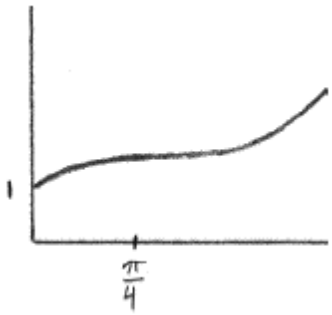
SL Differentiation Kinematics

0 min
0 marks

1.	(a)	$v = 1$	A1	N1	1
	(b)	(i) $\frac{\mathrm{d}}{\mathrm{d}t}(2t) = 2$	A1		
		$\frac{\mathrm{d}}{\mathrm{d}t}(\cos 2t) = -2\sin 2t$	A1A1		
		Note: *Award A1 for coefficient 2 and A1 for –sin 2t.*			
		evidence of considering acceleration = 0	(M1)		
		e.g. $\frac{\mathrm{d}v}{\mathrm{d}t} = 0, 2 - 2\sin 2t = 0$			
		correct manipulation	A1		
		e.g. $\sin 2k = 1,\ \sin 2t = 1$			
		$2k = \frac{\pi}{2}\left(\text{accept } 2t = \frac{\pi}{2}\right)$	A1		
		$k = \frac{\pi}{4}$	AG	N0	
	(ii)	attempt to substitute $t = \frac{\pi}{4}$ into v	(M1)		
		e.g. $2\left(\frac{\pi}{4}\right) + \cos\left(\frac{2\pi}{4}\right)$			
		$v = \frac{\pi}{2}$	A1	N2	8

(c)



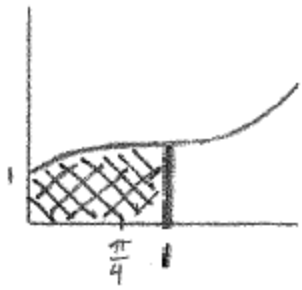
A1A1A2 N4 4

Notes: *Award A1 for y-intercept at (0, 1), A1 for curve having zero gradient at* $t = \frac{\pi}{4}$*, A2 for shape that is concave down to the left of* $\frac{\pi}{4}$ ***and*** *concave up to the right of* $\frac{\pi}{4}$*. If a correct curve is drawn without indicating* $t = \frac{\pi}{4}$*, do not award the second A1 for the zero gradient, but award the final A2 if appropriate. Sketch need not be drawn to scale. Only essential features need to be clear.*

(d) (i) correct expression A2

e.g. $\int_0^1 (2t + \cos 2t)\,\mathrm{d}t, \left[t^2 + \frac{\sin 2t}{2}\right]_0^1, 1 + \frac{\sin 2}{2}, \int_0^1 v\,\mathrm{d}t$

(ii)



A1 3

Note: *The line at t = 1 needs to be clearly after* $t = \frac{\pi}{4}$.

[16]

2. (a) $f(x) = -10(x + 4)(x - 6)$ A1A1 N2 2

(b)	**METHOD 1**				
	attempting to find the x-coordinate of maximum point	(M1)			
	e.g. averaging the x-intercepts, sketch, $y' = 0$, axis of symmetry				
	attempting to find the y-coordinate of maximum point	(M1)			
	e.g. $k = -10(1+4)(1-6)$				
	$f(x) = -10(x-1)^2 + 250$	A1A1	N4	4	
	METHOD 2				
	attempt to expand $f(x)$	(M1)			
	e.g. $-10(x^2 - 2x - 24)$				
	attempt to complete the square	(M1)			
	e.g. $-10((x-1)^2 - 1 - 24)$				
	$f(x) = -10(x-1)^2 + 250$	A1A1	N4	4	
(c)	attempt to simplify	(M1)			
	e.g. distributive property, $-10(x-1)(x-1) + 250$				
	correct simplification	A1			
	e.g. $-10(x^2 - 6x + 4x - 24)$, $-10(x^2 - 2x + 1) + 250$				
	$f(x) = 240 + 20x - 10x^2$	AG	N0	2	
(d) (i)	valid approach	(M1)			
	e.g. vertex of parabola, $v'(t) = 0$				
	$t = 1$	A1	N2		
(ii)	recognizing $a(t) = v'(t)$	(M1)			
	$a(t) = 20 - 20t$	A1A1			
	speed is zero $\Rightarrow t = 6$	(A1)			
	$a(6) = -100$ (m s^{-2})	A1	N3	7	
					[15]

3. evidence of integrating the acceleration function (M1)

e.g. $\int\left(\frac{1}{t}+3\sin 2t\right)\mathrm{d}t$

correct expression $\ln t - \frac{3}{2}\cos 2t + c$ A1A1

evidence of substituting (1, 0) (M1)

e.g. $0 = \ln 1 - \frac{3}{2}\cos 2 + c$

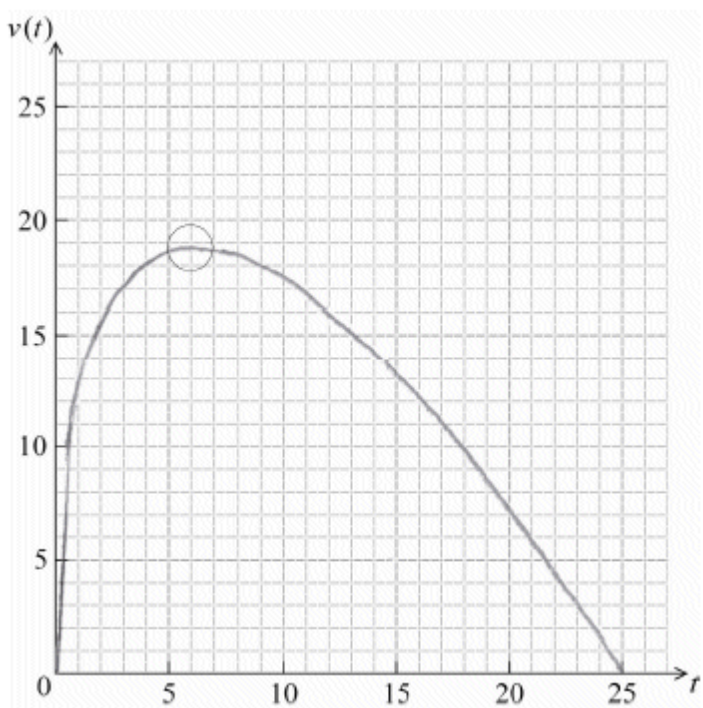
$c = -0.624 \left(=\frac{3}{2}\cos 2 - \ln 1 \text{ or } \frac{3}{2}\cos 2\right)$ (A1)

$v = \ln t - \frac{3}{2}\cos 2t - 0.624 \left(=\ln t - \frac{3}{2}\cos 2t + \frac{3}{2}\cos 2 \text{ or } \ln t - \frac{3}{2}\cos 2t + \frac{3}{2}\cos 2 - \ln 1\right)$ (A1)

$v(5) = 2.24$ (accept the exact answer $\ln 5 - 1.5\cos 10 + 1.5\cos 2$) A1 N3

[7]

4. (a)



A1A1A1 N3

Note: *Award A1 for approximately correct shape, A1 for right endpoint at (25, 0) and A1 for maximum point in circle.*

(b) (i) recognizing that d is the area under the curve (M1)

e.g. $\int v(t)$

correct expression in terms of t, with correct limits A2 N3

e.g. $d = \int_0^9 (15\sqrt{t} - 3t)\mathrm{d}t, d = \int_0^9 v\mathrm{d}t$

(ii) d = 148.5 (m) (accept 149 to 3 sf) A1 N1

[7]

5. (a)

Function	**Graph**
displacement	A
acceleration	B

A2A2 N4

(b) $t = 3$ A2 N2

[6]

6. **Note:** In this question, do not penalize absence of units.

(a) (i) $s = \int (40 - at)\mathrm{d}t$ (M1)

$s = 40t - \frac{1}{2}at^2 + c$ (A1)(A1)

substituting $s = 100$ when $t = 0$ ($c = 100$) (M1)

$s = 40t - \frac{1}{2}at^2 + 100$ A1 N5

(ii) $s = 40t - \frac{1}{2}at^2$ A1 N1

(b) (i) stops at station, so $v = 0$ (M1)

$t = \frac{40}{a}$ (seconds) A1 N2

(ii) evidence of choosing formula for s from (a) (ii) (M1)

substituting $t = \frac{40}{a}$ (M1)

e.g. $40 \times \frac{40}{a} - \frac{1}{2}a \times \frac{40^2}{a^2}$

setting up equation M1

e.g. $500 = s$, $500 = 40 \times \frac{40}{a} - \frac{1}{2}a \times \frac{40^2}{a^2}$, $500 = \frac{1600}{a} - \frac{800}{a}$

evidence of simplification to an expression which obviously leads to $a = \frac{8}{5}$ A1

e.g. $500a = 800$, $5 = \frac{8}{a}$, $1000a = 3200 - 1600$

$a = \frac{8}{5}$ AG N0

(c) **METHOD 1**

$v = 40 - 4t$, stops when $v = 0$

$40 - 4t = 0$ (A1)

$t = 10$ A1

substituting into expression for s M1

$s = 40 \times 10 - \frac{1}{2} \times 4 \times 10^2$

$s = 200$ A1

since $200 < 500$ (allow ***FT*** on their s, if $s < 500$) R1

train stops before the station AG N0

METHOD 2

from (b) $t = \frac{40}{4} = 10$ A2

substituting into expression for s

e.g. $s = 40 \times 10 - \frac{1}{2} \times 4 \times 10^2$ M1

$s = 200$ A1

since $200 < 500$, R1

train stops before the station AG N0

METHOD 3

a is deceleration	A2		
$4 > \frac{8}{5}$	A1		
so stops in shorter time	(A1)		
so less distance travelled	R1		
so stops before station	AG	N0	
			[17]

7.	evidence of anti-differentiation *e.g.* $s = \int \left(6e^{3x} + 4\right) dx$	(M1)		
	$s = 2e^{3t} + 4t + C$	A2A1		
	substituting $t = 0$,	(M1)		
	$7 = 2 + C$	A1		
	$C = 5$			
	$s = 2e^{3t} + 4t + 5$	A1	N3	
				[7]

8.	(a)	(i)	range of f is $[-1, 1]$, $(-1 \le f(x) \le 1)$	A2	N2
		(ii)	$\sin^3 x = 1 \Rightarrow \sin x = 1$	A1	
			justification for one solution on $[0, 2\pi]$	R1	
			e.g. $x = \frac{\pi}{2}$, unit circle, sketch of $\sin x$		
			1 solution (seen anywhere)	A1	N1
	(b)		$f'(x) = 3\sin^2 x \cos x$	A2	N2

(c) using $V = \int_a^b \pi y^2 \mathrm{d}x$ (M1)

$$V = \int_0^{\frac{\pi}{2}} \pi \left(\sqrt{3} \sin x \cos^{\frac{1}{2}} x \right)^2 \mathrm{d}x$$ (A1)

$$= \pi \int_0^{\frac{\pi}{2}} 3 \sin^2 x \cos x \, \mathrm{d}x$$ A1

$$V = \pi \left[\sin^3 x \right]_0^{\frac{\pi}{2}} \quad \left(= \pi \left(\sin^3 \left(\frac{\pi}{2} \right) - \sin^3 0 \right) \right)$$ A2

evidence of using $\sin \frac{\pi}{2} = 1$ and $\sin 0 = 0$ (A1)

e.g. $\pi(1 - 0)$

$V = \pi$ A1 N1

[14]

9. (a) substituting $t = 0$ (M1)
e.g. $a(0) = 0 + \cos 0$
$a(0) = 1$ A1 N2

(b) evidence of integrating the acceleration function (M1)
e.g. $\int (2t + \cos t) \mathrm{d}t$

correct expression $t^2 + \sin t + c$ A1A1

Note: *If "+c" is omitted, award no further marks.*

evidence of substituting (0, 2) into indefinite integral (M1)
e.g. $2 = 0 + \sin 0 + c$, $c = 2$
$v(t) = t^2 + \sin t + 2$ A1 N3

(c) $\int (t^2 + \sin t + 2) \mathrm{d}t = \frac{t^3}{3} - \cos t + 2t$ A1A1A1

Note: *Award A1 for each correct term.*

evidence of using $v(3) - v(0)$ (M1)
correct substitution A1
e.g. $(9 - \cos 3 + 6) - (0 - \cos 0 + 0)$, $(15 - \cos 3) - (-1)$
$16 - \cos 3$ (accept $p = 16$, $q = -1$) A1A1 N3

(d) reference to motion, reference to first 3 seconds — R1R1 — N2
e.g. displacement in 3 seconds, distance travelled in 3 seconds

[16]

10. (a) $a = \frac{dv}{dt}$ — (M1)

$= -10 \text{ (m s}^{-2}\text{)}$ — A1 — N2

(b) $s = \int v \, dt$ — (M1)

$= 50t - 5t^2 + c$ — A1

$40 = 50(0) - 5(0) + c \Rightarrow c = 40$ — A1

$s = 50t - 5t^2 + 40$ — A1 — N2

Note: *Award **(M1)** and the first **A1** in part (b) if c is missing, but do **not** award the final 2 marks.*

[6]

11. Evidence of integration — (M1)

$s = -0.5\,e^{-2t} + 6t^2 + c$ — A1A1

Substituting $t = 0$, $s = 2$ — (M1)

eg $2 = -0.5 + c$

$c = 2.5$ — (A1)

$s = -0.5\,e^{-2t} + 6t^2 + 2.5$ — A1 — N4

[6]

12. (a) Evidence of using $a = \frac{dv}{dt}$ — (M1)

eg $3e^{3t-2}$

$a(1) = 3e \quad (= 8.15)$ — A1 — N2

(b) Attempt to solve $e^{3t-2} = 22.3$ — (M1)

eg $(3t - 2)(\ln e) = \ln 22.3$, sketch

$t = 1.70$ — A1 — N2

(c) Evidence of using $s = \int v\,\mathrm{d}t$ (limits not required) M1

e.g. $\int e^{3t-2}\,\mathrm{d}t, \frac{1}{3}\left[e^{3t-2}\right]_0^1$

$\frac{1}{3}\left(e^1 - e^{-2}\right)$ $\left[= \frac{1}{3}\left(e - e^{-2}\right) = 0.861\right]$ A1 N1

[6]

13. Finding anti-derivative of $4t^3 - 2t$ (M1)

$s = t^4 - t^2 + c$ A1A1

Substituting correctly $8 = 2^4 - 2^2 + c$ A1

Note: *Exception to the **FT** rule. Allow full **FT** on incorrect integration.*

$c = -4$ (A1)

$s = t^4 - t^2 - 4$ A1 N3

[6]

14. (a) $S_{\min} = 6.05$ (accept (1, 6.05)) A1 N1

(b) $\frac{\mathrm{d}s}{\mathrm{d}t} = -15\sin 3t + 2t$ A1

$a = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2}$ (M1)

$a = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2} = -45\cos 3t + 2$ (Exception to ***FT*** rule : allow ***FT***

from $\frac{\mathrm{d}s}{\mathrm{d}t}$) A1 N2

(c) **EITHER**

Maximum value of a when $\cos 3t$ is minimum *ie* $\cos 3t = -1$ (A1)

OR

At maximum $\frac{\mathrm{d}a}{\mathrm{d}t} = 0$ $(135 \sin 3t = 0)$ (A1)

THEN

$t = \frac{\pi}{3}$ (accept 1.05; do **not** accept 60°) A1 N2

[6]

15. $s = \int v \, \mathrm{d}t$ (M1)

$s = \frac{1}{2}\mathrm{e}^{2t-1} + c$ A1A1

Substituting $t = 0.5$

$\frac{1}{2} + c = 10$

$c = 9.5$ (A1)

Substituting $t = 1$ M1

$s = \frac{1}{2}\mathrm{e} + 9.5 \left(= 10.9 \text{ to } 3 \text{ s. f.}\right)$ A1 N3

[6]

16. (a) $a = \frac{\mathrm{d}v}{\mathrm{d}t}$ (M1)

$= -10$ A1 3

(b) $s = \int v dt$ (M1)

$= 50t - 5t^2 + c$ A1

$40 = 50(0) - 5(0) + c \Rightarrow c = 40$ A1

$s = 50t - 5t^2 + 40$ A1 3

***Note**: Award (M1) and the first (A1) in part (b) if c is missing, but do not award the final 2 marks.*

[6]

17. (a) $s = 25t - \frac{4}{3}t^3 + c$ (M1)(A1)(A1)

***Note**: Award no further marks if "c" is missing.*

Substituting $s = 10$ and $t = 3$ (M1)

$10 = 25 \times 3 - \frac{4}{3}(3)^3 + c$

$10 = 75 - 36 + c$

$c = -29$ (A1)

$s = 25t - \frac{4}{3}t^3 - 29$ (A1) (N3)

(b) **METHOD 1**

s is a maximum when $v = \frac{\mathrm{d}\boldsymbol{s}}{\mathrm{d}\boldsymbol{t}} = 0$ (may be implied) (M1)

$25 - 4t^2 = 0$ (A1)

$t^2 = \frac{25}{4}$

$t = \frac{5}{2}$ (A1) (N2)

METHOD 2

Using maximum of s ($12\frac{2}{3}$, may be implied) (M1)

$25t - \frac{4}{3}t^3 - 29 = 12\frac{2}{3}$ (A1)

t = 2.5 (A1) (N2)

(c) $25t - \frac{4}{3}t^3 - 29 > 0$ (accept equation) (M1)

$m = 1.27$, $n = 3.55$ (A1)(A1) (N3)

[12]

18. (a) $d = \int_0^4 (4t + 5 - 5\mathrm{e}^{-t})\,\mathrm{d}t$ (M1)(A1)(A1) (C3)

***Note:** Award (M1) for $\int$, (A1) for **both** limits, (A1) for $4t + 5 - 5e^{-t}$*

(b) $d = [2t^2 + 5t + 5e^{-t}]_0^4$ (A1)(A1)

Note: *Award (A1) for $2t^2 + 5t$, (A1) for $5e^{-t}$.*

$= (32 + 20 + 5e^{-4}) - (5)$

$= 47 + 5e^{-4}$ (47.1, 3sf) (A1) (C3)

[6]

19. (a) Velocity is $\frac{ds}{dt}$. (M1)

$\frac{ds}{dt} = 10 - t$ (A1)

10 (m s^{-1}) (A1) (C3)

(b) The velocity is zero when $\frac{ds}{dt} = 0$ (M1)

$10 - t = 0$

$t = 10$ (secs) (A1) (C2)

(c) $s = 50$ (metres) (A1) (C1)

Note: *Do not penalize absence of units.*

[6]

20. (a) (i) When $t = 0$, $v = 50 + 50e^0$ (A1)

$= 100$ m s^{-1} (A1)

(ii) When $t = 4$, $v = 50 + 50e^{-2}$ (A1)

$= 56.8$ m s^{-1} (A1) 4

(b) $v = \frac{ds}{dt} \Rightarrow s = \int v\,dt$

$\int_0^4 \left(50 + 50e^{-0.5t}\right) dt$ (A1)(A1)(A1) 3

Note: *Award (A1) for each limit in the correct position and (A1) for the function.*

(c) Distance travelled in 4 seconds $= \int_0^4 \left(50 + 50e^{-0.5t}\right) dt$

$= [50t - 100e^{-0.5t}]_0^4$ (A1)

$= (200 - 100e^{-2}) - (0 - 100e^{0})$

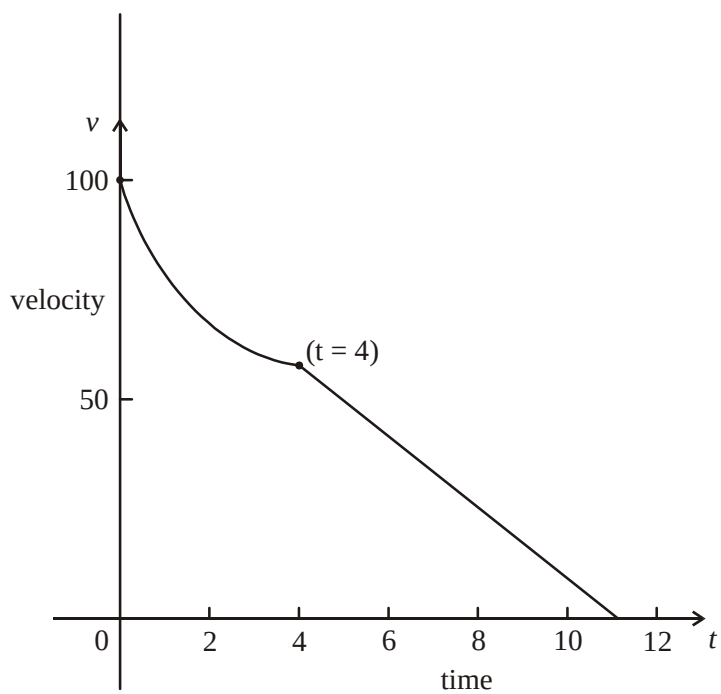
$= 286$ m (3 sf) (A1)

Note: *Award first (A1) for $[50t - 100e^{-0.5t}]$, ie limits not required.*

OR

Distance travelled in 4 seconds = 286 m (3 sf) (G2) 2

(d)



Notes: *Award (A1) for the exponential part, (A1) for the straight line through (11, 0),*
Award (A1) for indication of time on x-axis ***and*** *velocity on y-axis,*
(A1) for scale on x-axis ***and*** *y-axis.*
Award (A1) for marking the point where t = 4.

5

(e) Constant rate $= \dfrac{56.8}{7}$ (M1)

$= 8.11$ m s^{-2} (A1) 2

Note: *Award (M1)(A0) for –8.11.*

(f) distance = $\frac{1}{2}(7)(56.8)$ (M1)

= 199 m (A1) 2

Note: *Do not award* ***ft*** *in parts (e) and (f) if candidate has not used a straight line for t = 4 to t = 11 or if they continue the exponential beyond t = 4.*

[18]

21. (a) $\frac{ds}{dt} = 30 - at \Rightarrow s = 30t - a\frac{t^2}{2} + C$ (A1)(A1)(A1)

Note: *Award (A1) for 30t, (A1) for* $a\frac{t^2}{2}$*, (A1) for C.*

$t = 0 \Rightarrow s = 30(0) - a\frac{(0^2)}{2} + C = 0 + C \Rightarrow C = 0$ (M1)

$\Rightarrow s = 30t - \frac{1}{2}at^2$ (A1) 5

(b) (i) vel = $30 - 5(0) = 30 \text{ m s}^{-1}$ (A1)

(ii) Train will stop when $0 = 30 - 5t \Rightarrow t = 6$ (M1)

Distance travelled = $30t - \frac{1}{2}at^2$

$= 30(6) - \frac{1}{2}(5)(6^2)$ (M1)

= 90m (A1)

90 < 200 => train stops before station. (R1)(AG) 5

(c) (i) $0 = 30 - at \quad => \quad t = \dfrac{30}{a}$ (A1)

(ii) $30\left(\dfrac{30}{a}\right) - \dfrac{1}{2}(a)\left(\dfrac{30}{a}\right)^2 = 200$ (M1)(M1)

Note: *Award (M1) for substituting* $\dfrac{30}{a}$*, (Ml) for setting equal to 200.*

$=> \dfrac{900}{a} - \dfrac{450}{a} = \dfrac{450}{a} = 200$ (A1)

$=> a = \dfrac{450}{200} = \dfrac{9}{4} = 2.25 \text{ m s}^{-2}$ (A1) 5

Note: *Do not penalize lack of units in answers.*

[15]

22. (a) (i) $v(0) = 50 - 50e^0 = 0$ (A1)

(ii) $v(10) = 50 - 50e^{-2} = 43.2$ (A1) 2

(b) (i) $a = \dfrac{dv}{dt} = -50(-0.2e^{-0.2t})$ (M1)

$= 10e^{-0.2t}$ (A1)

(ii) $a(0) = 10e^0 = 10$ (A1) 3

(c) (i) $t \to \infty \Rightarrow v \to 50$ (A1)

(ii) $t \to \infty \Rightarrow a \to 0$ (A1)

(iii) when $a = 0$, v is constant at 50 (R1) 3

(d) (i) $y = \int v dt$ (M1)

$= 50t - \dfrac{e^{-0.2t}}{-0.2} + k$ (A1)

$= 50t + 250e^{-0.2t} + k$ (AG)

(ii) $0 = 50(0) + 250e^0 + k = 250 + k$ (M1)

$\Rightarrow k = -250$ (A1)

(iii) Solve $250 = 50t + 250e^{-0.2t} - 250$ (M1)

$\Rightarrow 50t + 250e^{-0.2t} - 500 = 0$

$\Rightarrow t + 5e^{-0.2t} - 10 = 0$

$\Rightarrow t = 9.207\ s$ (G2) 7

[15]

23. (a) When $t = 0$, (M1)

$h = 2 + 20 \times 0 - 5 \times 0^2 = 2$ $h = 2$ (A1) 2

(b) When $t = 1$, (M1)

$h = 2 + 20 \times 1 - 5 \times 1^2$ (A1)

$= 17$ (AG) 2

(c) (i) $h = 17 \Rightarrow 17 = 2 + 20t - 5t^2$ (M1)

(ii) $5t^2 - 20t + 15 = 0$ (M1)

$\Leftrightarrow 5(t^2 - 4t + 3) = 0$

$\Leftrightarrow (t - 3)(t - 1) = 0$ (M1)

Note: *Award (M1) for factorizing or using the formula*

$\Leftrightarrow t = 3$ or 1 (A1) 4

Note: *Award (A1) for t = 3*

(d) (i) $h = 2 + 20t - 5t^2$

$\Rightarrow \frac{dh}{dt} = 0 + 20 - 10t$

$= 20 - 10t$ (A1)(A1)

(ii) $t = 0$ (M0)

$\Rightarrow \frac{dh}{dt} = 20 - 10 \times 0 = 20$ (A1)

(iii) $\frac{dh}{dt} = 0$ (M1)

$\Leftrightarrow 20 - 10t = 0 \Leftrightarrow t = 2$ (A1)

(iv) $t = 2$ (M1)

$\Rightarrow h = 2 + 20 \times 2 - 5 \times 2^2 = 22 \Rightarrow h = 22$ (A1) 7

[15]

24. (a) (i) $t = 0$ $s = 800$

$t = 5$ $s = 800 + 500 - 100 = 1200$ (M1)

distance in first 5 seconds $= 1200 - 800$

$= 400$ m (A1) 2

(ii) $v = \dfrac{ds}{dt} = 100 - 8t$ (A1)

At $t = 5$, velocity $= 100 - 40$ (M1)

$= 60$ m s^{-1} (A1) 3

(iii) Velocity $= 36$ m s^{-1} $\Rightarrow 100 - 8t = 36$ (M1)

$t = 8$ seconds after touchdown. (A1) 2

(iv) When $t = 8$, $s = 800 + 100(8) - 4(8)^2$ (M1)

$= 800 + 800 - 256$ (A1)

$= 1344$ m (A1) 3

(b) If it touches down at P, it has $2000 - 1344 = 656$ m to stop. (M1)

To come to rest, $100 - 8t = 0 \Rightarrow t = 12.5$ s (M1)

Distance covered in 12.5 $s = 100(12.5) - 4(12.5)^2$ (M1)

$= 1250 - 625$

$= 625$ (A1)

Since $625 < 656$, it can stop safely. (R1) 5

[15]

25. (a) $t = 2 \Rightarrow h = 50 - 5(2^2) = 50 - 20$

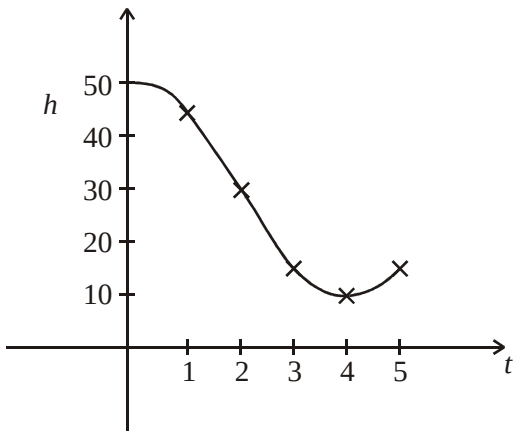
$= 30$ (A1)

OR

$h = 90 - 40(2) + 5(2^2)$

$= 30$ (A1) 1

(b)



(A4) 4

Note: *Award (A1) for marked scales on each axis, (A1) for each section of the curve.*

(c) (i) $\frac{dh}{dt} = \frac{d}{dt}(50 - 5t^2)$

$= 0 - 10t = -10t$ (A1)

(ii) $\frac{dh}{dt} = \frac{d}{dt}(90 - 40t + 5t^2)$

$= 0 - 40 + 10t = -40 + 10t$ (A1) 2

(d) When $t = 2$ (i) $\frac{dh}{dt} = -10(2)$ **or** $\frac{dh}{dt} = -40 + 10 \times 2$ (M1)

$= -20$ $= -20$ (A1) 2

(e) $\frac{dh}{dt} = 0 \Rightarrow -10t = 0 (0 \le t \le 2)$ **or** $-40 + 10t = 0 (2 \le t \le 5)$ (M1)

$t = 0$ **or** $t = 4$ (A1)(A1) 3

(f) When $t = 4$ (M1)

$h = 90 - 40(4) + 5(4^2)$ (M1)

$= 90 - 160 + 80$

$= 10$ (A1) 3

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