SOLUTION SP015 PRE PSPM-SET 1

NO	ANSWER SCHEME	MARKS
1.	$S = \sqrt{Sx^2 + Sy^2}$	
	$=\sqrt{(1.5)^2+(1.4)^2}$	
	= 2.05 m	TT 11
	$\tan \theta = \frac{Sy}{Sx}$	JU1
	$\theta = 43.03^{\circ}$	JU1
	TOTAL	2
2.(a)	$(i) \ v^2 = u^2 + 2aS$	
	$260^2 = 345^2 + 2a(5.5 \times 10^{-2})$	G1
	$a = -4.67 \times 10^5 m s^{-2}$	JU1
	(ii) v = u + at	
	$260 = 345 + (-4.67 \times 10^5)t$	G1
	$t = 1.82 \times 10^{-4} s$	JU1
2.(b)	$(i) S_y = u_y t - \frac{1}{2} g t^2$	
	$0 = u(8) - \frac{1}{2}(9.81)(8^2)$	G1
	8u = 313.92	
	$u = 39.24 m s^{-1}$	JU1
	$(ii) v_y = 0$	
	$v_y^2 = u_y^2 - 2gS$	
	$0 = 39.24^2 - 2(9.81)S$	G1
	S = 78.48 m	JU1
	$(iii) \ v = u - gt$	
	v = (39.24) - (9.81)(8)	G1
	$v_y = -39.24 m s^{-1}$	JU1
	TOTAL	10

$ \begin{array}{c} 3. (a) \\ \hline (i) \ J = area \ under \ graph \ F - t \\ \hline = \frac{1}{2} (1.5 \times 10^{-3}) (18000) \\ \hline = 13.5 \ Ns \\ \hline \\ (ii) \ J = Ft \\ \hline 13.5 = F (1.5 \times 10^{-3}) \\ F = 9000 \ N \\ \hline \\ (b) \ \Sigma P_t = \Sigma P_f \\ m_p u_p + m_q u_q = m_p v_p + m_q v_q \\ (8) (4) + (6) (-5) = (8) (-1) + 6 v_q \\ \hline v_q = 1.67 \ m \ s^{-1} \\ \hline \\ 3. \ (c) \ (i) \\ \hline \\ F \\ \hline \\ (ii) \ \Sigma F_y = 0 \\ N - F \sin 37 - mg \cos 37 = 0 \\ N = F \sin 37 + mg \cos 37 \end{array} \right. $	NO	ANSWER SCHEME	MARKS
$ \begin{array}{c} (ii) \ J = Ft \\ 13.5 = F(1.5 \times 10^{-3}) \\ F = 9000 \ N \end{array} \qquad \begin{array}{c} G1 \\ JU1 \end{array} $	3.(a)	(i) $J = area under graph F - t$	
$ \begin{array}{c} (ii) \ J = Ft \\ 13.5 = F(1.5 \times 10^{-3}) \\ F = 9000 \ N \end{array} \qquad \begin{array}{c} G1 \\ JU1 \end{array} $		$=\frac{1}{2}(1.5\times10^{-3})(18000)$	
(ii) $J = Ft$ $13.5 = F(1.5 \times 10^{-3})$ GI F = 9000 N JU1 (b) $\Sigma P_i = \Sigma P_f$ $m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q$ $(8)(4) + (6)(-5) = (8)(-1) + 6v_Q$ GI $v_Q = 1.67 \text{ m s}^{-1}$ JU1 3. (c) (i) $V_Q = 1.67 \text{ m s}^{-1}$ JU1 $V_Q = 1.67 \text{ m s}^{-1}$ JU1 $V_Q = 1.67 \text{ m s}^{-1}$ JU1 $V_Q = 1.67 \text{ m s}^{-1}$ JU1		2	
$ \begin{array}{c c} 13.5 = F(1.5 \times 10^{-3}) & \text{GI} \\ F = 9000 N & \text{JUI} \\ \hline \\ (b) & \Sigma P_i = \Sigma P_f \\ m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q \\ (8)(4) + (6)(-5) = (8)(-1) + 6 v_Q \\ v_Q = 1.67 m s^{-1} & \text{JUI} \\ \hline \\ 3. \text{(c)} & \text{(i)} \\ \hline \\ F & & W \\ \hline \\ (ii) \Sigma F_y = 0 \\ N - F \sin 37 - mg \cos 37 = 0 \\ \hline \end{array} \right. $		- 15.5 NS	JU1
$ \begin{array}{c c} 13.5 = F(1.5 \times 10^{-3}) & \text{GI} \\ F = 9000 N & \text{JUI} \\ \hline \\ (b) & \Sigma P_i = \Sigma P_f \\ m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q \\ (8)(4) + (6)(-5) = (8)(-1) + 6 v_Q \\ v_Q = 1.67 m s^{-1} & \text{JUI} \\ \hline \\ 3. \text{(c)} & \text{(i)} \\ \hline \\ F & & W \\ \hline \\ (ii) \Sigma F_y = 0 \\ N - F \sin 37 - mg \cos 37 = 0 \\ \hline \end{array} \right. $			
$F = 9000 N$ $F = 9000 N$ $EP_i = \Sigma P_f$ $m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q$ $(8)(4) + (6)(-5) = (8)(-1) + 6v_Q$ $v_Q = 1.67 m s^{-1}$ $3. (c) (i)$ N $4 label correct - 2 marks$ $3 label correct - 1 marks$ F W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ $K1$			
(b) $\Sigma P_i = \Sigma P_f$ $m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q$ (8)(4) + (6)(-5) = (8)(-1) + 6 v_Q $v_Q = 1.67 m s^{-1}$ 3. (c) (i) N 4 label correct - 2 marks 3 label correct - 1 marks F W (ii) $\Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$			
$m_{p}u_{p} + m_{Q}u_{Q} = m_{p}v_{p} + m_{Q}v_{Q}$ $(8)(4) + (6)(-5) = (8)(-1) + 6v_{Q}$ $v_{Q} = 1.67 m s^{-1}$ $3. \text{ (c)} \text{(i)}$ N $4 label correct - 2 marks$ $3 label correct - 1 marks$ $F \leftarrow W$ $(ii) \Sigma F_{y} = 0$ $N - F \sin 37 - mg \cos 37 = 0$ $K1$		F = 9000 N	JU1
$m_{p}u_{p} + m_{Q}u_{Q} = m_{p}v_{p} + m_{Q}v_{Q}$ $(8)(4) + (6)(-5) = (8)(-1) + 6v_{Q}$ $v_{Q} = 1.67 m s^{-1}$ $3. \text{ (c)} \text{(i)}$ N $4 label correct - 2 marks$ $3 label correct - 1 marks$ $F \leftarrow W$ $(ii) \Sigma F_{y} = 0$ $N - F \sin 37 - mg \cos 37 = 0$ $K1$			
$(8)(4) + (6)(-5) = (8)(-1) + 6v_Q$ $v_Q = 1.67 m s^{-1}$ N $4 label correct - 2 marks$ $3 label correct - 1 marks$ F W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ $K1$	(b)	$\Sigma P_i = \Sigma P_f$	
$v_Q = 1.67 m s^{-1}$ $3. (c) (i)$ $V_Q = 1.67 m s^{-1}$ $3. (c) (i)$ $V_Q = 1.67 m s^{-1}$ $3. (d) (i) ($		$m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q$	
3. (c) (i)		$(8)(4) + (6)(-5) = (8)(-1) + 6v_Q$	
$F \longleftarrow W$ $(ii) \Sigma F_y = 0$ $N \longrightarrow F \sin 37 - mg \cos 37 = 0$ $N \longrightarrow A label correct - 2 marks$ $3 label correct - 1 marks$ $K1$		$v_Q = 1.67 m s^{-1}$	JU1
$F = \frac{4 \ label \ correct - 2 \ marks}{3 \ label \ correct - 1 \ marks}$ $F = \frac{W}{W}$ $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1	3. (c)	(i)	20
$F \leftarrow W$ $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1		N 4 label correct — 2 marks	D2
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1		3 label correct – 1 marks	
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1			
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1			
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1		$F \longleftarrow$	
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1			
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1		f	
W $(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1			
$(ii) \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ K1			
			K1
$N = F \sin 37 + mg \cos 37$		$N - F\sin 37 - mg\cos 37 = 0$	
		$N = F \sin 37 + mg \cos 37$	
$\Sigma F_{x} = 0$		$\Sigma F_{x} = 0$	
$F\cos 37 - f - mg\sin 37 = 0$		$F\cos 37 - f - mg\sin 37 = 0$	
0.7986F - 0.15[0.6018F + 62.68] - 47.23 = 0		0.7986F - 0.15[0.6018F + 62.68] - 47.23 = 0	
0.7986F - 0.09027F - 9.402 - 47.23 = 0		0.7986F - 0.09027F - 9.402 - 47.23 = 0	
0.70833F = 56.632		0.70833F = 56.632	
F = 79.95 N JU1		F = 79.95 N	JU1

	$\Sigma F_{y} = 0$	
	$N = F \sin 37 + mg \cos 37$	
	N = 0.6018(79.95) + 62.68	G1
	N = 110.79 N	JU1
	Or	
	$\Sigma F_{\nu} = 0$	
	$N - F \sin 37 - mg \cos 37 = 0$	
	$N = F \sin 37 + mg \cos 37$	
	$\Sigma F_{x} = 0$	
	$mg \sin 37 - F \cos 37 - f = 0$	
	47.23 - 0.7986F - 0.15[0.6018F + 62.68] = 0	
	-0.7986F - 0.09027F + 47.23 - 9.402 = 0	
	0.8889F = 37.828	
	F = 42.5 N	
	$\Sigma F_{\mathcal{Y}} = 0$	
	$N = F \sin 37 + mg \cos 37$	
	N = 0.6018(42.5) + 62.68	
	N = 88.53 N	
	mom v v	10
4.(a)		13
	$= 10(1.5)\cos 30^{\circ}$	G1
	= 12.99 <i>J</i>	JU1
	$(ii) W_g = mg. s \cos \theta$	
	$= 2(9.81)(1.5)\cos 90^{\circ}$	
	=0J	JU1
(b)	$(i) K = \frac{1}{2} m v^2$	
	_	
	$=\frac{1}{2}(8)(20)^2$	G1
	= 1600 J	JU1
	(ii) U = mgh	
	=(8)(9.81)(10)	G1
	= 784.8 J	JU1
	= 70±.0 j	

	$(iii) \Sigma E_i = \Sigma E_f$	
	$K_c = U + K$	
	$\frac{1}{2}mv^2 = 784.8 + 1600$	
	-	
	$v = 24.42 m s^{-1}$	JU1
	TOTAL	8
5.	(i)	D1
	W	
	v_{min} , $T = 0$, $\Sigma F_y = \frac{mv^2}{r}$ $T + mg = \frac{mv^2}{r}$ $0 + mg = \frac{mv^2}{r}$ $v = \sqrt{rg}$ $v = \sqrt{(1.2)(9.81)}$ $v = 3.43 \text{ m s}^{-1}$	G1 JU1
	(ii) $T - mg = \frac{mv^2}{r}$ $T_{min} = \frac{mv^2}{r} + mg$ $= \frac{(4)(3.43)^2}{1.2} + (4)(9.81)$	G1
	= 78.46 N	JU1
6 (2)	$rac{2\pi}{2}$	5
6.(a)	(i) $\omega = \frac{2\pi}{T}$ $= \frac{2\pi}{\pi} = \pi rad s^{-1}$	JU1
	(ii) $v_{max} = A\omega$ = $(0.06)(\pi)$ $v = 0.06\pi m s^{-1}$	G1 JU1

	$(iii) y = A \sin \omega t$	
	$y = 0.06 \sin \pi t$	J1
(b)	where y in m and t in second $b = 35 \text{ Nm}^{-1} \text{ m} = 50 \times 10^{-3} \text{ h} \text{ s. } 4 = 4.0 \text{ cm}$	J1
(b)	$k = 35 N m^{-1}, m = 50 \times 10^{-3} kg, A = 4.0 cm$	
	(i) $E = \frac{1}{2}kA^2$ = $\frac{1}{2}(35)(4 \times 10^{-2})^2$	
	$=\frac{1}{2}(35)(4\times10^{-2})^2$	G1
	= 0.028 J	JU1
	(::) <u>1422</u>	
	$(ii) v = \omega \sqrt{A^2 - y^2}$	
	$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{35}{50 \times 10^{-3}}} = 26.46 \ rad \ s^{-1}$	J1
	\sqrt{m} $\sqrt{50 \times 10^{-3}}$	
	$v = 26.46\sqrt{(4 \times 10^{-2})^2 - (1.6 \times 10^{-2})^2}$	11.11
	$v = 0.97 \text{m s}^{-1}$	JU1
	$v = 0.97 \text{m s}^{-1}$ $(iii) T_1 = 2\pi \sqrt{\frac{m}{k}}$	
	$=2\pi\sqrt{\frac{50\times10^{-3}}{35}}=0.24s$	J1
	\	
	$T_2 = 2\pi \sqrt{\frac{m_1 + m_2}{k}}$	
	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	
	$=2\pi\sqrt{\frac{56\times10^{-3}}{35}}=0.25s$	J1
	$\Delta T = T_2 - T_1 = 0.25 - 0.24 = 0.01 s$	
	$\Delta I = I_2 - I_1 = 0.23 - 0.24 = 0.013$	JU1
(c)	$y = A\sin(\omega t \pm kx)$ $y = 1300\sin(314t + 0.43x)$	
	$y = 1200\sin(314t - 0.42x)$	
	direction to the right	
	$\omega = 2\pi f$ $314 = 2\pi f$	
	f = 49.97 Hz	J1
	2π	
	$k = \frac{2\lambda}{\lambda}$	
	$k = \frac{2\pi}{\lambda}$ $0.42 = \frac{2\pi}{\lambda}$	
	$\lambda = 14.96 cm$	J1
	$v = f\lambda = 49.97(14.96 \times 10^{-2}) = 7.48 m s^{-1}$	JU1
	$\nu - j \lambda - 49.97 (14.90 \times 10^{-3}) = 7.48 \text{m/s}^{-3}$	301
	$(ii) v_{max} = A\omega$	
	$= 1200 \times 10^{-2}(314)$ = 3768 m s ⁻¹	JU1
(d)	$v = 550 \text{ m s}^{-1}, T = 800 \text{ N}, f = 440 \text{ Hz}$	

	$(i)v = \sqrt{\frac{T}{u}}$	
	$(i)v = \sqrt{\frac{T}{\mu}}$ $v^2 = \frac{T}{\mu}$	
	$v^{2} = \frac{\pi}{\mu}$ $\mu = \frac{T}{v^{2}} = \frac{800}{550^{2}} = 2.65 \times 10^{-3} \ kg \ m^{-1}$	JU1
	$(ii) f_n = \frac{n}{2L} \sqrt{\frac{T}{\mu}}$	
	$=\frac{nv}{2I}$	
	$= \frac{nv}{2L}$ $440 = \frac{1(550)}{2L}$	G1
	L = 0.625 m	JU1
	$(iii) f_3 = 3f_1 = 3(440) = 1320 Hz$	JU1
		D1
(e)	$f_a = \left(\frac{v}{v - v_S}\right) f_S$	
		G1
	$= \left(\frac{340}{340 - 25}\right) 1100$ $= 1187.3 \ Hz$	JU1
	TOTAL	23
7. (a)		23
7. (a)	$l = 75 \text{ cm}, d = 0.13 \text{ cm}, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} \text{m}^2,$	23
7. (a)	$l = 75 \text{ cm}, d = 0.13 \text{ cm}, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} \text{m}^2,$ $\Delta l = 0.035 \times 10^{-2} \text{ m}, F = 8 \times 9.81 = 78.48 \text{ N}$	23
7. (a)	$l = 75 \text{ cm}, d = 0.13 \text{ cm}, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} \text{ m}, F = 8 \times 9.81 = 78.48 \text{ N}$ $\Upsilon = \frac{F}{A} \times \frac{l_o}{\Delta l}$	
7. (a)	$l = 75 \text{ cm}, d = 0.13 \text{ cm}, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} \text{ m}, F = 8 \times 9.81 = 78.48 \text{ N}$ $\Upsilon = \frac{F}{A} \times \frac{l_o}{\Delta l}$	23
7. (a)	$l = 75 \text{ cm}, d = 0.13 \text{ cm}, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} \text{m}^2,$ $\Delta l = 0.035 \times 10^{-2} \text{ m}, F = 8 \times 9.81 = 78.48 \text{ N}$	
7. (a) (b)	$l = 75 cm, d = 0.13 cm, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} m, F = 8 \times 9.81 = 78.48 N$ $\Upsilon = \frac{F}{A} \times \frac{l_o}{\Delta l}$ $= \frac{78.48(75)}{1.33 \times 10^{-6}(0.035)}$	G1 JU1
	$l = 75 cm, d = 0.13 cm, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} m, F = 8 \times 9.81 = 78.48 N$ $\Upsilon = \frac{F}{A} \times \frac{l_o}{\Delta l}$ $= \frac{78.48(75)}{1.33 \times 10^{-6}(0.035)}$ $= 1.26 \times 10^{11} N m^{-2}$	G1
	$l = 75 cm, d = 0.13 cm, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} m, F = 8 \times 9.81 = 78.48 N$ $Y = \frac{F}{A} \times \frac{l_o}{\Delta l}$ $= \frac{78.48(75)}{1.33 \times 10^{-6}(0.035)}$ $= 1.26 \times 10^{11} N m^{-2}$ $(i) \left(\frac{Q}{t}\right)_B = \left(\frac{Q}{t}\right)_C$ $k_B A \left(\frac{dT}{x}\right) = k_C A \left(\frac{dT}{x}\right)$	G1 JU1
	$l = 75 cm, d = 0.13 cm, A = \frac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} m, F = 8 \times 9.81 = 78.48 N$ $Y = \frac{F}{A} \times \frac{l_o}{\Delta l}$ $= \frac{78.48(75)}{1.33 \times 10^{-6}(0.035)}$ $= 1.26 \times 10^{11} N m^{-2}$ $(i) \left(\frac{Q}{t}\right)_B = \left(\frac{Q}{t}\right)_C$	G1 JU1 K1

	$T = 32.5 ^{\circ}C$	JU1
	$(ii) \frac{Q}{t} = -kA\left(\frac{dT}{x}\right)$	
	$Q = -0.6(55) \left(\frac{32.5 - 40}{12 \times 10^{-2}} \right) (3600)$	G1
	$Q = -0.0(33) \left(\frac{12 \times 10^{-2}}{12 \times 10^{-2}} \right) (3000)$ $Q = 7.43 \times 10^{6} I$	JU1
9 (a)	TOTAL	8
8.(a)	$m = 3.346 \times 10^{-27} kg, T = 3.5 K$ $(i) v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3kT}{m}}$	
	$=\sqrt{\frac{3(1.38\times10^{-23})(3.5)}{3.346\times10^{-27}}}$	G1
	$= 208.1 m s^{-1}$	JU1
	$(ii)\rho = \frac{m}{V}$	G1
	$= \frac{3.346 \times 10^{-27}}{1 \times 10^{-6}}$ $= 3.346 \times 10^{-21} kg m^{-3}$	JU1
	(iii) $pV = nRT$ $p = \frac{nRT}{V}$ $p = \frac{1}{3}\rho(v_{rms})^{2}$	
	$p = \frac{1}{3}\rho(v_{rms})^2$ $= \frac{1}{3}(3.346 \times 10^{-21})(208.1)^{-2}$	G1
	$= 4.83 \times 10^{-17} N m^{-1}$	JU1
	$= 4.83 \times 10^{-17} N m^{-1}$ $(iv)K_{Trans} = \frac{3}{2}kT$	
	$=\frac{3}{2}(1.38\times10^{-23})(3.5)$	G1
	$= 7.25 \times 10^{-23} J$	JU1
(b)	$ \Delta U = Q - W \\ 0 = Q - W $	K1
	Q = W	
	$= 3p(3V - V) + nRT ln\left(\frac{V}{3V}\right) \qquad nRT = 3PV$	
	$= 3(2 \times 10^{5})[2(3 \times 10^{-2})] + 3(2 \times 10^{5})(3 \times 10^{-2})ln\frac{1}{3}$	G1
	$=1.62\times10^4J$	JU1
	TOTAL	11