07 May 2011
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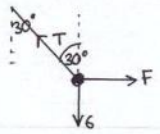
(1)

M1 - November 02 Solutions

1.



a) Vertically $T\cos 30 = 6 \Rightarrow T = \frac{6}{\cos 30} = 6.93\text{N}$ (3sf)

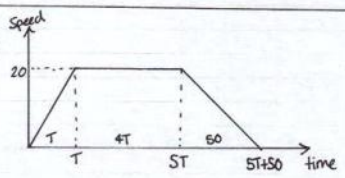
b) Horizontally $T\sin 30 = F \Rightarrow F = 6.93 \times \sin 30 = 3.46\text{N}$ (3sf)

2. a) $\underline{F} = m\underline{a}$ magnitude $= \sqrt{2^2+5^2} = \sqrt{29}$

$3\underline{i} - 7.5\underline{j} = 1.5\underline{a} \quad \therefore \underline{a} = \frac{3\underline{i} - 7.5\underline{j}}{1.5} = (2\underline{i} - 5\underline{j})\text{ms}^{-2}$

b) $\underline{V} = \underline{u} + \underline{a}t = (2\underline{i}+3\underline{j}) + (2\underline{i}-5\underline{j}) \times 4 = (10\underline{i} - 17\underline{j})\text{ms}^{-1}$

3. a)



b) Dist travelled = area under graph

$1220 = \frac{1}{2}(5T+50+4T)\,20$

$1220 = 10 \times (9T+50)$

(2)

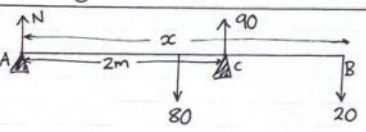
$9T = 72 \Rightarrow T = 8\text{s}$

c) $V = u + at$

$20 = 0 + 8a$

$a = \frac{20}{8} = 2.5\text{ms}^{-2}$

4. a)



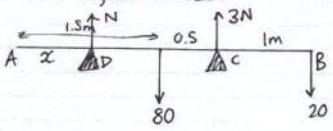
A) $90 \times 2 - 80 \times \frac{x}{2} - 20x = 0$

$180 = 40x + 20x$

$x = 3\text{m}$

b) It has mass, but no size.

c)



A) $Nx - 1.5 \times 80 + 2 \times 3N - 3 \times 20 = 0$

but $4N = 100 \Rightarrow N = 25$

$\therefore 25x - 1.5 \times 80 + 2 \times 75 - 3 \times 20 = 0$

$25x - 120 + 150 - 60 = 0 \quad x = \frac{30}{25} = 1.2\text{m}$

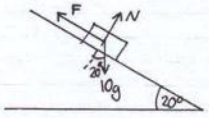
(3)

5. a)

s	5	$v^2 = u^2 + 2as$
u	10	$64 = 100 + 10a$
v	8	$10a = -36$
a	a	$a = -3.6\text{ms}^{-2}$
t	x	

b) Force $= ma$

$= -3.6 \times 10 = -36\text{N}$



$\parallel$ to plane $10g\sin 20° - F = -36$

$F = 10g\sin 20 + 36 = 69.5\text{N}$

$F = \mu N, \quad N = 10g\cos 20$

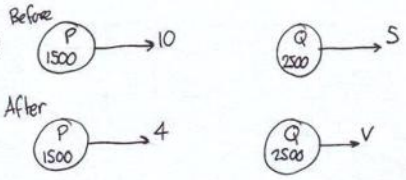
$\therefore \mu = \frac{69.5}{10g\cos 20} = 0.755$ (3sf)

c) Greatest possible length $\Rightarrow$ speed 0 at bottom

s	s	$v^2 = u^2 + 2as$
u	10	$0 = 100 - 7.2s$
v	0	$s = \frac{100}{7.2} = 13.9\text{m}$ (3sf)
a	-3.6	
t	x	

(4)

6. a)



Cons. of Mom.

$15000 + 12500 = 6000 + 2500V$

$2500V = 21500$

$V = 8.6\text{ms}^{-1}$

b) Force $= ma$

$-500 = 1500a \Rightarrow a = -\frac{1}{3}\text{ms}^{-2}$

s	s	
u	4	$v^2 = u^2 + 2as$
v	0	$0 = 16 - \frac{2}{3}s \quad s = 24\text{m}$
a	$-\frac{1}{3}$	
t	x	

c) $V = u + at$

$0 = 4 - \frac{1}{3}t \quad t = 12\text{s}$

in 12s Q travels $8.6 \times 12 = 103.2\text{m}$

$\therefore PQ = 103.2 - 24 = 79.2\text{m}$

(5)

7. a) velocity = $\frac{\text{change in displacement}}{\text{time}} = \frac{(50\underline{i}-25\underline{j})-(20\underline{i}+35\underline{j})}{0.5}$

$= \frac{30\underline{i}-60\underline{j}}{0.5}$

$= (60\underline{i}-120\underline{j})\ ms^{-1}$

b) $\underline{r} = 20\underline{i}+35\underline{j}+(60\underline{i}-120\underline{j})t$

c) $\underline{q} = \frac{120}{5}(4\underline{i}-3\underline{j})t$

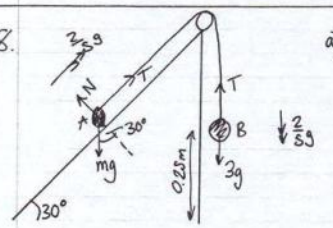
d) $\overrightarrow{PQ} = \underline{q}-\underline{r}$ when $t=2$ $\underline{r} = 140\underline{i}-205\underline{j}$

$\underline{q} = 192\underline{i}-144\underline{j}$

$\overrightarrow{PQ} = 52\underline{i}+61\underline{j}$

dist PQ $= \sqrt{52^2+61^2} = 80.2\text{km (3sf)}$

8.



a) Force = ma

$3g-T = 3\times\frac{2}{5}g$

$T = 3g-\frac{6}{5}g$

$T = 17.64\text{N}$

(6)

$F=ma$

b) $T-mg\sin30 = m\times\frac{2}{5}g$

$17.64-mg\sin30 = \frac{2}{5}mg$

$17.64 = m\left(\frac{2}{5}g+g\sin30\right)$

$17.64 = 8.82m$

$m = \frac{17.64}{8.82} = 2\text{kg}$

c) velocity at floor:

s	0.25
u	0
v	v
a	$\frac{2}{5}g$
t	x

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

$v = \sqrt{2\times\frac{2}{5}g\times0.25} = 1.4\text{ms}^{-1}$

Impulse = change in mom = mom be after - mom bef

$= 0-1.4\times3$

$= -4.2\text{ Ns}$

magnitude 4.2 Ns

d) B strikes the ground ⇒ string goes slack ⇒ only force on A is $mg\sin30$ down the slope.

$F=ma$

$-mg\sin30 = ma$

$a = -4.9\text{ms}^{-2}$

s	x
u	1.4
v	0
a	-4.9
t	t

$v = u+at$

$0 = 1.4-4.9t$

$t = \frac{1.4}{4.9} = \frac{2}{7}\text{s}$