constant speed of 80 ft/s.

$$v = u + at$$

$$80 = 0 + 6t \Rightarrow t = \frac{80}{6} = 13.33\ s$$

$$s = ut + \frac{1}{2}at^2$$

$$s = 0(13.33) + \frac{1}{2}(6)(13.33)^2 = 533.067\ ft$$

Once constant speed kicks in to total distance of travel (or position)

$$S_A = 533.067 + 80(t - 13.33) \quad \text{— (1)}$$

Car B:

constant speed $s = vt = 60t$

Now using car A start position as our frame of reference;

$$S_B = 6000 - 60t \quad \text{— (2)}$$

So at the point they pass each other,

$$S_A = S_B$$

$$533.067 + 80(t - 13.33) = 6000 - 60t$$

$$80t + 60t = 6000 - 533.067 + 80(13.33)$$

$$140t = 6533.33$$

$$t = 46.66 \text{ s.}$$

so for car A its position at this time will be

$$S_A = 533.067 + 80(46.66 - 13.33)$$

$$= 3199.47 \text{ ft.}$$

Students review other Equations and see how else we would have set this up.