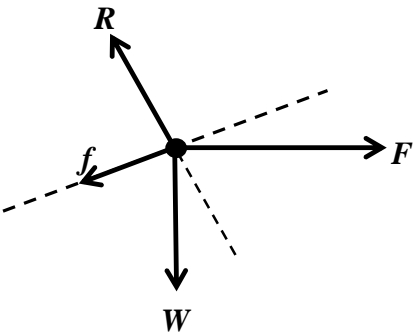| NO	ANSWER SCHEME	MARKS
1	$Y = \dfrac{\sigma}{\varepsilon}$ $[Y] = \dfrac{[\sigma]}{[\varepsilon]} = \dfrac{[F]}{[A]} \times \dfrac{[l]}{[\Delta l]}$	K1
	$= \dfrac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$	GJU1
		2

NO	ANSWER SCHEME	MARKS
2 (a)(i)	$v^2 = u^2 + 2as$ $12^2 = 16^2 + 2a(80)$ $a = -0.7 ms^{-2}$	G1 JU1
2 (a)(ii)	$v = u + at$ $12 = 16 + (-0.7)t$ $t = 5.7s$	GJU1
2 (b) (i)	$v_x = u_x = 3 m s^{-1}$ $v_y{}^2 = u_y{}^2 - 2gs$ $\qquad = -2(9.81)(-2)$ $v_y = 6.26 m s^{-1}$	G1
	$v = \sqrt{v_x{}^2 + v_y{}^2}$ $\quad = \sqrt{3^2 + 6.26^2}$ $\quad = 6.94 m s^{-1}$	K1 G1 JU1
2 (b)(ii)	$s_y = u_y t - \dfrac{1}{2} gt^2$ $-2 = -\dfrac{1}{2} 9.81 t^2$ $\quad = 0.639 s$	G1
	$s_x = u_x t$ $\quad = 3(0.639)$ $\quad = 1.92 m$	G1 JU1
		10

NO	ANSWER SCHEME	MARKS
3 (a)(i)	$$\sum P_{initial} = \sum P_{final}$$ $$(m_1 + m_2)u = m_1 v_1 + m_2 v_2$$ $$(65 + 450)\,(0) = (65)(1.5) + (450)v_2$$ $$v_2 = -0.217 \text{ m s}^{-1} \quad \text{(in the opposite direction)}$$	K1 G1 JU1
3 (a)(ii)	$$J = Ft = \Delta P$$ $$Ft = m(v - u)$$ $$F(10 \times 10^{-3}) = 65(-1.5 - 0)$$ $$F = -9750\ N$$ $$|F| = 9750\ N$$	K1 G1 JU1

3 (b)(i)	All 4 correct – D3 / Any 3 correct – D2 / Any 2 correct – D1 / Others – 0	D3
3 (b)(ii)	$$\sum F_y = 0$$ $$R - mg\cos\theta - F\sin\theta = 0$$ $$R = mg\cos\theta + F\sin\theta$$ $$R = (2)(9.81)\cos 30° + 50\sin 30° = 41.99\ N$$ $$\sum F_x = ma$$ $$F\cos\theta - mg\sin\theta - f = ma$$ $$F\cos\theta - mg\sin\theta - \mu R = ma$$ $$50\cos 30° - (2)(9.81)\sin 30° - (0.25)(41.99) = (2)a$$ $$\therefore a = 11.497\ \text{m s}^{-2}$$	K1 K1 G1 JU1
		13

NO	ANSWER SCHEME	MARKS
4 (a)	W = area under the graph	K1
	$$=\frac{1}{2}(6+4)(10) + \frac{1}{2}(3+4)(-5)$$	
	$$=32.5\,J$$	
	$$W = K_f - K_i$$	
	$$W = K_f - \frac{1}{2}mu^2$$	
	$$32.5 = K_f - \frac{1}{2}(2)(10^2)$$	G1
	$$K_f = 132.5\ J$$	JU1
4 (b) (i)	$$\sum E_i = \sum E_f$$	K1
	$$U = K$$	
	$$mgh = \frac{1}{2}mv^2$$	
	$$(2)(9.81)(0.3) = \frac{1}{2}(2)v^2$$	G1
	$$v = 2.43\,\mathrm{m\,s^{-1}}$$	JU1
4 (b)(ii)	$$\sum E_i = \sum E_f$$	
	$$K = U_s$$	
	$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$	
	$$\frac{1}{2}(2)(2.43)^2 = \frac{1}{2}(20)x^2$$	G1
	$$x = 0.768\,m$$	JU1
		8

NO.	ANSWER SCHEME	MARK(S)
5 (i)	$$\omega = \frac{v}{r}$$	
	$$\omega = \frac{10}{25}$$	G1
	$$\omega = 0.4\ rads^{-1}$$	JU1
5 (ii)	$$T = \frac{2\pi}{\omega}$$	

	$T = \dfrac{2\pi}{0.4}$	
	$T = 15.71\ s$	GJU1
5 (iii)	$F_{nett} = F_c = \dfrac{mv^2}{r}$	
	$F_c = \dfrac{(900)(10)^2}{25}$	G1
	$\therefore F_c = 3600\ N$	JU1
		5

NO	ANSWER SCHEME	MARKS
6 (a) (i)	$\omega = 2\pi f = 8\pi\ rads^{-1}$ $v = \pm\omega\sqrt{(A^2 - x^2)}$ $\quad = \pm 8\pi\sqrt{(2^2 - 1^2)}$ $\quad = \pm 43.53\ cm\,s^{-1}$	K1 G1 JU1
6(a)(ii)	$a = -\omega^2 x$ $\quad = -(8\pi)^2(1) = -631.65\ cm\,s^{-2}$	GJU1
6(b)(i)	$\omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{4} = 0.5\pi\ rads^{-1}$	G1 JU1
6(b)(ii)	$x = A\sin\omega t$ $\quad = 5\sin 0.5\pi t$ where x is in centimeter and t is in second	G1 JU1
6(b)(iii)	$E = \dfrac{1}{2}m\omega^2 A^2$ $\quad = \dfrac{1}{2}(0.025)(0.5\pi)^2(0.05)^2$ $\quad = 7.70\times 10^{-5}\ J$	G1 JU1
6(c)	(i) Right (ii)$k = \dfrac{2\pi}{\lambda}$ $\quad 2\pi = \dfrac{2\pi}{\lambda}$	J1

	$\lambda = 1m$	GJU1
	(iii)$\omega = 2\pi f$	
	$\quad 4\pi = 3\pi f$	
	$\quad f = 0.5m$	GJU1
	(iv)$v = f\lambda$	
	$\quad v = 0.5(1)$	
	$\quad = 0.5ms^{-1}$	GJU1
	(v)$v = A\omega \cos(\omega t - kx)$	
	$\quad v = (6)(4\pi)\cos(4\pi x 0.1 - 2\pi)$	G1
	$\quad v = 23.3 \ ms^{-1}$	JU1
(d)	(i) $y = 16 \cos 2x \sin 2\pi t$ where y and x in m and t in s.	J1
	(ii) $A = 16 \ m$	KGJU1
(e)	(i) n = 5 $\quad f = \dfrac{nv}{4l}$ $\quad = \dfrac{5(340)}{4(0.50)}$ $\quad = 850 Hz$ (ii) $l = 0.25$ m $n = 1$ $\quad f = \dfrac{nv}{4l}$ $\quad = \dfrac{1(340)}{4(0.25)}$ $\quad = 340 Hz$	KGJU1 KGJU1

(f)	$f_o = \left(\dfrac{v}{v - v_s}\right) f_s$	K1
	$= \left(\dfrac{340}{340 - 65}\right) 800$	G1
	$= 989\,Hz$	GJU1
		23

NO	ANSWER SCHEME	MARKS
7 (a)(i)	$A = \pi r^2 = 1.767 \times 10^{-6}\,m^2$	
	$Y = \dfrac{Fl_o}{Ae} = \dfrac{(mg)l_o}{A(l - l_o)}$	
	$7 \times 10^{10} = \dfrac{150(9.81)l_o}{1.767 \times 10^{-6}(5.5 - l_o)}$	G1
	$l_o = 5.435\,m$	JU1
7 (a)(ii)	$e = 5.5 - l_o$	
	$= 5.5 - 5.435$	
	$= 0.065\,m \qquad ecf$	JU1

(b)	$\left(\dfrac{dQ}{dt}\right)_1 = \left(\dfrac{dQ}{dt}\right)_2$	K1
	$-k_1 A \left(\dfrac{dt}{x}\right)_1 = -k_2 A \left(\dfrac{dt}{x}\right)_2$	
	$240\left(\dfrac{T_{int} - 80}{l}\right) = 110\left(\dfrac{5 - T_{int}}{l}\right)$	G1
	$T_i = 56.42°C$	JU1
7 (c)	$\gamma = 3\alpha$	K1
	$\Delta V = 3\alpha V_o \Delta T$	
	$= 3(1.4 \times 10^{-6})(0.12 \times 0.10 \times 0.08)(120 - 30)$	
	$= 3.63 \times 10^{-7}\,m^3$	GJU1
		8

NO	ANSWER SCHEME	MARKS
8 (a)	$n = \dfrac{pV}{RT}$ $= \dfrac{(1.3 \times 10^5)(1)}{(8.31)(350)}$ $= 45 \; moles$ $f = 3 \; for \; monatomic$ $\Delta U = \dfrac{f}{2} nR\Delta T$ $= \dfrac{3}{2}(45)(8.31)(370 - 350)$ $= 1.12 \times 10^4 \; J$	G1 J1 K1 GJU1
8 (b)	$v_{rmsH} = \sqrt{\dfrac{3RT}{M_H}} \qquad (1)$ $v_{rmsN} = \sqrt{\dfrac{3RT}{M_N}} \qquad (2)$ $2 \div 1, \quad v_{rmsN} = \sqrt{\dfrac{2}{28}} \times 1330$ $= 355 ms^{-1}$	G1 JU1

8 (c)(i)	$W_{AB} = p\Delta V$ $\quad = 3p_o(2V_o - V_o)$ $\quad = 3(1.0 \times 10^5)(0.02)$ $\quad = 6000 J$ $W_{BC} = 0 \rightarrow no \; change \; in \; volume$	G1 JU1 JU1
8 (c)(ii)	BC: $\quad Q = W + \Delta U$ $-4000 = 0 + \Delta U$ $\quad \Delta U = -4000 J$	G1 JU1
		11