Pra-PSPM SP015 Set 1

NO.	ANSWER SCHEME	MARK
1.	$v^2 = u + 2as$ $[\ v^2\ ] = (\ L\ T^{-1}\ )^2 = L^2\ T^{-2}$ $[\ u\ ] = L\ T^{-1}$ $[\ 2as\ ] = 1\ (\ L\ T^{-2}\ )(\ L\ ) = L^2\ T^{-2}$ Since $[\ v^2\ ] = [\ 2as\ ] \neq [\ u\ ]$ $\Rightarrow$ This equation is **not** homogenous.	 J1 J1
	TOTAL	**2**
2. (a)(i)	Given $u = 345$ m s^{-1}, $v = 260$ m s^{-1}, $s = 5.5$ cm $v^2 = u^2 + 2as$ $260^2 = 345^2 + 2a\,(5.5\times10^{-2})$ $a = -4.68\times10^5\ \text{m s}^{-2}$ Deceleration through the box is 4.68×10^5 m s^{-2}.	 G1 JU1
2. (a)(ii)	Using equation: $v = u + at$ Time taken to get through the box, $t = \dfrac{v-u}{a}$ $t = \dfrac{260-345}{-4.68\times10^5}$ $t = 1.82\times10^{-4}$ s	 G1 JU1
2. (b)(i)	Projectile Motion ${v_y}^2 = {u_y}^2 - 2gs_y$ $0^2 = (25\ \sin\ 53°)^2 + 2\,(9.81)\,H$ $H = 20.32$ m So, the maximum height from the ground = 20.32 + 60 = 80.32 m	 G1 JU1

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2. (b) (ii)	Horizontal velocity, $v_x = u_x$ $v_x = 25 \cos 53°$ $v_x = 15.05 \text{ m s}^{-1}$ Vertical velocity, $v_y = u_y - gt$ $v_y = 25\sin 53° - 9.81(6.08)$ $v_y = -39.7 \text{ m s}^{-1}$ Or use $v_y^{\,2} = u_y^{\,2} - 2gs_y$ where $s_y = -60$ m Speed, $v = \sqrt{v_x^{\,2} + v_y^{\,2}}$ $v = \sqrt{15.05^2 + 39.7^2}$ $v = 42.46 \text{ m s}^{-1}$	 G1 G1 G1 JU1
	TOTAL	**10**
3. (a)	Impulse, $J = mv - mu = F\Delta t$ Average force, $F = \dfrac{mv - mu}{\Delta t}$ $F = \dfrac{50\times10^{-3}(50-0)}{0.7\times10^{-3}}$ $F = 3.57\times10^{3}$ N	 G1 JU1
3. (b)(i)	Time duration, $t = 40 - 30$ $t = 10$ ms at maximum force 6 N	JU1
3. (b)(ii)	Impulse, J = area under $F - t$ graph $J = 4(5\times10^{-3}) + \frac{1}{2}(4+6)(10\times10^{-3}) + 6(10\times10^{-3})$ $J = 0.13 \text{ kg m s}^{-1}$	K1 G1 JU1

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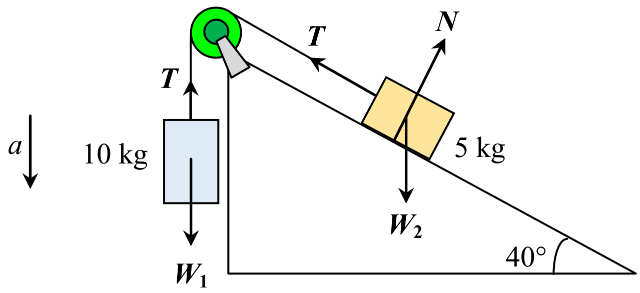
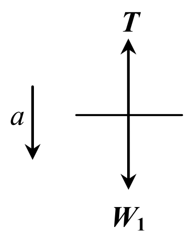
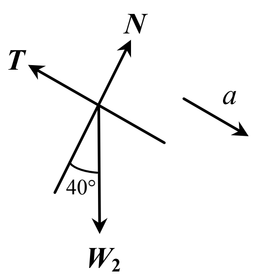
3. (c)(i)	Given $m_1 = 10$ kg, $m_2 = 5$ kg **Identify the forces:**  Free body diagram **10 kg**  *1 mark for each correct force and direction.*	D2
	5 kg  *3 correct forces and directions, 2 marks.* *1 mistake, deduct 1 mark.*	D2

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3. (c)(ii)	Apply Newton's second law, $\Sigma\vec{F}_y = \vec{F}_{\text{net}}$ $m_1 g - T = m_1 a$ $10g - T = 10a$ $T = 10g - 10a \quad ..... \ (1)$ $\Sigma\vec{F}_x = \vec{F}_{\text{net}}$ $T - m_2 g \sin 40° = m_2 a$ $T - 5g \sin 40° = 5a$ $T = 5g \sin 40° + 5a \quad .....(2)$ Acceleration of the crates, a = 4.44 m s^{-2}.	K1 K1 JU1
	TOTAL	13
4. (a)	$\Sigma E_{\text{i}} = \Sigma E_{\text{f}}$ $U = K$ $mgh = \frac{1}{2}mv^2$ $gh = \frac{1}{2}v^2$ $g = \frac{v^2}{2h}$ $g = \frac{12^2}{2\,(60)}$ $g = 1.2 \text{ m s}^{-2}$ Acceleration of gravity, g on this planet is 1.2 m s^{-2}.	K1 GJU1
4. (b)(i)	Work done by the pushing force, $W_F = Fs\cos\theta$ $W_F = 50\,(12)\cos 40°$ $W_F = 459.63 \text{ J}$	G1 JU1
4. (b)(ii)	$W_F = \Delta K$ $W_F = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ $459.63 = \frac{1}{2}(10)v^2 - \frac{1}{2}(10)(0)^2$ $v = 9.59 \text{ m s}^{-1}$	G1 JU1

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4. (b)(iii)	Given $t = 15$ min $= 15 \times 60$ s $= 900$ s Power supplied by the force, $P = \dfrac{W_F}{t}$ $P = \dfrac{459.63}{15 \times 60}$ $P = 0.51\ \text{W}$	G1 JU1
	TOTAL	**8**
5. (a)	Given $d = 25$ m $\Rightarrow$ $r = 12.5$ m $a_c = r\omega^2$ $10 = 12.5\omega^2$ $\omega = \sqrt{\dfrac{10}{12.5}}$ $\omega = 0.89\ \text{rad s}^{-1}$	K1 G1 JU1
5. (b)	$F_c = ma_c$ $F_c = 50\,(10)$ $F_c = 500\ \text{N}$	G1 JU1
	TOTAL	**5**
6. (a) (i)	Given displacement, $y = 5 \sin 2\pi t$ Velocity, $v = A\omega \cos \omega t$ $v = 5\,(2\pi) \cos 2\pi t$ $v = 5\,(2\pi) \cos [\,2\pi\,(4)\,]$ $v = 10\pi$ $v = 31.42\ \text{cm s}^{-1}$ or $0.314\ \text{m s}^{-1}$ Acceleration, $a = -A\omega^2 \sin \omega t$ $a = -5\,(2\pi)^2 \sin 2\pi t$ $a = -5\,(2\pi)^2 \sin [\,2\pi\,(4)\,]$ $a = 0\ \text{cm s}^{-2}$	G1 JU1 G1 J1

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6. (a)(ii)	Maximum speed, $v = A\omega$ $v = 5\,(2\pi)$ $v = 10\pi$ $v = 31.42\ \text{cm s}^{-1}$ or $0.314\ \text{m s}^{-1}$ Maximum acceleration, $a = A\omega^2$ $a = 5\,(2\pi)^2$ $a = 197.39\ \text{cm s}^{-2}$ or $1.97\ \text{m s}^{-2}$	GJU1 GJU1
6. (a)(iii)	Total energy of the system, $E = \frac{1}{2} m\omega^2 A^2$ $E = \frac{1}{2}(0.2)(2\pi)^2(5\times10^{-2})^2$ $E = 9.87\times10^{-3}$ J	G1 JU1
6. (b)(i)	Frequency, $f = \dfrac{1}{T}$ $f = \dfrac{1}{1.6}$ $f = 0.625$ Hz	G1 JU1
6. (b)(ii)	Speed of wave, $v = f\lambda$ $v = 0.625\,(0.75)$ $v = 0.47\ \text{m s}^{-1}$	G1 JU1
6. (c)(i)	Angular frequency, $\omega = 2\pi f$ $\omega = 2\pi\,(8)$ $\omega = 16\pi\ \text{rad s}^{-1}$ or $\omega = 50.27\ \text{rad s}^{-1}$ Wave number, $k = \dfrac{2\pi}{\lambda}$ $k = \dfrac{2\pi}{0.40}$ $k = 5\pi\ \text{rad m}^{-1}$ or $k = 15.71\ \text{rad m}^{-1}$	G1 JU1 G1 JU1
6. (c)(ii)	$y = A\sin(\omega t - kx)$ $y = 0.15\sin(16\pi t - 5\pi x)$ where y and x in m and t in second.	K1 JU1

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6. (d)(i)	Mass per unit length, $\mu = \dfrac{m}{L}$ $\mu = \dfrac{1\times 10^{-3}}{0.5}$ $\mu = 2\times 10^{-3}$ kg m^{-1} Speed of transverse wave on the string, $v = \sqrt{\dfrac{T}{\mu}}$ $v = \sqrt{\dfrac{100}{2\times 10^{-3}}}$ $v = 223.61$ m s^{-1}	G1 G1 JU1
6. (d)(ii)	$f_n = \dfrac{nv}{2L}$ Fundamental frequency, $f_1 = \dfrac{1(223.61)}{2(0.5)}$ $f_1 = 223.61$ Hz	G1 JU1
	TOTAL	**23**
7. (a)(ii)	Stress, $\sigma = \dfrac{F}{A}$ Force, $F = \sigma A$ $F = 1.2\times 10^{8}(2.0\times 10^{-6})$ $F = 240$ N	G1 JU1
7. (b)(i)	$L = L_o(1+\alpha\Delta T)$ $4.004 = 4.000[1+2.5\times 10^{-5})(T-T_o)]$ $1.001 = (1+2.5\times 10^{-5})(T-20)$ $T-20 = 40$ Temperature of the disc, $T = 60$ °C	G1 JU1

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7. (b)(ii)	$\beta = 2\alpha$ $\beta = 2\,(2.5\times10^{-5})$ $\beta = 5.0\times10^{-5}\ ^\circ\text{C}^{-1}$	GJU1
7. (b)(iii)	Coefficient of linear expansion, $\alpha = 2.5\times10^{-5}\ ^\circ\text{C}^{-1}$ Coefficient of area expansion, $\beta = 5.0\times10^{-5}\ ^\circ\text{C}^{-1}$ $\frac{\alpha}{\beta} = \frac{2.5\times10^{-5}}{5.0\times10^{-5}}$ $\frac{\alpha}{\beta} = \frac{1}{2}$ Ratio between the coefficient of linear and area expansion = 1:2	GJ1
	TOTAL	**8**
8. (a)(i)	Total kinetic energy, $K = \frac{f}{2}nRT$ $K = \frac{3}{2}(2)(8.31)(20+273)$ $K = 7.31\times10^{3}\ \text{J}$	G1 JU1
8. (a)(ii)	Average kinetic energy, $K_{\text{av}} = \frac{f}{2}kT$ $K_{\text{av}} = \frac{3}{2}(1.38\times10^{-23})(20+273)$ $K_{\text{av}} = 6.07\times10^{-21}\ \text{J}$	G1 JU1
8. (b)	Internal energy, $U = \frac{f}{2}nRT$ $U = \frac{3}{2}(0.98)(8.31)(300)$ $U = 3.66\times10^{3}\ \text{J}$	G1 JU1
8. (c)(i)	Total work done, $W =$ area under $P-V$ graph from A to C $W = 1\,(1.013\times10^{5})(4-8)\times10^{-3}$ $W = -405.2\ \text{J}$	G1 JU1

<table>
<tr><th>NO.</th><th>ANSWER SCHEME</th><th>MARK</th></tr>
<tr><td>8. (c)(ii)</td><td>

$\mathbf{A} \rightarrow \mathbf{B} \;\Rightarrow\;$ isobaric $\;\Rightarrow\; P_A = P_B = 1$ atm

Charles' law, $V \propto T$

$$\frac{V_A}{T_A} = \frac{V_B}{T_B}$$
$$\frac{8}{T_A} = \frac{4}{T_B}$$

$$T_A = 2T_B$$

$\mathbf{B} \rightarrow \mathbf{C} \;\Rightarrow\;$ isochoric $\;\Rightarrow\; V_B = V_C$

Gay – Lussac law, $P \propto T$

$$\frac{P_C}{T_C} = \frac{P_B}{T_B} \quad \text{where} \quad T_C = T_A = 2T_B$$
$$\frac{P_f}{2T_B} = \frac{1}{T_B}$$

$$P_f = 2 \text{ atm}$$

</td><td>G1

G1

JU1</td></tr>
<tr><td colspan="2" align="right">TOTAL</td><td>11</td></tr>
<tr><td colspan="2" align="right">GRAND TOTAL</td><td>80</td></tr>
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