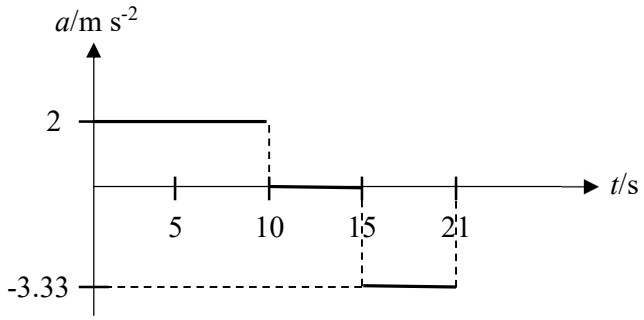
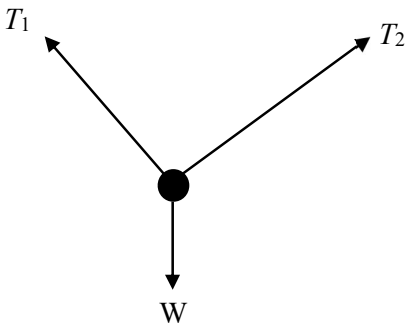
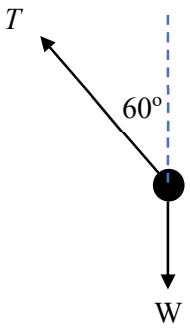
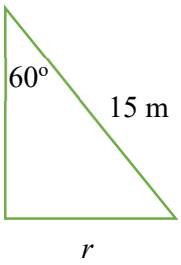
ANSWER SCHEME PRE-PSPM SP015 2023/2034

1)	$A = \pi r^2$ $[\text{length}][\text{width}] = [\text{radius}][\text{radius}]$ $L^2 = L^2$ $\text{LHS} = \text{RHS}$ This expression is homogeneous.	**G1** **J1**
	TOTAL	**2**

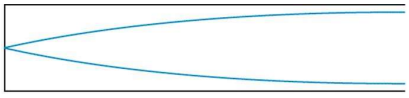
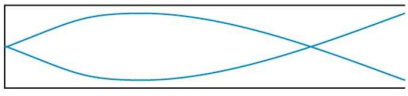
2) a) i.	$v = u + at$ $0 = 63 + a(2)$ $a = -31.5 \text{ m s}^{-2}$	**GJU1**
ii.	$v^2 = u^2 + 2as$ $0^2 = 63^2 + 2(-31.5)s$ $s = 63 \text{ m}$	**GJU1**
b) i.	Total distance travelled = area under the *v-t* graph $S = \frac{1}{2}(10)(20) + 5(20) + \frac{1}{2}(6)(20) = 260 \text{ m}$	**GJU1**
ii.	$v = u + at$ $20 = 0 + a(10)$ $a = 2 \text{ m s}^{-2}$ $v = u + at$ $0 = 20 + a(6)$ $a = -3.33 \text{ m s}^{-2}$ Label both axes correctly (symbol & unit) – **D1** Shape of the graph – **D1** Label all values on *x* and *y* axis – **D1** 	
c) i.	$u_x = 11\cos 20^o = 10.33 \text{ m s}^{-1}$ $u_y = 11\sin 20^o = 3.76 \text{ m s}^{-1}$ $S_y = u_y t - \frac{1}{2}gt^2$ $0 = 3.76(t) - 4.90t^2$ $t = 0.767 \text{ s}$ $S_x = u_x t = 10.33(0.767)$ $S_x = 7.92 \text{ m}$	**G1** **JU1**
ii.	${v_y}^2 = {u_y}^2 - 2gS_y$ $0^2 = 3.76^2 - 2(9.81)S_y$ $S_y = 0.72 \text{ m}$	**G1** **JU1**
	TOTAL	**10**

3) a) i.	$Fdt = m(v-u)$ $F(0.14) = 3.5\big(3.5-(-4.5)\big)$ $F = 200$ N	**K1** *for negative u* **G1** **JU1**
ii.	$\sum K_i = \frac{1}{2}mu^2 = \frac{1}{2}(3.5)(-4.5^2) = 35.4375$ J $\sum K_f = \frac{1}{2}mv^2 = \frac{1}{2}(3.5)(3.5^2) = 21.4375$ J Loss in kinetic energy = 35.4375 – 21.4375 = 14 J	**G1** **G1** **JU1**
b)	 $\sum \boldsymbol{F = 0}$ $\sum F_x = 0$ $T_1 \cos 50^o = T_2 \cos 40^o$ $T_1 = 1.19T_2$ $\sum F_y = 0$ $T_1 \sin 50^o + T_2 \sin 40^o = W$ $1.19T_2 \sin 50^o + T_2 \sin 40^o = 7.5$ $T_2 = 4.83$ N $T_1 = 5.75$ N	**D2** **K1** **G1** **G1** **JU1** **JU1**
	TOTAL	**13**

4) a)	$W_T = F_T \cdot s$ $W_T = (F\cos 25^o - f)s\ \cos 0^o$ $W_T = (20\cos 25^o - 2)3\ \cos 0^o$ $W_T = 48.39$ J	 **G1** **JU1**
b)	$\sum E_i = \sum E_f$ $U + K = U + K$ $mgh_i + \frac{1}{2}mu^2 = mgh_f + \frac{1}{2}mv^2$ $(9.81)(70) + \frac{1}{2}38^2 = (9.81)(35) + \frac{1}{2}mv^2$ $v = 46.16$ m s^{-1}	**K1** **R1** **G1** **JU1**
c)	$P = F \cdot v$ $P = mgv\cos 0^o$ $P = (1.1 \times 10^{-3})9.81(2.5 \times 10^{-2})$ $P = 2.7 \times 10^{-4}$ W	 **G1** **JU1**
	TOTAL	**8**

5) a)	 $\sum \boldsymbol{F_c} = \boldsymbol{ma_c}$ $\sum F_y = 0$ $T\cos 60^{\circ} = W$ $T\cos 60^{\circ} = 179(9.81)$ $T = 3511.98$ N	**G1** **JU1**
b)	 $r = 13$ m $\sum F_x = ma_c$ $T\sin 60^{\circ} = \frac{mv^2}{r}$ $3511.98\sin 60^{\circ} = \frac{179v^2}{13}$ $v = 14.86$ m s^{-1}	**G1** **G1** **JU1**
	TOTAL	**5**

6) a) i.	$k = m\omega^2$ $7 = 0.2\omega^2$ $\omega = \sqrt{35}$ rad s^{-1}	**G1**
	$v_{max} = A\omega$ $= 0.05\left(\sqrt{35}\right)$ $= 0.3$ m s^{-1}	**GJU1**
ii.	$v = \pm\omega\sqrt{A^2 - y^2}$ $= \pm\sqrt{35}\sqrt{0.05^2 - 0.03^2}$ $= \pm 0.237$ m s^{-1}	**G1** **JU1**
	$a = -\omega^2 y$ $= -\left(\sqrt{35}\right)^2 0.03$ $= -1.05$ m s^{-2}	**GJU1**
iii.	$K_{max} = \frac{1}{2}m{v_{max}}^2$ $= \frac{1}{2}(0.2)(0.3)^2$ $= 0.009$ J	**G1** **JU1**
b)	$\omega = 2\pi f$ $= 2\pi(500)$ $= 1000\pi$ rad s^{-1}	**G1**
	$v = f\lambda$ $300 = 500\,\lambda$ $\lambda = 0.6$ m	**G1**
	$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.6} = \frac{10\pi}{3}$ m^{-1}	**G1**
	$y = A\sin(\omega t \pm kx)$ $y = 0.5\sin\left(1000\pi t + \frac{10\pi}{3}x\right)$, where x, y in meters, t in seconds	**K1** **JU1**

c)	$f = \frac{nv}{2l}$ $440 = \frac{1(500)}{2l}$ $l = 0.57$ m	**GJU1**
	$v = \sqrt{\frac{T}{\mu}}$ $500 = \sqrt{\frac{850}{\mu}}$ $\mu = 3.4 \times 10^{-3}$ kg m^{-1}	**G1**
	$\mu = \frac{m}{l}$ $3.4 \times 10^{-3} = \frac{m}{0.57}$ $m = 1.938 \times 10^{-3}$ kg	**JU1**
d)	Fundamental mode: 	**D1**
	$f = \frac{nv}{4l}$	**K1**
	$= \frac{1(330)}{4(0.18)}$ $= 458.33$ Hz	**GJU1**
	First overtone: 	**D1**
	$f = \frac{nv}{4l}$ $= \frac{3(330)}{4(0.18)}$ $= 1375$ Hz	**GJU1**

e)	$f_o = \left(\frac{v + v_o}{v}\right) f_s$ $= \left(\frac{330 + 30}{330}\right) 5000$ $= 5454.55$ Hz	**K1** **G1** **JU1**
	TOTAL	**23**

7) a) i.	$\sigma = \frac{F}{A}$ $= \frac{50}{0.52 \times 10^{-6}}$ $= 96.2 \times 10^{6}\ \text{N m}^{-2}$	**GJU1**
ii.	$\varepsilon = \frac{\Delta L}{L_o}$ $= \frac{0.12 \times 10^{-2}}{0.6}$ $= 2 \times 10^{-3}$	**GJU1**
iii.	$Y = \frac{\sigma}{\varepsilon}$ $= \frac{96.2 \times 10^{6}}{2 \times 10^{-3}}$ $= 4.81 \times 10^{10}\ \text{Pa}$	**GJU1**
iv.	$U = \frac{1}{2} F \Delta L$ $= \frac{1}{2}(50)(0.12 \times 10^{-2})$ $= 0.03\ \text{J}$	**GJU1**
b)	$\frac{Q}{t} = -kA\left(\frac{\Delta T}{L}\right)$ $= -(3.78 \times 10^{-2})(2 \times 2)\left(\frac{28 - 87}{0.01}\right)$ $= 892.08\ \text{W}$	**G1** **JU1**
c)	$\Delta L = \alpha L_o \Delta T$ $0.8 \times 10^{-3} = (1.6 \times 10^{-5})(0.15)\Delta T$ $\Delta T = 333.33\ ^{o}\text{C}$ $\Delta T = T_f - T_i$ $333.33 = T_f - 33$ $T_f = 366.33\ ^{o}\text{C}$	**G1** **JU1**
	TOTAL	**8**

8) a)	$v_{rms} = \sqrt{\frac{3kT}{m}}$ $v_{rms1} = \sqrt{\frac{3k(86+273.15)}{m}} = \sqrt{\frac{3k(359.15)}{m}}$ ..... (1) $v_{rms2} = \sqrt{\frac{3k(25+273.15)}{m}} = \sqrt{\frac{3k(298.15)}{m}}$ ..... (2) $\frac{(1)}{(2)}$ $\frac{v_{rms1}}{v_{rms2}} = \frac{\sqrt{\frac{3k(359.15)}{m}}}{\sqrt{\frac{3k(298.15)}{m}}}$ $= 1.098$	**G1** **G1** **GJ1**
b) i.	$K_{tr} = \frac{3}{2}nRT$ $= \frac{3}{2}(1.3)(8.31)(3+273.15)$ $= 4474.87$ J	**GJU1**
ii.	$K_{ave} = \frac{3}{2}kT$ $= \frac{3}{2}(1.38\times10^{-23})(3+273.15)$ $= 5.71\times10^{-21}$ J	**GJU1**

c) i.	$W_T = W_{XY} + W_{YZ}$ $W_{YZ} = 0$ J $W_T = [1(1.013 \times 10^5)(1.5 \times 10^{-3} - 3.0 \times 10^{-3})] + 0$ $W_T = -151.95$ J	**K1** **G1** **JU1**
ii.	$T_x = T_z$ ····· Isothermal process $P_X V_X = P_Z V_Z$ $1(3) = P_Z(1.5)$ $P_Z = 2$ atm	**K1** **G1** **JU1**
	TOTAL	**11**