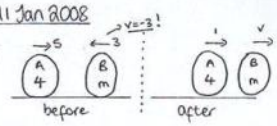
M1 Jan 2008

1) 

In b) v=2

a) Impulse on A is change in momentum of A

before = 4×5 after = 4×1 change = 20−4 = 16Ns

b) Total momentum does not change

before = 4×5 + m×-3 = 20−3m

after = 4×1 + m×2 = 4+2m

20−3m = 4+2m

5m = 16

m = 3.2kg

2) u=0 s=27m t=3. u, s, t, a

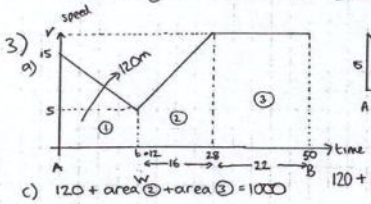
$s=ut+\frac{1}{2}at^2 \Rightarrow 27=0+\frac{1}{2}a\times 9 \Rightarrow a=\frac{54}{9}=6ms^{-2}$

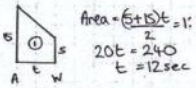
b) $s=\frac{(u+v)t}{2} \Rightarrow 54=(0+v)\times 3$ $v=18ms^{-1}$

c) After burn out! u=18 a=−g t=2 (s=3!)

$s=ut+\frac{1}{2}at^2 \Rightarrow s=18\times 2-4.9\times 2^2 = 16.4m$

Total height = 16.4+27 = 43.4m

3) 



b) total time = 12+16+22 = 50sec

c) 120 + area ② + area ③ = 1000

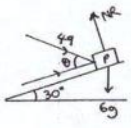
$120+\frac{(5+v)16}{2}+22v=1000$

$120+8(5+v)+22v=1000$

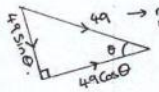
$120+40+8v+22v=1000$

$30v=840$

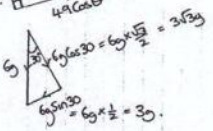
$v=28ms^{-1}$

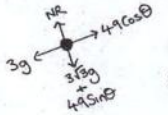
4) 

Smooth = no friction



→ make force given the hypotenuse of a RA triangle

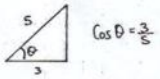


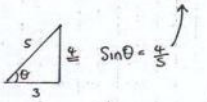


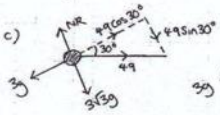
equilibrium ↗=↙ ↑=↓

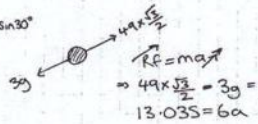
a) $4g\cos\theta=3g \Rightarrow \cos\theta=\frac{3g}{4g}=\frac{3}{5}$ ✓

b) NR = 3√3g + 4gSinθ = 50.92 + 4g×4/5 = 90.12N



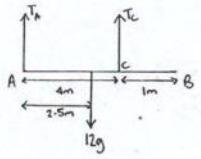


c) 



$\Rightarrow 4g\times\frac{\sqrt{3}}{2}-3g=6\times a$

$13.035=6a$ $a=2.17$

5) 

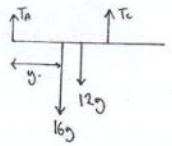
↑=↓ $T_A+T_C=12g$

A↺ $12g\times 2.5\curvearrowright = T_C\times 4\curvearrowleft$

$30g=4T_C \Rightarrow T_C=\frac{15}{2}g$.

a)i) $T_C = 7.5g$ N.

ii) $T_A = 4.5g$ N

b) 

$T_A+T_C=28g$.

A↺ $16g\times y+12g\times 2.5=T_C\times 4$

$16gy+30g=4T_C$

$4gy+7.5g=T_C$

c) if $T_C<98 \Rightarrow 4gy+7.5g<98$ $98=10g$

$4gy+7.5g<10g$

$4gy<2.5g$ $\Rightarrow y<\frac{2.5}{4}$

$y<0.625m$

$\Rightarrow 0<y<0.625m$

6) Vel = (−5i+8j)ms⁻¹ speed = $\sqrt{5^2+8^2}$ = 9.43ms⁻¹

b)

$\theta=\tan^{-1}\left(\frac{8}{5}\right)=58°$ bearing = 270+58 = 328°

c) Vel = −5i+8j so after 3 seconds P moves −15i+

Original Pos = 7i−10j ; Position after 3sec = −8j+14j

In 4 seconds to pass through O it most move 8i−14j

Velocity = $\frac{8i-14j}{4}$ = 2i−3.5j u=2 v=−3.5

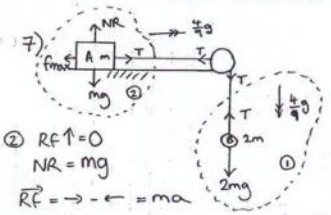
d) when t=3 position = −8i+14j Vel = 2i−3.5j

position = (−8i+14j) + (2i−3.5j)t = (−8+2t)i+(14−

due south of A when i becomes 7 again A(7i−

$\Rightarrow -8+2t=7 \Rightarrow 2t=15 \Rightarrow t=7.5$ sec

Total time to be due South = 3+7.5 = 10.5sec

7) 

① Rf↓ = ↓−↑ = ma

2mg − T = 2m × 4/9

2mg − T = 8/9 mg

② Rf↑ = 0

NR = mg

Rf = → − ← = ma

T − fmax = m × 4/9 g

fmax = μNR

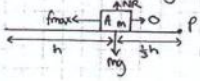
fmax = μ × mg

T − μmg = 4/9 mg ②

2mg − T = 8/9 mg ① +

$2mg-\mu mg=\frac{12}{9}mg$ $\mu g=2g-\frac{12}{9}g$ $\mu=2-\frac{12}{9}=\mu=\frac{2}{3}$

c) When B hits the ground



Rf = −fmax = ma ⇒ $-\frac{2}{3}mg=ma$ $a=-\frac{2}{3}g$

Before B hits the ground

u=0 $a=\frac{4}{9}g$ s=h $v^2=u^2+2as \Rightarrow v^2=2\times\frac{4}{9}g\times h$

$v^2=\frac{8}{9}gh$.

So when B hits the ground

$u^2=\frac{8}{9}gh$ $s=\frac{1}{3}h$ $a=-\frac{2}{3}g$

$v^2=u^2+2as \Rightarrow v^2=\frac{8}{9}gh+2\times-\frac{2}{3}g\times\frac{1}{3}h$

$v^2=\frac{8}{9}gh-\frac{4}{9}gh$

$v^2=\frac{4}{9}gh$

$v=\frac{2}{3}\sqrt{gh}$ ms⁻¹

d) Same tension on A and B.