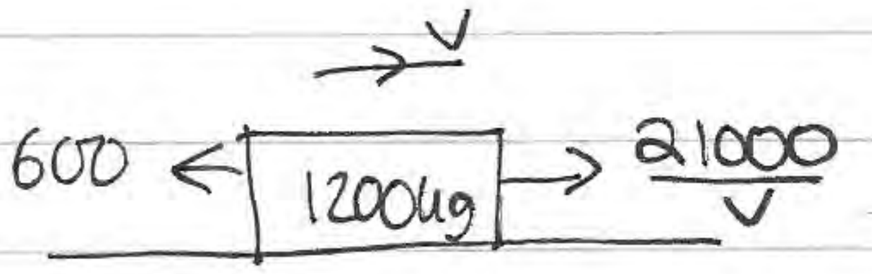
M2 JUNE 05

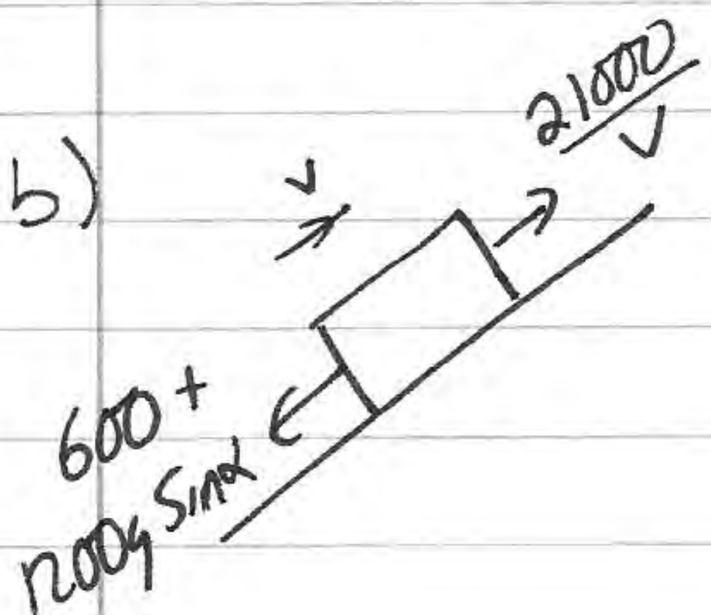
1)



$\overrightarrow{RF} = 0 \Rightarrow \frac{21000}{V} = 600$

$\Rightarrow V = 35\,ms^{-1}$

b)

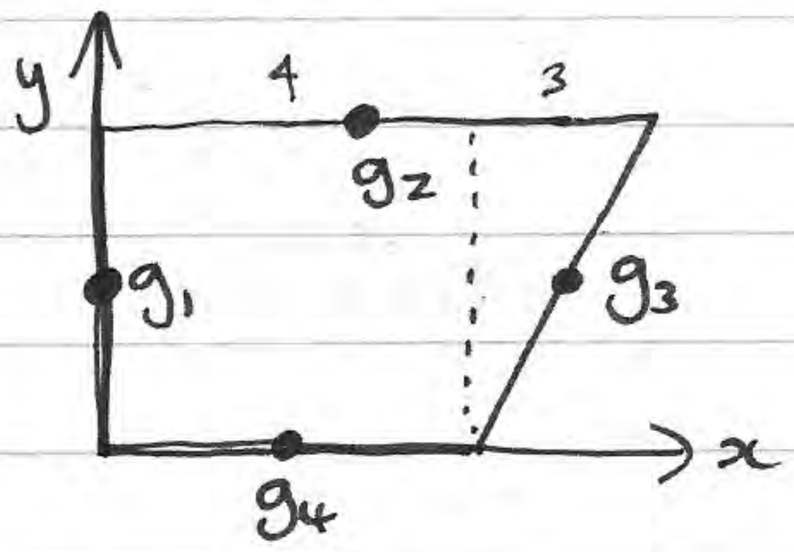


$\frac{21000}{V} = 600 + 1200g \times \frac{1}{14}$

$\Rightarrow 21000 = (600 + \frac{600}{7}g)V \Rightarrow V = \frac{21000}{600 + \frac{600}{7}g}$

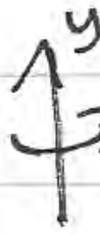
$\Rightarrow V = 14.6\,ms^{-1}$ (3sf)

2.



① $M = 4\rho$ $g_1(0,2)$
② $M = 7\rho$ $g_2(3.5,4)$
③ $M = 5\rho$ $g_3(5.5,2)$
④ $M = 4\rho$ $g_4(2,0)$

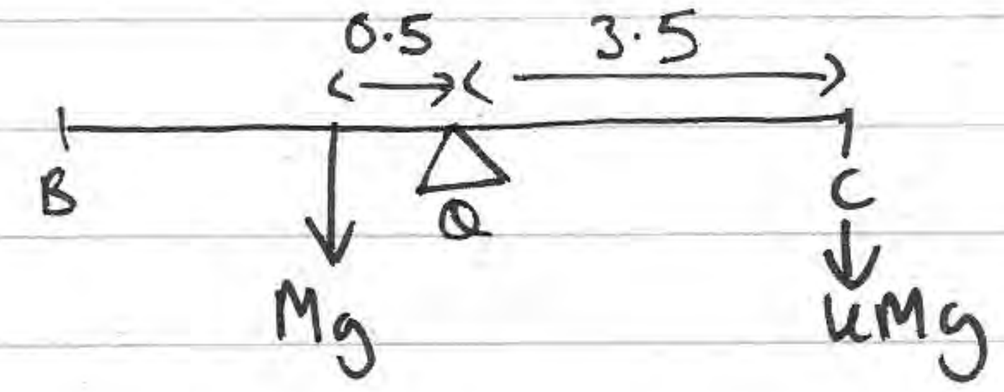
mass per unit $cm^2 = \rho$



$4\rho g \times 0 + 7\rho g \times 3.5 + 5\rho g \times 5.5 + 4\rho g \times 2 = 20\rho g \bar{x}$

$\Rightarrow 60 = 20\bar{x} \Rightarrow \bar{x} = 3$

b)



$\circlearrowleft^2$ $0.5Mg = 3.5kMg$

$\Rightarrow k = \frac{1}{7}$

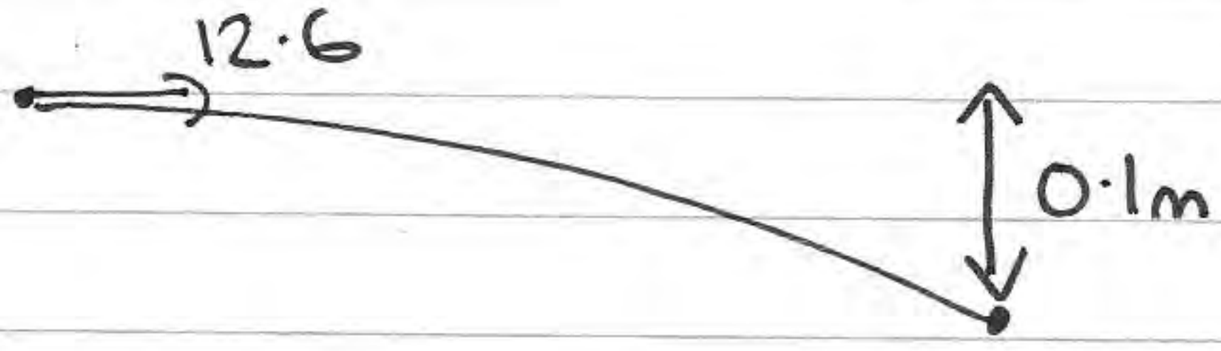
3) $v = \frac{dr}{dt} = (18 - 12t^2)i + 2ct\,j$

$t = 1.5$, $v = -9i + 3c\,j$ speed $= \sqrt{9^2 + (3c)^2} = 15$

$\Rightarrow 81 + 9c^2 = 225 \Rightarrow c^2 = 16 \Rightarrow c = 4$

b) $a = \frac{dv}{dt} = -24t\,i + 8j$ $t = 1.5$, $a = -36i + 8j\ ms^{-2}$

4)



(V↓) $u=0\downarrow$ $a=9.8\downarrow$ $s\downarrow=0.1$

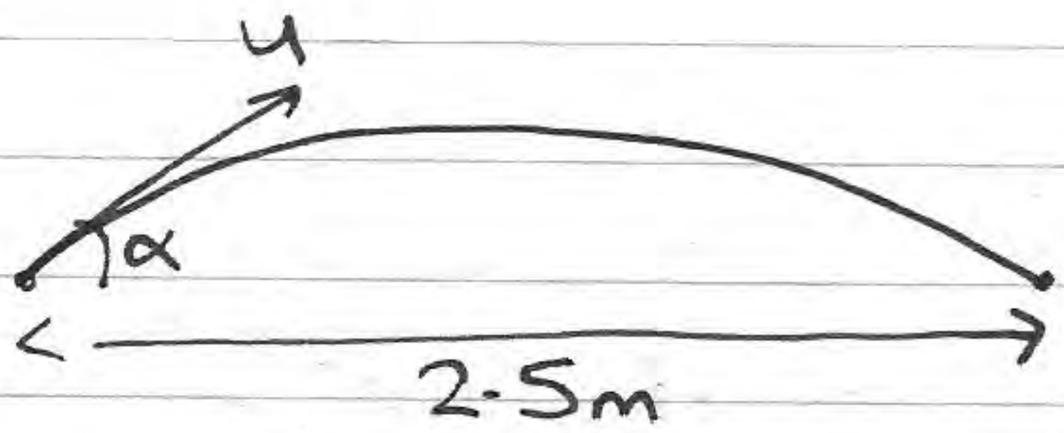
$s=ut+\frac{1}{2}at^2$

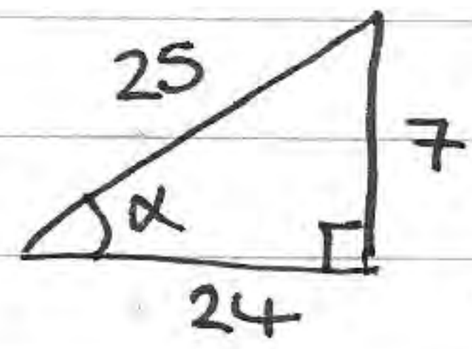
$\Rightarrow 0.1=4.9t^2$

$\Rightarrow t=\frac{1}{7}$ sec

(→) $Vel=12.6$ $t=\frac{1}{7}$ $x=12.6\times\frac{1}{7}=1.8m$

b)





$\cos\alpha=\frac{24}{25}$

$\sin\alpha=\frac{7}{25}$

(V↑) $u\uparrow=u\sin\alpha=\frac{7}{25}u$ $a\uparrow=-9.8$ $s=0$

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

$0=\frac{7}{25}ut-4.9t^2$

$t(\frac{7}{25}u-4.9t)=0$

$\Rightarrow t=\frac{2}{35}u$ sec

(→) $Vel=u\cos\alpha=\frac{24}{25}u$

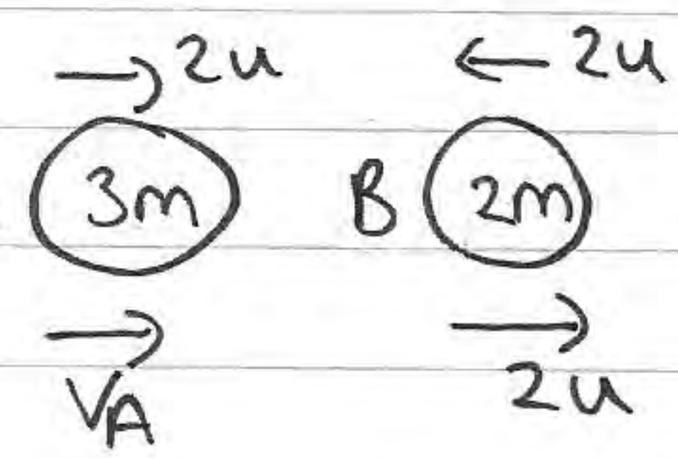
$x=2.5$ $t=\frac{2}{35}u$ sec

$2.5=\frac{24}{25}u\times\frac{2}{35}u$

$u^2=45.6\ ms^{-1}$

$\Rightarrow u=6.75ms^{-1}$ (3sf)

5)



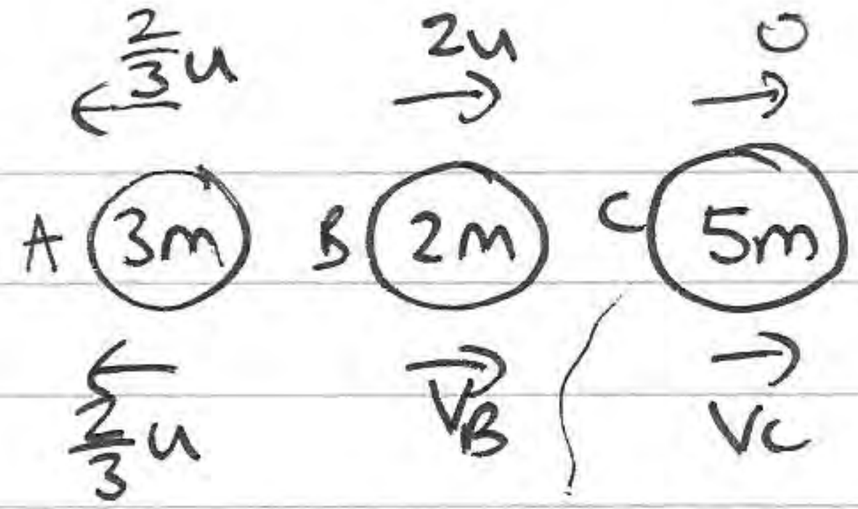
CLM $\Rightarrow 6mu-4mu=3mV_A+4mu$

$\Rightarrow -2mu=3mV_A$

$\Rightarrow V_A=-\frac{2}{3}u$

$e=\frac{sep}{app}=\frac{2\frac{2}{3}u}{4u}=\frac{2}{3}$

b)



$e_{BC} = \frac{V_C - V_B}{2u} = \frac{3}{5}$

$\Rightarrow 5V_C - 5V_B = 6u$

$\Rightarrow 5V_C = 6u + 5V_B$

$CLM_{BC} \Rightarrow 4mu = 2mV_B + 5mV_C$

$\Rightarrow 4mu = 2mV_B + m(6u + 5V_B)$

$\Rightarrow 4u = 7V_B + 6u$

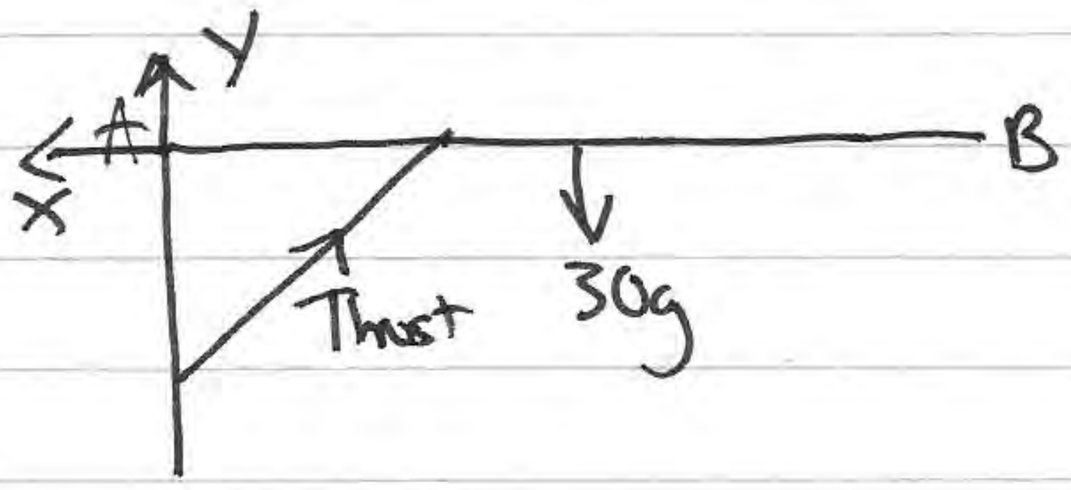
$\Rightarrow -2u = 7V_B$

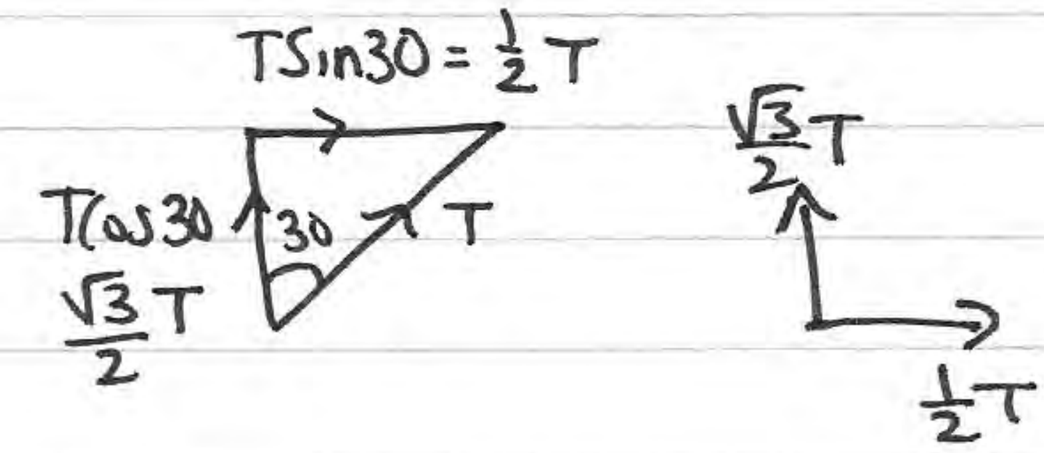
$\Rightarrow V_B = -\frac{2}{7}u$

$\leftarrow \quad \leftarrow$

$\therefore$ Since $V_A > V_B$ there will be no further collisions between A and B.

6)





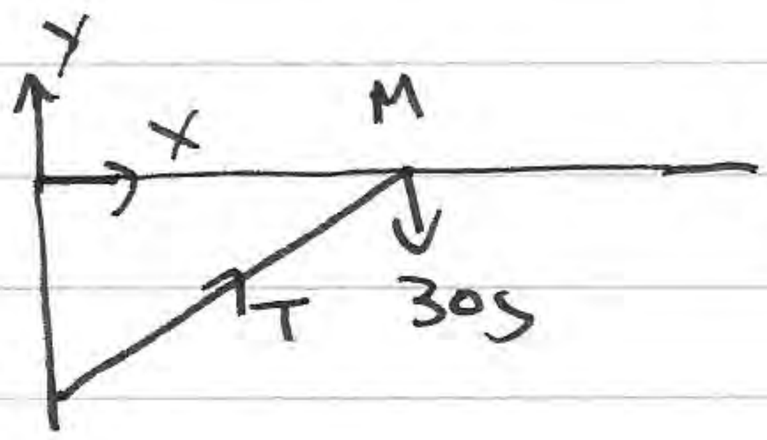
A2 $\frac{\sqrt{3}}{2}T \times 0.5 = 30g \times 1.5 \quad \Rightarrow T = \underline{60\sqrt{3}g\,N}$

b) $R\!\uparrow = 0 \quad Y + \frac{\sqrt{3}}{2}T = 30g \quad \Rightarrow Y = 60g\,N \downarrow$

$\overrightarrow{R} = 0 \quad X = \frac{1}{2}T \quad \Rightarrow X = 30\sqrt{3}g\,N \leftarrow$

$R = \sqrt{(30\sqrt{3}g)^2 + (60g)^2} \quad \Rightarrow R = \underline{30\sqrt{7}g\,N}$

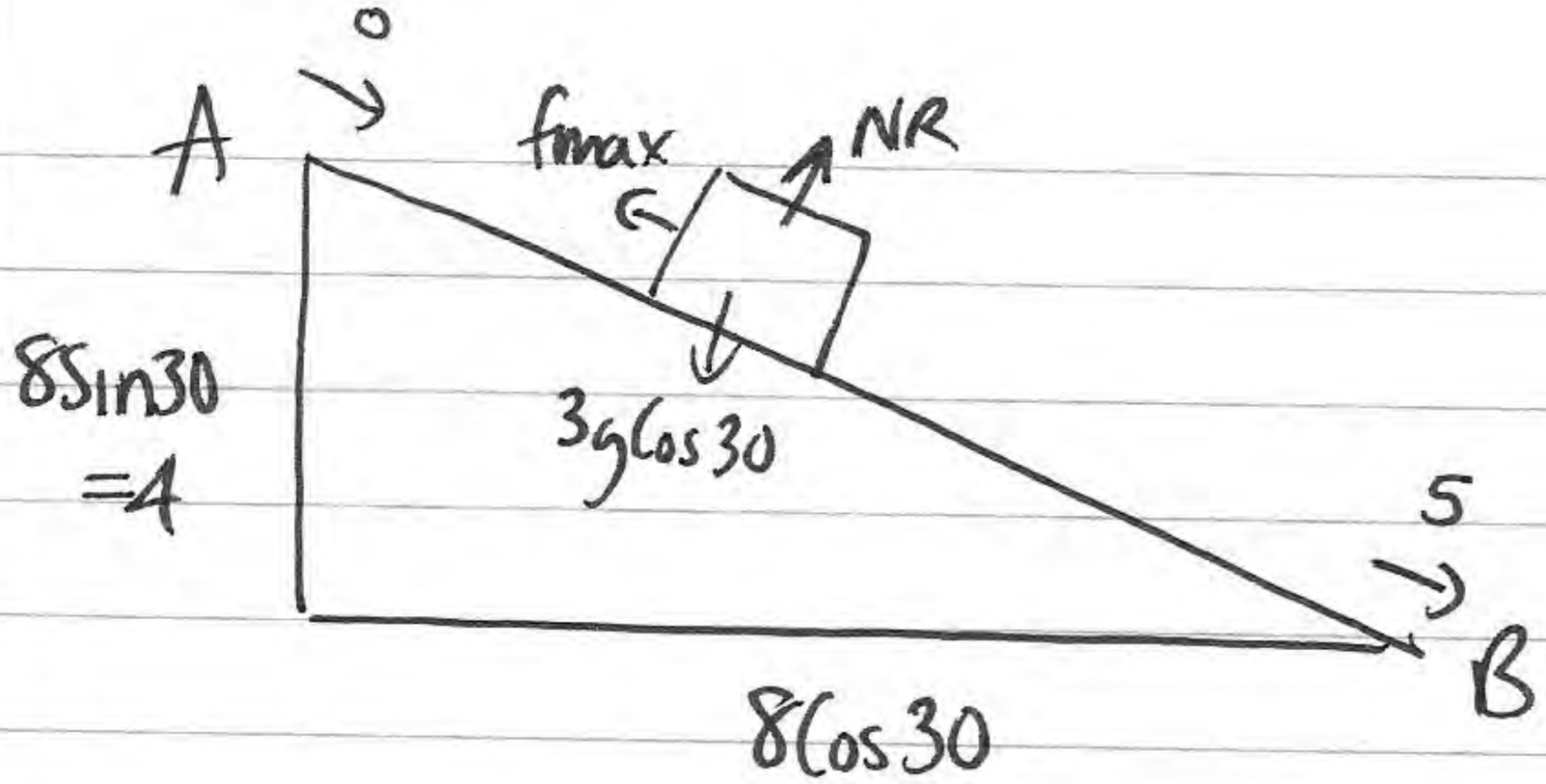
c)



$\curvearrowright M \quad Y \times 1.5 = 0 \Rightarrow Y = 0$

all other forces pass through M.

7)



a) PE lost = mgh = 3g(4) = 12g J

b) $KE_A + PE_A$ − Wd against friction = $KE_B + PE_B$

⇒ PE lost − friction × 8 = KE gain

⇒ $12g - 8f_{max} = \frac{1}{2}(3)5^2$ ⇒ $8f_{max} = 80.1$

⇒ $f_{max} = 10.0125$ $f_{max} = 10_N$ (2sf)

c) $f_{max} = \mu NR$ ⇒ $10 = \mu\, 3g(\frac{\sqrt{3}}{2})$ ⇒ $\mu = 0.39$ (2sf)

d) PE lost − Wd against friction = KE gain

$12g - 80.1 = \frac{1}{2}(3)(v^2 - 2^2)$ ⇒ $25 = v^2 - 4$

⇒ $v^2 = 29$ ⇒ $v = \underline{5.4\ ms^{-1}}$ (2sf)