Section 3: The constant acceleration formulae

Solutions to Exercise level 1

1. (i) $v = u + at$

$= 5 + (3 \times 2)$

$= 11$

(ii) $v = u + at$

$= 4 + (-2 \times 3)$

$= -2$

(iii) $v^2 = u^2 + 2as$

$10^2 = 4^2 + 2 \times 6s$

$100 = 16 + 12s$

$84 = 12s$

$s = 7$

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

$= 15 \times 3 + \frac{1}{2} \times -5 \times 3^2$

$= 45 - 22.5$

$= 22.5$

2. (i) $v^2 = u^2 + 2as$

$1^2 = 6^2 + 2a \times 4$

$1 = 36 + 8a$

$8a = -35$

$a = -4.375$

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

$12 = 3 \times 4 + \frac{1}{2}a \times 4^2$

$12 = 12 + 8a$

$a = 0$

(iii) $v^2 = u^2 + 2as$

$0^2 = u^2 + 2 \times 4 \times -12$

$u^2 = 96$

$u = 9.80$

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

$10 = 2u + \frac{1}{2} \times -4 \times 2^2$

$10 = 2u - 8$

$2u = 18$

$u = 9$

3. (i) $v = u + as$

$v = 5 + 2 \times 3$

$v = 11$

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

$s = 5 \times 3 + \frac{1}{2} \times 2 \times 3^2$

$s = 24$

(ii) $s = vt - \frac{1}{2}at^2$

$-64 = -18 \times 8 - \frac{1}{2}a \times 8^2$

$64 = 144 + 32a$

$32a = -80$

$a = -2.5$

$s = \frac{1}{2}(u + v)t$

$-64 = \frac{1}{2} \times 8(u - 18)$

$-16 = u - 18$

$u = 2$

4. (i) $v^2 = u^2 + 2as$

(ii) $v = u + at$

(iii) $s = \frac{1}{2}(u + v)t$

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

(v) $s = \frac{1}{2}(u + v)t$

5. $u = 0$ $\quad$ $s = \frac{1}{2}(u + v)t$

$v = 17$ $\quad$ $= \frac{1}{2}(0 + 17) \times 30$

$t = 30$ $\quad$ $= 255$

$s = ?$

The distance travelled is 255 m.

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6. (i) $80 \text{ km h}^{-1} = \frac{80\times1000}{3600} = \frac{200}{9} \text{ m s}^{-1}$

$u = 0$ $\quad v = u + at$

$v = \frac{200}{9}$ $\quad \frac{200}{9} = 0 + 10a$

$a = ?$ $\quad a = \frac{20}{9} = 2.22 \text{ (3 s.f.)}$

$t = 10$

The acceleration is 2.22 m s^{-2} (3 s.f.)

(ii) $s = \frac{1}{2}(u+v)t$

$= \frac{1}{2}\left(0+\frac{200}{9}\right)\times 10 = \frac{1000}{9} = 111 \text{ (3 s.f)}$

The distance travelled is 111 m)3 s.f.)

7. (i) Taking the upward direction as positive:

$s = ?$

$u = 3$

$a = -9.8$

$t = t$

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

$s = 3t - 4.9t^2$

So the height above the ground is given by $h = 1 + 3t - 4.9t^2$

(ii) $h = 0$

$1 + 3t - 4.9t^2 = 0$

$4.9t^2 - 3t - 1 = 0$

$t = \frac{3 \pm \sqrt{9+19.6}}{9.8}$

t = 0.85 s or t = -0.24 s (2 s.f.)

Only the positive answer makes sense so t = 0.85 s (2 s.f.)

(iii) Using $v = u + at$

$v = 3 - 9.8\times 0.8518...$

$v = -5.347...$

It hits the ground at 5.35 m s^{-1} in the downward direction.

(iv) Air resistance is negligible.

8. For the first part of the journey (acceleration):

$u = 0$	$v = u + at$
$v = 18$	$18 = 0 + 3t$
$a = 3$	$t = 6$
$t = ?$	

For the last part of the journey (deceleration)

$u - 18$	$v = u + at$
$v = 0$	$0 = 18 - 6t$
$a = -6$	$t = 3$
$t = ?$	

Total journey time = 8 mins 9 s.

For the first part of the journey (acceleration)

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

$18^2 = 0^2 + 2 \times 3 \times s$

$6s = 324$

$s = 54$

For the second part of the journey (constant speed)

$t = 8 \times 60 = 480$

$s = 18 \times 480 = 8640$

For the last part of the journey (deceleration)

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

$0^2 = 18^2 + 2 \times -6 \times s$

$12s = 324$

$s = 27$

Total distance travelled = 54 + 8640 + 27 = 8720 m.

9. (i) Taking the downward direction as positive:

$s = h$	$s = ut + \frac{1}{2}at^2$
$u = 0$	$h = 0 + 4.9 \times 1.5^2$
$a = 9.8$	$h = 11.025$
$t = 1.5$	

The height = 11 m (2.s.f.)

(ii) $u = 0$

$v = ?$

$a = 9.8$

$t = t$

$v = u + at$

$v = 9.8t \text{ m s}^{-1}$ in a downward direction

(iii) $t = 1.5$

$v = 9.8 \times 1.5 = 14.7$

The ball is moving at 14.7 m s^{-1}.