07 May 2011
22:28

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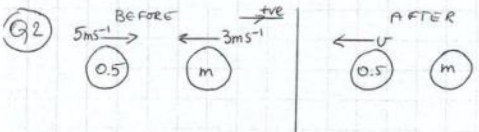
Q1 $s = 50m$

(a) $u = 5ms^{-1}$ $\quad s = ut + \frac{1}{2}at^2$
$t = 4s$ $\quad 50 = 5\times4 + \frac{1}{2}a\times4^2$
$a = ?$ $\quad 50 = 20 + 8a$
$a = 3.75ms^{-2}$ (3)

(b) $s = ?$
$u = 5ms^{-1}$ $\quad v^2 = u^2 + 2as$
$v = 30ms^{-1}$ $\quad 30^2 = 5^2 + 2\times3.75s$
$a = 3.75ms^{-2}$ $\quad s = 116\frac{2}{3}m$ (116.7m) (3)

Q2



(a) Impulse on A = 3.6Ns
Impulse = change in momentum:
Before: $0.5\times5 = 2.5$
After: $-0.5v = -0.5v$ ↓

$3.6 = 2.5 + 0.5v$
$v = 2.2ms^{-1}$ (3)

(b) speed of b = $1ms^{-1}$
Momentum before = after:
(i) B changes direction
(ii) B does not change direction

$+1ms^{-1}$: $0.5\times5 - m\times3 = -0.5\times2.2 + m\times1$
(i) $4m = 3.6 \Rightarrow m = 0.9kg$

$-1ms^{-1}$: $0.5\times5 - m\times3 = -0.5\times2.2 - m\times1$
(ii) $2m = 3.6 \Rightarrow m = 1.8kg$
(4)

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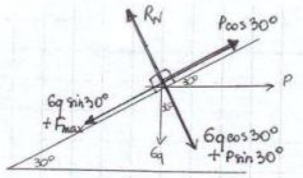
Q4 $\mu = 0.4$

$F_{max} = \mu R_N$
$F_{max} = 0.4R_N$



$R_N = 6g\cos30 + P\sin30°$
$R_N = 50.9(222) + 0.5P$ (i)

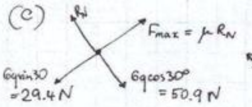
substitute R_N into this equation (ii)

$6g\sin30° + F_{max} = P\cos30°$
$29.4 + 0.4R_N = 0.866(025)P$ (ii)

$29.4 + 0.4(50.9 + 0.5P) = 0.866P$
$29.4 + 20.36888 + 0.2P = 0.866P$
(b) $P = 74.7N$ (3)

from (i)
(a) $R_N = 50.9 + 0.5\times P$
$= 88.3N$ (88N) (4)

(c)

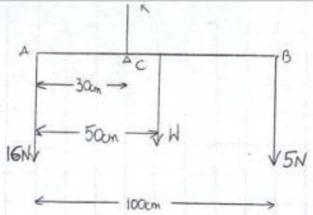


$F_{max} = 0.4R_N$
$R_N = 50.9N$
$F_{max} = 0.4\times50.9$
$= 20.36N$

$F_{max} < 29.4N$
so the box will move towards 29.4 force (downhill)

Q3.

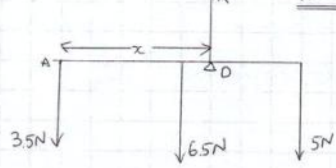
(a)



Either take moments about C:
↶ ↷
$30\times16 = 20\times W + 70\times5$
$480 = 20W + 350$
$W = 6.5N$ (3)

or ↑=↓ $R = 21 + W$
and moments about A:
↶ ↷
$30\times R = 50W + 100\times5$
$30(21+W) = 50W + 500$
$630 + 30W = 50W + 500$
$20W = 130$
$W = 6.5N$ (3)

(b)



↑=↓ $R = 15N$
Moments about A: ↶ ↷ $x\times15 = 50\times6.5 + 100\times5$
$15x = 825$
$x = 55cm$ (4)

(c) The height of the strings doesn't affect the moments equation (isn't taken into consideratio
(1)

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Q5

(a) at $t = 3$ $\quad v = i - 2j$

$\alpha = 90° + \tan^{-1}\left(\frac{2}{1}\right) = 153.4°$
(3)

Q5(b) acceleration = $\frac{\text{change in velocity}}{\text{time}}$

$a = \frac{(i - 2j) - (-5i + 7j)}{3} = \frac{6i - 9j}{3} = 2i - 3j$

$a = 2i - 3j$ (2)

(c) $F = ma = 2\times(2i - 3j) = 4i - 6j$
$F = |4i - 6j| = \sqrt{4^2 + 6^2} = 2\sqrt{13} = 7.21N$ (3)

(d) velocity = $-5i + 7j$ (initial velocity) + $t(2i - 3j)$ (t × acceleration)

$v = (-5 + 2t)i + (7 - 3t)j$ (2)

(e) P parallel to $i + j$ when its velocity is a multiple of $(i + j)$ i.e.: i and j components are e
$(-5 + 2t)i + (7 - 3t)j = k(i + j)$
$\Rightarrow -5 + 2t = 7 - 3t$
$5t = 12$
$t = 2.4s$ (3)

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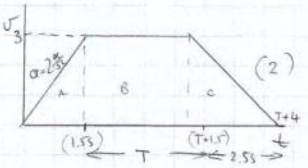
Q6.



(2)

(a)

$A + B + C = 27m$

(b) $a = \frac{3-0}{t} \Rightarrow 2 = \frac{3}{t}$

$\underline{t = 1.5s}$

$A + B + C = 27m$

$\text{Area}_{\text{trapezium}} = \frac{T + (T+4)}{2} \times 3 = \frac{2T+4}{2} \cdot 3 = 3(T+2)$

$3(T+2) = 27$

$T + 2 = 9$

$\underline{T = 7s}$ (3)

(b) Alternatively:

$\triangle\ A = \frac{1}{2} \times 1.5 \times 3 = 2.25$

$\square\ B = T \times 3 = 3T$

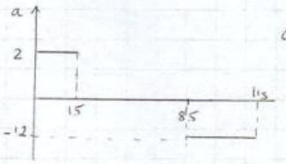
$\triangle\ C = \frac{1}{2} \times 2.5 \times 3 = 3.75$

$3T + 6$

$3T + 6 = 27$

$\underline{T = 7s}$

(c)



deceleration for C:

$-\frac{3}{2.5} = -1.2$

(3)

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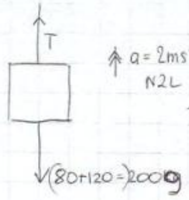
Q6 (d)



$a = 2ms^{-2}$

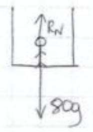
N2L $F = ma$

$T - 200g = 200 \times 2$

$T = 400 + 200g$

$\underline{T = 2360N}$ (3)

(e)



N2L $F = ma$

$R_N - 80g = 80 \times (-1.2)$

$R_N = 80g - 96$

$\underline{R_N = 688N}$ (3)

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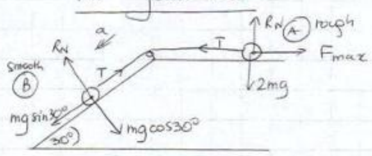
Q7



$R_N = 2mg$

(a) B : N2L $ma = mg\sin 30° - T$

A : N2A $2ma = T - F_{max}$ $\quad F_{max} = \mu R_N = \mu\, 2mg$

B : $ma = mg\sin 30° - T$

A : $+\ 2ma = T - 2\mu mg$

$3ma = mg(\sin 30° - 2\mu)$

$a = \frac{1}{3}\left(\frac{1}{2} - 2\mu\right)g$

$\underline{a = \frac{1}{6}(1 - 4\mu)g}$ (7)

(b) $\mu = 0.2 \Rightarrow a = \frac{1}{6}\left(1 - 4 \times \frac{1}{5}\right)g = \frac{1}{30}g$

When the string snaps the velocity of the system is:

$v^2 = u^2 + 2as \quad (u = 0,\ s = h)$

$v^2 = 2 \times \frac{1}{30}g \times h$

$v^2 = \frac{gh}{15}$

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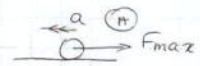
Q7 (b) so $u = \sqrt{\frac{gh}{15}}$ is the initial velocity

$v = 0$ is the final

$F = ma$



$2ma = -F_{max}$

$2ma = -2\mu mg \quad \mu = 0.2$

$\underline{a = -0.2g}$

Hence the distance: $v^2 = u^2 + 2as$

$0 = \frac{gh}{15} - 2 \times 0.2g\, s$

$0.4g\, s = \frac{gh}{15}$

$s = \frac{h}{6} \cdot = \frac{h}{6}$

$\frac{1}{15} \div 0.4 = \frac{1}{15} \div \frac{2}{5} = \frac{1}{15} \times \frac{5}{2} = \frac{1}{6}$

Hence the total distance:

$\underline{h + \frac{h}{6} = \frac{7}{6}h}$ (6)

(c) weight of pulley or string; friction on slope or pulley; (2)