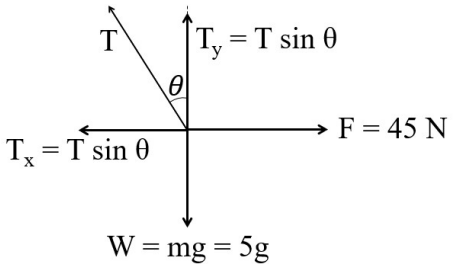
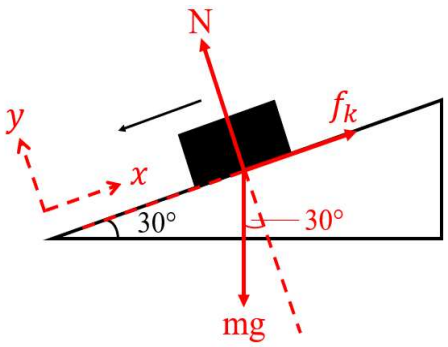
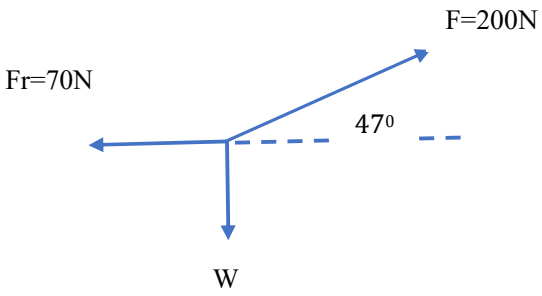
ANSWER SCHEME

QUESTION	SOLUTION	MARKS
1 (a)	$[Ft] = [mv - mu]$ $MLT^{-1} = MLT^{-1}$ Therefore, the formulae are dimensionally homogeneous $kgms^{-1}$	J1 K1 J1
(b)	$F_x = 10\cos 40 = 7.66\ N$ $F_y = 10\sin 40 - 8 = -1.57\ N$	JU1 JU1
		TOTAL: 5
2(a) (i) (ii) (iii) (iv)	$s_{AB} = 8 \times 2 = 16$ m $s_{BC} = 5 \times 4 = 20$ m $s_{CD} = 9 \times 3 = 27$ m $s_{AD} = \sqrt{(20)^2 + (11)^2} = 22.83\ m$ Average speed $= \frac{16+20+27}{2+4+3} = 7\ ms^{-1}$ Average velocity $= \frac{22.83}{9} = 2.54\ ms^{-1}$	J1 (If all three correct) K1 JU1 GJU1 GJU1
2(b) (i)	$s_x = u_x t$ $-25 = u_x(1.5)$ $u_x = -16.67\ ms^{-1}$ $u_x = u\cos 60^0$ $16.67 = u\ \cos 60^0$ $u = 33.34\ ms^{-1}$ $s_y = u_y t - \frac{1}{2}gt^2$ $s_y = (u\sin 60^0)(1.5) - \frac{1}{2}(9.81)(1.5^2)$ $s_y = 32.27\ m$	 J1 GJU1 GJU1
2(b) (ii)	$v_x = -16.67\ ms^{-1}$ $v_y^2 = u_y^2 - 2gs_y$ $v_y^2 = (33.34\sin 60)^2 - 2(9.81)(32.27)$ $v_y = -14.16\ ms^{-1}$ $v = \sqrt{v_x^2 + v_y^2}$ $v = \sqrt{(-16.67)^2 + (-14.15)^2}$ $v = 21.86\ ms^{-1}$ $\theta = tan^{-1}\left\lvert\frac{-14.16}{-16.67}\right\rvert$ $\theta = 40^0$	 G1 JU1 J1

		TOTAL :11
3(a) (i)	$\Delta p = m(v-u)$ $\Delta p = (0.080)(-22-32)$ $\Delta p = -4.32\ kg\ m\ s^{-1}\ (to\ the\ left)$ @ $\Delta p = 4.32\ kg\ m\ s^{-1}\ (to\ the\ right)$	G1 JU1
3(a) (ii)	$F\Delta t = \Delta p$ $F = \frac{\Delta p}{\Delta t}$ $F = -\frac{4.32}{0.15} = -28.8\ N$ $F = -28.8\ N$ @ $F = 28.8\ N$	 GJU1
3(b)(i)	 $\sum F_x = 0$ $T \sin\theta = F$ $T \sin\theta = 45 \rightarrow (1)$ $\sum F_y = 0$ $T \cos\theta = W$ $T \cos\theta = 5\ g \rightarrow (2)$ $(1) \div (2)$ $\tan\theta = \frac{45}{5(9.81)}$ $\theta = 42.5°$	 G1 G1 GJU1

3(b)(ii)	FBD 3 correct – 1 mark < 3 correct – 0 mark  $\sum F_y = 0$ $N = mg\cos 30°$ $N = 2(9.81)\cos 30°$ $N = 16.99\ N$ $\sum F_x = ma$ $mg\sin 30° - f_k = ma$ $mg\sin 30° - \mu_k N = ma$ $2(9.81)\sin 30° - \mu_k(16.99) = 2(4.0)$ $\mu_k = 0.107$	D1 G1 G1 JU1
		TOTAL: 10

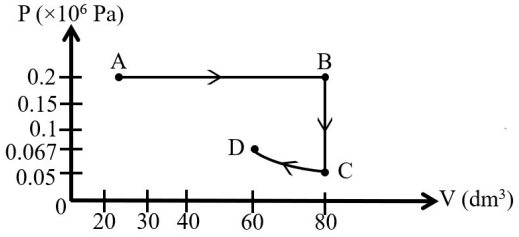
4(a)	 Work Done by Force F $Wforce = Fscos\theta$ $W = (200)(50)\cos(47)$ $W = 6819.98\,J$ Work Done by Friction $Wfriction = Frscos\theta$ $W = (70)(50)\cos(180)$ $W = -3500\,J$ Net Work Done $Wnet = Wforce - Wfriction$ $Wnet = 6819.98 - 3500$ $Wnet = 3319.98\,J$	G1 JU1 GJU1 K1 JU1
4(b)	(i) Potential Energy at Point A $U_A = mgh$ $U_A = (4)(9.81)(40)$ $U_A = 1569.6\,J$ (ii) Speed of sphere at point B $K_B = U_A - U_B$ $\frac{1}{2}mv^2 = mgh_A - mgh_B$	G1 JU1 K1

	$\frac{1}{2}(4)v^2 = (4)(9.81)(40) \quad -(4)(9.81)(20)$ $\frac{1}{2}(4)v^2 = (4)(9.81)(20)$ $v^2 = 392.4$ $v \quad = 19.81\ ms^{-1}$	G1 JU1
		TOTAL: 10
5	$T = F_c$ $T = \frac{mv^2}{r}$ $50 = \frac{(0.2)v^2}{1.5}$ $v^2 = 375$ $v = 19.37ms^{-1}$	K1 (Hidden if start with formula) G1 JU1
		TOTAL: 3
6(a)	(i) $\lambda_A = 2\ m$ $\lambda_B = 4\ m$ (ii) $v = f_A\lambda_A$ $12 = f_A(2)$ $f_A = 6\ Hz$ $v = f_B\lambda_B$ $12 = f_B(4)$ $f_B = 3\ Hz$ (iii) $A_A = 0.5\ m$ $A_B = 0.25\ m$	 JU1 JU1 G1 JU1 G1 JU1 K1 K1

	$\omega_A = 2\pi f_A$ $= 2\pi(6)$ $= 12\pi \ rad \ s^{-1}$	G1
	$\omega_B = 2\pi f_B$ $= 2\pi(3)$ $= 6\pi \ rad \ s^{-1}$	G1
	$v_{\max A} = A\omega_A$ $= 0.5(12\pi)$ $= 6\pi$ $= 18.85 \ m \ s^{-1}$	JU1
	$v_{\max B} = A\omega_B$ $= 0.25(6\pi)$ $= 1.5\pi$ $= 4.71 \ m \ s^{-1}$	JU1
6(b)	$\mu = 0.1 \ g \ cm^{-1}$ $= 0.01 \ kg \ m^{-1}$	
	$v = \sqrt{\frac{T}{\mu}}$ $= \sqrt{\frac{50}{0.01}}$ $= 70.71 \ m \ s^{-1}$	G1
	$f_n \le 20000$ $\frac{nv}{2l} \le 20000$ $\frac{n(70.71)}{2(0.6)} \le 20000$ $n \le 339.41$ $n = 339$	K1 J1

	$f_n = \frac{nv}{2l}$ $f_{339} = \frac{339(70.71)}{2(0.6)}$ $= 19975.58\ Hz$	G1 JU1
6(c)	(i) Open pipe $f_n = \frac{nv}{2l}$ $f_{1(A)} = \frac{1(343)}{2l_A} = 256$ $l_A = 0.67\ m$ $f_{1(B)} = \frac{1(343)}{2l_B} = 440$ $l_A = 0.39\ m$ $l_T = l_A + l_B$ $= 0.67 + 0.39$ $= 1.06\ m$ (ii) $f_n = \frac{nv}{2l}$ $f_{1(T)} = \frac{1(343)}{2(1.06)}$ $= 161.79\ Hz$	 G1 G1 G1 JU1 G1 JU1
		TOTAL: 23
7(a)	l = 75 cm = 0.75 m ; d = 0.55 mm = 0.55 x 10^{-3} m ; r = 0.275 mm = 0.275 x 10^{-3} m ; m = 25 kg ; Δl = 1.10 mm = 1.10 x 10^{-3} m $6 = \frac{F}{A} = 4\frac{mg}{\pi r^2}$ $= 4\frac{(25)(9.81)}{\pi[0.275 \times 10^{-3}]^2}$	 K1 G1

	$\therefore 6 \quad = \quad 1.032 \times 10^9$ N.m^{-2}	JU1
7(b)	$\Delta T = -30\ ^oC, x = 0.02$ m The rate of heat flow, $\frac{Q}{t} = -\frac{kA\Delta T}{x}$ $= -\frac{(0.01)(0.8)(-3\ )}{(0.02)}$ $= 12.0\ W$ Therefore, $Q \quad = 12 \div 60$ $= 0.2\ J$	K1 G1 J1 K1 GJU1
		TOTAL: 8
8(a)	(i) $PV = nRT$ $(1 \times 10^5)(0.04) = n(8.31)(273)$ $n = 1.76\ moles$ (ii) $U = \frac{f}{2}nRT, \qquad f = 3$ $U = \frac{3}{2}(1.76)(8.31)(273)$ $U = 5989\ J$	K1 GJU1 K1 GJU1
(b)	(i) Using Charles's Law $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{30 \times 10^{-3}}{300.15} = \frac{80 \times 10^{-3}}{T_2} \rightarrow T_2 = 800.4\ K$ (ii) Using Pressure's Law $\frac{P_2}{T_2} = \frac{P_3}{T_3}$ $\frac{0.2 \times 10^6}{800.4} = \frac{P_3}{200.15} \rightarrow P_3 = 5 \times 10^4\ Pa$ For process CD, use Boyle's Law $P_3V_3 = P_4V_4$	GJU1 GJU1

	$(5 \times 10^4)(80) = P_4(60) \rightarrow P_4 = 6.67 \times 10^4\ Pa$ (iii) $W = nRT \ln\left(\frac{V_4}{V_3}\right)$ $W = P_3V_3 \ln\left(\frac{V_4}{V_3}\right)$ $W = PV \ln\left(\frac{V_4}{V_3}\right)$ $W = (5 \times 10^4)(80 \times 10^{-3}) \ln\left(\frac{60}{80}\right) = -1150.7\ J$ (iv) 3 shapes correct – 1 mark Label axes and values correctly – 1 mark  	GJU1 GJU1 D2
		TOTAL: 10