Laws: Principle of conservation of momentum
Newton's Experimental law

} see 1990 solutions or TEXTBOOK

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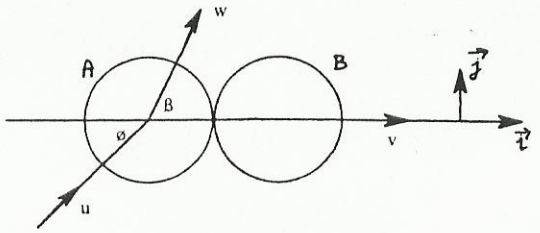
(i)



		vel before	vel after
A:	m	$u\cos\phi\,\vec{i} + u\sin\phi\,\vec{j}$	$w\cos\beta\,\vec{i} + u\sin\phi\,\vec{j}$
B:	m	$0\,\vec{i} + 0\,\vec{j}$	$v\,\vec{i} + 0\,\vec{j}$

PCM $\quad mu\cos\phi + 0 = mw\cos\beta + mv$

$$w\cos\beta = u\cos\phi - v$$

NEL $\quad v - w\cos\beta = -0.4(0 - u\cos\phi)$

$$w\cos\beta = v - 0.4\,u\cos\phi$$

$$\therefore\ u\cos\phi - v = v - 0.4\,u\cos\phi$$

$$v = 0.7\,u\cos\phi$$

$$= 0.7\,u\,\frac{5}{\sqrt{35}}$$

$$= u\,\frac{\sqrt{35}}{10}$$

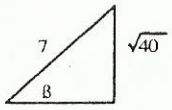
$$w\cos\beta = 0.3\,u\cos\phi$$

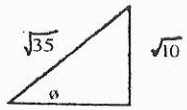
$$w\,(3/7) = 0.3\,u\,\frac{5}{\sqrt{35}} \Rightarrow w = u\,\frac{\sqrt{35}}{10} = v$$

(ii) KE before $= 0.5\,m\,u^2$

KE after $= 0.5\,m\,v^2 + 0.5\,m\,w^2 = m\,u^2(0.35)$

Loss of KE $= 0.5\,m\,u^2 - 0.35\,m\,u^2 = 0.15\,m\,u^2$ or $\frac{3mu^2}{20}$





6 (a) (i) Force = mass x acceleration
$= m\omega^2 a$

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$$\frac{7m}{16} = m\omega^2 a$$

$a = 4 \Rightarrow \frac{7}{16} = 4\omega^2$

$$\Rightarrow \omega = \frac{\sqrt{7}}{8} \text{ or } 0.33 \text{ rad/s}$$

$$T = \frac{2\pi}{\omega} = \frac{16\pi}{\sqrt{7}} \text{ or } 19 \text{ seconds}$$

(ii) $x = a\sin\omega t$

$$= 4\sin\left(\frac{\sqrt{7}}{8}\cdot\frac{2\pi}{\sqrt{7}}\right)$$

$$= 2\sqrt{2}$$

$$v = \sqrt{a^2 - x^2}$$

$$= \frac{\sqrt{7}}{8}\sqrt{16 - 8}$$

$$= \sqrt{\frac{7}{8}} \text{ or } 0.94 \text{ s}$$

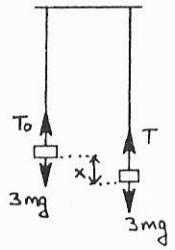
$v = a\omega\cos\omega t$

$$= 4\,\frac{\sqrt{7}}{8}\cos\left(\frac{\sqrt{7}}{8}\cdot\frac{2\pi}{\sqrt{7}}\right)$$

$$= \frac{\sqrt{7}}{2}\cos(\pi/4)$$

$$= \frac{\sqrt{7}}{2\sqrt{2}} \text{ or } \sqrt{\frac{7}{8}}$$

(b) (i)



$T_o = 3mg$

$ke = 3mg$

Force in direction of x increasing

$$= 3mg - T$$

$$= 3mg - k(e + x)$$

$$= 3mg - ke - kx$$

$$= -kx$$

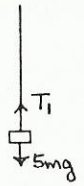
$$= -\frac{48mg}{\ell}x$$

$$\text{Acceleration} = -\frac{16g}{\ell}x$$

$\Rightarrow$ S.H.M. about $x = 0$ with $\omega = \sqrt{\frac{16g}{\ell}}$

$$\text{Period} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{\ell}{16g}} \text{ or } \frac{\pi}{2}\sqrt{\frac{\ell}{g}}$$

(ii)



$T_1 = 5mg$

$ke + ky = 5mg$

$$3mg + \frac{48mgy}{\ell} = 5mg$$

$$\text{amplitude} = y = \frac{\ell}{24}$$