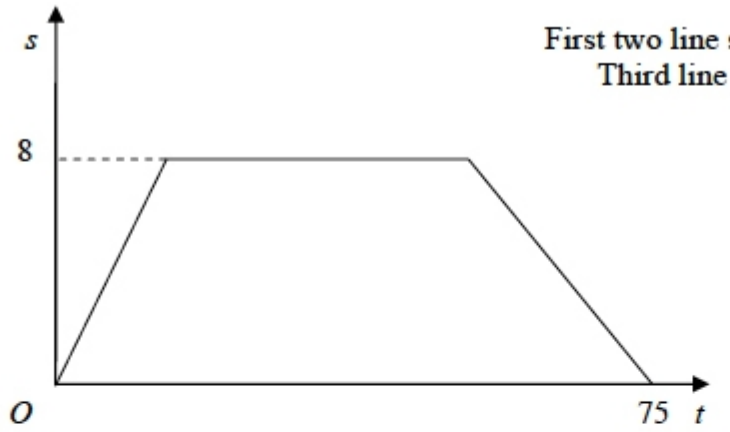
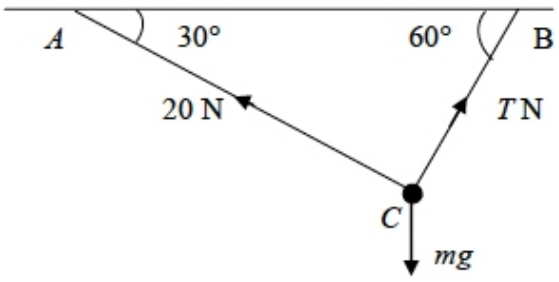
A level Applied Paper 3B Mechanics Practice Paper J10 MARK SCHEME

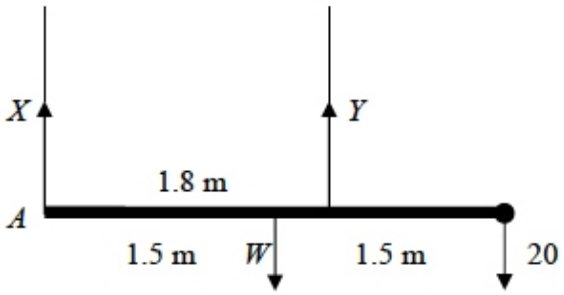
Question 1

(a)	 First two line segments Third line segment 8, 75	B1 B1 B1 (3)
(b)	$\frac{1}{2}\times 8\times(T+75)=500$ Solving to $T=50$	M1 A2 (1,0) DM1 A1 (5) **[8]**

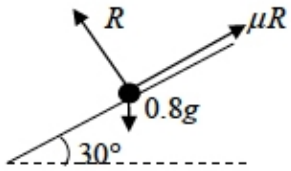
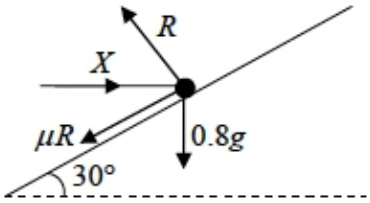
Question 2:

Question Number	Scheme	Marks
		
(a)	R(→) $20\cos 30° = T\cos 60°$ $T = 20\sqrt{3}$, 34.6, 34.64,…	M1 A2 (1,0) A1 (4)
(b)	R(↑) $mg = 20\sin 30° + T\sin 60°$ $m = \frac{40}{g} (\approx 4.1)$,4.08	M1 A2 (1,0) A1 (4) **[8]**

Question 3:

(a)	 M (A) $W\times 1.5 + 20\times 3 = Y\times 1.8$ $Y = \frac{5}{6}W + \frac{100}{3}$ * cso	M1 A2 (1, 0) A1 (4)
(b)	↑ $X + Y = W + 20$ or equivalent $X = \frac{1}{6}W - \frac{40}{3}$	M1 A1 A1 (3)
(c)	$\frac{5}{6}W + \frac{100}{3} = 8\left(\frac{1}{6}W - \frac{40}{3}\right)$ $W = 280$	M1 A1 ft A1 (3) **[10]**
Alternative to (b) M(C)	$X\times 1.8 + 20\times 1.2 = W\times 0.3$ $X = \frac{1}{6}W - \frac{40}{3}$	M1 A1 A1

Question 4

Question Number	Scheme	Marks
	(a) $s = ut + \frac{1}{2}at^2 \Rightarrow 2.7 = \frac{1}{2}a \times 9$	M1 A1
	$a = 0.6\left(\text{m s}^{-2}\right)$	A1 (3)
	(b) 	
	↖ $R = 0.8g\cos 30° \left(\approx 6.79\right)$	B1
	Use of $F = \mu R$	B1
	↙ $0.8g\sin 30° - \mu R = 0.8 \times a$	M1 A1
	$\left(0.8g\sin 30° - \mu 0.8g\cos 30° = 0.8 \times 0.6\right)$	
	$\mu \approx 0.51$ accept 0.507	A1 (5)
	(c) 	
	↑ $R\cos 30° = \mu R\cos 60° + 0.8g$	M1 A2 (1,0)
	$\left(R \approx 12.8\right)$	
	→ $X = R\sin 30° + \mu R\sin 60°$	M1 A1
	Solving for X, $X \approx 12$ accept 12.0	DM1 A1 (7)
		[15]
	Alternative to (c)	
	↖ $R = X\sin 30° + 0.8 \times 9.8\sin 60°$	M1 A2 (1,0)
	↙ $\mu R + 0.8g\cos 60° = X\cos 30°$	M1 A1
	$X = \frac{\mu 0.8g\sin 60° + 0.8g\cos 60°}{\cos 30° - \mu\sin 30°}$	
	Solving for X, $X \approx 12$ accept 12.0	DM1 A1 (7)

Question 5

Question Number	Scheme	Marks
	(a) $\mathbf{v} = \dfrac{21\mathbf{i}+10\mathbf{j}-(9\mathbf{i}-6\mathbf{j})}{4} = 3\mathbf{i}+4\mathbf{j}$	M1 A1
	speed is $\sqrt{(3^2+4^2)} = 5\,(\text{km h}^{-1})$	M1 A1 (4)
	(b) $\tan\theta = \dfrac{3}{4}$ $(\Rightarrow \theta \approx 36.9°)$	M1
	bearing is 37, 36.9, 36.87, …	A1 (2)
	(c) $\mathbf{s} = 9\mathbf{i}-6\mathbf{j}+t(3\mathbf{i}+4\mathbf{j})$	M1
	$= (3t+9)\mathbf{i}+(4t-6)\mathbf{j}$ * cso	A1 (2)
	(d) Position vector of S relative to L is	
	$(3T+9)\mathbf{i}+(4T-6)\mathbf{j}-(18\mathbf{i}+6\mathbf{j}) = (3T-9)\mathbf{i}+(4T-12)\mathbf{j}$	M1 A1
	$(3T-9)^2+(4T-12)^2 = 100$	M1
	$25T^2-150T+125=0$ or equivalent	DM1 A1
	$(T^2-6T+5=0)$	
	$T = 1, 5$	A1 (6)
		[14]

Question 6

Question Number	Scheme	Marks
	(a) N2L A: $5mg - T = 5m \times \frac{1}{4}g$	M1 A1
	$T = \frac{15}{4}mg$ * cso	A1 (3)
	(b) N2L B: $T - kmg = km \times \frac{1}{4}g$	M1 A1
	$k = 3$	A1 (3)
	(c) The tensions in the two parts of the string are the same	B1 (1)
	(d) Distance of A above ground $s_1 = \frac{1}{2} \times \frac{1}{4}g \times 1.2^2 = 0.18g \ (\approx 1.764)$	M1 A1
	Speed on reaching ground $v = \frac{1}{4}g \times 1.2 = 0.3g \ (\approx 2.94)$	M1 A1
	For B under gravity $(0.3g)^2 = 2gs_2 \Rightarrow s_2 = \frac{(0.3)^2}{2}g \ (\approx 0.441)$	M1 A1
	$S = 2s_1 + s_2 = 3.969 \approx 4.0$ (m)	A1 (7)
		[14]

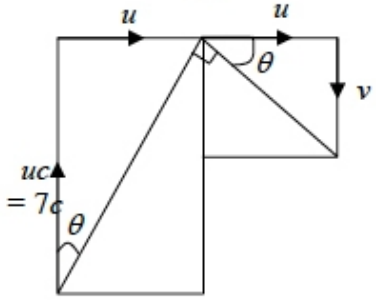
Question 7

Question Number	Scheme	Marks
	$\frac{dv}{dt} = 6t - 4$	M1 A1
	$6t - 4 = 0 \Rightarrow t = \frac{2}{3}$	M1 A1
	$s = \int 3t^2 - 4t + 3 \, dt = t^3 - 2t^2 + 3t \ (+c)$	M1 A1
	$t = \frac{2}{3} \Rightarrow s = -\frac{16}{27} + 2$ so distance is $\frac{38}{27}$ m	M1 A1
		[8]

Question 8

	$m(B): R \times 4\cos\alpha = F \times 4\sin\alpha + 20g \times 2\cos\alpha$	M1 A2
	Use of $F = \frac{1}{2}R$	M1
	Use of correct trig ratios	B1
	R = 160N or 157N	DM1 A1
		[7]

Question 9

Question Number	Scheme	Marks
	(a) $x = ut$	B1
	$y = cut - 4.9t^2$	M1 A1
	eliminating t and simplifying to give $y = cx - \frac{4.9x^2}{u^2}$ **	DM1 A1 (5)
	(b)(i) $0 = cx - \frac{4.9x^2}{u^2}$	M1
	$0 = x(c - \frac{4.9x}{u^2}) \Rightarrow R = \frac{u^2 c}{4.9} = 10c$	M1 A1
	(ii) When $x = 5c$, $y = H$	M1
	$= 5c^2 - \frac{(5c)^2}{10} = 2.5c^2$	M1 A1 (6)
	(c) $\frac{dy}{dx} = c - \frac{9.8x}{u^2} = c - \frac{x}{5}$	M1 A1
	When $x = 0$, $\frac{dy}{dx} = c$	B1
	So, $c - \frac{x}{5} = \frac{-1}{c}$	DM1 A1
	$x = 5(c + \frac{1}{c})$	A1 (6)
		[17]
	Alternative to 8(c)  $\tan\theta = \frac{u}{cu} = \frac{1}{c} = \frac{v}{u}$	B1
	$\Rightarrow v = \frac{u}{c} = \frac{7}{c}$	M1 A1
	$v = u + at$; $-\frac{7}{c} = 7c - 9.8t$	M1
	$t = \frac{7}{9.8}(c + \frac{1}{c})$	A1
	$x = ut = 7t$; $x = 5(c + \frac{1}{c})$	A1