footnote. It is important to realise that the distance A has to travel relative to B is actually a + distance as it is to the right and is not the same as s_{AB} which is just the displacement of A rel to B. Rule of thumb:- Treat distances to be travelled as +. But be prepared to interpret -distance in your answers.

Q1. 84

A B

$u_A = 20$ $u_B = 8$

$a_A = a$ $a_B = 0$

$t = t$ $t = t$

$s_A = ?$ $s_B = ?$

misleading to worry about this.

(a) To travel a relative distance $s_{AB} = 0$ after a distance of +120 m has been travelled [See Footnote]

$u_A - u_B = 20 - 8$

$u_{AB} = 12$

$a_{AB} = a$

$s = 120\,m$

$v_{AB} = 0$

$v^2 = u^2 + 2as$

$\Rightarrow 0 = 12^2 + 2a(120)$

$\Rightarrow -\frac{144}{240} = a$

$\Rightarrow \boxed{a = -\frac{3}{5}\,ms^{-2}}$

(b) (i) A ← 54m → ← 66m → B

Want time for car A to travel a distance of 54m to the right ie Relative distance gone = +54 m

$a_{AB} = -1\,m$

$u_{AB} = 12$

$s = +54$

$t = ?$

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

$54 = 12t + \frac{1}{2}(-1)t^2$

$\Rightarrow t^2 - 24t + 108 = 0$

$\Rightarrow (t - 18)(t - 6) = 0$

$\Rightarrow t = 18\,sec$ or $t = 6\,secs$

The shortest time is when A is 66m behind for the first time.

(ii) Shortest distance between cars:

$a_{AB} = -1$

$u_{AB} = 12$

$s = ?$

$t = t$

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

$s = 12t + \frac{1}{2}(-1)t^2$

$\Rightarrow s = 12t - \frac{1}{2}t^2$

This is a min when $\frac{ds}{dt} = 0$.

$\Rightarrow \frac{ds}{dt} = 12 - t \Rightarrow 12 - t = 0$ for min

$\Rightarrow t = 12\,secs$

* Alternative overleaf

ie after 12 secs the distance is a minimum.

$\therefore s = 12(12) - \frac{1}{2}(12)^2 = 144 - 72 = 72\,m.$

$\Rightarrow$ 72m has elapsed $\Rightarrow$ 120 − 72 = 48m gap between.