SOLUTION SP015 PRE PSPM-SET 1
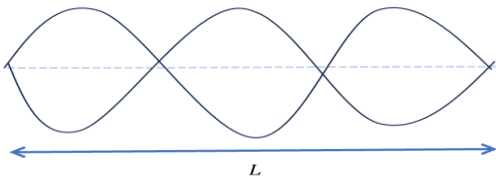
NO	ANSWER SCHEME	MARKS
1.	$$S = \sqrt{Sx^2 + Sy^2}$$ $$= \sqrt{(1.5)^2 + (1.4)^2}$$ $$= 2.05\ m$$ $$\tan\theta = \frac{Sy}{Sx}$$ $$\theta = 43.03°$$	JU1 JU1
	TOTAL	**2**
2.(a)	$(i)\ v^2 = u^2 + 2aS$ $260^2 = 345^2 + 2a(5.5 \times 10^{-2})$ $a = -4.67 \times 10^5\ m\ s^{-2}$	G1 JU1
	$(ii)\ v = u + at$ $260 = 345 + (-4.67 \times 10^5)t$ $t = 1.82 \times 10^{-4}\ s$	G1 JU1
2.(b)	$(i)\ S_y = u_y t - \dfrac{1}{2}gt^2$ $0 = u(8) - \dfrac{1}{2}(9.81)(8^2)$ $8u = 313.92$ $u = 39.24\ m\ s^{-1}$	G1 JU1
	$(ii)\ v_y = 0$ $v_y{}^2 = u_y{}^2 - 2gS$ $0 = 39.24^2 - 2(9.81)S$ $S = 78.48\ m$	G1 JU1
	$(iii)\ v = u - gt$ $v = (39.24) - (9.81)(8)$ $v_y = -39.24\ m\ s^{-1}$	G1 JU1
	TOTAL	**10**

NO	ANSWER SCHEME	MARKS
3.(a)	$(i)\ J = area\ under\ graph\ F - t$ $= \dfrac{1}{2}(1.5 \times 10^{-3})(18000)$ $= 13.5\ Ns$	G1 JU1
	$(ii)\ J = Ft$ $13.5 = F(1.5 \times 10^{-3})$ $F = 9000\ N$	G1 JU1
(b)	$\Sigma P_i = \Sigma P_f$ $m_p u_p + m_Q u_Q = m_p v_p + m_Q v_Q$ $(8)(4) + (6)(-5) = (8)(-1) + 6v_Q$ $v_Q = 1.67\ m\ s^{-1}$	G1 JU1
3. (c)	(i) 4 label correct − 2 marks 3 label correct − 1 marks	D2
	$(ii)\ \Sigma F_y = 0$ $N - F \sin 37 - mg \cos 37 = 0$ $N = F \sin 37 + mg \cos 37$ $\Sigma F_x = 0$ $\quad F \cos 37 - f - mg \sin 37 = 0$ $\quad 0.7986F - 0.15[0.6018F + 62.68] - 47.23 = 0$ $\quad 0.7986F - 0.09027F - 9.402 - 47.23 = 0$ $\qquad\qquad 0.70833F = 56.632$ $\qquad\qquad\qquad F = 79.95\ N$	K1 G1 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		
	$\Sigma F_y = 0$		
	$N - F \sin 37 - mg \cos 37 = 0$		
	$N = F \sin 37 + mg \cos 37$		
	$\Sigma F_x = 0$		
	$mg \sin 37 - F \cos 37 - f = 0$		
	$47.23 - 0.7986F - 0.15[0.6018F + 62.68] = 0$		
	$-0.7986F - 0.09027F + 47.23 - 9.402 = 0$		
	$0.8889F = 37.828$		
	$F = 42.5 \, N$		
	$\Sigma F_y = 0$		
	$N = F \sin 37 + mg \cos 37$		
	$N = 0.6018(42.5) + 62.68$		
	$N = 88.53 \, N$		
		TOTAL	**13**
4.(a)	$(i) \, W = F.s \cos\theta$		
	$= 10(1.5) \cos 30°$	G1	
	$= 12.99 \, J$	JU1	
	$(ii) \, W_g = mg.s \cos\theta$		
	$= 2(9.81)(1.5) \cos 90°$		
	$= 0 \, J$	JU1	
(b)	$(i) \, K = \frac{1}{2}mv^2$		
	$= \frac{1}{2}(8)(20)^2$	G1	
	$= 1600 \, J$	JU1	
	$(ii) \, U = mgh$		
	$= (8)(9.81)(10)$	G1	
	$= 784.8 \, J$	JU1	

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

	(iii) $y = A \sin \omega t$ $y = 0.06 \sin \pi t$ $where\ y\ in\ m\ and\ t\ in\ second$	J1 J1
(b)	$k = 35\ N\ m^{-1}, m = 50 \times 10^{-3}\ kg, A = 4.0\ cm$ (i) $E = \dfrac{1}{2} k A^2$ $\qquad = \dfrac{1}{2}(35)(4 \times 10^{-2})^2$ $\qquad = 0.028\ J$	G1 JU1
	(ii) $v = \omega \sqrt{A^2 - y^2}$ $\omega = \sqrt{\dfrac{k}{m}} = \sqrt{\dfrac{35}{50 \times 10^{-3}}} = 26.46\ rad\ s^{-1}$ $v = 26.46\sqrt{(4 \times 10^{-2})^2 - (1.6 \times 10^{-2})^2}$ $v = 0.97\ m\ s^{-1}$	J1 JU1
	(iii) $T_1 = 2\pi \sqrt{\dfrac{m}{k}}$ $\qquad = 2\pi \sqrt{\dfrac{50 \times 10^{-3}}{35}} = 0.24\ s$ $T_2 = 2\pi \sqrt{\dfrac{m_1 + m_2}{k}}$ $\qquad = 2\pi \sqrt{\dfrac{56 \times 10^{-3}}{35}} = 0.25\ s$ $\Delta T = T_2 - T_1 = 0.25 - 0.24 = 0.01\ s$	J1 J1 JU1
(c)	$y = A \sin(\omega t \pm kx)$ $y = 1200 \sin(314t - 0.42x)$ $direction\ to\ the\ right$ $$\omega = 2\pi f$$ $$314 = 2\pi f$$ $$f = 49.97\ Hz$$ $$k = \dfrac{2\pi}{\lambda}$$ $$0.42 = \dfrac{2\pi}{\lambda}$$ $$\lambda = 14.96\ cm$$ $$v = f\lambda = 49.97(14.96 \times 10^{-2}) = 7.48\ m\ s^{-1}$$	J1 J1 JU1
	(ii) $v_{max} = A\omega$ $\qquad = 1200 \times 10^{-2}(314)$ $\qquad = 3768\ m\ s^{-1}$	JU1
(d)	$v = 550\ m\ s^{-1}, T = 800\ N, f = 440\ Hz$	

	$(i) v = \sqrt{\dfrac{T}{\mu}}$ $v^2 = \dfrac{T}{\mu}$ $\mu = \dfrac{T}{v^2} = \dfrac{800}{550^2} = 2.65 \times 10^{-3} \ kg \ m^{-1}$		JU1
	$(ii) \ f_n = \dfrac{n}{2L}\sqrt{\dfrac{T}{\mu}}$ $= \dfrac{nv}{2L}$ $440 = \dfrac{1(550)}{2L}$ $L = 0.625 \ m$		G1 JU1
	$(iii) \ f_3 = 3f_1 = 3(440) = 1320 \ Hz$ L		JU1 D1
(e)	$f_a = \left(\dfrac{v}{v - v_s}\right) f_s$ $= \left(\dfrac{340}{340 - 25}\right) 1100$ $= 1187.3 \ Hz$		G1 JU1
		TOTAL	**23**
7. (a)	$l = 75 \ cm, d = 0.13 \ cm, A = \dfrac{\pi d^2}{4} = 1.33 \times 10^{-6} m^2,$ $\Delta l = 0.035 \times 10^{-2} \ m, F = 8 \times 9.81 = 78.48 \ N$ $Υ = \dfrac{F}{A} \times \dfrac{l_o}{\Delta l}$ $= \dfrac{78.48(75)}{1.33 \times 10^{-6}(0.035)}$ $= 1.26 \times 10^{11} \ N \ m^{-2}$		G1 JU1
(b)	$(i) \left(\dfrac{Q}{t}\right)_B = \left(\dfrac{Q}{t}\right)_C$ $k_B A\left(\dfrac{dT}{x}\right) = k_C A\left(\dfrac{dT}{x}\right)$ $0.6(55)\left(\dfrac{T - 40}{12}\right) = 0.8(55)\left(\dfrac{20 - T}{24}\right)$ $0.05(T - 40) = 0.03(20 - T)$ $0.08T = 2.6$		K1 G1 G1

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