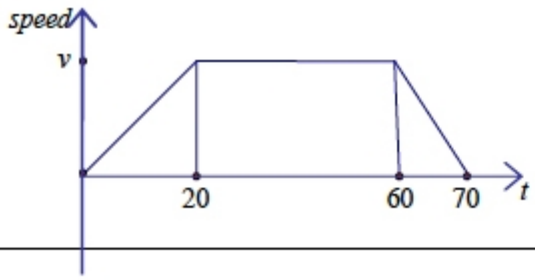
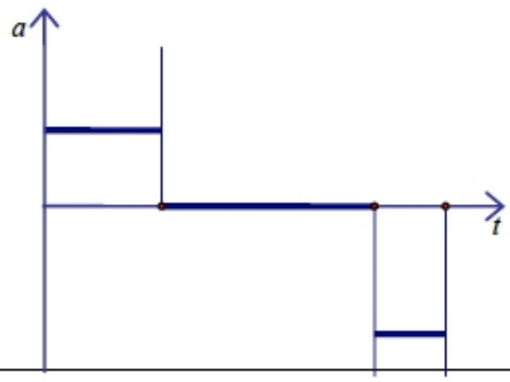
A level Applied Paper 3B Mechanics Practice Paper J11 MARK SCHEME

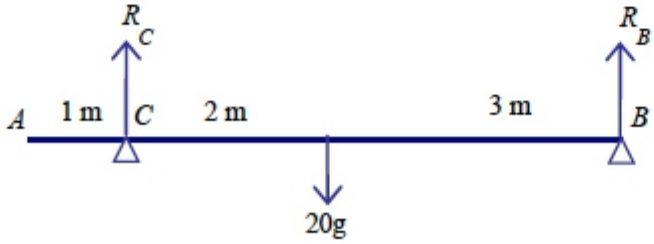
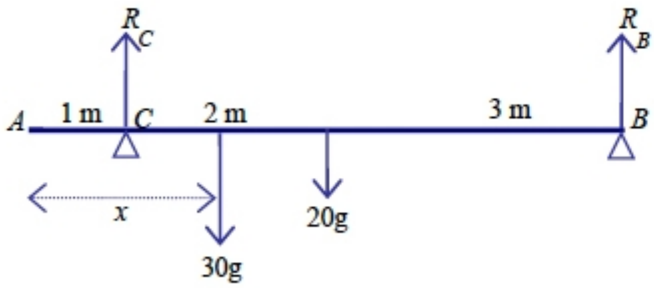
Question 1

Question Number	Scheme	Marks
(a) (i)	 1^{st} section correct 2^{nd} & 3^{rd} sections correct Numbers and v marked correctly on the axes.	B1 B1 DB1
(ii)	 1^{st} section correct 2^{nd} section correct 3^{rd} 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]**

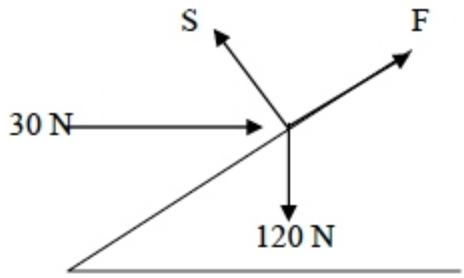
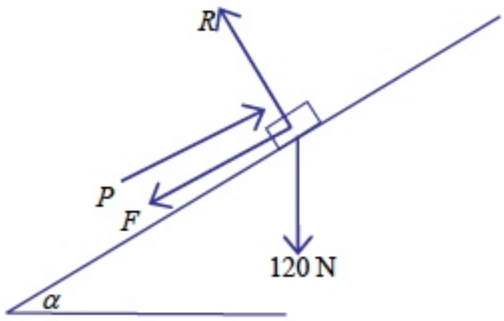
Question 2

Question Number	Scheme	Marks
(a)	$-6.45 = u - 9.8 \times 0.75$ $0.9 = u$ **	M1 A1 A1 (3)
(b)	$0 = 0.81 - 2 \times 9.8 \times s$ $s = 0.041$ or 0.0413	M1 A1 (2)
(c)	$h = -0.9 \times 0.75 + 4.9 \times 0.75^2$ $h = 2.1$ or 2.08	M1 A1 A1 (3) [8]

Question 3

Question Number	Scheme	Marks
(a)		
	Taking moments about B: $5 \times R_C = 20g \times 3$	M1A1
	$R_C = 12g$ or $60g/5$ or 118 or 120	A1
	Resolving vertically: $R_C + R_B = 20g$	M1
	$R_B = 8g$ or 78.4 or 78	A1
		(5)
(b)		
	Resolving vertically: $50g = R + R$	B1
	Taking moments about B:	
	$5 \times 25g = 3 \times 20g + (6 - x) \times 30g$	M1 A1 A1
	$30x = 115$	
	$x = 3.8$ or better or 23/6 oe	A1
		(5) [10]

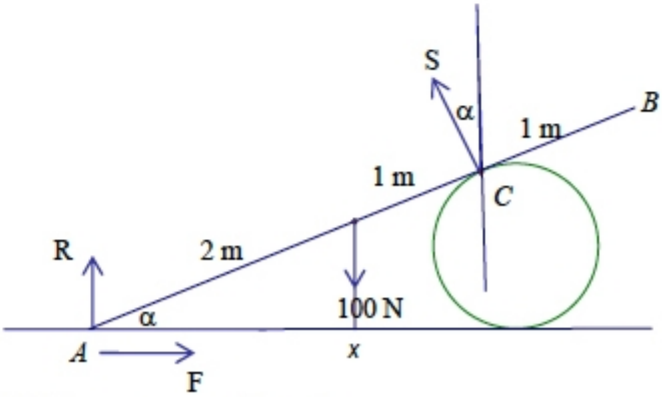
Question 4

Question Number	Scheme	Marks
(a)		
	Resolving perpendicular to the plane: $S = 120\cos\alpha + 30\sin\alpha$ $= 114$ *	M1 A1 A1 A1 (4)
(b)		
	Resolving perpendicular to the plane: $R = 120\cos\alpha$ $= 96$ $F_{max} = \frac{1}{2}R$	M1 A1 A1 M1
	Resolving parallel to the plane: In equilibrium: $P_{max} = F_{max} + 120\sin\alpha$ $= 48 + 72 = 120$	M1 A(2,1,0) A1 (8)
(c)	$30 + F = 120\sin\alpha$ **OR** $30 - F = 120\sin\alpha$ So $F = 42\text{N}$ acting up the plane.	M1 A1 A1 (3) [15]

Question 5

Question Number	Scheme	Marks
(a)	speed $= \sqrt{2^2 + (-5)^2}$ $= \sqrt{29} = 5.4$ or better	M1 A1 (2)
(b)	$((7\mathrm{i}+10\mathrm{j})-(2\mathrm{i}-5\mathrm{j}))/5$ $=(5\mathbf{i}+15\mathbf{j})/5=\mathbf{i}+3\mathbf{j}$ $\mathbf{F}=m\mathbf{a}=2(\mathbf{i}+3\mathbf{j})=2\mathbf{i}+6\mathbf{j}$	M1 A1 A1 DM1 A1ft (5)
(c)	$\mathbf{v}=\mathbf{u}+\mathbf{a}t=(2\mathbf{i}-5\mathbf{j})+(\mathbf{i}+3\mathbf{j})t$ $(-5+3t)\mathrm{j}$ Parallel to $\mathbf{i} \Rightarrow -5+3t=0$ $t=5/3$	M1 A1 M1 A1 (4) **[11]**

Question 6

Question Number	Scheme	Marks
		
	Taking moments about A: $3S = 100 \times 2 \times \cos\alpha$	M1 A1
	Resolving vertically: $R + S\cos\alpha = 100$	M1 A1
	Resolving horizontally: $S\sin\alpha = F$	M1 A1
	(Most alternative methods need 3 independent equations, each one worth M1A1. Can be done in 2 e.g. if they resolve horizontally and take moments about X then $R \times 2 \times \cos\alpha = S \times (3 - 2 \times \cos^2\alpha)$ scores M2A2)	
	Substitute trig values to obtain correct values for F and R (exact or decimal equivalent).	DM1
	$\left(S = \frac{200\sqrt{8}}{9}\right)$, $R = 100 - \frac{1600}{27} = \frac{1100}{27} \approx 40.74$, $F = \frac{200\sqrt{8}}{27} \approx 20.95...$	A1
	$F \le \mu R$, $200\sqrt{8} \le \mu \times 1100$, $\mu \ge \frac{200\sqrt{8}}{1100} = \frac{2\sqrt{8}}{11}$.	M1
	Least possible μ is 0.514 (3sf), or exact.	A1
		[10]

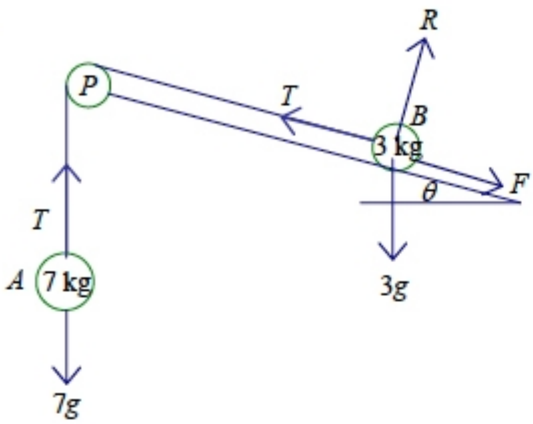
Question 7

(a)	$a = 4t^3 - 12t$ Convincing attempt to integrate $v = t^4 - 6t^2 (+c)$ Use initial condition to get $v = t^4 - 6t^2 + 8\left(\text{ms}^{-1}\right)$.	M1 A1 A1 **(3)**
(b)	Convincing attempt to integrate $s = \frac{t^5}{5} - 2t^3 + 8t(+0)$ Integral of their v	M1 A1ft **(2)**
(c)	Set their $v = 0$ Solve a quadratic in t^2 $(t^2 - 2)(t^2 - 4) = 0 \Rightarrow$ at rest when $t = \sqrt{2},\ t = 2$	M1 DM1 A1 **(3)** **[8]**

Question 8

(a)	Using $s = ut + \frac{1}{2}at^2$ Method must be clear $\mathbf{r} = (3t)\mathbf{i} + \left(10 + 5t - 4.9t^2\right)\mathbf{j}$ Answer given	M1 A1 A1 (3)
(b)	$\mathbf{j}$ component $= 0$: $10 + 5t - 4.9t^2$ quadratic formula: $t = \frac{5 \pm \sqrt{25 + 196}}{9.8} = \frac{5 \pm \sqrt{221}}{9.8}$ $T = 2.03\text{(s)}, 2.0\text{ (s)}$ positive solution only.	M1 DM1 A1 (3)
(c)	Differentiating the position vector (or working from first principles) $\mathbf{v} = 3\mathbf{i} + (5 - 9.8t)\mathbf{j}$ (ms^{-1})	M1 A1 (2)
(d)	At B the $\mathbf{j}$ component of the velocity is the negative of the $\mathbf{i}$ component: $5 - 9.8t = -3$, $8 = 9.8t$, $t = 0.82$	M1 A1 (2)
(e)	$\mathbf{v} = 3\mathbf{i} - 3\mathbf{j}$, speed $= \sqrt{3^2 + 3^2} = \sqrt{18} = 4.24\,(\text{m s}^{-1})$	M1A1 (2) **[12]**

Question 9

Question Number	Scheme	Marks
(a)	 $\tan\theta = \frac{5}{12}$ $\sin\theta = \frac{5}{13}$ $\cos\theta = \frac{12}{13}$	
	For A: $7g - T = 7a$	M1 A1
	For B: parallel to plane $T - F - 3g\sin\theta = 3a$	M1 A1
	perpendicular to plane $R = 3g\cos\theta$	M1 A1
	$F = \mu R = 3g\cos\theta = 2g\cos\theta$	M1
	Eliminating T, $7g - F - 3g\sin\theta = 10a$	DM1
	Equation in g and a: $7g - 2g\times\frac{12}{13} - 3g\frac{5}{13} = 7g - \frac{39}{13}g = 4g = 10a$	DM1
	$a = \frac{2g}{5}$ *oe* or 3.9 or 3.92	A1
		(10)
(b)	After 1 m,	
	$v^2 = u^2 + 2as$, $v^2 = 0 + 2\times\frac{2g}{5}\times 1$	M1
	$v = 2.8$	A1
		(2)
(c)	$-(F + 3g\ \sin\theta) = 3a$	M1
	$\frac{2}{3}\times 3g\times\frac{12}{13} + 3g\times\frac{5}{13} = 3g = -3a$, $a = -g$	A1
	$v = u + at$, $0 = 2.8 - 9.8t$,	DM1
	$t = \frac{2}{7}$ oe, 0.29. 0.286	A1
		(4) **[16]**