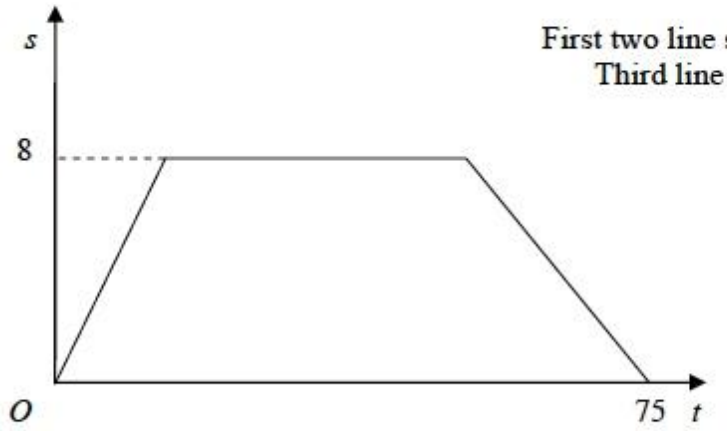
Kinematics (Velocity and Displacement – Time Graphs) (Sheet 2) Mark Scheme

Q1.

Question Number	Scheme	Marks
(a)	$30^2 = 2a.300$ $a = 1.5$	M1 A1 (2)
(b)	$0^2 = 30^2 - 2 \times 1.25s$ OR $0 = 30 - 1.25t_2$ $s = 360$ $t_2 = 24$ $300 + 30T + 360 = 1500$ $\frac{(20+T+24+T)}{2} \times 30 = 1500$ $T = 28$ $T = 28$	M1 A1 M1 A1 A1 (5)
(c)	triangle, *drawn on the diagram*, with base coinciding with base of trapezium, top vertex above line $v = 30$ and meeting trapezium at least once V marked correctly	B1 DB1 (2)
(d)	$30 = 1.5t_1 \Rightarrow t_1 = 20$ $30 = 1.25t_2 \Rightarrow t_2 = 24$ $\frac{1}{2}(20 + 28 + 24)V = 1500$ $V = \frac{750}{18} = 41.67$ $= \frac{125}{3}$ (oe) 0r 42 (or better)	M1 A1 A1 M1 A1 A1 (6)

Q2.

(a)



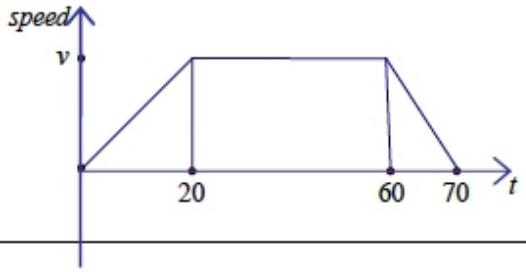
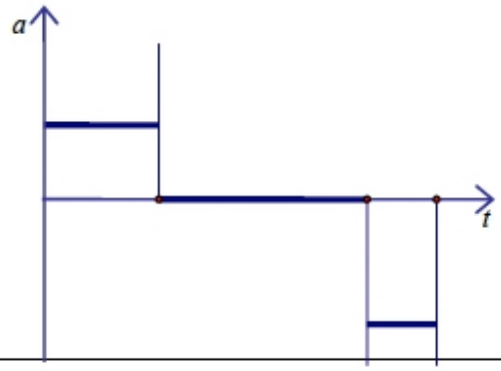
First two line segments B1
Third line segment B1
8, 75 B1 (3)

(b) $\frac{1}{2}\times 8\times(T+75)=500$ M1 A2 (1,0)

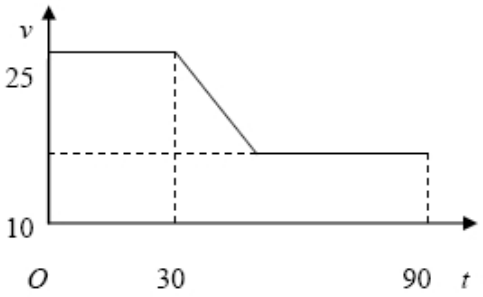
Solving to $T=50$ DM1 A1 (5)

[8]

Q3.

Question Number	Scheme	Marks
(a) (i)	 1st section correct 2nd & 3rd sections correct Numbers and v marked correctly on the axes.	B1 B1 DB1
(ii)	 1st section correct 2nd section correct 3rd section correct and no "extras" on the sketch	B1 B1 B1 (6)
(b)	$\frac{70+40}{2}\times v = 880$ $v = 880\times\frac{2}{110} = 16$	M1 A1 DM1 A1 (4) [10]

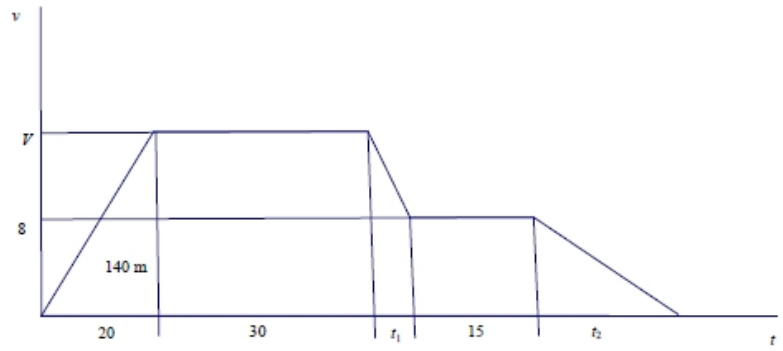
Q4.

Question Number	Scheme	Marks
(a)	 shape 25, 10, 30, 90	B1 B1 (2)
(b)	(b) $30\times 25+\frac{1}{2}(25+10)t+10(60-t)=1410$	M1 A1 A1
	$7.5t=60$	
	$t=8\ (\text{s})$	M1 A1
	$a=\frac{25-10}{8}=1.875\ (\text{ms}^{-2})$ $1\frac{7}{8}$	M1 A1 (7)
		(9 marks)

Q5.

Question Number	Scheme	Marks
(a)		B1 (shape) B1 (V) (2)
(b) (i) (ii)	$\frac{V}{t_1}=\frac{1}{2}\ \Rightarrow\ t_1=2V\ \text{s};\ t_2=4V\ \text{s}$	M1 A1; A1
(iii)	$t_3=300-2V-4V=300-6V\ \text{s}$	M1 A1 (5)
(c)	$6300=\frac{V(300+300-6V)}{2}$ or $\frac{1}{2}2V.V+(300-6V).V+\frac{1}{2}4V.V$ $V^2-100V+2100=0$ $(V-30)(V-70)=0$ $V=30$ or 70 $V=30\ (<50)$	M1 **A1 ft** A1 M1 A1 A1 (6)
		13

Q6.

Question Number	Scheme	Marks
(a)		B1 $0 < t < 50$ B1 $50 < t$ B1 (V,8,15, 20,30) (3)
(b)	Use area under graph or *suvat* to form an equation in V only. $140 = \frac{1}{2} \times 20 \times V$ $V = 14$	M1 A1 (2)
(c)	$8 = V - \frac{1}{2}t_1$ (and /or $0 = 8 - \frac{1}{3}t_2$) $t_1 = 12$, (and/or $t_2 = 24$) Total time $= 20 + 30 + t_1 + 15 + t_2 = 101$ (seconds)	M1 A1 **DM1** A1 (4)
(d)	Total distance $= 140 + 30V + \frac{V+8}{2}t_1 + 15 \times 8 + \frac{1}{2} \times 8 \times t_2$ $= 140 + 30 \times 14 + 11 \times 12 + 15 \times 8 + 24 \times 4$ =908 (m)	M1A2 **ft** A1 (4)
		[13]

Notes for Question

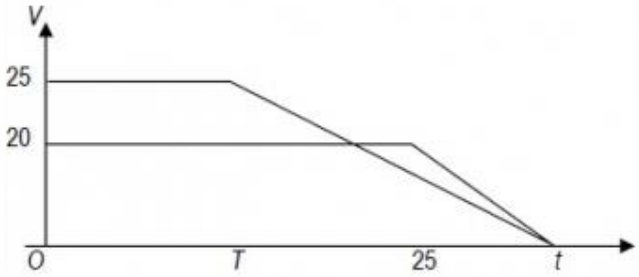
Question (a)
First B1 for shape of graph for $0 \leq t \leq 50$
Second B1 for shape of graph for $t > 50$
Third B1 for V, 8, 15, 20, 30 appropriately used

Question (b)
M1 for use of area under graph (must have '1/2') or *suvat* to obtain an equation in V only.
A1 for $V = 14$

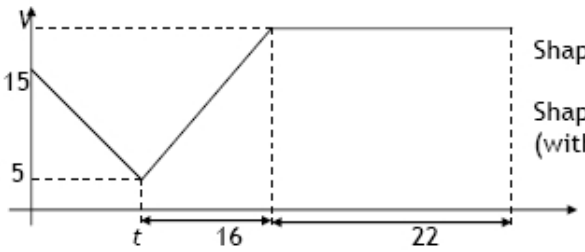
Question (c)
First M1 for use of either $8 = V - ½\,t_1$ or $0 = 8 - {}^1/_3\,t_2$
First A1 for either $t_1 = 12$ or $t_2 = 24$
Second M1, **dependent on the first M1**, for $20 + 30 + t_1 + 15 + t_2$ (must include all 5 times)
Second A1 for 101 (s)

Question (d)
First M1 for an expression for the total area (distance) **including all parts of the motion**. Where a triangle or trapezium is used , a '1/2' must be seen.
Second A2 **ft** on their V, t_1 and t_2, -1 each error.
Fourth A1 for 908 (m).

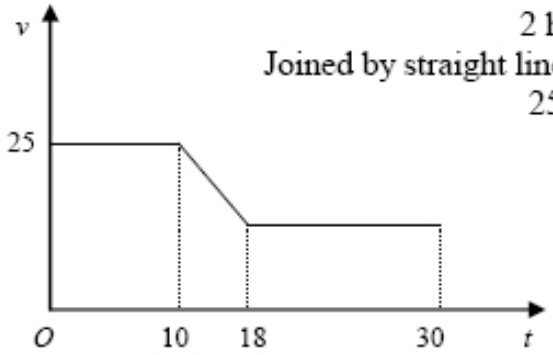
Q7.

Question Number	Scheme	Marks
(a)	 Shape (both) Cross Meet on t-axis Figures 25,20,T,25	B1 B1 B1 B1 (4)
(b)	For Q: $20\left(\frac{t+25}{2}\right)=800$ $t=55$	M1 A1 DM1 A1
	For P: $25\left(\frac{T+55}{2}\right)=800$ solving for T: $T=9$	M1 A1 DM1 A1 (8) [12]

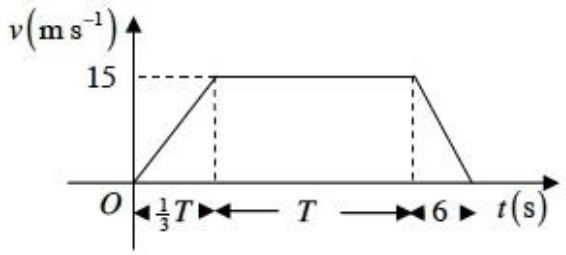
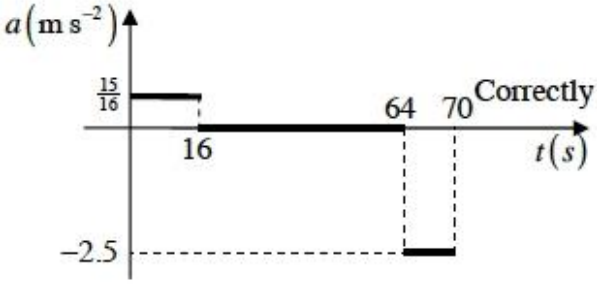
Q8.

Question Number	Scheme	Marks
(a)	 Shape 'V' Shape for last 22s (with $V > 15$) Figures	B1 B1 B1 (3)
(b)	$\frac{1}{2}(15+5) \times t = 120$ $\Rightarrow t = 12 \rightarrow T = 12+16+22 = \underline{50\text{ s}}$	M1 M1 A1 (3)
(c)	$120+\underline{\frac{1}{2}(V+5).16}+22V=1000$ Solve: $30V = 840 \Rightarrow V = \underline{28}$	M1 B1 A1 DM1 A1 (5) **11**

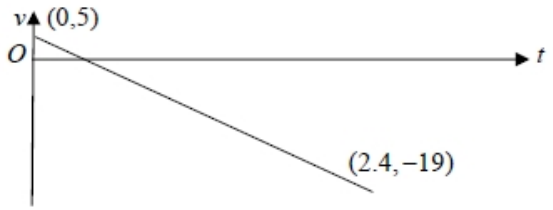
Q9.

Question Number	Scheme	Marks
	(a)  2 horizontal lines Joined by straight line sloping down 25, 10, 18, 30 oe	B1 B1 B1 (3)
	(b) $25\times10+\frac{1}{2}(25+V)\times8+12\times V=526$ Solving to $V=11$	M1 A1 A1 DM1 A1 (5)
	(c) $"v=u+at" \Rightarrow 11=25-8a$ ft their V $a=1.75 \quad (\text{ms}^{-2})$	M1 A1ft A1 (3)
		[11]

Q10.

Question Number	Scheme		Marks
(a)	$v = u + at \Rightarrow 0 = 15 - 2.5t$ $t = 6 \quad (\text{s})$		M1 A1 (2)
(b)		Shape $15, T$	B1 B1 (2)
(c)	$\frac{1}{2}15\left(\frac{4}{3}T + 6 + T\right) = 885$ $\frac{7}{3}T = 118 - 6$ $T = 112 \times \frac{3}{7} = 48$	ft their 6	M1 A1ft M1 A1 (4)
(d)	$a = \frac{15}{\frac{1}{3}T} = \frac{15}{16}$, 0.9375, 0.938, 0.94		M1 A1 (2)
(e)		3 horizontal lines Correctly placed;no cts vert line −2.5 , ft their $\frac{15}{16}$	B1 B1 B1 (3)
			13

Q11.

Question	Scheme	Marks	AOs
(a)	$19^2 = (-U)^2 + 2\times10\times16.8$ (Allow use of $g = 9.8$ for this M mark)	M1	2.1
	$U = 5$ *	A1*	1.1b
		(2)	
	For consistent use of $g = 9.8$ in parts (b), (c) and (d), treat as a MR. i.e. max (b) M1A0 (c)M1A0M(A)0A1ft (d)B1B1ft		
(b)	$19 = -5 + 10T$ **OR** $16.8 = \frac{(-5+19)}{2}T$ **OR** $16.8 = -5T + \frac{1}{2}\times10T^2$ **OR** $16.8 = 19T - \frac{1}{2}\times10T^2$	M1	2.1
	$T = 2.4$	A1	1.1b
		(2)	
(c)	$1.2 = -5t + \frac{1}{2}\times10\times t^2$	M1	2.1
	$5t^2 - 5t - 1.2 = 0$	A1	1.1b
		M(A)1	1.1b
	$t = 1.2$ (s)	A1	1.1b
		(4)	
(d)		B1 shape	1.1b
	(0,5) and (2.4, −19) Allow these to be marked on the axes.	B1ft	1.1b
		(2)	
(e)	Greater since air resistance would slow the ball down.	B1	3.5a
		(1)	
(f)	Take into account: spin, wind effects, use a more accurate value of g, not model the ball as a particle	B1	3.5c
		(1)	
		(12 marks)	