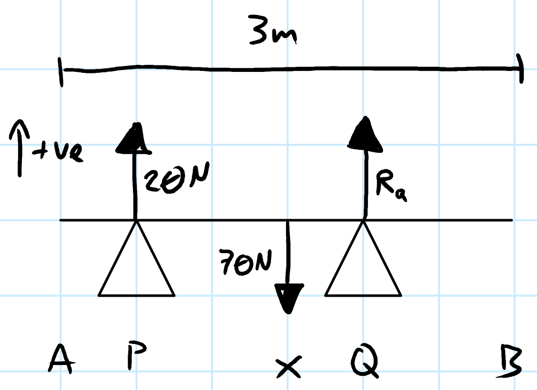
January 2001 MA - M1

1)



AB = 3m
AP = 0.5m
AX = XB = 1.5m
PX = 1m

a) Resolve forces vertically

$20 + R - 70 = 0$ ∵ static Rod

$R = 50N$

b) moments around P

↻ moments = ↺ moments ∵ Static Rod

$70(PX) = 50(PQ)$

$\frac{70 \times 1}{50} = PQ$

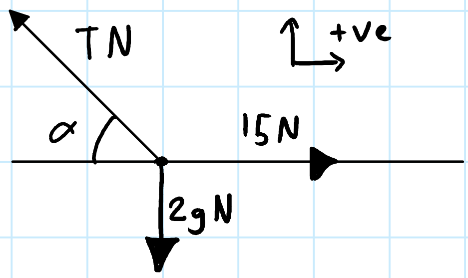
$= 1.4m$

$AQ = AP + PQ$

$= 0.5 + 1.4$

$= 1.9m$

2)



Resolving Forces

$15 - T\cos(\alpha) = 0$

$T\sin(\alpha) - 2g = 0$

$\frac{T\sin(\alpha)}{T\cos(\alpha)} = \frac{2g}{15}$

$\tan(\alpha) = \frac{98}{75}$

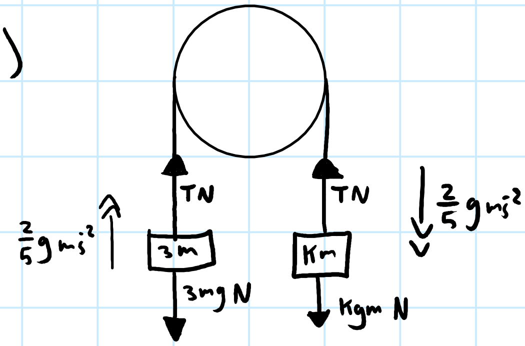
$\alpha = 52.6°$

b) $15 - T\cos(\alpha) = 0$

$\frac{15}{0.608} = T$

$T = 24.7\text{ N}$

3)



↑ +ve

$T - 3mg = \frac{2}{5}g(3m)$ Left side

$T = \frac{6}{5}mg + 3mg$ Resultant Force

$T = \frac{21}{5}mg$ = Mass x Acceleration

(F=ma)

b) String is Inextensible

c) $T - Kmg = -\frac{2}{5}g(Km)$ Right side

$T = Kmg\left[-\frac{2}{5} + 1\right]$

$\frac{21}{5}mg = Kmg\frac{3}{5}$

$\frac{21}{\cancel{5}}\cancel{mg} = K\cancel{mg}\frac{3}{\cancel{5}}$

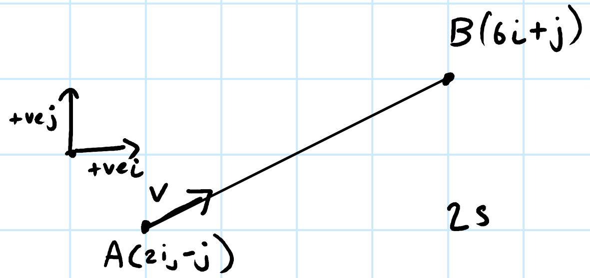
$21 = 3K$

$K = 7$

d) Weight of the string isn't included in calculations s
tension in string is consistent throughout the string.

4)

a)



$\Delta \rightarrow$ change in

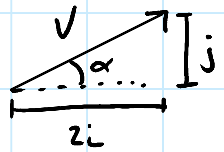
$$V = \frac{\Delta s}{\Delta t}$$

$$V = \frac{6i+j-(2i-j)}{2-0}$$

$$V = \frac{4i+2j}{2}$$

$$V = (2i+j)\,ms^{-1}$$

b)



$$\tan\alpha = \frac{1}{2}$$

$$\alpha = 26.6$$

c)

$$C = (2i+j)\times 3 + (6i+j)$$

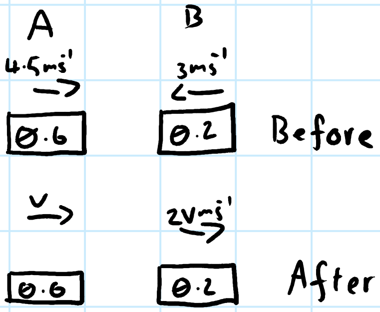
$$= 12i + 4j$$

$$12^2 + 4^2 = 160$$

$$\sqrt{160} = 12.6\,m$$

5)

a)



total momentum conserved

$(0.6 \times 4.5) + (0.2 \times -3) = 0.6V + 0.2(2v)$

$2.7 - 0.6 = V$

$V = 2.1ms^{-1}$

$2V = 4.2ms^{-1}$

b) initial momentum of B

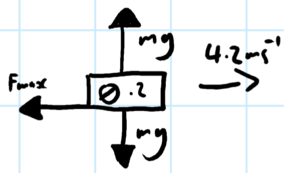
$0.2 \times -3 = -0.6\ Ns$

final momentum of B

$0.2 \times 4.2 = 0.84$

$\Delta P = 0.84 - -0.6$

$= 1.44\ Ns$

c) 

$F_{max} = \mu R$

$\text{acceleration } (\leftarrow) = \frac{F_{max}}{m}$

$= \mu g$

S 2m

U $4.2ms^{-1}$ $\quad V^2 = U^2 + 2AS$

V $0ms^{-1}$

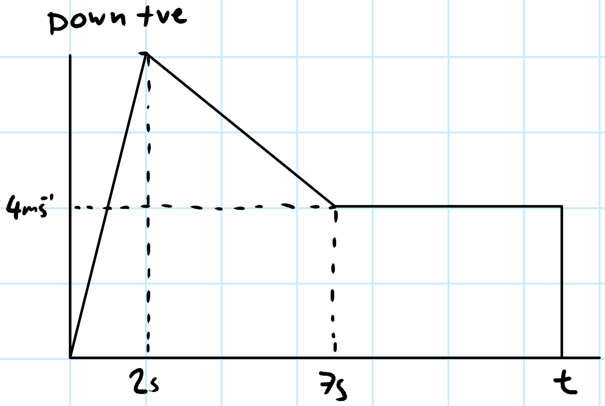
A $-\mu g ms^{-2}$ $\quad 0 = 17.6 - 4\mu g$

T X $\quad 39.2\mu = 17.6$

$\mu = 0.449$ (3sf)

6)

a)



b)

S X
U $0ms^{-1}$
V —
A $g\,ms^{-2}$
T 2s

$V = U + AT$

$V = 0 + 19.6$

$V = 19.6\,ms^{-1}$

c)

S —
U $0ms^{-1}$
V X
A $g\,ms^{-2}$
T 2s

$S = UT + \frac{1}{2}AT^2$

$S = 0 + \frac{4g}{2}$

$= 19.6m$

S —
U $19.6ms^{-1}$
V $4ms^{-1}$
A X
T 5s

$S = \left(\frac{U+V}{2}\right)T$

$S = \frac{19.6+4}{2} \times 5$

$= 59m$

$H_{min} = 19.6 + 59$

$= 78.6$

d) Distance travelled at $4\ ms^{-1}$

$125 - 78.6 = 46.4\ m$

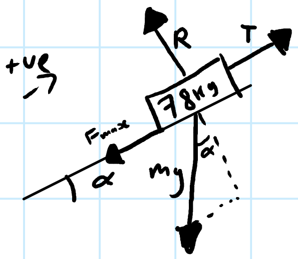
$$\frac{46.4\ m}{4\ ms^{-1}} = 11.6s$$

$7 + 11.6 = 18.6\ s$

e) Include drag caused by air resistance

7)

a)



$\mu = 0.25$

if $\tan(\alpha) = \frac{5}{12}$, $\sin(\alpha) = \frac{5}{13}$ & $\cos(\alpha) = \frac{12}{13}$

$R = mg\cos(\alpha)$

$= 78 \times 9.8 \times \frac{12}{13}$

$= 705.6$

$F_{max} = \frac{1}{4}(705.6)$

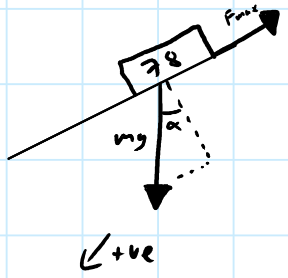
$= 176.4$

$T - F_{max} - mg\sin(\alpha) = 78 \times 0.5$

$T - 176.4 - 294 = 39$

$T = 509.4\text{N}$

b) After it has come to rest means friction now acts up the slope



$$mg\sin(\alpha) - 176.4 = ma$$

$$294 - 176.4 = 78a$$

$$\frac{117.6}{78} = a$$

$$a = 1.51 \text{ (3 s.f.)}$$