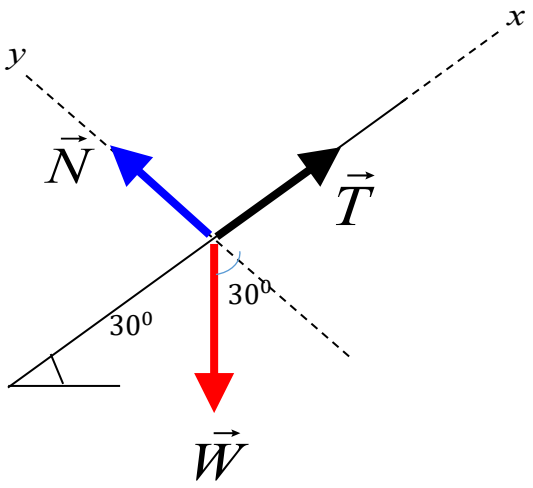
DAQ SET A ANSWER SCHEME (SP015, SESSION 2022/2023)

QUESTION	ANSWER	MARKS
1	5 sin 40° + (-10)= - 6.79 m Direction: downward.	JU1 J1
		2M
2 (a)	$v_{ave} = \frac{s_2 - s_1}{t_2 - t_1}$ $= \frac{8-0}{3-0}$ $= 2.67\ ms^{-1}$ Direction: Positive-*x* @ same as initial direction	R1 G1 JU1 J1
(b)	$v = u + at$ $15 = u + 6.7a$ $u + 6.7a$=15 a= $\frac{15-u}{6.7}$ .....(1) $s = ut + \frac{1}{2}at^2$ $90 = 6.7u + \frac{1}{2}a(6.7)^2$ $6.7u + 22.445a = 90$ .....(2) $u = 11.87\ ms^{-1}$ **OR** $s = \frac{1}{2}(u + v)t$ $90 = \frac{1}{2}(u + 15)(6.70)$ $u = 11.87\ m\ s^{-1}$	GJ1 GJ1 JU1
(c) (i)	$s_y = u_y t - \frac{1}{2}gt^2$ $-90 = (-u\ sin40°)(3.5) - \frac{1}{2}(9.81)(3.5^2)$ $u = 13.30\ m\ s^{-1}$	G1 JU1
(ii)	$s_x = u_x t$ $= (13.30 \cos 40°)(3.5)$ $= 35.66\ m$	GJU1
		10M

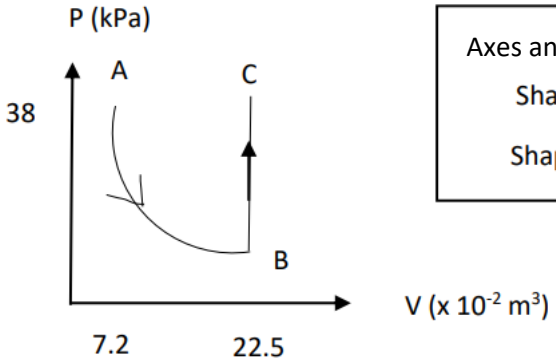
3 (a)	$F = \frac{J}{t}$ $J = \frac{mv - mu}{t}$ $J = \frac{0.015\ (0 - 250)}{10}$ $F = \frac{(-3.75)}{10}$ $F = -0.375$ N The force experienced by the bullet F= 0.375 N to the left	G1 JU1 J1
3 (b)	Impluse = Area under the graph $= \frac{1}{2}(10)(3x10^3)$ = 15000 N s	K1 G1 JU1
3(c) (i)		D3 (1 mark for each force)
3(b) (ii)	**For m_1 :** $\Sigma F_x = ma$ $T - mg\sin 30^0 = m_1 a$ $T - (12)(9.81)\sin 30^0 = 12a$ $-12a + T = (12)(9.81)\sin 30^0$ ....(1) **For m_2 :**	K1 G1

	$\Sigma F_y = ma$ $m_2 g - T = m_2 a$ $(7)(9.81) - T = 7a$ $7a + T = (7)(9.81)$ ..... (2) a = 0.52 ms^{-2} T= 65.06 N $\therefore$ a = 0.52 ms^{-2}	G1 JU1
		13M
4(a)(i)	$W = F.s = area\ under\ graph$ $W = \frac{1}{2}(3+5)\ 15$ $= 60\ J$	K1 G1 JU1
4(a)(ii)	$W = \Delta K$ $= \frac{1}{2}m(v^2 - u^2) = \frac{1}{2}8(v^2 - 6^2)$ $v = 7.14\ ms^{-1}$	G1 JU1
4(b)	Using conservation of energy $U = K$ $mgh = \frac{1}{2}mv^2$ $K = (0.5)\ (9,81)\ (6)$ $= 29.43J$	 K1 G1 JU1
		8M
5 (a)	$v = \frac{200.0}{25.0}$ $= 8\,\text{ms}^{-1}$	G1 JU1
5 (b)	$r = \frac{200.0}{2\pi} = 31.83\,\text{m}$ $F_c = \frac{mv^2}{r}$ $= \frac{1.5(8)^2}{31.83}$ $= 3.02\,\text{N}$	K1 G1 JU1
		5M
6 (a) (i)	$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.2}$ $\omega = 10\pi\ rad\ s^{-1}$	G1 JUI

(ii)	$A = \frac{v_{max}}{\omega} = \frac{3\pi}{10\pi}$ $A = 0.3\ m$	G1 JU1
(iii)	$m = \frac{k}{\omega^2} = \frac{250}{(10\pi)^2}$ $m = 0.253\ kg$	G1 JUI
(iv)	$K_{max} = \frac{1}{2}mv_{max}{}^2 = \frac{1}{2}(0.253)(3\pi)^2$ $= 11.24\ J$	G1 JU1
(b) (i)	$l = 6 \times 0.02 = 0.12\,m$ $\mu = \frac{m}{l} = \frac{0.035}{0.12} = 0.29\,kg\,m^{-1}$ $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{50}{0.29}} = 13.13\,m\,s^{-1}$	K1 G1 GJU1
(ii)	wavelength: $\lambda = 2 \times 4$ $= 8\,cm$ or $0.08\,m$ frequency: method 1 or method 2 $f = \frac{v}{\lambda} = \frac{13.13}{0.08}$ $f_3 = \frac{nv}{2l} = \frac{(3)(13.13)}{2(0.12)}$ $= 164.13\,Hz$ $= 164.13\,Hz$	K1 JU1 G1 JU1
(c) (i)	$f_n = \frac{nv}{2l}$ fundamental frequency, $f_1 = \frac{(1)(343)}{2(0.85)}$ $= 201.76\,Hz$	G1 JU1
(ii)	second harmonic, $n = 2$ $f_n = nf_1 = 2(201.76) = 403.52\,Hz$	GJU1
(iii)	third overtone, $n = 4$ $f_n = nf_1 = 4(201.76) = 807.04\,Hz$	GJU1
(d) (i)	$f_1 = \left(\frac{v + v_o}{v}\right) f_s = \left(\frac{340 + 30}{340}\right)(400)$ $= 435.29\,Hz$	G1 JU1
(ii)	$f_1 = \left(\frac{v + v_o}{v}\right) f_s = \left(\frac{340 - 30}{340}\right)(400)$ $= 364.71\,Hz$	G1 JU1
		23M

7.(a)(i)	$Y = \frac{stress}{strain} = \frac{\sigma}{\varepsilon}$ $1.3\times10^{11} = \frac{\sigma}{0.015}$ $\sigma = 1.95\times10^{9}\ \text{N m}^{-2}$ $\sigma = \frac{F}{A}$ $F = \sigma A = (1.95\times10^{9})(3.75\times10^{-7})$ $F = 731.25\text{N}$ OR $stress \quad \sigma = \frac{F}{A}$ $Y = \frac{stress}{strain} = \frac{\sigma}{\varepsilon} = \frac{\left(\frac{F}{A}\right)}{\varepsilon}$ $Y = \frac{F}{A\varepsilon}$ $1.3\times10^{11} = \frac{F}{(3.75\times10^{-7})(0.015)}$ $F = 731.25\text{N}$	G1 G1 JU1
7.(a)(ii)	$\text{Strain energy} = \frac{1}{2}F\Delta l$ $= \frac{1}{2}(731.25)(L_o \times \varepsilon)$ $= \frac{1}{2}(731.25)(0.755)(0.015)$ $= 4.14\text{J}$ $\text{Strain}, \varepsilon = \left(\frac{\Delta l}{L_o}\right)$	G1 JU1

7.(b)	The rate of heat flow in rod in P, $\left(\frac{Q}{t}\right)_P = -k_P A\left(\frac{\Delta T}{L}\right)_P$ The rate of heat flow in rod in Q, $\left(\frac{Q}{t}\right)_Q = -k_P A\left(\frac{\Delta T}{L}\right)_Q$ At steady state $\left(\frac{Q}{t}\right)_P = \left(\frac{Q}{t}\right)_Q$	K1
	$-k_P A\left(\frac{\Delta T}{L}\right)_P = -k_Q A\left(\frac{\Delta T}{L}\right)_Q$ $\frac{k_P}{k_Q} = \frac{\left(\frac{\Delta T}{L}\right)_Q}{\left(\frac{\Delta T}{L}\right)_P}$ $\frac{k_P}{k_Q} = \frac{\left(\frac{0-25}{40\times10^{-2}}\right)_Q}{\left(\frac{25-100}{80\times10^{-2}}\right)_P}$ $\frac{k_P}{k_Q} = \frac{62.5}{93.75}$ $= 0.67$	G1 JU1
		8M
8. (a)(i)	$<K> = \frac{3}{2}kT$ $<K> = \frac{3}{2}(1.38\times10^{-23})(273.15+25)$ $<K> = 6.17\times10^{21}$ J	G1 JU1
(ii)	$U = \frac{1}{2}fNkT$ $U = \frac{1}{2}fnN_Akt$ $U = \frac{1}{2}(3)(1.5)(6.02\times10^{23})(1.38\times10^{-23})(273.15+25)$ $U = 5.57\times10^{3}$J	G1 JU1

(b)	$v_{rms}=\sqrt{\frac{3RT}{M}}=\sqrt{\frac{(3)(8.31)(263.15)}{0.046}}$ $v_{rms}=377.65\ m\ s^{-1}$	G1 JU1
(c) (i)	 Axes and Label – 1M Shape AB- 1M Shape BC – 1M	D3
(ii)	$W_{AB}=nRT\ \ln\left[\frac{v_f}{v_i}\right]$ $W_{AB}=PV\ \ln\left[\frac{v_f}{v_i}\right]$ $W_{AB}=(38\times10^3)(7.2\times10^{-2})\ \ln\left[\frac{22.5\times10^{-2}}{7.2\times10^{-2}}\right]$ $W_{AB}=3117.49\ J$	G1 JU1
		11M
	TOTAL	**80 Marks**