MI JAN 11

1) max height = 40m

a) $a\uparrow = -9.8$
$S = 40m$
$V\uparrow = 0$ (at max height)

$V^2 = U^2 + 2aS \Rightarrow 0 = U^2 - 19.6 \times 40 \Rightarrow U^2 = 784$
$\Rightarrow U = \underline{28 ms^{-1}}$

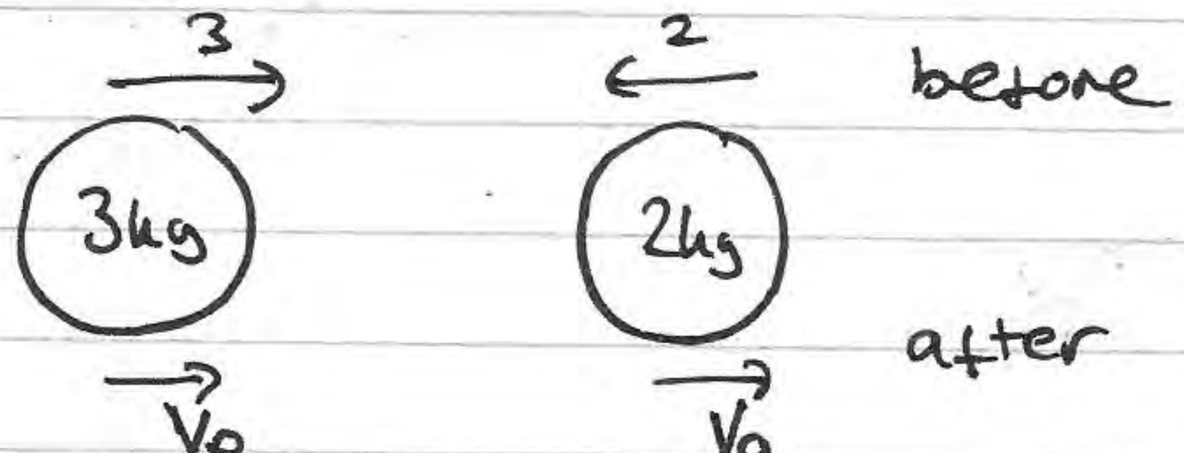
b) $U\uparrow = 28$
$a\uparrow = -9.8$
$S\uparrow = 33.6$

$S = Ut + \frac{1}{2}at^2$
$33.6 = 28t - 4.9t^2$
$\Rightarrow 4.9t^2 - 28t + 33.6 = 0$

$t = \frac{28 \pm \sqrt{28^2 - 4(4.9)(33.6)}}{9.8}$ $t_1 = 4$ $t_2 = \frac{12}{7}$

(Total time above $= 4 - \frac{12}{7} = \frac{16}{7}$ sec)

2)



$V_q = V_p + 1$

CLM $\Rightarrow 3(3) + 2(-2) = 3(V_p) + 2(V_p + 1)$
$\Rightarrow 5 = 5V_p + 2$
$\Rightarrow 5V_p = 3 \Rightarrow V_p = \frac{3}{5} \Rightarrow V_q = \frac{8}{5}$

Speed of P $= \frac{3}{5} ms^{-1}$ Speed of Q is $\frac{8}{5} ms^{-1}$

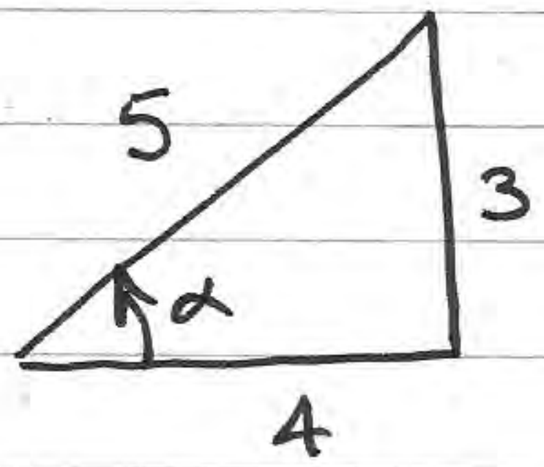
b) Mom P before $= 3(3) = 9$ Ns

Mom P after $= 3\left(\frac{3}{5}\right) = \frac{9}{5}$ Ns

Impulse = change in Mom $= 9 - \frac{9}{5} = \underline{\frac{36}{5}\text{ Ns}}$

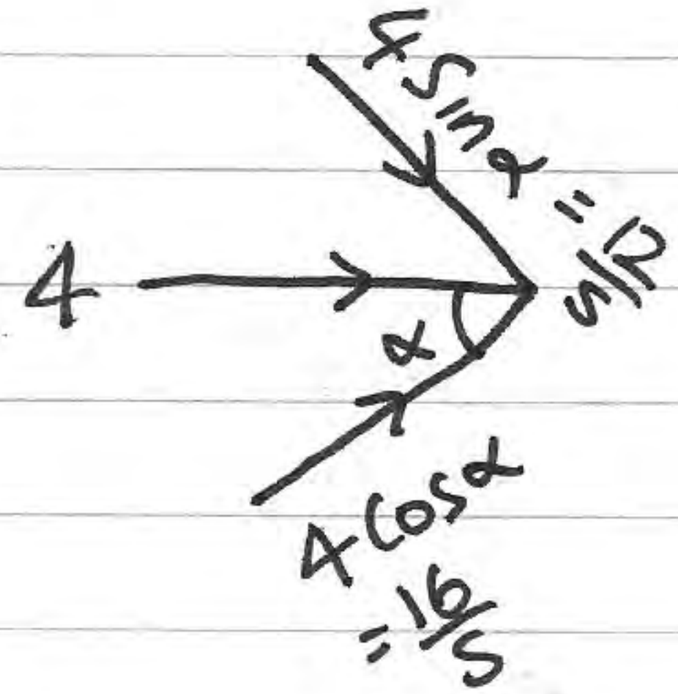
3)

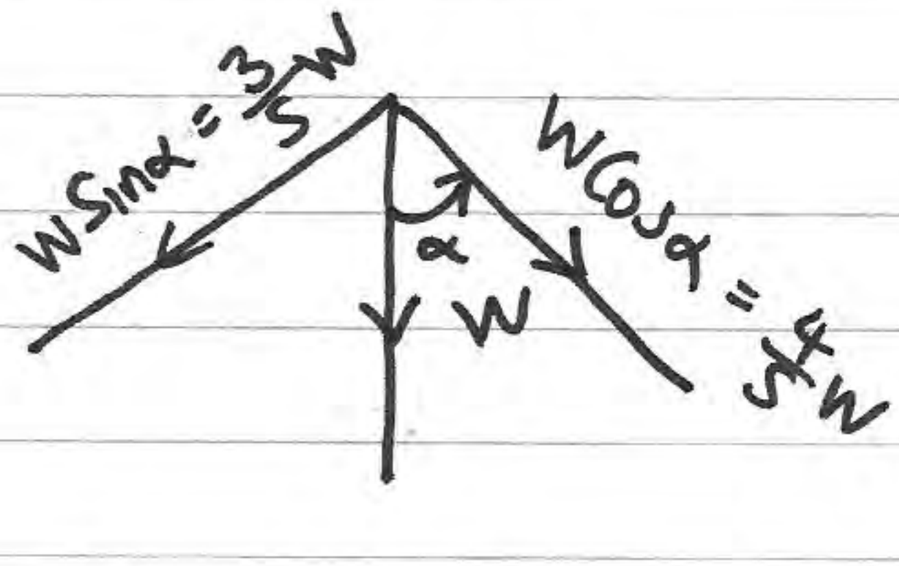
$\tan\alpha = \frac{3}{4}$

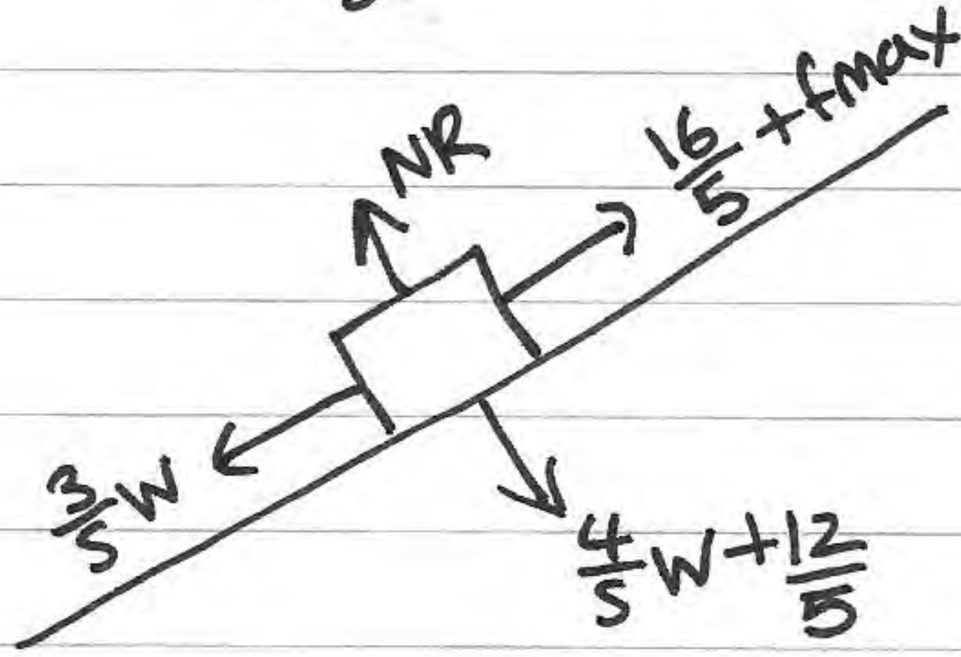


$\sin\alpha = \frac{3}{5}$

$\cos\alpha = \frac{4}{5}$







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

point of sliding down

$\swarrow \Rightarrow f_{max} \nearrow$

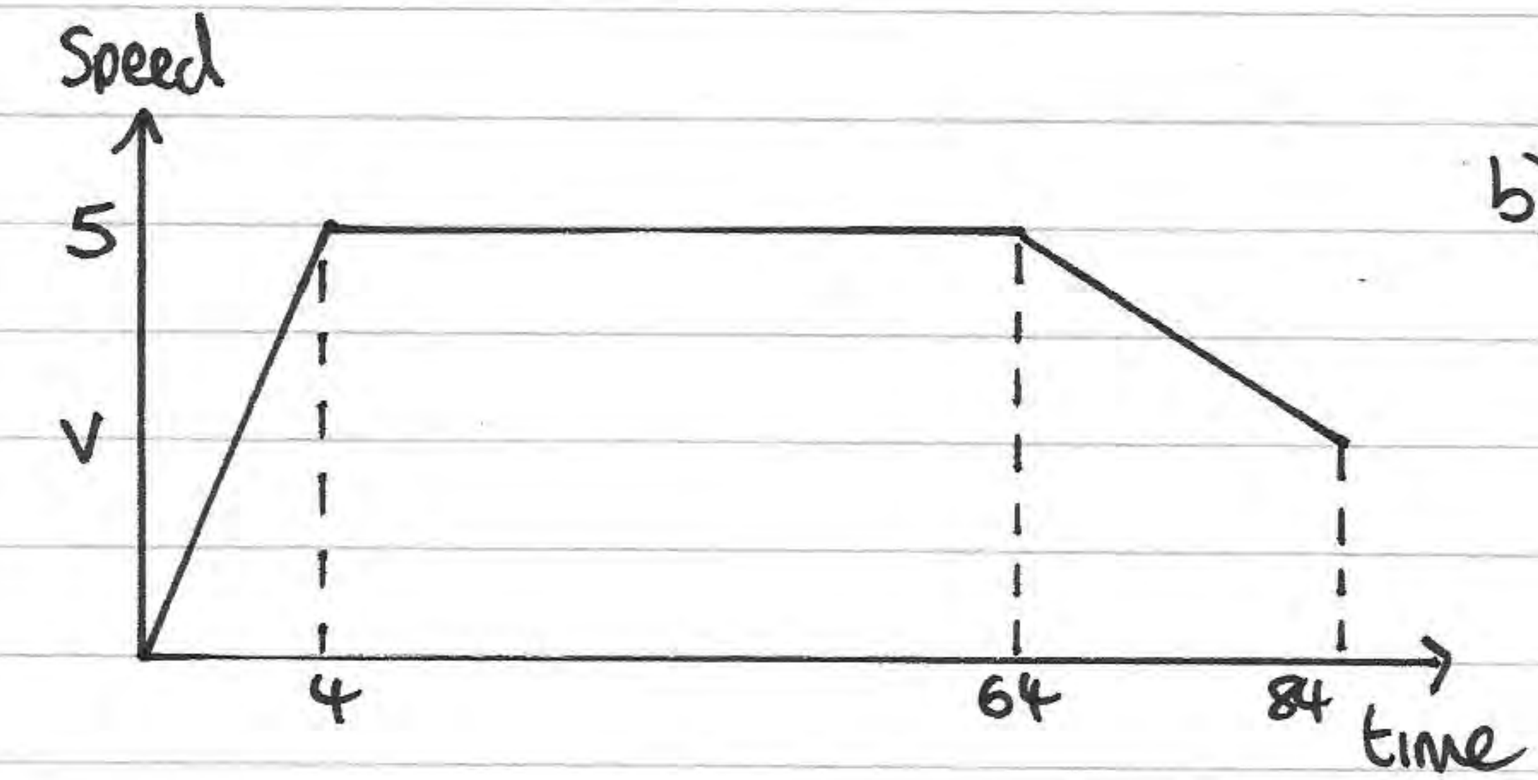
$RF\uparrow = 0 \Rightarrow NR = \frac{4}{5}W + \frac{12}{5}$ $\quad fmax = \mu NR = \frac{2}{5}W + \frac{6}{5}$

$Rf\nearrow = 0 \Rightarrow fmax = \frac{3}{5}W - \frac{16}{5} \Rightarrow \frac{3}{5}W - \frac{16}{5} = \frac{2}{5}W + \frac{6}{5}$

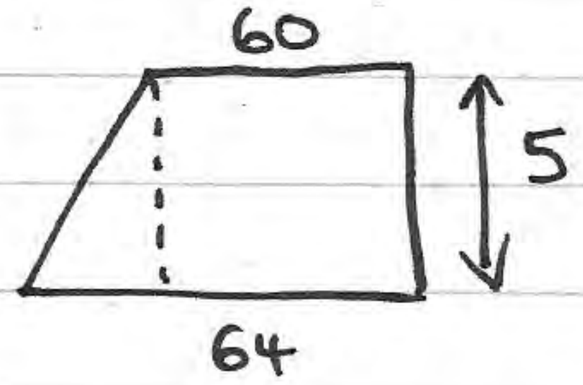
$\Rightarrow \frac{1}{5}W = \frac{22}{5} \Rightarrow \underline{W = 22N}$ (ii)

$NR = \frac{4}{5}(22) + \frac{12}{5} = \frac{100}{5} = \underline{\underline{20N}}$ # (i)

4)



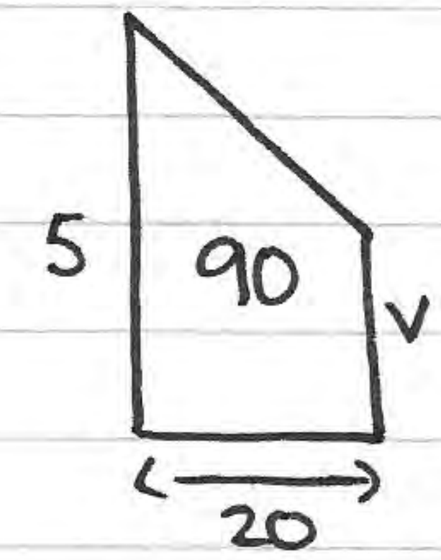
b)



$S = \frac{1}{2}(5)(60+64)$

$\underline{S = 310m}$

c)

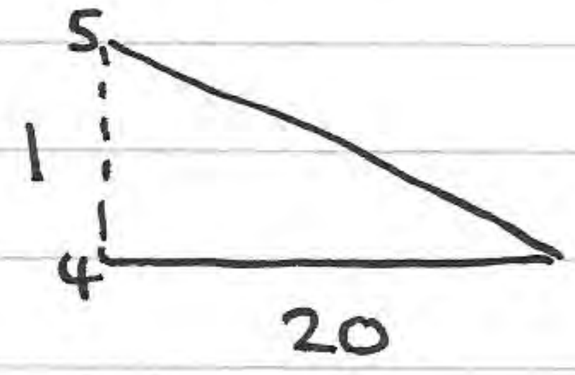


$\frac{1}{2}(20)(5+V) = 90$

$\Rightarrow 5 + V = 9$

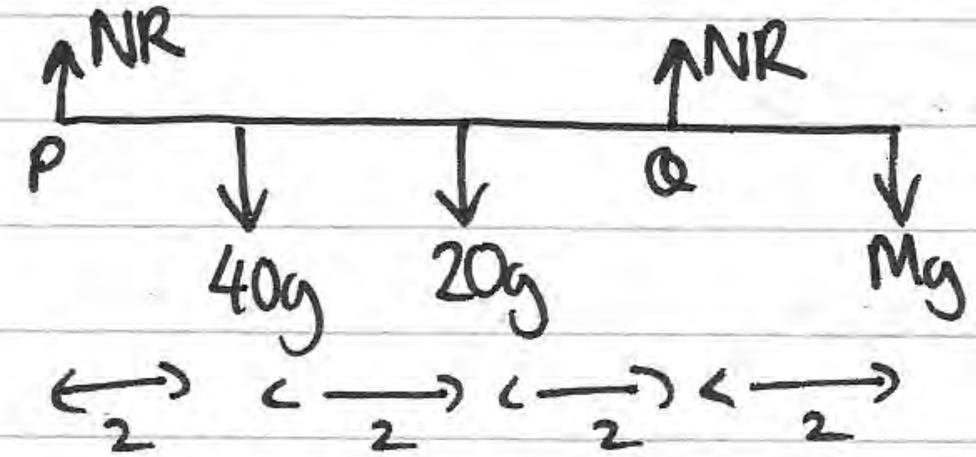
$\Rightarrow \underline{V = 4\,ms^{-1}}$

d)



$acc = \frac{-1}{20} \Rightarrow deceleration = \underline{\frac{1}{20}\,ms^{-2}}$

5)



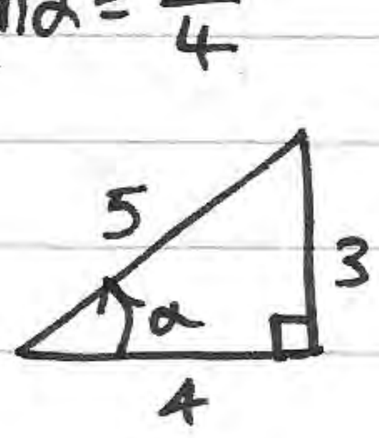
R↻ $NR\times2+NR\times8=20g\times4+40g\times6$

$\Rightarrow 10NR=320g$

$\Rightarrow NR=\underline{32gN}$

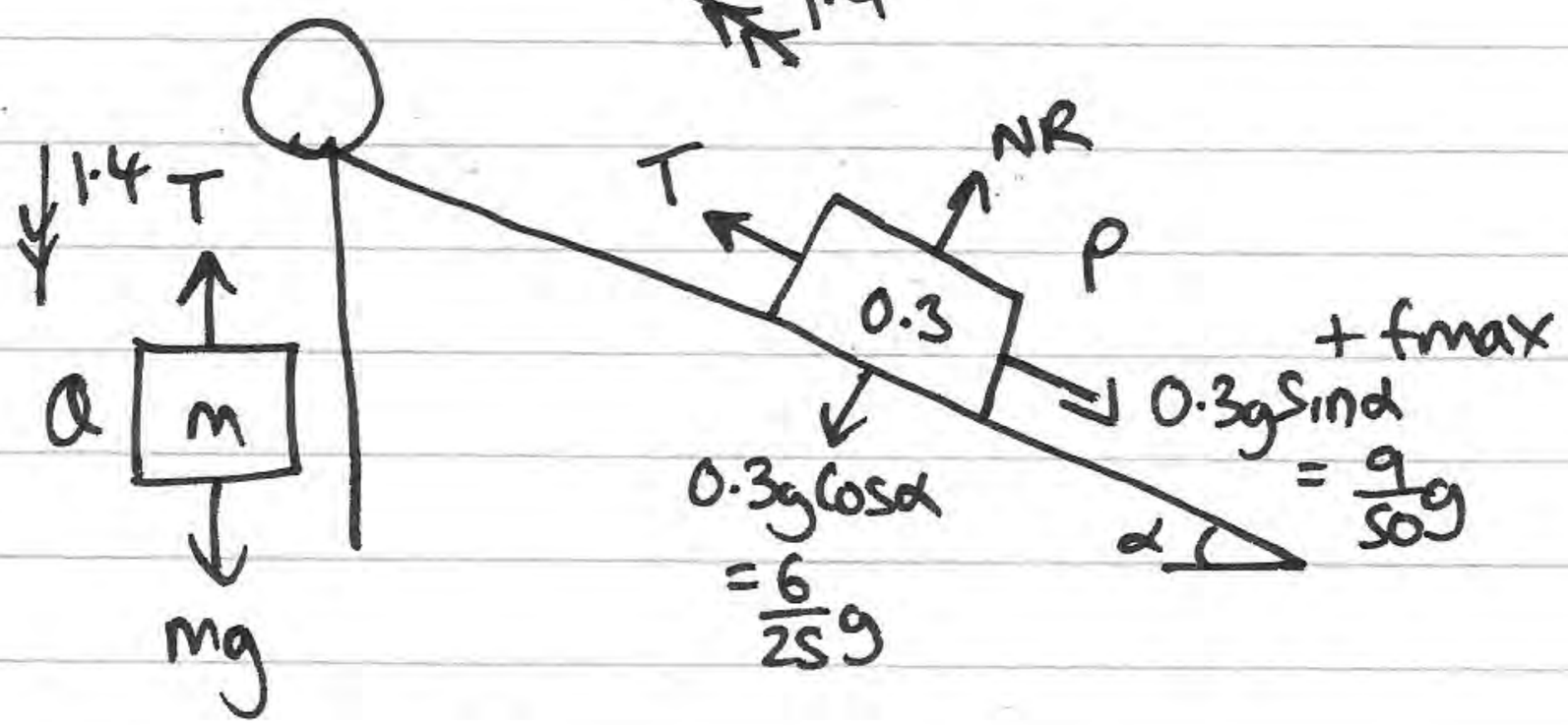
$Rf\uparrow=0 \Rightarrow 2NR=60g+Mg \Rightarrow 64g=60g+Mg \Rightarrow M=\underline{4kg}$

6) $\tan\alpha=\frac{3}{4}$



$\sin\alpha=\frac{3}{5}$

$\cos\alpha=\frac{4}{5}$

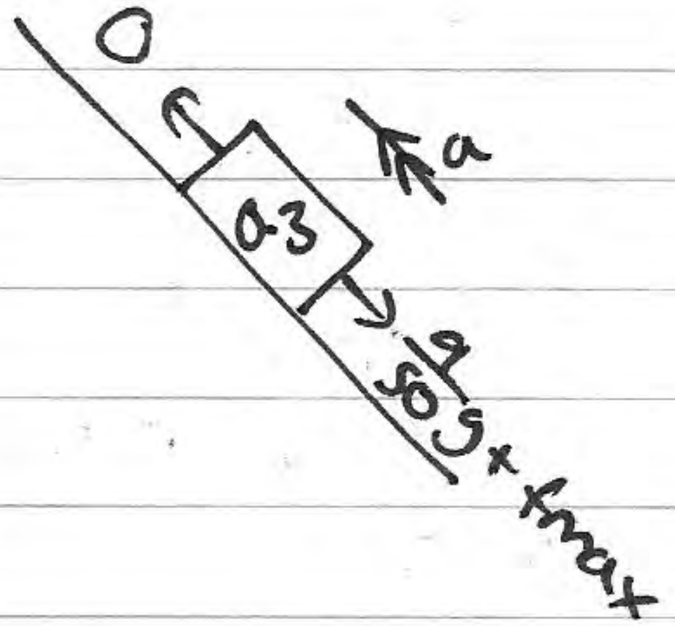


a) (P) $Rf\nearrow=0 \Rightarrow NR=\frac{6}{25}g$ $\quad fmax=\mu NR=\frac{3}{25}g$

b) (P) $Rf\uparrow=ma \Rightarrow T-\frac{9}{50}g-\frac{3}{25}g=0.3\times1.4$

$\Rightarrow T=\frac{21}{50}+\frac{15}{50}g \Rightarrow \underline{T=3.36N}$

c) $u\uparrow = 0 \quad a\uparrow = 1.4 \quad t = 0.5 \quad V = u + at \Rightarrow \underline{V = 0.7 ms^{-1}}$



$-\frac{9}{50}g - \frac{6}{50}g = 0.3a \Rightarrow -0.3g = 0.3a$

$\Rightarrow \underline{a = -9 ms^{-2}}$

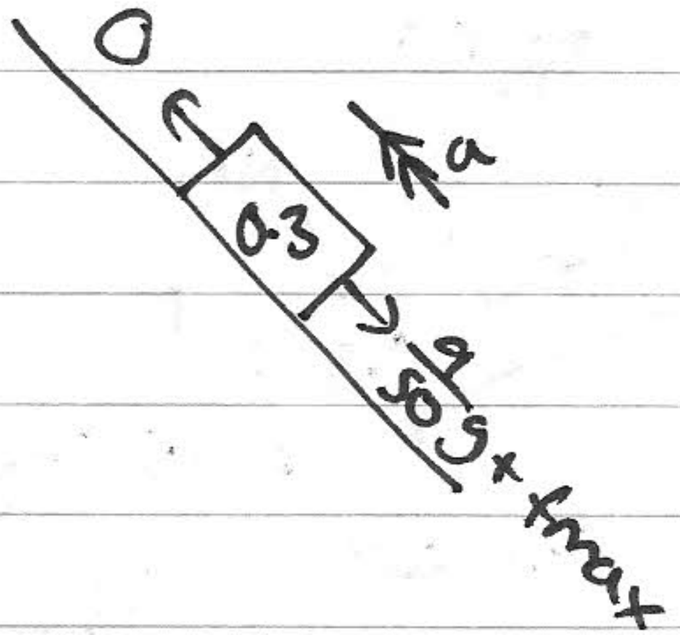
$u\uparrow = 0.7 \quad a\uparrow = -9.8 \quad v\uparrow = 0$

$V = u + at \Rightarrow 0 = 0.7 - 9.8t \quad \Rightarrow t = \underline{\frac{1}{14} \text{ sec}}$

(Q) $R\!f\downarrow = ma \Rightarrow mg - 3.36 = m \times 1.4 \Rightarrow 8.4m = 3.36$

$\Rightarrow m = \underline{0.4\,kg}$

c) $u\uparrow = 0 \quad a\uparrow = 1.4 \quad t = 0.5 \quad V = u + at \Rightarrow \underline{V = 0.7\,ms^{-1}}$

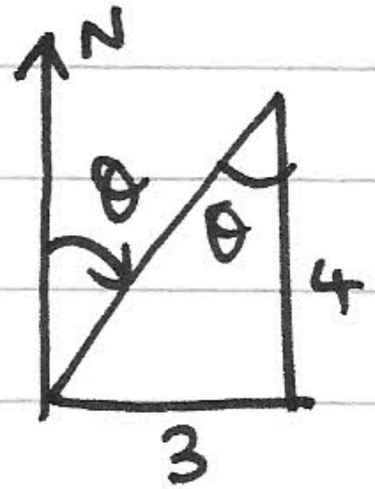


$-\frac{9}{50}g - \frac{6}{50}g = 0.3a \Rightarrow -0.3g = 0.3a$

$\Rightarrow a = \underline{-9\,ms^{-2}}$

$u\uparrow = 0.7 \quad a\uparrow = -9.8 \quad v\uparrow = 0$

$V = u + at \Rightarrow 0 = 0.7 - 9.8t \quad \Rightarrow t = \underline{\frac{1}{14}\ sec}$

7) 

$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 36.9°$

$\Rightarrow$ bearing = <u>037°</u>

b) position = original position + velocity x time

(i) position = $(i+j)+(2i-3j)t \Rightarrow p = (1+2t)i+(1-3t)j$

(ii) position = $(-2j)+(3i+4j)t \Rightarrow q = 3ti+(-2+4t)j$

(iii) $\overrightarrow{PQ} = q-p = (3t-1-2t)i+(-2+4t-1+3t)j$

$$= (t-1)i + (7t-3)j$$

c) Q is due North of P when $i = 0 \Rightarrow t = 1 \Rightarrow$ 3pm

d) Q is due North-West of P when $-i = j$

$$\Rightarrow -(t-1) = 7t-3 \quad \Rightarrow 8t = 4 \Rightarrow t = \tfrac{1}{2} \quad (2{:}30\text{pm})$$