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Q1 $s = 50m$

(a) $u = 5ms^{-1}$, $t = 4s$, $a = ?$

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

$50 = 5\times4 + \frac{1}{2}a\times4^2$

$50 = 20 + 8a$

$a = 3.75ms^{-2}$ (3)

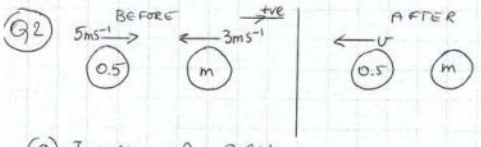
(b) $s = ?$, $u = 5ms^{-1}$, $v = 30ms^{-1}$, $a = 3.75ms^{-2}$

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

$30^2 = 5^2 + 2\times3.75s$

$s = 116\frac{2}{3}m$ (116.7m) (3)

Q2



(a) Impulse on A = 3.6Ns

Impulse = change in momentum:

Before: $0.5\times5 = 2.5$ ↓

After: $-0.5v = -0.5v$

$3.6 = 2.5 + 0.5v$

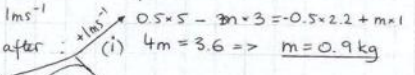
$v = 2.2ms^{-1}$ (3)

(b) speed of b = $1ms^{-1}$

Momentum before = after:

(i) B changes direction

(ii) B does not change direction



(i) $0.5\times5 - m\times3 = -0.5\times2.2 + m\times1$

$4m = 3.6 \Rightarrow m = 0.9kg$

(ii) $0.5\times5 - m\times3 = -0.5\times2.2 - m\times1$

$2m = 3.6 \Rightarrow m = 1.8kg$ (4)

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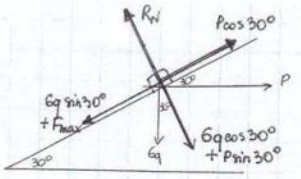
Q4 $\mu = 0.4$

$F_{max} = \mu R_N$

$F_{max} = 0.4R_N$



$R_N = 6g\cos30 + P\sin30°$

$R_N = 50.9(222) + 0.5P$ (i)

substitute R_N into this equation (ii)

$6g\sin30° + F_{max} = P\cos30°$

$29.4 + 0.4R_N = 0.866(025)P$ (ii)

$29.4 + 0.4(50.9 + 0.5P) = 0.866P$

$29.4 + 20.36888 + 0.2P = 0.866P$

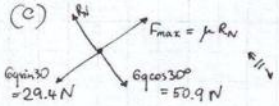
(b) $P = 74.7N$ (3)

from (i)

(a) $R_N = 50.9 + 0.5\times P$

$= 88.3N$ (88N) (4)

(c)



$F_{max} = 0.4R_N$

$R_N = 50.9N$

$F_{max} = 0.4\times50.9$

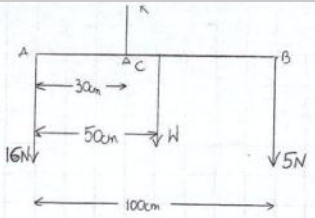
$= 20.36N$

$F_{max} < 29.4N$

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:

↶ ↷

$30\times R = 50W + 100\times5$

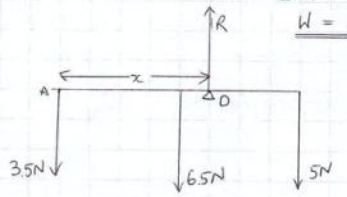
$30(21+W) = 50W + 500$

$630 + 30W = 50W + 500$

$20W = 130$

$W = 6.5N$ (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 consideration (1)

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Q5.

(a) at $t=3$ $\underline{v} = \underline{i} - 2\underline{j}$

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

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

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

$\underline{a} = 2\underline{i} - 3\underline{j}$ (2)

(c) $\underline{F} = m\underline{a} = 2\times(2\underline{i}-3\underline{j}) = 4\underline{i}-6\underline{j}$

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

(d) Velocity = initial velocity $-5\underline{i}+7\underline{j}$ + t × acceleration $t(2\underline{i}-3\underline{j})$

$\underline{v} = (-5+2t)\underline{i} + (7-3t)\underline{j}$ (2)

(e) ∥ parallel to $\underline{i}+\underline{j}$ when its velocity is a multiple of $(\underline{i}+\underline{j})$ i.e: i and j components are e

$(-5+2t)\underline{i} + (7-3t)\underline{j} = k(\underline{i}+\underline{j})$

$\Rightarrow -5+2t = 7-3t$

$5t = 12$

$t = 2.4s$ (3)

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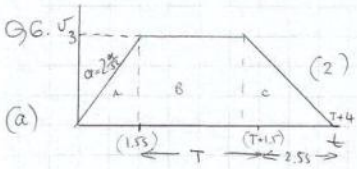
Q6. 

(2)

(a) $A+B+C = 27m$

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

$t = 1.5s$

$A+B+C = 27m$

Area $\square = \frac{T+(T+4)}{2} \times 3 = \frac{2T+4}{2} \times 3 = 3(T+2)$

$3(T+2) = 27$

$T+2 = 9$

$T = 7s$ (3)

(b) Alternatively:

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

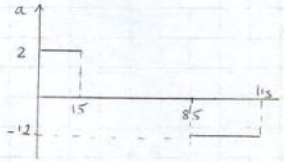
$\square B = T \times 3 = 3T$

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

$3T + 6$

$3T + 6 = 27$

$T = 7s$

(c) 

(3)

deceleration for C:

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

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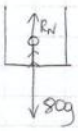
Q6 (a) 

N2L $F = ma$

$T - 200g = 200 \times 2$

$T = 400 + 200g$

$T = 2360N$ (3)

(e) 

N2L $F = ma$

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

$R_N = 80g - 96$

$R_N = 688N$ (3)

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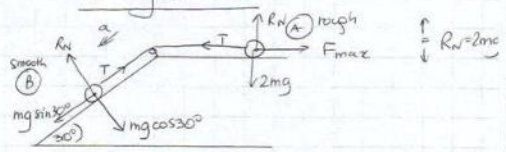
Q7 

(a) B: N2L $ma = mg\sin 30° - T$

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

B: $ma = mg\sin 30° - T$

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

$3ma = mg(\sin 30° - 2\mu)$

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

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

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

When the string snaps the velocity of the system is:

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

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

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

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

$v = 0$ is the final

$F = ma$ 

$2ma = -F_{max}$

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

$a = -0.2g$

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

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

$0.4g\,s = \frac{gh}{15}$ $\frac{1}{15} \div 0.4$

$s = \frac{gh}{6} = \frac{h}{6}$ $= \frac{1}{15} \div \frac{2}{5}$

$= \frac{1}{15} \times \frac{5}{2}$

$= \frac{1}{6}$

Hence the total distance:

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

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