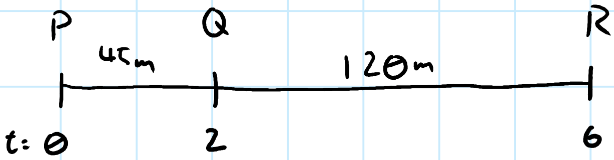
June 2009 MA - M1

1)



S	45m	S	165m
U	u	U	U
V	x	V	x
A	a	A	a
T	2	T	6

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

$45 = 2u + \frac{2^2}{2}a$

$165 = 6u + \frac{6^2}{2}a$

$\Rightarrow$

$45 = 2u + 2a$

$165 = 6u + 18a$

$165 - 3(45) = 6u + 18a - 6u - 6a$

$30 = 12a$

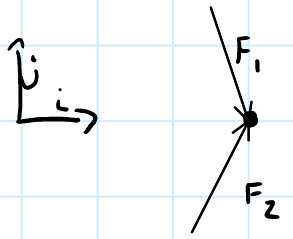
$a = 2.5\,ms^{-1}$

$45 = 2u + 2(2.5$

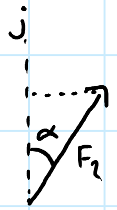
$40 = 2u$

$u = 20\,ms^{-1}$

2)



a)



$\tan(\alpha) = \frac{O}{a}$

$\tan(\alpha) = \frac{P}{2P}$

$= \frac{1}{2}$

$\therefore \alpha = 26.6°$

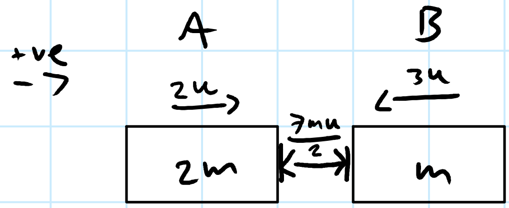
b) given $F_1 + F_2 = k(i + 0j)$ where k is constant

$i - 3j + pi + 2pj = ki$

$\therefore -3 + 2P = 0$

$P = \frac{3}{2}$

3)



a) $(2u \times 2m) - \frac{7}{2}mu = \frac{8}{2}mu - \frac{7}{2}mu$

$= \frac{1}{2}mu$

$P = mv \therefore v = \frac{P}{m}$

$\frac{1}{2}mu \div 2m = \frac{u}{4}$

$V_A = \frac{u}{4}$

b) $-3u \times m + \frac{7}{2}mu = -\frac{6}{2}mu + \frac{7}{2}mu$

$= \frac{1}{2}mu$

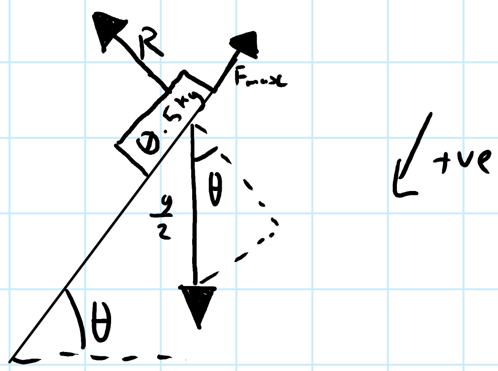
$P = mv \therefore V = \frac{P}{m}$

$\frac{1}{2}mu \div m = \frac{u}{2}$

$V_B = \frac{u}{2}$

4)

$\mu = \frac{1}{3}$



Resultant force down the plane

$F_R = \frac{g}{2}\sin(\theta) - F_{max}$ where $F_{max} = \frac{1}{3}R$

$= \frac{4g}{5\times2} - \frac{1}{3}\times\frac{g}{2}\cos(\theta)$

$= \frac{2g}{5} - \frac{3g}{3\times2\times5}$

$= \frac{2g}{5} - \frac{g}{10}$

$= 2.94\,N$

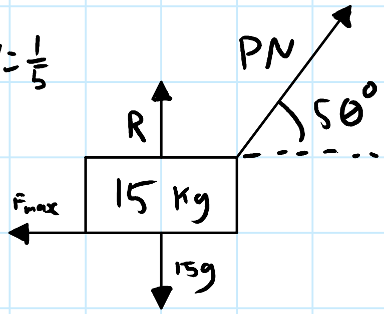
$F = ma$

$2.94 = \frac{1}{2}a$

$a = 5.88\,ms^{-1}$ (3sf)

5)

$\mu = \frac{1}{5}$



Forces balanced, ∴

$R + P\sin(50) = 15g$

$\frac{1}{5}R = P\cos(50)$

$R = 5P\cos(50)$

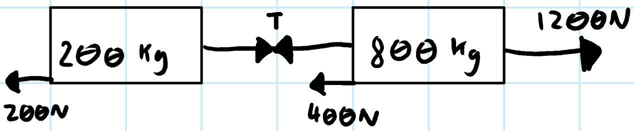
$5P\cos(50) + P\sin(50) = 15g$

$P[5\cos(50) + \sin(50)] = 15g$

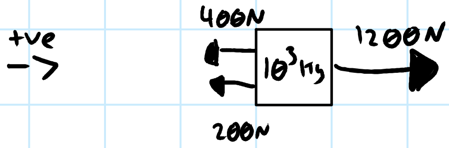
$P = \frac{147}{3.98}$

$P = 37$ (2 sf)

6)



a) as 1 system :



$$1200 - 400 - 200 = 10^3 \times a$$

$$600 = 1000a$$

$$a = 0.6 ms^{-1}$$

b) For trailer

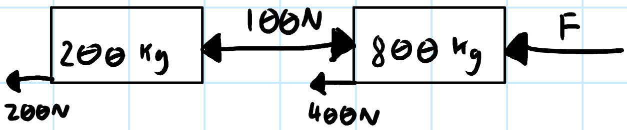
$$T - 200 = 200 \times 0.6$$

$$T = 120 + 200$$

$$T = 320 N$$

b)

c)



Car: $100 - 400 - F = 800a$

Trailer: $-100 - 200 = 200a$

$\frac{-300}{200} = a \quad \therefore a = -1.5$

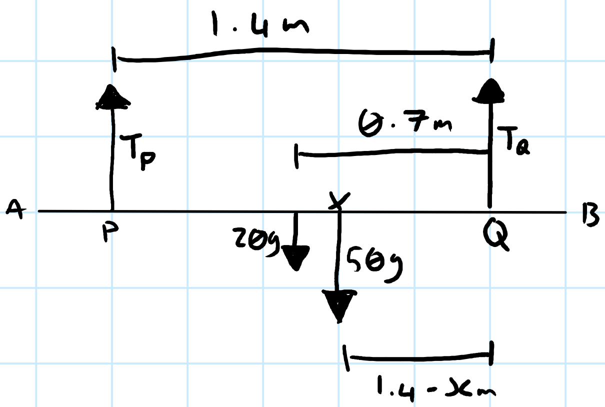
$-300 - F = 800 \times -\frac{3}{2}$

$-F = -1200 + 300$

$F = 900N$

7)

a)



moments around Q

moments ↻ = moments ↺

$(1.4-x)50g + (0.7)20g = 1.4T_P$

$686 - 490x + 137.2 = 1.4\ T_P$

$823.2 - 490x = 1.4\ T_P$

$(588 - 350x) = T_P$

b) $T_P + T_Q = 20g + 50g$

$T_Q = 686 - 588 + 350x$

$T_Q = 98 + 350x$

7)

c) $588 - 350(1.4) < T_P < 588 - 350(0)$

$\therefore \; 98 < T_P < 588$

$T_P + T_Q = 686$

$\therefore \; 98 < T_Q < 588$

$\therefore \; 686 = 98 + 588$

d) given $T_Q = 3T_P$

$98 + 350x = 3(588 - 350x)$

$98 + 350x = 1764 - 1050x$

$1400x = 1666$

$x = 1.19$

8)

a) $V = (1.2i - 0.9j)$

$|V| = [1.2^2 - 0.9^2]^{\frac{1}{2}}$

$= \sqrt{2.25}$

$= 1.5 \text{ ms}^{-1}$

b) $H = 0i + 100j + t(1.2i + 0.9j)$

c) $K = 9i + 46j + t(0.75i + 1.8j)$

$\overrightarrow{HK} = K - H$

$= (9 + 0.75t)i + (46 + 1.8t)j - (1.2t)i - (100 + 0.9t)j$

Collect together the i and j terms

$= (9 - 0.45t)i + (-54 + 2.7t)j$

8)

d) $\vec{Hk} = 0$

$9 - 0.45t = 0$

$54 - 2.7t = 0$

$\therefore t = \frac{9}{0.45}$

$= \frac{54}{2.7}$

$= 20s$

$100j + 20(1.2i - 0.9j) = 24i + 82j$