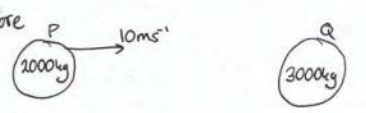
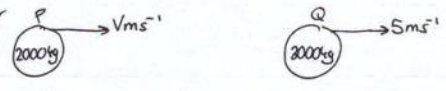


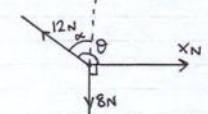
① M1 Jan 03 - Solutions

1. Before 

After 

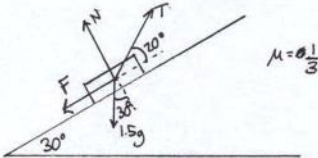
a) Cons. of mom. $10 \times 2000 = 2000v + 3000 \times 5$
 $20000 = 2000v + 15000$
 $5000 = 2000v$
 $v = \frac{5}{2} \text{ms}^{-1}$

b) Impulse = Change in mom.
 = mom. _{after} - mom. _{before}
 = $5 \times 3000 - 0 = \underline{15000 \text{Ns}}$

2. 

a) Vertically $12 \cos \alpha = 8$
 $\cos \alpha = \frac{8}{12}$ $\alpha = 48.2^\circ \Rightarrow \theta = 138.2^\circ$

b) Horizontally $X = 12 \sin \alpha = 12 \sin(48.18968)$
 $= \underline{8.94 \text{N}}$

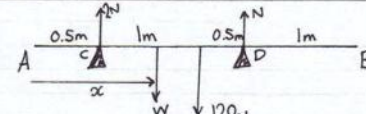
③ 5. 

Parallel to Plane: $T \cos 20 - 1.5g \sin 30 - F = 0$ ①

Perpendicular to Plane: $N + T \sin 20 - 1.5g \cos 30 = 0$ ②

From ② $N = 1.5g \cos 30 - T \sin 20$ and $F = \mu N$

subin ① $T \cos 20 - 1.5g \sin 30 - \frac{1}{3}(1.5g \cos 30 - T \sin 20) = 0$
 $T \cos 20 + \frac{1}{3} T \sin 20 - 1.5g \sin 30 - \frac{1}{3} \times 1.5g \cos 30 = 0$
 $T = \frac{1.5g \sin 30 + 0.5g \cos 30}{\cos 20 + \frac{1}{3} \sin 20} = \underline{11.0 \text{N}}$

6. 

Resolve forces $3N = W + 120$ - ①

$\sum \tau = 0$ $0.5 \times 2N - Wx - 1.5 \times 120 + 2N = 0$
 $N - Wx - 180 + 2N = 0$
 $3N - Wx - 180 = 0$ - ②

② 3. a) $s = 6i - 27j$
 $u = 14i + 21j$
 $v = u + at$
 $a = \frac{v-u}{t} = \frac{-20i + 48j}{4} = \underline{(-5i + 12j) \text{ms}^{-2}}$

b) $F = ma = 0.4(-5i + 12j) = -2i + 4.8j$
 $|F| = \sqrt{(-2)^2 + (4.8)^2} = \underline{5.2 \text{N}}$

4 a) $p = 10t \text{ j km}$
 $q = 6i + 12j + t(-8i + 6j) = \underline{(6-8t)i + (12+6t)j}$

b) $PQ = q - p$
 $= (6-8t)i + (12+6t)j - 10tj$
 $= (6-8t)i + (12-4t)j$

When $t=3$ $PQ = (6-24)i + (12-12)j = -18i$
 $\therefore \text{dist } P \rightarrow Q = \underline{18 \text{km}}$

c) If Q is North of P i component = 0
 $\therefore 6-8t = 0$
 $t = \frac{6}{8} = \underline{0.75 \text{hrs}}$

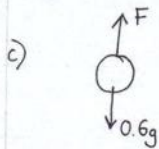
④ From eqn ① $3N = W + 120$
 subin ② $W + 120 - Wx - 180 = 0$
 $W(1-x) = 60$
 $W = \frac{60}{1-x}$

b) $0 < x < 1$

7. a) At Greatest height
 $S = 25.6$
 $u = u$
 $v = 0$
 $a = -9.8$
 $t = x$
 $v^2 = u^2 + 2as$
 $0 = u^2 + 2 \times 25.6 \times -9.8$
 $u^2 = 501.76$
 $u = \underline{22.4 \text{ms}^{-1}}$

b) When ball hits the ground
 $S = -1.5$
 $u = 22.4$
 $v = x$
 $a = -9.8$
 $t = t$
 $S = ut + \frac{1}{2}at^2$
 $-1.5 = 22.4t - 4.9t^2$
 $4.9t^2 - 22.4t - 1.5 = 0$
 $t = \frac{22.4 \pm \sqrt{(22.4)^2 - 4 \times 4.9 \times -1.5}}{2 \times 4.9}$
 $= \frac{22.4 \pm \sqrt{531.16}}{9.8} = 4.64 \text{ or } -0.07 \text{s}$
 $\therefore T = \underline{4.64 \text{s}}$

5



Resultant force = $0.6g - F$

Force = mass \times acc.

$0.6g - F = 0.6a$

$a = \frac{0.6g - F}{0.6}$

$s = 0.025$

$u = u$

$v = 0$

$a = \frac{0.6g - F}{0.6}$

$t = x$

Initial velocity upon striking the ground
in the final velocity from falling

from b) $v = u + at$

$= 22.4 - 9.8 \times 4.64 = -23.07$

so 23.07 ms^{-1} downwards

$\therefore v^2 = u^2 + 2as$

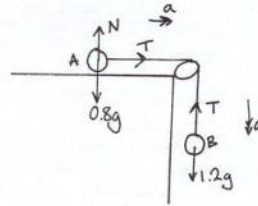
$0 = 23.07^2 + 2 \times \left(\frac{0.6g - F}{0.6} \right) \times 0.025$

$0 = 532.2249 + 0.05g - 0.08333F$

$F = \frac{532.2249 + 0.05g}{0.083333} = \underline{6390 \text{ N}} \text{ (3sf)}$

d) Air resistance.

6



8.

a) For A Force = mass \times acc.
 $T = 0.8a$ (1)

For B $1.2g - T = 1.2a$ (2)

(1) + (2) $1.2g = 2a$
 $a = 0.6g = 5.88 \text{ ms}^{-2}$

sub in (1) $T = 0.8 \times 0.6g = 0.48g = \underline{4.70 \text{ N}}$

b) $s = 0.6$

$u = 0$

$v = x$

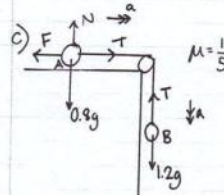
$a = 5.88$

$t = t$

$s = ut + \frac{1}{2}at^2$

$0.6 = \frac{1}{2} \times 5.88 t^2$

$t = \sqrt{\frac{1.2}{5.88}} = \underline{0.452 \text{ s}}$



$\mu = \frac{1}{5}$

For A

$T - F = 0.8a$

$T - \frac{1}{5} \times 0.8g = 0.8a$ ($F = \mu N$)

$T - 0.16g = 0.8a$ (1)

For B

$1.2g - T = 1.2a$ (2)

7

(1) + (2) $1.2g - 0.16g = 2a$

$a = \frac{1.04g}{2} = 5.096 \text{ ms}^{-2}$

$s = 0.6$

$u = 0$

$v = x$

$a = 5.096$

$t = t$

$s = ut + \frac{1}{2}at^2$

$0.6 = \frac{1}{2} \times 5.096 \times t^2$

$t = \sqrt{\frac{1.2}{5.096}} = \underline{0.485 \text{ s}}$