AS 2.1

1 Frequency, f = 60 Hz

Initial average speed, u = distance / time = $\dfrac{5.0}{\left(\dfrac{2}{60}\right)}$ = 150 cm s^{-1} [1]

Final average speed, v = distance / time = $\dfrac{2.0}{\left(\dfrac{4}{60}\right)}$ = 30 cm s^{-1} [1]

Average acceleration, a = $\dfrac{v-u}{t}$ = $\dfrac{30-150}{\left(\dfrac{5}{60}\right)}$ = -1440 cm s^{-2}

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ = **-14 m s^{-2}** or **-14.4 m s^{-2}**   [1]

2 (a) The velocity increases by a constant value of 0.80 m s^{-1} every second.
$\quad$ (b) a = (v-u) / t = (3.2 – 0.0) / 4.0 = 0.8 m s^{-2}
$\quad$ (c) Distance = speed * time = ½ (3.20)(4.0) = 6.4 m
$\quad$ (d) 1.60 m s^{-1}

3 (a) 120 + 400 = 520 m
$\quad$ (b) 120 – 400 = 280 m West
$\quad$ (c) 520 ÷ (80+30+25) = 520 ÷ 135 = 3.85 m s^{-1}
$\quad$ (d) 280 ÷ 135 = 2.07 m s^{-1} West

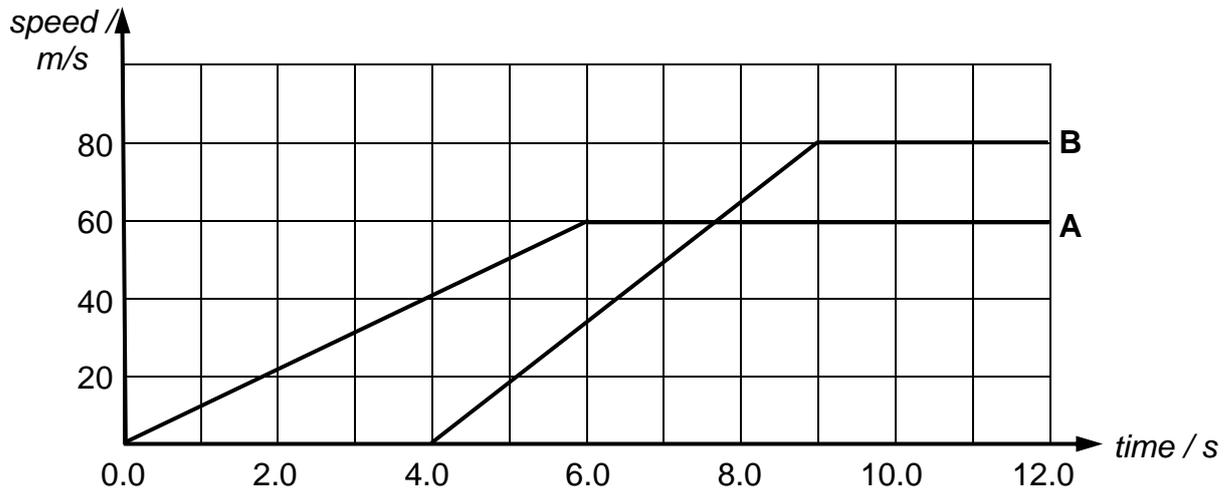4 $\;$ If downstream is given a positive sign convention,

$\quad$ (a) resultant velocity = 5.0 – 20.0 = -15.0 km h^{-1}
$\quad$ (b) resultant velocity = 5 + 20.0 = 25.0 km h^{-1}

AS 2.2

1. A : constant deceleration or velocity decreasing at a constant rate
   B : constant velocity or zero acceleration
   C : constant acceleration or velocity increasing at a constant rate
   D : decreasing acceleration or velocity increasing at an decreasing rate
   E : increasing deceleration or velocity decreasing at an increasing rate

2. a)

b) average speed = total distance / total time = [(½ x 60 x 6.0)+(60 x 6.0)] / 12.0
   = **45 m s⁻¹**

c) Let **t** be the time taken for the cars to reach the finishing line.

   distance travelled by car A = distance travelled by car B
     (½ x 60 x 6.0) + (**t** – 6.0)(60) = (½ x 80 x 5.0) + (**t** – 9.0)(80)
                 t = 340 / 20
                 t = **17 s**

3 a) downwards positive

   bi) distance traveled = ½ x 1.2 x 12.0 = **7.2 m**

   bii) acceleration = 0 – (-12.0) / 1.2 or 16.0 – (-12.0) / 2.8 = **10 m s⁻²**

   ci) Ball will end up **lower** [1]. The distance moved downwards is greater than the distance moved upwards as shown by the areas under the graph.

   cii) displacement = ½ (12.0 + 16.0) (2.8 – 2.4) = **5.6 m**

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AS 2.3

1 a) Sign convention: A towards B is positive
$v = u + at$
$25.0 = u + (0.670)(12.0)$
$u = 16.96$ m s^{-1} = **17.0 m s^{-1} (to 3 s.f.)**

   b) $s = ut + \frac{1}{2} at^2$
$s = (16.96)(12.0) + \frac{1}{2}(0.670)(12.0)^2$
$s = 251.76 =$ **252 m (to 3 s.f.)**

2 a) Sign convention: downhill is positive
$s = ut + \frac{1}{2} at^2$
$s = (3.0)(8.0) + \frac{1}{2}(1.5)(8.0)^2 =$ **72 m (to 2 s.f.)**

   b) $v^2 = u^2 + 2as$
$7.0^2 = 3.0^2 + 2(1.5)(s)$
$s = 13.33 =$ **13 m (to 2 s.f.)**

3 a) Sign convention: A towards B is positive
$s = ut + \frac{1}{2} at^2$
$30 = (14)(2.5) + \frac{1}{2}(a)(2.5)^2$
$a = -1.6$ m s^{-2}

   Retardation is **1.6 m s^{-2}**

   b) $v = u + at$
$v = 14 + (-1.6)(2.5) =$ **10 m s^{-1} (to 2 s.f.)**

   c) $v = u + at$
$0 = 14 + (-1.6)(t)$
$t = 8.75 =$ **8.8 s (to 2 s.f.)**

4 a) Sign convention: upwards is positive
$v^2 = u^2 + 2as$
$0 = 40^2 + 2(-10)(s)$
$s =$ **80 m (to 2 s.f.)**

   b) $s = ut + \frac{1}{2} at^2$
$0 = (40)(t) + \frac{1}{2}(-10)t^2$
$t =$ **8 s**

5 Sign convention: downwards is positive
(a) t = 4.0 s
(b) v = 40 m s^{-1}
(c) t = 1.0 s
(d) v = 20 m s^{-1}