07 May 2011
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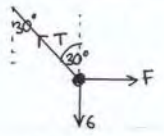
(1)

M1 - November 02 Solutions

1.



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

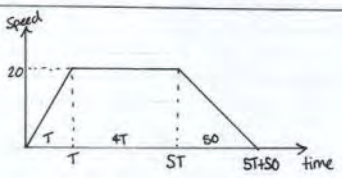
b) Horizontally $T\sin 30 = F \Rightarrow F = 6.93 \times \sin 30$
$= \underline{3.46N}$ (3sf)

2. a) $\underline{F} = m\underline{a}$ magnitude $= \sqrt{2^2+5^2} = \underline{5.39}$

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

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

3. a)



b) Dist travelled = area under graph

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

$1220 = 10 \times (9T+5O)$

(2)

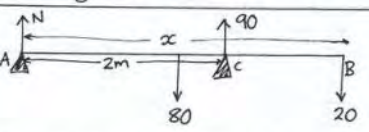
$9T = 72 \Rightarrow \underline{T = 8s}$

c) $V = u + at$

$20 = 0 + 8a$

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

4. a)



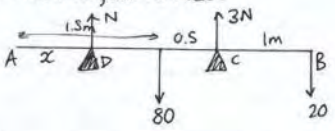
A) $90x2 - 80 \times \frac{x}{2} - 20x = 0$

$180 = 40x + 20x$

$\underline{x = 3m}$

b) It has mass, but no size.

c)



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

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

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

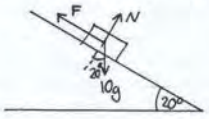
$25x - 120 + 150 - 60 = 0 \quad x = \frac{30}{25} = \underline{1.2m}$

(3)

5. a)

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

b) Force $= ma$
$= -3.6 \times 10 = -36N$



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

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

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

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

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

s	s
u	10
v	0
a	-3.6
t	x

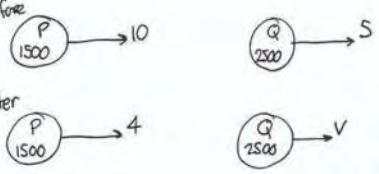
$v^2 = u^2 + 2as$

$0 = 100 - 7.2s$

$s = \frac{100}{7.2} = \underline{13.9m}$ (3sf)

(4)

6. a)



Cons. of Mom.

$15000 + 12500 = 6000 + 2500V$

$2500V = 21500$

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

b) Force $= ma$

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

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

c) $V = u + at$

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

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

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

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

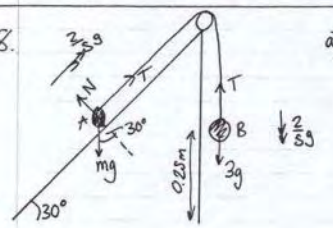
d) $\overrightarrow{PQ} = \underline{q} - \underline{r}$ when $t = 2$ $\underline{r} = 140\underline{i} - 205\underline{j}$

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

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

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

8.



a) Force = ma

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

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

$T = 17.64\ N$

(6)

F = ma

b) $T - mg\sin 30 = m \times \frac{2}{5}g$

$17.64 - mg\sin 30 = \frac{2}{5}mg$

$17.64 = m\left(\frac{2}{5}g + g\sin 30\right)$

$17.64 = 8.82m$

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

c) velocity at floor:

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

$V^2 = u^2 + 2as$

$V = \sqrt{2 \times \frac{2}{5}g \times 0.25} = 1.4\ ms^{-1}$

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

$= 0 - 1.4 \times 3$

$= -4.2\ Ns$

magnitude 4.2 Ns

d) B strikes the ground ⇒ string goes slack ⇒ only force on A is $mg\sin 30$ down the slope.

$F = ma$

$-mg\sin 30 = ma$

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

s	x
u	1.4
v	0
a	-4.9
t	t

$v = u + at$

$0 = 1.4 - 4.9t$

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