58) The time to maximum height is 2.5s. calculate v_0 using kinematics

$v_0 = ?$ $v_f = 0$ $t = 2.5s$ $a = -9.8\,m/s^2$ $x_i = 0$ $x_f = ?$

$$v_f = v_0 + at \Rightarrow v_0 = v_f - at = 0 - (-9.8)(2.5)$$
$$v_0 = 24.5\,m/s$$

Now find x_f at $t = 1.5s$.

$$x_f = x_i + v_0 t + \tfrac{1}{2}at^2$$
$$= 0 + 24.5 \times 1.5 + \tfrac{1}{2}(-9.8)(1.5)^2$$
$$= 36.75 - 11.025$$
$$= \boxed{25.7m}$$

71) Equation of motion for the car

$v_{oc} = 0$ $v_{fc} = ?$ $x_{fc} = ?$ $x_{i_c} = 0$ $a_c = 2.2\,m/s^2$ $t = t$

$$x_{fc} = x_i + v_0 t + \tfrac{1}{2}at^2$$
$$x_{fc} = 0 + 0 + \tfrac{1}{2}2.2t^2$$
$$x_{fc} = 1.1t^2$$

Equation of motion for the truck $\boxed{a = 0}$

$$x_{ft} = v_t t = 9.5t$$

The car will pass the truck when $x_{fc} = x_{ft}$

$$1.1t^{\cancel{2}} = 9.5\cancel{t}$$
$$t = 8.64s$$

The position of the car at this time is

(a) $x_c = 1.1 \times 8.64^2 = 82$ m from light

71(cont) (b) At $t = 8.64s$ the speed of the car is

$$v_{fc} = v_0 + at = 0 + 2.2 \times 8.64$$
$$= \boxed{19\ m/s}$$

74| The trip is in 2 parts – the first part has $a = g$ the second part in the water has $a = 0$.

Part 1. Set axes with $+x$ downward ie $g = +9.8\ m/s$
$X_0 = 0$ $X_f = 5.2m$ $v_0 = 0$ $v_f = ?$ $a = 9.8\ m/s^2$ $t = ?$
– Find v_f and t.

$$X_f = X_0 + v_0 t + \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2X_f}{a}} = \sqrt{\frac{2 \times 5.2}{9.8}} = 1.03s.$$

$$v_f = v_0 + at = 0 + 9.8 \times 1.03 = 10\ m/s$$

– Now for the second part of the trip $a = 0$ and $v = 10\ m/s$. The time for the second part is $4.80 - 1.03 = 3.77s$.

$$X_f - X_0 = vt = 10 \times 3.77 = 37.7m.$$

(a) The lake is 37.7m deep.

(b) Average velocity $v_{ave} = \frac{X_f - X_i}{t} = \frac{(37.7 + 5.2) - (}{4.8}$

$$= +8.94\ m/s.$$

+ in this case means downwards as I chose the x direction to be down initially.

If the lake was empty then we have a constant acceleration kinematics problem with the following conditions

$x_i = 0 \quad x_f = 42.9 \quad v_i = ? \quad v_f = ? \quad a = +9.8 m/s^2 \quad t = 4.8$

(note $+x$ is still downwards ie $a = +9.8 m/s^2$)

$$x_f = x_i + v_i t + \frac{1}{2} a t^2$$

$$\left(\frac{x_f - x_i - \frac{1}{2} a t^2}{t}\right) = v_i$$

$$\left(\frac{42.9 - 0 - \frac{1}{2} 9.8 \times 4.8^2}{4.8}\right) = v_i$$

$$v_i = -14.6 m/s$$

ie the lead ~~b~~ ball is thrown <u>upwards</u> with an initial velocity of 14.6 m/s.

<u>86</u> $v_r = 72 km/hr = 72 \frac{km}{hr} \times 1000 \frac{m}{km} \times \frac{1 hr}{3600 s} = 20 m/s$

$v_g = 144 kmr = 144 \frac{km}{hr} \times 1000 \frac{m}{km} \times \frac{1 hr}{3600 s} = 40 m/s$

Stopping distance of green train

~~$x_f = x_0 + v_0 t +$~~ $\quad v_f^2 = v_i^2 + 2a(x_f - x_i)$

$v_f = 0 \quad v_i = 40 m/s \quad a = -1 m/s^2$

$$x_f - x_i = \frac{v_f^2 - v_i^2}{2a} = \frac{0 - 40^2}{-2} = 800 m$$

For the red train by same manner $x_f - x_i = 200 m$

ie The combined distance is 1000 m so they collide.

The slower red train stops after 20 s at a distance of 200 m. So $v_r = 0$ at collision.

The green train is still moving when it reaches the 200 m point. The kinematic equation for the position of the green train X_g is given by

$$X_g = 950 - 40t + 0.5t^2$$

At what time does the collision occur ~~ie~~? when $X_g = 200$

$$200 = 950 - 40t + 0.5t^2$$

or $$t^2 - 80t + 1500 = 0$$

$$(t-30)(t-50) = 0$$

ie when $t = 30s$.

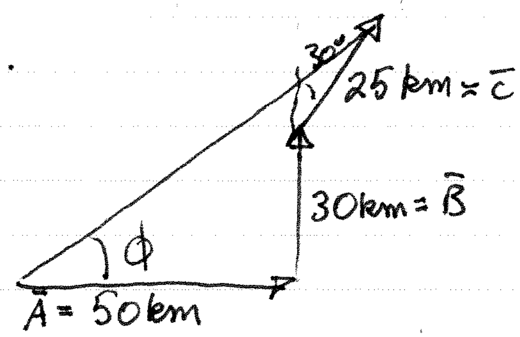
What is the speed of the green train at $t = 30s$

$$v_g = -40 + t$$

ie $V_g = -10\,m/s$ ie moving in the negative x at $10\,m/s$.

Chater 3

8.



$$\bar{R} = \bar{A} + \bar{B} + \bar{C}$$

$$R_x = 50 + 0 + 25\sin 30 = 62.5$$

$$R_y = 0 + 30 + 25\cos 30 = 51.7$$

$$|R| = \sqrt{62.5^2 + 51.7^2} = 81\ km$$

$$\tan\phi = \frac{51.7}{62.5} \Rightarrow \phi = 40^\circ$$

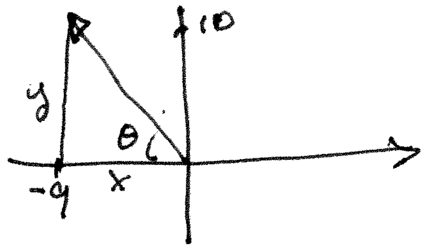
9. Add components

$$\bar{c} = \bar{a} + \bar{b}$$
$$c_x = a_x + b_x = 4 - 13 = -9$$
$$c_y = a_y + b_y = 3 + 7 = +10$$

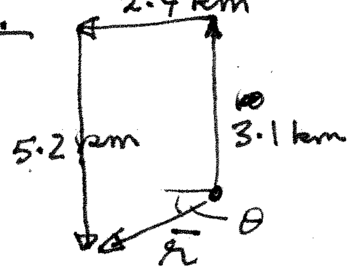
$$c = -9\hat{\imath} + 10\hat{\jmath}$$

$$|c| = \sqrt{9^2 + 10^2} = \sqrt{181} = 13.5$$

$\tan\theta = \left|\frac{10}{-9}\right| = 48^\circ$ ← to figure out the meaning of the angle draw $\bar{c}$.
If they asked for the angle with respect to $+x$ it would be 138°.



10.



$\bar{a} = 3.1\hat{\jmath}$ $\bar{b} = -2.4\hat{\imath}$ $\bar{c} = -5.2\hat{\jmath}$

$$\bar{r} = \bar{a} + \bar{b} + \bar{c}$$
$$= -2.4\hat{\imath} + (3.1 - 5.2)\hat{\jmath}$$
$$= -2.4\hat{\imath} - 2.1\hat{\jmath}$$

$$|r| = \sqrt{2.4^2 + 2.1^2} = 3.2\,\text{km}$$

$$\tan\theta = \left|\frac{r_y}{r_x}\right| = \left|\frac{2.1}{2.4}\right| \Rightarrow \theta = 41.2.$$

13. (a) Add components

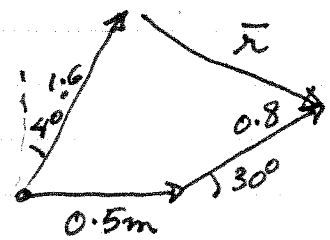
$$\bar{a} + \bar{b} = (a_x + b_x)\hat{\imath} + (a_y + b_y)\hat{\jmath} + (a_z + b_z)\hat{k}$$
$$= (4 - 1)\hat{\imath} + (-3 + 1)\hat{\jmath} + (1 + 4)\hat{k}$$
$$= 3\hat{\imath} + -2\hat{\jmath} + 5\hat{k}$$

(b) $\bar{a} - \bar{b} = 5\hat{\imath} - 4\hat{\jmath} - 3\hat{k}$

13 (c) $\bar{a} - \bar{b} + \bar{c} = 0 \Rightarrow$ $\bar{c}$'s components must zero out each component of $(\bar{a} - \bar{b})$

$$\Rightarrow \quad \bar{c} = -5\hat{i} + 4\hat{j} + 3\hat{k}.$$

24



Find $\bar{r}$.

$$\bar{b}_1 = (0.5 + 0.8\cos 30)\hat{i} + 0.8\sin \hat{j}$$

$$\bar{b}_2 = 1.6 \,\cancel{\cos}\, \sin 40° \hat{i} + 1.6\cos 40 \hat{j}$$

$$\bar{r} = \bar{b}_1 - \bar{b}_2 = (0.5 + 0.8\cos 30 - 1.6\sin 40°)\hat{i} + (0.8\sin 30° - 1.6\cos 40°)\,j$$

$$\bar{r} = \underbrace{-0.03\hat{i}}_{\text{almost zero.}} - 0.83\hat{j}$$

$$\Rightarrow |\bar{r}| = 0.83\text{m south.}$$