A level Applied Paper 3B Mechanics Practice Paper M9 MARK SCHEME

Question 1:

Question Number	Scheme	Marks
	$45 = 2u + \frac{1}{2}a2^2 \Rightarrow 45 = 2u + 2a$	M1 A1
	$165 = 6u + \frac{1}{2}a6^2 \Rightarrow 165 = 6u + 18a$	M1 A1
	eliminating either u or a	M1
	$u = 20$ and $a = 2.5$	A1 A1 [7]

Question 2:

Question Number	Scheme	Marks
(a)	$\tan\theta = \frac{p}{2p} \Rightarrow \theta = 26.6°$	M1 A1 (2)
(b)	$\mathbf{R} = (\mathbf{i} - 3\mathbf{j}) + (p\mathbf{i} + 2p\mathbf{j}) = (1 + p)\mathbf{i} + (-3 + 2p)\mathbf{j}$	M1 A1
	$\mathbf{R}$ is parallel to $\mathbf{i} \Rightarrow (-3 + 2p) = 0$	DM1
	$\Rightarrow p = \frac{3}{2}$	A1 (4) [6]

Question 3:

Question Number	Scheme	Marks
(a)	For whole system: $1200 - 400 - 200 = 1000a$	M1 A1
	$a = 0.6 \text{ m s}^{-2}$	A1 (3)
(b)	For trailer: $T - 200 = 200 \times 0.6$	M1 A1 ft
	$T = 320$ N	A1
		OR:
	OR: For car: $1200 - 400 - T = 800 \times 0.6$	M1 A1 ft
	$T = 320$ N	A1 (3)
(c)	For trailer: $200 + 100 = 200f$ or $-200f$	M1 A1
	$f = 1.5 \text{ m s}^{-2}$ (-1.5)	A1
	For car: $400 + F - 100 = 800f$ or $-800f$	M1 A2
	$F = 900$	A1 (7)
	(N.B. For both: $400 + 200 + F = 1000f$)	[13]

Question 4:

Question Number	Scheme	Marks
(a)	$M(Q),\ 50g(1.4-x)+20g \text{ x } 0.7 = T_P \text{ x } 1.4$	M1 A1
	$T_P = 588 - 350x$ Printed answer	A1 (3)
(b)	$M(P),\ 50gx + 20g \text{ x } 0.7 = T_Q \text{ x } 1.4$ or $R(\uparrow),\ T_P + T_Q = 70g$	M1 A1
	$T_Q = 98 + 350x$	A1 (3)
(c)	Since $0 < x < 1.4$, $98 < T_P < 588$ and $98 < T_Q < 588$	M1 A1 A1 (3)
(d)	$98 + 350x = 3(588 - 350x)$	M1
	$x = 1.19$	DM1 A1 (3) [12]

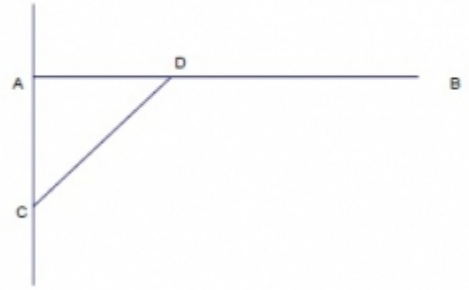
Question 5:

Question Number	Scheme	Marks
	$F = P\cos 50°$	M1 A1
	$F = 0.2R$ seen or implied.	B1
	$P\sin 50° + R = 15g$	M1 A1 A1
	Eliminating R; Solving for P; $P = 37$ (2 SF)	DM1;D M1; A1 [9]

Question 6:

Question Number	Scheme	Marks
	$0.5g\sin\theta - F = 0.5a$	M1 A1 A1
	$F = \frac{1}{3}R$ seen	B1
	$R = 0.5g\cos\theta$	M1 A1
	Use of $\sin\theta = \frac{4}{5}$ or $\cos\theta = \frac{3}{5}$ or decimal equiv or decimal angle e.g 53.1° or 53°	B1
	$a = \frac{3g}{5}$ or $5.88\ \text{m s}^{-2}$ or $5.9\ \text{m s}^{-2}$	DM1 A1 [9]

Question 7:

Question Number	Scheme	Marks
(a)	 Taking moments about A: $3g \times 0.75 = \frac{T}{\sqrt{2}} \times 0.5$	M1A1A1
	$T = 3\sqrt{2}g \times \frac{7.5}{5} = \frac{9\sqrt{2}g}{2} (= 62.4N)$	A1 (4)
(b)	$\leftarrow \pm H = \frac{T}{\sqrt{2}} (= \frac{9g}{2} \approx 44.1N)$	B1
	$\uparrow \pm V + \frac{T}{\sqrt{2}} = 3g \quad (\Rightarrow V = 3g - \frac{9g}{2} = \frac{-3g}{2} \approx -14.7\text{N})$	M1A1
	$\Rightarrow \lvert R\rvert = \sqrt{81+9} \times \frac{g}{2} \approx 46.5(N)$	M1A1
	at angle $\tan^{-1}\frac{1}{3} = 18.4^\circ$ (0.322 radians) below the line of BA	M1A1
	161.6° (2.82 radians) below the line of AB (108.4° or 1.89 radians to upward vertical)	(7) [11]

Question 8:

Question Number	Scheme	Marks
(a)	$\rightarrow \quad x = u\cos\alpha t = 10$	M1A1
	$\uparrow \quad y = u\sin\alpha t - \frac{1}{2}gt^2 = 2$	M1A1
	$\Rightarrow t = \frac{10}{u\cos\alpha}$	
	$2 = u\sin\alpha \times \frac{10}{u\cos\alpha} - \frac{g}{2} \times \frac{100}{u^2\cos^2\alpha}$	M1
	$= 10\tan\alpha - \frac{50g}{u^2\cos^2\alpha}$ (given answer)	A1 (6)
(b)	$2 = 10\times 1 - \frac{100g\times 2}{2u^2\times 1}$	M1A1
	$u^2 = \frac{100g}{8}, \; u = \sqrt{\frac{100g}{8}} = 11.1 \text{ (m s}^{-1}\text{)}$	A1
	$\frac{1}{2}mu^2 = m\times 9.8\times 2 + \frac{1}{2}mv^2$	M1A1
	$v = 9.1ms^{-1}$	A1 (6)
		[12]

Question 9:

Question Number	Scheme	Marks
(a)	$\frac{dv}{dt} = 8 - 2t$	M1
	$8 - 2t = 0$	M1
	Max $v = 8\times 4 - 4^2 = 16 \text{ (ms}^{-1}\text{)}$	M1A1 (4)
(b)	$\int 8t - t^2 dt = 4t^2 - \frac{1}{3}t^3 (+c)$	M1A1
	(t=0, displacement = 0 $\Rightarrow$ c=0)	
	$4T^2 - \frac{1}{3}T^3 = 0$	DM1
	$T^2(4 - \frac{T}{3}) = 0 \Rightarrow T = 0, 12$	DM1
	$T = 12$ (seconds)	A1 (5)
		[9]

Question 10:

Question Number	Scheme	Marks
(a)	$\lvert\mathbf{v}\rvert = \sqrt{1.2^2 + (-0.9)^2} = 1.5 \text{ m s}^{-1}$	M1 A1 (2)
(b)	$(\mathbf{r}_H =) 100\mathbf{j} + t(1.2\mathbf{i} - 0.9\mathbf{j})$ m	M1 A1 (2)
(c)	$(\mathbf{r}_K =) 9\mathbf{i} + 46\mathbf{j} + t(0.75\mathbf{i} + 1.8\mathbf{j})$ m	M1 A1
	$\overrightarrow{HK} = \mathbf{r}_K - \mathbf{r}_H = (9 - 0.45t)\mathbf{i} + (2.7t - 54)\mathbf{j}$ m **Printed Answer**	M1 A1 (4)
(d)	Meet when $\overrightarrow{HK} = \mathbf{0}$	
	$(9 - 0.45t) = 0$ and $(2.7t - 54) = 0$	M1 A1
	$t = 20$ from both equations	A1
	$\mathbf{r}_K = \mathbf{r}_H = (24\mathbf{i} + 82\mathbf{j})$ m	DM1 A1 cso
		(5)
		[13]