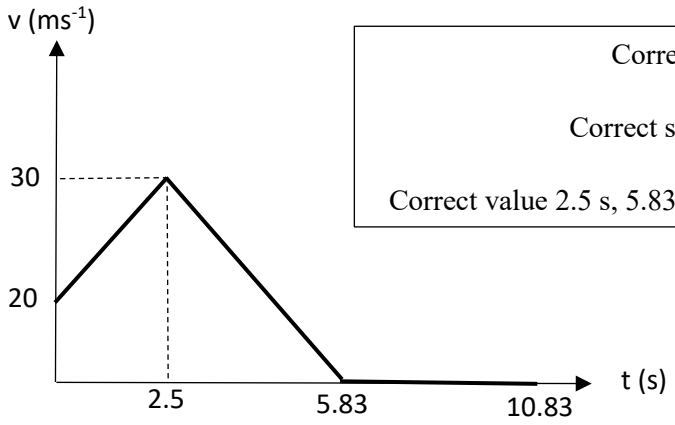
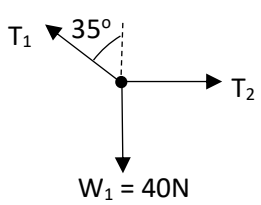
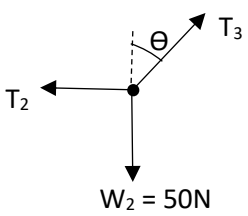
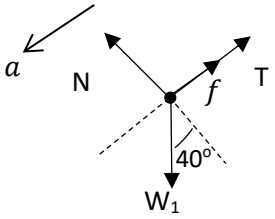
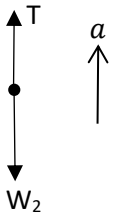
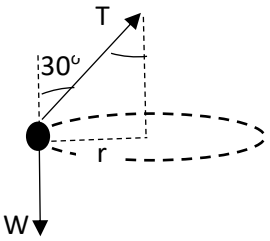
SUGGESTED ANSWER PRE-PSPM 2324

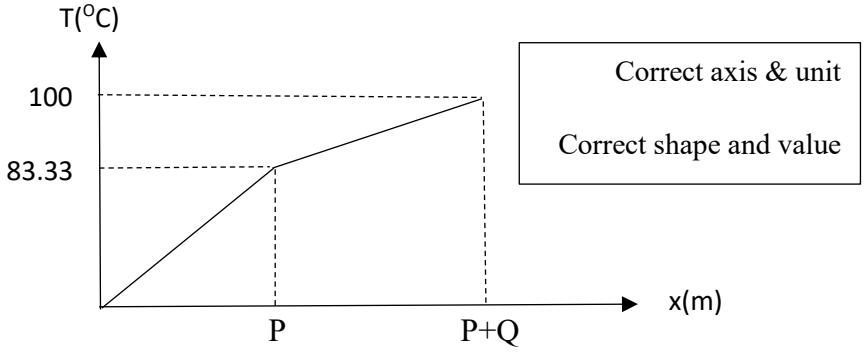
No.	Suggested Answer	Marks
1.	$[T] = T$ $\frac{[\,l\,]^{\frac{1}{2}}}{[\,g\,]^{\frac{1}{2}}} = \frac{[\,L]^{1/2}}{[\,LT^{-2}\,]^{1/2}}$ $= \frac{[\cancel{L^{\frac{1}{2}}}]}{\left[\cancel{L^{\frac{1}{2}}}\,T^{-1}\right]}$ $= T$ LHS = RHS ∴ equation is dimensionally correct	G1 G1
	TOTAL	2
2.(a)(i)	I : $v = u + at$ $30 = 20 + 4t$ $t = 2.5\ s$ II : $v^2 = u^2 + 2as$ $0 = 30^2 + 2a(50)$ $a = -9\ ms^{-2}$ $s = ut + \frac{1}{2}at^2$ $50 = 30t + \frac{1}{2}(-9)t^2$ $t = 3.33\ s$ $t_{II} = 2.5 + 3.33 = 5.83\ s$ III : $t_{III} = 5.83 + 5 = 10.83\ s$  Correct axis & unit Correct shape of graph Correct value 2.5 s, 5.83 s and 10.83 s	D1 D1 D1
2.(a)(ii)	Total distance $= \frac{1}{2} \times 2.5 \times (20 + 30) + \frac{1}{2} \times 30 \times (10.83 - 5.83)$ $= 112.45\ m$ @ Total distance $= \frac{1}{2} \times 2.5 \times (20 + 30) + 50$ $= 112.5\ m$	G1 JU1

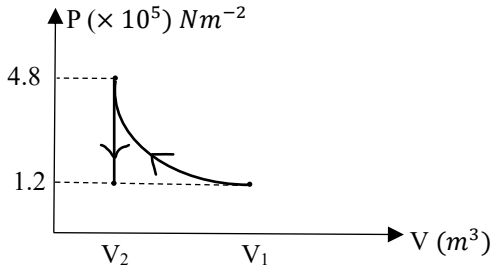
2.(b)(i)	$s_x = u_x t$ $5 = u_x(0.5)$ $u_x = 10\ ms^{-1}$ $s_y = u_y t - \frac{1}{2}gt^2$ $1.5 = u_y(0.5) - \frac{1}{2}(9.81)(0.5)^2$ $u_y = 5.45\ ms^{-1}$ $u = \sqrt{10^2 + 5.45^2} = 11.39\ ms^{-1}$	G1 G1 GJU1
2.(b)(ii)	$v_x = u_x = 10\ ms^{-1}$ $v_y = u_y - gt$ $v_y = 5.45 - 9.81(0.5)$ $v_y = 0.545\ ms^{-1}$ $v = \sqrt{10^2 + 0.545^2} = 10.01\ ms^{-1}$	G1 GJU1
	TOTAL	10
3.(a)	x-component : $m_A u_{Axi} + m_B u_{Bxi} = m_A v_{Axf} + m_B v_{Bxf}$ $25 = v_{Axf} + 10\cos 30$ $v_{Axf} = 16.34\ ms^{-1}$ y-component : $m_A u_{Ayi} + m_B u_{Byi} = m_A v_{Ayf} + m_B v_{Byf}$ $0 = v_{Ayf} + 10\sin 30$ $v_{Ayf} = -5\ ms^{-1}$ $v_A = \sqrt{16.34^2 + (-5)^2} = 17.09\ ms^{-1}$ $\theta = tan^{-1}\left\lvert\frac{-5}{16.34}\right\rvert = 17.01^o\ below\ positive\ x-axis$	KG1 KG1 GJU1
3.(b)	 $\Sigma F_x = 0$ $T_2 - T_1 \sin 35 = 0$ $T_2 = 48.83 \sin 35$ $T_2 = 28N$  $\Sigma F_x = 0$ $T_3 \sin\theta - T_2 = 0$ $T_3 \sin\ \theta = 28 - - - - - (1)$ $T_3 \sin\ 29.25 = 28$ $T_3 = 57.3N$	GJU1(T_2) GJU1(T_3)

	$\Sigma F_y = 0$ $T_1 \cos 35 - 40 = 0$ $T_1 = 48.83N$ (1) ÷ (2) $\frac{T_3 \sin\theta}{T_3 \cos\theta} = \frac{28}{50}$ $\tan\theta = 0.56$ $\theta = 29.25^o$ $\Sigma F_y = 0$ $T_3 \cos\theta - 50 = 0$ $T_3 \cos\theta = 50 - - - - - (2)$	GJU1(T_1) G1 JU1
3.(c)	  $\Sigma F_x = ma$ $T + \mu N - (6 \times 9.81)\sin 40 = -6a$ $T = -6a + 37.83 - (0.15)(45.09)$ $T = -6a + 31.07 \_\_(1)$ $\Sigma F_y = ma$ $T - (2 \times 9.81) = 2a$ $T = 19.62 + 2a \_\_(2)$ $\Sigma F_y = 0$ $N - (6 \times 9.81)\cos 40 = 0$ $N = 45.09N$ *(subst. into (1))* (1) = (2) $-6a + 31.07 = 19.62 + 2a$ $a = 1.43\ ms^{-2}$ *(subst. into (2))* $T = 19.62 + 2(1.43)$ $T = 22.48N$	G1(1) G1(2) G1 JU1 JU1
	TOTAL	13
4.(i)	$mgh = \frac{1}{2}kx^2$ $(5)(9.81)h = \frac{1}{2}(4000)(0.23)^2$ $h = 2.16\ m$	K1 G1 JU1
4.(ii)	$mgh = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$ $(5)(9.81)(2.16) = \frac{1}{2}(4000)(0.15)^2 + \frac{1}{2}(5)v^2$ $v = 7.81\ ms^{-1}$	K1 G1 JU1
4.(iii)	$P = \frac{\Delta E}{t} = \frac{\frac{1}{2}m(v^2 - u^2)}{t}$	

	$P = \dfrac{\frac{1}{2}(5)(7.81^2 - 0^2)}{50 \times 10^{-3}}$ $P = 3049.81\ W$	G1 JU1
	TOTAL	8
5.(i)	 $r = 0.5 \cos 30 = 0.43\ m$ $\Sigma F_x = ma_C$ $T sin\ 30 = 0.2\ a_C$_____(1) $2.27 \sin 30 = 0.2\ a_C$ $a_C = 5.68\ ms^{-2}$ $\Sigma F_y = 0$ $T cos\ 30 - W = 0$_____(2) $T = \frac{(0.2)(9.81)}{\cos 30}$ $T = 2.27N$ *(subst. into (1))*	G1(1) G1(2) JU1
5.(ii)	$a_C = r\omega^2$ $5.68 = 0.43\omega^2$ $\omega = 3.63\ rad\ s^{-1}$ $T = \dfrac{2\pi}{\omega}$ $T = \dfrac{2\pi}{3.63}$ $T = 1.73\ s$	GJ1 GJU1
	TOTAL	5
6.(a)(i)	$v = A\omega \cos \omega t$ $v = (0.05)(4\pi) \cos 4\pi t$ $v = 0.2\pi \cos 4\pi t$ where v in ms^{-1}, t in s.	JU1
6.(a)(ii)	$a = -A\omega^2 \sin \omega t$ $a = -(0.05)(4\pi)^2 \sin(4\pi(15))$ $a = 0\ ms^{-2}$	G1 JU1
6.(a)(iii)	$\dfrac{T_{new}}{T_{old}} = \dfrac{2\pi\sqrt{\frac{m}{k}}}{2\pi\sqrt{\frac{2m}{k}}}$ $T_{new} = \dfrac{1}{\sqrt{2}}\ T_{old}$	G1 JU1

6.(b)(i)	$v = f\lambda$ $5 = \left(\frac{1}{0.5}\right)\lambda$ $\lambda = 2.5\ m$ $Value\ S = 250\ cm$	G1 JU1
6.(b)(ii)	$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.5} = 4\pi$ $k = \frac{2\pi}{\lambda} = \frac{2\pi}{250} = 0.025\ cm^{-1}$ $y = Asin(\omega t \pm kx)$ $y = 6\sin(4\pi t - 0.025x)$ where y and x in cm, t in s.	 GJU1
6.(b)(iii)	$v = \pm\omega\sqrt{A^2 - y^2}$ $v = \pm 4\pi\sqrt{0.06^2 - 0.035^2}$ $v = \pm 0.612\ ms^{-1}$	G1 JU1
6.(c)(i)	$y = 8\cos(5\pi(1.2))$ $y = 8\ cm$	GJU1
6.(c)(ii)	$\omega = 2\pi f$ $\frac{\pi}{2} = 2\pi f$ $f = 0.25\ Hz$ $k = \frac{2\pi}{\lambda}$ $5\pi = \frac{2\pi}{\lambda}$ $\lambda = 0.4\ cm$ $v = f\lambda$ $v = (0.25)(0.4)$ $v = 0.1\ cm\ s^{-1}$	G1 G1 GJU1
6.(d)(i)	$1\frac{3}{4}\lambda = l$ $\frac{7}{4}\lambda = 0.3$ $\lambda = 0.17\ m$	K1 JU1
6.(d)(ii)	$f = \frac{nv}{4l}$ $2100 = \frac{n(343)}{4(0.3)}$ $n = 7$	 G1 JU1

6.(e)	$v_S = \dfrac{322 \times 10^3}{60 \times 60} = 89.44\ ms^{-1}$ $f_A = \left(\dfrac{v}{v + v_s}\right) f$ $f_A = \left(\dfrac{343}{343 + 89.44}\right) 750$ $f_A = 594.88\ Hz$ $f_B = \left(\dfrac{v}{v - v_s}\right) f$ $f_B = \left(\dfrac{343}{343 - 89.44}\right) 750$ $f_B = 1014.55\ Hz$ $\dfrac{f_B}{f_A} = 1.71$	K1 K1 G1 G1 J1
	TOTAL	23
7.(a)(i)	$\dfrac{U}{V} = \dfrac{1}{2}\sigma\varepsilon$ $\dfrac{U}{V} = \dfrac{1}{2}(4 \times 10^5)(0.2)$ $\dfrac{U}{V} = 4.0 \times 10^4\ J\ m^{-3}$	GJU1
7.(a)(ii)	Point C	J1
7.(b)(i)	$k_P = \dfrac{20}{100} k_Q = 0.2k_Q$ $\left(\dfrac{dQ}{dt}\right)_P = \left(\dfrac{dQ}{dt}\right)_Q$ $-k_P A_P \left(\dfrac{T_{PQ} - T_P}{x}\right) = -k_Q A_Q \left(\dfrac{T_Q - T_{PQ}}{x}\right)$ $(0.2\ k_Q)(T_{PQ} - 0) = k_Q(100 - T_{PQ})$ $T_{PQ} = 83.33\ ℃$	KG1 JU1
7.(b)(ii)		D1 D1

7.(c)	$\beta = 2\alpha = 2(9 \times 10^{-6}) = 1.8 \times 10^{-5}\ ^{\circ}C^{-1}$ $\Delta A = \beta A_i \Delta T$ $\Delta A = (1.8 \times 10^{-5})(9000)(36 - 0)$ $\Delta A = 5.832\ cm^2$	K1 GJU1
	TOTAL	8
8.(a)(i)	$v_{rms} = \sqrt{\frac{3RT}{M}}$ $v_{rms} = \sqrt{\frac{3(8.31)(550)}{(2.02 \times 10^{-3})}}$ $v_{rms} = 2.61 \times 10^3\ ms^{-1}$	G1 JU1
8.(a)(ii)	$P = \frac{1}{3}\rho {v_{rms}}^2$ $P = \frac{1}{3}(83.75 \times 10^{-3})(2.61 \times 10^3)^2$ $P = 1.90 \times 10^5\ Pa$	G1 JU1
8.(a)(iii)	$K_{tr} = \frac{3}{2}kT$ $K_{tr} = \frac{3}{2}(1.38 \times 10^{-23})(550)$ $K_{tr} = 1.14 \times 10^{-20}\ J$	GJU1
8.(b)(i)	$P_1V_1 = P_2V_2$ $(1.2 \times 10^5)\cancel{V_1} = P_2(0.25\cancel{V_1})$ $P_2 = 1.2 \times 10^5\ Pa$	GJU1
8.(b)(ii)	$W_{TOTAL} = W_{isothermal} + \cancel{W_{isochoric}}^{0}$ $W_{TOTAL} = nRT \ln \frac{V_2}{V_1}$ $W_{TOTAL} = (2)(8.31)(50 + 273.15) \ln \frac{0.25\cancel{V_1}}{\cancel{V_1}}$ $W_{TOTAL} = -7445.44\ J$	K1 GJU1
8.(b)(iii)	 Correct axis & unit Correct shape and value	D1 D2
	TOTAL	11