Acceleration + Displacement

Constant Velocity: $v = \frac{\Delta d}{\Delta t}$

Constant Acceleration: $a = \frac{\Delta v}{\Delta t}$ $(\Delta v = v_2 - v_1)$

$v_{ave} = \frac{\Delta d}{\Delta t}$ $\left(v_{ave} = \frac{v_1 + v_2}{2} \right)$

Maybe Useful Equations.

① $\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$

② $\Delta d = v_2 \Delta t - \frac{1}{2} a (\Delta t)^2$

③ $v_2^2 = v_1^2 + 2a\Delta d$

There are 5 kinematics variables for acceleration problems: v_1 v_2 Δt a Δd

You only need to know 3 variables to find the other 2.

MP|84

$V_1 = -8.3 m/s$ ↑ down

$\Delta t = 6.9 s$

$a = -9.81 \frac{m}{s^2}$ ↑ down (acc due to gravity)

$\Delta d = ?$

$$\Delta d = V_1 \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$\Delta d = \left(-8.3 \frac{m}{s}\right)(6.9 s) + \frac{1}{2}\left(-9.81 \frac{m}{s^2}\right)(6.9 s)^2$$

$$\Delta d = -57.27 m - 233.53 m$$

$$\Delta d = -290.80 m$$

$$\Delta d = -2.9 \times 10^2 m$$

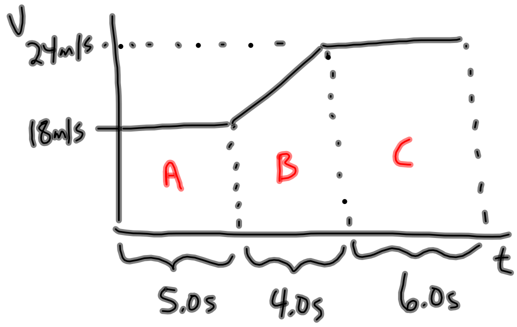
↑ down

The displacement of the rock is $2.9 \times 10^2 m$ [down]

Therefore the height of the cliff is $2.9 \times 10^2 m$

MP|85

Recall that Δd is the area under a v-t graph, so we should draw a v-t graph to represent the given information.



Section A - constant velocity

$v = 18 m/s$
$\Delta t = 5.0 s$
$\Delta d = ??$

$$v = \frac{\Delta d}{\Delta t}$$

$$\Delta d = v\Delta t$$

$$\Delta d = (18\frac{m}{s})(5.0s)$$

$$\Delta d = 90 m$$

Section B - Constant Acceleration

$v_1 = 18\frac{m}{s}$
$v_2 = 24\frac{m}{s}$
$\Delta t = 4.0s$
$\Delta d = ?$

$$v_{ave} = \frac{\Delta d}{\Delta t}$$

$$\Delta d = v_{ave}\Delta t$$

$\rightarrow v_{ave} = \frac{v_1 + v_2}{2}$ (constant acc)

$$\Delta d = \left(\frac{v_1 + v_2}{2}\right)\Delta t$$

$$\Delta d = \left(\frac{18 m/s + 24 m/s}{2}\right)(4.0s)$$

$$\Delta d = (21\frac{m}{s})(4.0s)$$

$$\Delta d = 84 m$$

Section C - constant velocity

$v = 24\frac{m}{s}$
$\Delta t = 6.0s$
$\Delta d = ?$

$$v = \frac{\Delta d}{\Delta t}$$

$$\Delta d = v\Delta t$$

$$\Delta d = (24\frac{m}{s})(6.0s)$$

$$\Delta d = 144 m$$

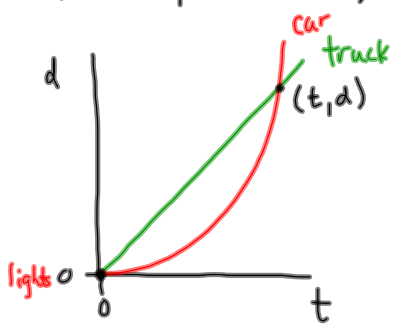
TOTAL:

90 m
84 m
+ 144 m
---
318 m

$3.2 \times 10^2 m$

MP|87

Sketch a position-time graph



Truck - Constant Velocity

$v = 22 m/s$
$\Delta d = ?$
$\Delta t = ?$

$$v = \frac{\Delta d}{\Delta t}$$
$$\Delta d = v \Delta t$$
$$d - 0 = \left(22 \frac{m}{s}\right)(t - 0)$$
$$d = \left(22 \frac{m}{s}\right)t$$
$(y = mx + b)$

Car - Constant Acceleration

$v_1 = 0$
$a = 4.8 \frac{m}{s^2}$
$\Delta d = ?$
$\Delta t = ?$

$$\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$$
$$\Delta d = 0(\Delta t) + \frac{1}{2}\left(4.8 \frac{m}{s^2}\right)(\Delta t)^2$$
$$\Delta d = \left(2.4 \frac{m}{s^2}\right)(\Delta t)^2$$
$$d = \left(2.4 \frac{m}{s^2}\right)t^2$$

Using substitution:

$$22t = 2.4t^2$$
$$0 = 2.4t^2 - 22t$$
$$0 = t(2.4t - 22) \quad \leftarrow \text{factor } t$$
$$t = 0 \quad \text{and} \quad 2.4t - 22 = 0 \quad \leftarrow \text{set each factor} = 0$$
$$2.4t = 22$$
$$t = \frac{22 m/s}{2.4 m/s^2}$$
$$t = 9.2 s$$

Sub $t = 9.2 s$ into:

$$d = \left(22 \frac{m}{s}\right)t$$
$$d = \left(22 \frac{m}{s}\right)(9.2 s)$$
$$d = 2.0 \times 10^2 m$$

The car will catch up with the truck after 9.2s and will have travelled $2.0 \times 10^2 m$.

PP|89