3 A car travels along a straight road with constant acceleration $a\,\mathrm{m\,s^{-2}}$, where $a > 0$. The car passes through points A, B and C in that order. The speed of the car at A is $u\,\mathrm{m\,s^{-1}}$ in the direction AB. The distance BC is twice the distance AB. The car takes 8 seconds to travel from A to B and 10 seconds to travel from B to C.

(a) Find u in terms of a. [4]

AB: $s = x$ | $s = ut + \frac{1}{2}at^2$
$u = u$ | $x = u \times 8 + \frac{1}{2} \times a \times 8^2$
$v =$ | $= 8u + \frac{1}{2} \times a \times 64$
$a = a$ | $x = 8u + 32a$ (1)
$t = 8$

Distance BC $= 2x$ so distance AC $= x + 2x = 3x$:

AC: $s = 3x$ | $s = ut + \frac{1}{2}at^2$
$u = u$ | $3x = u \times 18 + \frac{1}{2} \times a \times 18^2$
$v =$ | $= 18u + \frac{1}{2} \times a \times 324$
$a = a$ | $3x = 18u + 162a$ $\div 3$
$t = 18$ | $x = 6u + 54a$ (2)

(1) = (2):

$$8u + 32a = 6u + 54a$$
$$2u = 22a$$
$$\underline{u = 11a}$$

(b) Find the speed of the car at C in terms of a. [2]

AC: $s =$ | $v = u + at$
$u = 11a$ | $= 11a + a \times 18$
$v =$ | $v = \underline{29a\ \mathrm{ms^{-1}}}$
$a = a$
$t = 18$

4 A cyclist travels along a straight road with constant acceleration. He passes through points A, B and C. The cyclist takes 2 seconds to travel along each of the sections AB and BC and passes through B with speed $4.5\ \mathrm{m\,s^{-1}}$. The distance AB is $\frac{4}{5}$ of the distance BC.

$\leftarrow 4x$ $\leftarrow 5x$

(a) Find the acceleration of the cyclist. [5]

AB: $s = 4x$, $u =$, $v = 4.5$, $a =$, $t = 2$

$s = vt - \frac{1}{2}at^2$ (useful fifth suvat formula - learn!)

$4x = 4.5 \times 2 - \frac{1}{2} \times a \times 2^2$

$4x = 9 - 2a$ (1)

BC: $s = 5x$, $u = 4.5$, $v =$, $a =$, $t = 2$

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

$5x = 4.5 \times 2 + \frac{1}{2} \times a \times 2^2$

$5x = 9 + 2a$ (2)

(1) + (2): $9x = 18$

$x = 2$

Sub into (2): $5(2) = 9 + 2a$

$10 = 9 + 2a$

$1 = 2a$

$a = 0.5\ \mathrm{ms^{-2}}$

(b) Find AC. [2]

$AC = 4x + 5x$

$= 9x$

$x = 2$:

$AC = 9 \times 2$

$= 18m$

4 A particle A, moving along a straight horizontal track with constant speed $8\,\mathrm{m\,s^{-1}}$, passes a fixed point O. Four seconds later, another particle B passes O, moving along a parallel track in the same direction as A. Particle B has speed $20\,\mathrm{m\,s^{-1}}$ when it passes O and has a constant deceleration of $2\,\mathrm{m\,s^{-2}}$. B comes to rest when it returns to O.

(a) Find expressions, in terms of t, for the displacement from O of each particle t seconds after B passes O. [3]

A: In the 4 seconds before B passes O, A travels:

$8 \times 4 = 32\,\mathrm{m}$

After that A travels: $8 \times t = 8t$

So for A: $S_A = \underline{\underline{32 + 8t}}$

B:

$s =$	$S_B = ut + \frac{1}{2}at^2$
$u = 20$	$= 20t + \frac{1}{2}(-2)t^2$
$v =$	$= 20t - t^2$
$a = -2$	
$t =$	$\rightarrow S_B = \underline{\underline{20t - t^2}}$

(b) Find the values of t when the particles are the same distance from O. [3]

$S_A = S_B$:

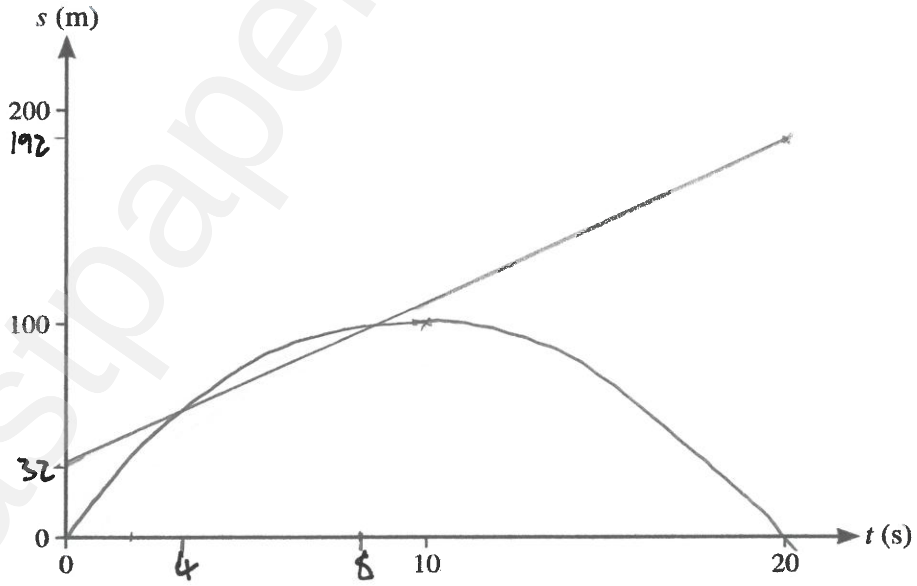
$32 + 8t = 20t - t^2$

$t^2 - 12t + 32 = 0$

$(t-4)(t-8) = 0$

$\underline{t = 4\text{s}}$ and $\underline{t = 8\text{s}}$

(c) On the given axes, sketch the displacement-time graphs for both particles, for values of t from 0 to 20. [3]



A: at $t = 20$:
$S_A = 32 + 8 \times 20$
$= \underline{192}$

B: roots: $20t - t^2 = 0$
$t(20 - t) = 0$
$\underline{t = 0}$ or $\underline{t = 20}$

turning point: $t = 10$:
$S = 20 \times 10 - 10^2$
$= \underline{100}$
$\rightarrow (10, 100)$

4 A particle P travels in the positive direction along a straight line with constant acceleration. P travels a distance of 52 m during the 2nd second of its motion and a distance of 64 m during the 4th second of its motion.

(a) Find the initial speed and the acceleration of P. [5]

$t=1$:

$s=$	$s_1 = ut + \frac{1}{2}at^2$
$u = u$	$s_1 = u \times 1 + \frac{1}{2} \times a \times 1^2$
$v =$	$s_1 = u + \frac{1}{2}a$ (1)
$a = a$	
$t = 1$	

$t=2$:

$s = s_1 + 52$	$s = ut + \frac{1}{2}at^2$
$u = u$	$s_1 + 52 = 2u + \frac{1}{2} \times a \times 2^2$
$v =$	$s_1 + 52 = 2u + 2a$ (2)
$a = a$	
$t = 2$	

Sub. (1) into (2): $u + \frac{1}{2}a + 52 = 2u + 2a$

$\frac{1}{2}a + 52 = u + 2a$

$52 = u + 1.5a$ (A)

$t=3$:

$s=$	$s_3 = ut + \frac{1}{2}at^2$
$u = u$	$s_3 = 3u + \frac{1}{2} \times a \times 3^2$
$v =$	$s_3 = 3u + 4.5a$ (3)
$a = a$	
$t = 3$	

$t=4$:

$s = s_3 + 64$	$s = ut + \frac{1}{2}at^2$
$u = u$	$s_3 + 64 = 4u + \frac{1}{2} \times a \times 4^2$
$v =$	$s_3 + 64 = 4u + 8a$ (4)
$a = a$	
$t = 4$	

Sub. (3) into (4): $3u + 4.5a + 64 = 4u + 8a$

$4.5a + 64 = u + 8a$

$64 = u + 3.5a$ (B)

continued →

B − A: $12 = 2a$

$a = 6\ \text{ms}^{-2}$

sub into A: $52 = u + 1.5 \times 6$

$52 = u + 9$

$43 = u$

$u = 43\ \text{ms}^{-1}$

horrible question!

(b) Find the distance travelled by P during the first 10 seconds of its motion. [2]

$s =$
$u = 43$
$v =$
$a = 6$
$t = 10$

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

$= 43 \times 10 + \frac{1}{2} \times 6 \times 10^2$

$= 430 + 300$

$= 730\ \text{m}$