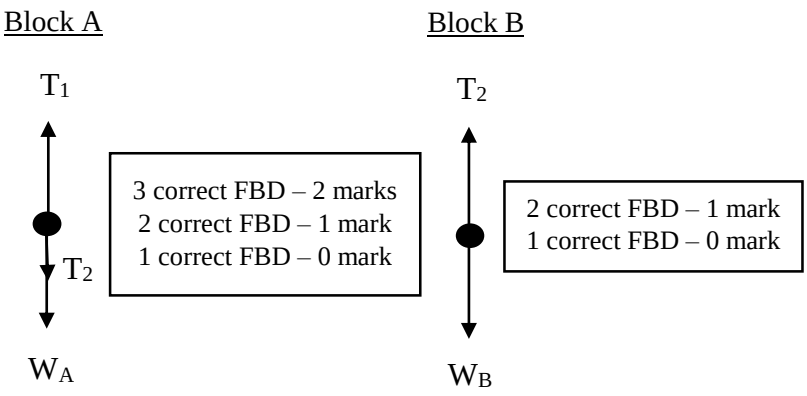
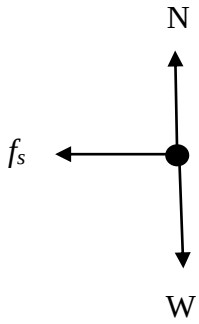
Mock PSPM SET 3 SP015 2022/2023 (Answer)

1		$z = xy$ $[x] = \frac{[z]}{[y]} = \frac{LM^{-1}}{LT^{-1}}$ $[x] = TM^{-1}$	 G1 J1
			TOTAL = 2 MARKS
2	a (i)	$average\ acceleration = \frac{\Delta v}{\Delta t}$ $a = \frac{8-(-8)}{15-5}$ $a = 1.6\ ms^{-2}$	 GJU1
	a (ii)	$displacement = area\ under\ the\ graph$ $= \frac{1}{2}(10-5)(-8) + \frac{1}{2}(15-10)(8)$ $= 0\ m$ $distance = area\ under\ the\ graph$ $= \frac{1}{2}(10-5)(8) + \frac{1}{2}(15-10)(8)$ $= 40\ m$	K1 GJU1 GJU1
	b (i)	$s_y = u_y t + \frac{1}{2}a_y t^2$ $8.6 = (25\ sin\ 35)\ t + \frac{1}{2}(-9.81)t^2$ $t = 2.08\ s$	 G1 JU1
	b (ii)	$s_x = u_x t + \frac{1}{2}a_x t^2$ $s_x = (25\ cos\ 35)\ (2.08)$ $s_x = 42.60\ m$	 GJU1
	b (iii)	$v_x = u_x = 25\ cos\ 35 = 20.48\ ms^{-1}$ $v_y = u_y + a_y t$ $v_y = -6.065\ ms^{-1}$	 K1

		$v = \sqrt{(v_x)^2 + (v_y)^2}$ $v = \sqrt{(20.48)^2 + (-6.065)^2}$ $v = 21.36\ ms^{-1}$	G1 JU1
			TOTAL = 10 MARKS
3	a	$F = \frac{m(v-u)}{t}$ $F = \frac{0.08(-22-32)}{0.15}$ $F = -28.8\ N$	G1 JU1
	b	*Consider y-componet of the collision* $\sum p_i = \sum p_f$ $m_1u_1 + m_2u_2 = (m_1 + m_{2)}v$ $0 + 3000u_2 = (2000 + 3000)(5.22\ sin40)$ $u_2 = 5.59\ ms^{-1}$	K1 G1 JU1
	c (i)		D3
	c (ii)	*Apply 2nd newton law to both object (y- comp)* $\sum F_B = m_B a$ $T_2 - W_B = m_B a$ $T_2 - 11(9.81) = 11(2)$	K1 G1

		$T_2 = 129.91\ N$ $\sum F_A = m_A a$ $T_1 - W_A - T_2 = m_A a$ $T_1 - 15(9.81) - T_2 = 15(2)$ $T_1 = 307.06\ N$	JU1 G1 JU1
			TOTAL = 13 MARKS
4	a (i)	$\Delta U = U_D - U_B$ $\Delta U = mgh_D - mgh_B$ $= 4(9.81)(7) - 4(9.81)(5)$ $= 78.48\ J$	 G1 JU1
	a (ii)	*Apply conservation of energy* $\sum E_A = \sum E_C$ $\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_C^2$ $\frac{1}{2}(4)(10)^2 + (4)(9.81)(5) = \frac{1}{2}(4)v_C^2$ $v_C = 14.07\ ms^{-1}$	K1 G1 JU1
	b	$P_{av} = \frac{\Delta W}{\Delta t} = \frac{\Delta K}{t}$ $= \frac{\frac{1}{2}mv^2 - \frac{1}{2}mu^2}{t}$ $= \frac{\frac{1}{2}(0.875)(0.62)^2 - \frac{1}{2}(0.875)(0)^2}{21 \times 10^{-3}}$ $= 8\ W$	K1 G1 JU1
			TOTAL = 8 MARKS

5	a	 3 correct FBD – 2 marks 2 correct FBD – 1 mark 1 correct FBD – 0 mark	D2
	b	$\sum F = ma_c$ $f_{s(max\ )} = mr\omega^2$ $0.72\ (9.81)m = m(0.35)\omega^2$ $\omega = 4.492\ rads^{-1}$ *convert to rpm* $\omega = 42.895\ rpm$ *max number of revolutions per minute = 42 revolutions.*	K1 G1 JU1
			TOTAL = 5 MARKS
6	a(i)	$v(t=5) = 0.1(4)\cos(4(5))$ $= 0.16\ m\ s^{-1}$	G1 J1
	a(ii)	$K_{max} = E = \frac{1}{2}m\omega^2A^2$ $= \frac{1}{2}(5\times10^{-3})(4)^2(0.1)^2$ $= 4\times10^{-4}\ J$	G1 JU1
	b	$mg = kx$ $k = \frac{10}{0.02} = 500\ \text{N m}^{-1}$ $m = \frac{W}{g} = \frac{10}{9.81} = 1.02\ \text{kg}$ $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1.02}{500}}$ $= 0.284\ \text{s}$	G1 G1 G1 JU1
	c	$f = \frac{\omega}{2\pi} = \frac{9\pi}{2\pi} = 4.5\ \text{Hz}$ $\lambda = \frac{2\pi}{k} = \frac{2\pi}{2\pi} = 1\ \text{m}$ $v = f\lambda = (4.5)(1) = 4.5\ \text{m s}^{-1}$ $v = \sqrt{\frac{T}{\mu}}$	G1 G1 G1

		$T = v^2\mu = (4.5)^2(0.15)$ $T = 3.04$ N	G1 JU1
	d(i)	1st overtone → $n = 3$ $f_3 = \frac{nv}{4l} = \frac{3(340)}{4(0.48)}$ $f_3 = 531.25$ Hz	K1 G1 JU1
	d(ii)	Fundamental → $n = 1$ $f_n = \frac{nv}{2L}$ $f_1 = \frac{1(340)}{2(0.48)}$ $f_1 = 354.17\ Hz$	 G1 JU1
	e(i)	*Approach* $f_{apparent} > f_{source}$	J1 K1
	e(ii)	$f_a = \left(\frac{v}{v - v_s}\right) f$ $1.1 \times 10^3 = \left(\frac{340}{340 - v_s}\right)(1 \times 10^3)$ $v_s = 30.9\ \text{m s}^{-1}$	K1 G1 JU1
			TOTAL = 23 MARKS
7	a	$Y = \frac{\sigma}{\varepsilon} = \frac{Fl_o}{A\Delta L} \rightarrow 2 \times 10^{11} = \frac{F(1.5)}{1 \times 10^{-6}(2 \times 10^{-3})}$ $F = 266.67$ N	G1 JU1
	b	*total area* $A = 2(2 \times 1) + 2(1.5 \times 1) + (2 \times 1.5) = 10\ m^2$ $\frac{Q}{t} = -kA\left(\frac{\Delta T}{L}\right)$ $Q = -(3.78\ \times\ 10^{-2})(10)\left(\frac{22 - 96}{0.015}\right)(3600)$ $Q = 6713.28\ kJ$	K1 G1 JU1
	c	$\Delta L_{steel} = (12 \times 10^{-6})L_o(100 - 25) = 0.0009L_o$ $\Delta L_{copper} = (16 \times 10^{-6})L_o(100 - 25) = 0.0012L_o$ $\Delta L_{copper} > \Delta L_{steel}$ *Longer = copper wire*	G1 K1 JU1
			TOTAL = 8 MARKS
8	a(i)	$v_{rms} = \sqrt{\frac{3RT}{M}}$	

		$v_{rms} = \sqrt{\frac{3(8.31)(283.45)}{0.04}}$ $v_{rms} = 420.08\, ms^{-1}$	G1 JU1
	a(ii)	*Monoatamic gas* → $f = 3$ $\Delta U = U_f - U_i$ $\Delta U = \frac{f}{2} nR\Delta T$ $\Delta U = \frac{3}{2}(125)(8.31)(323.15 - 283.45)$ $\Delta U = 61.86 \times 10^3\, J$	K1 K1 G1 JU1
	b(i)	$W = nRTln\left(\frac{V_f}{V_i}\right)$ $W = (1.2)(8.31)(303.15)ln\left(\frac{4}{1}\right)$ $W = 4190.78\, J$	G1 JU1
	b(ii)	$Q = \Delta U + W$ $Q = 0 + 4190.78$ $Q = 4190.78\, J -> ecf$	GJU1
	b(ii)	*Isochoric process, W = 0 J*	J1
	b(iv)	*Isobaric process*	J1
			TOTAL = 11 MARKS
			FULL MARKS = 80 MARKS