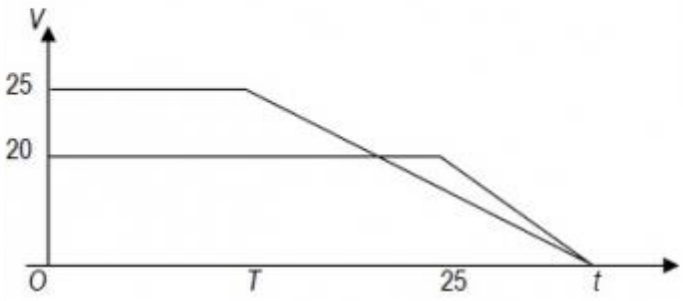
A level Applied Paper 3B Mechanics Practice Paper M10 MARK SCHEME

Question 1

Question Number	Scheme	Marks
(a)	$(\uparrow) v^2 = u^2 + 2as$ $0 = 14.7^2 - 2\text{x } 9.8 \text{ x } s$ $s = 11.025$ (or 11 or 11.0 or 11.03) m Height is 60 m or 60.0 m **ft**	M1A1 A1 A1ft (4)
(b)	$(\downarrow) v^2 = u^2 + 2as$ $v^2 = (-14.7)^2 + 2\text{x } 9.8 \text{ x } 49$ $v = 34.3$ or 34 m s^{-1}	M1 A1 A1 (3)
(c)	$(\downarrow) v = u + at$ **OR** $(\downarrow) s = ut + \frac{1}{2}at^2$ $34.3 = -14.7 + 9.8t$ $\quad$ $49 = -14.7t + 4.9t^2$ $t = 5$ $\quad$ $t = 5$	M1 A1 A1 (3) **[10]**

Question 2

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: $20\left(\frac{t+25}{2}\right) = 800$ $t = 55$ For P: $25\left(\frac{T+55}{2}\right) = 800$ solving for T: $T = 9$	M1 A1 DM1 A1 M1 A1 DM1 A1 (8) **[12]**

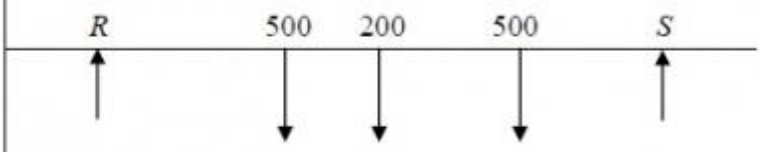
Question 3

Question Number	Scheme	Marks
(a)	$F = \frac{1}{3}R$	B1
	$(\uparrow)\ R\cos\alpha - F\sin\alpha = 0.4g$	M1 A1
	$R = \frac{2}{5}g = 6.53$ or 6.5	M1 A1 (5)
(b)	$(\rightarrow) P - F\cos\alpha - R\sin\alpha = 0$	M1 A2
	$P = \frac{26}{45}g = 5.66$ or 5.7	M1 A1 (5)
		[10]

Question 4

Question Number	Scheme	Marks
	$(-4\mathbf{i} - 7\mathbf{j}) = \mathbf{r} + 4(-3\mathbf{i} + 2\mathbf{j})$	M1 A1
	$\mathbf{r} = (8\mathbf{i} - 15\mathbf{j})$	A1
	$\lvert\mathbf{r}\rvert = \sqrt{8^2 + (-15)^2} = 17$ m	M1 A1 ft
		[5]

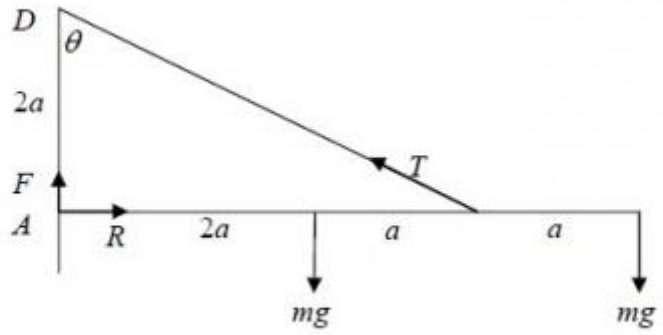
Question 5

Question Number	Scheme	Marks
		
	$M(B)$, $500x + 500.2x + 200x3 = Rx5 + Sx1$ (or any valid moments equation)	M1 A1 A1
	$(\downarrow)\ R + S = 500 + 500 + 200 = 1200$ (or a moments equation)	M1 A1
	solving for x; $x = 1.2$ m	M1 A1 cso
		[7]

Question 6

Question Number	Scheme	Marks
	$(\rightarrow)\ 100\cos 30 = F$ $F = 0.5\,R$ *seen* $(\downarrow)\ mg + 100\cos 60 = R$ $m = 13$ kg or 12.6 kg	M1 A1 A1 **(B1)** M1 A1 DM1 A1 **[7]**

Question 7

Question Number	Scheme	Marks
(a)	 M(A) $3a \times T\cos\theta = 2amg + 4amg$ $\cos\theta = \left(\frac{2}{\sqrt{9+4}} = \right)\frac{2}{\sqrt{13}}$ $\frac{6}{\sqrt{13}}T = 6mg$ $T = mg\sqrt{13}$ *	M1 A1 A1 B1 A1 (5)
(b)	$3a \times T \times \cos\theta = 2amg + 4aMg$ $T = \frac{(2mg + 4Mg)}{6}\sqrt{13} \leq 2mg\sqrt{13}$ $mg + 2Mg \leq 6mg$ $M \leq \frac{5}{2}m$ * cso	M1 A1 A1 (3) **[8]**

Question 8

Question Number	Scheme	Marks
		
	$\frac{dv}{dt} = 3t + 5$	
	$v = \int (3t+5)\,dt$	M1*
	$v = \frac{3}{2}t^2 + 5t \ (+c)$	A1
	$t = 0 \ \ v = 2 \ \Rightarrow \ c = 2$	B1
	$v = \frac{3}{2}t^2 + 5t + 2$	
	$t = T \quad 6 = \frac{3}{2}T^2 + 5T + 2$	DM1*
	$12 = 3T^2 + 10T + 4$	
	$3T^2 + 10T - 8 = 0$	
	$(3T-2)(T+4) = 0$	M1
	$T = \frac{2}{3} \quad (T = -4)$	
	$\therefore T = \frac{2}{3}$ (or 0.67)	A1
		[6]

Question 9

Question Number	Scheme	Marks
(a)	$(\downarrow) 0.4g - T = 0.4a$	M1 A1
Mark	$(\uparrow) T - 0.3g = 0.3a$	M1 A1
together	solving for T	DM1
	$T = 3.36$ or 3.4 or $12g/35$ (N)	A1 (6)
(b)	$0.4g - 0.3g = 0.7a$	DM1
	$a = 1.4$ m s^{-2}, $g/7$	A1 (2)
(c)	$(\uparrow) v = u + at$	
	$v = 0.5 \times 1.4$	M1
	$= 0.7$	A1 ft on a
	$(\uparrow) s = ut + \frac{1}{2}at^2$	
	$s = 0.5 \times 1.4 \times 0.5^2$	M1
	$= 0.175$	A1 ft on a
	$(\downarrow) s = ut + \frac{1}{2}at^2$	
	$1.175 = -0.7t + 4.9t^2$	DM1 A1 ft
	$4.9t^2 - 0.7t - 1.175 = 0$	
	$t = \frac{0.7 \pm \sqrt{0.7^2 + 19.6 \times 1.175}}{9.8}$	DM1 A1 cao
	$= 0.5663..$ or $-...$	
	Ans 0.57 or 0.566 s	A1 cao (9)
		[17]

Question 10

Question Number	Scheme	Marks
(a)	Vertical motion: $v^2 = u^2 + 2as$ $(40\sin\theta)^2 = 2 \times g \times 12$ $(\sin\theta)^2 = \frac{2 \times g \times 12}{40^2}$ $\theta = 22.54 = 22.5°$ (accept 23)	M1 A1 A1 (3)
(b)	Vert motion $P \to R$: $s = ut + \frac{1}{2}at^2$ $-36 = 40\sin\theta t - \frac{g}{2}t^2$ $\frac{g}{2}t^2 - 40\sin\theta t - 36 = 0$ $t = \frac{40\sin 22.54 \pm \sqrt{(40\sin 22.54)^2 + 4 \times 4.9 \times 36}}{9.8}$ $t = 4.694...$ Horizontal P to R: $s = 40\cos\theta t$ $= 173$ m (or 170 m)	M1 A1 A1 A1 M1 A1 (6)
(c)	Using Energy: $\frac{1}{2}mv^2 - \frac{1}{2}m \times 40^2 = m \times g \times 36$ $v^2 = 2\left(9.8\times 36 + \frac{1}{2}\times 40^2\right)$ $v = 48.0.....$ $v = 48$ m s^{-1} (accept 48.0)	M1 A1 A1 (3) [12]