

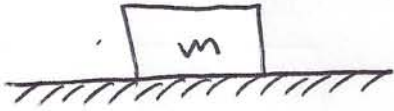
Draw a FBD and use Newton's 2nd Law to determine the unknown quantity for the following

A 10kg ball falling



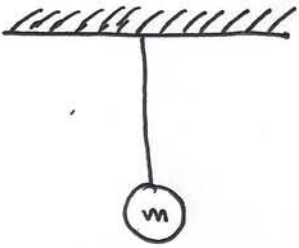
$$a =$$

A 10kg box on the floor



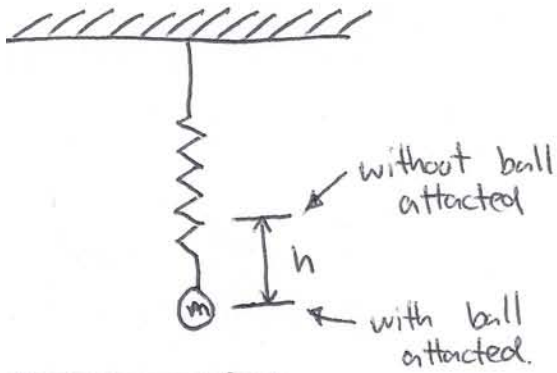
$N =$

A 10kg ball hanging from a rope



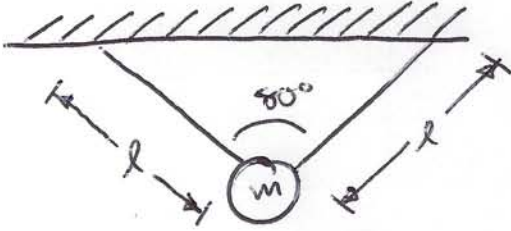
$T =$

A 10kg ball hanging from a spring ( $k=100 \text{ N/m}$ )

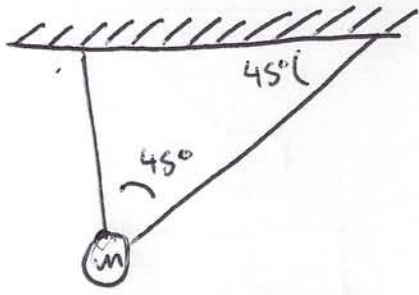


$h =$

A 10kg mass hanging from 2 ropes

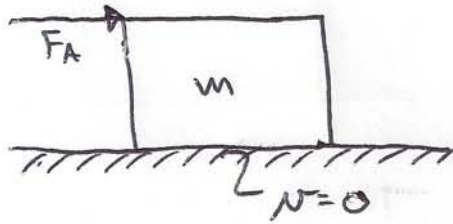


A 10kg mass hanging from 2 ropes



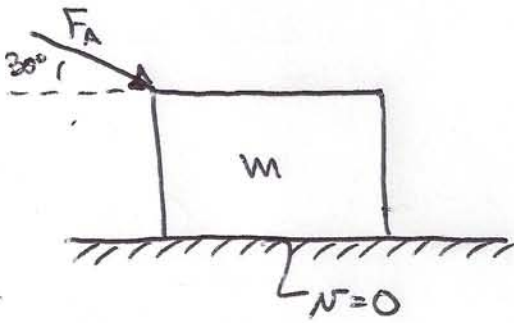
$T =$

Pushing a 1000kg mass with a force of 1000N on a frictionless surface ( $\mu=0$ )



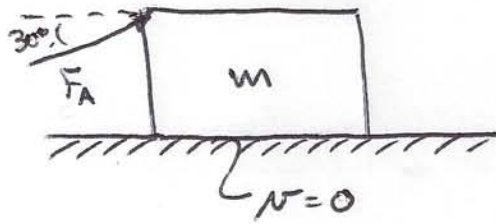
$a =$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  downward on a frictionless surface ( $\mu=0$ )



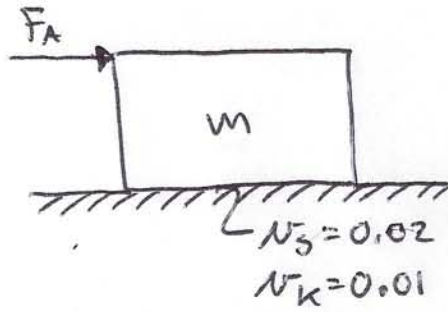
$a =$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  upward on a frictionless surface ( $\mu=0$ )



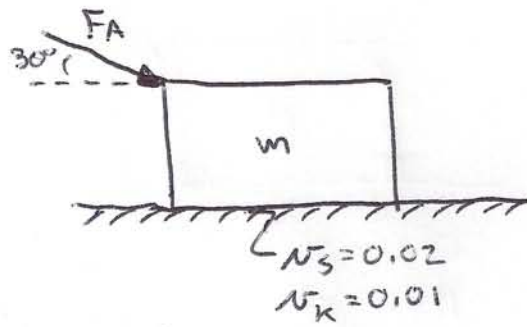
$a =$

Pushing a 1000kg mass with a force of 1000N on a surface with friction



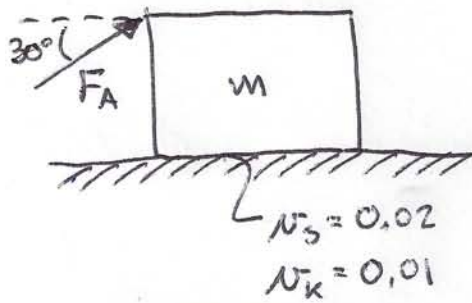
$a =$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  downward on a surface with friction



$a =$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  upward on a surface with friction

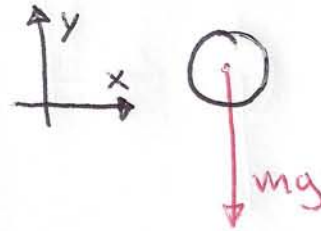


$a =$

Draw a FBD and use Newton's 2nd Law to determine the unknown quantity for the following

A 10kg ball falling

FBD:



x-dir

$$\sum F_x = ma_x$$

$$\boxed{0 = 0} \quad (a_x = 0)$$

-y-dir

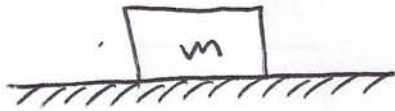
$$\sum F_y = ma_y$$

$$-mg = ma_y$$

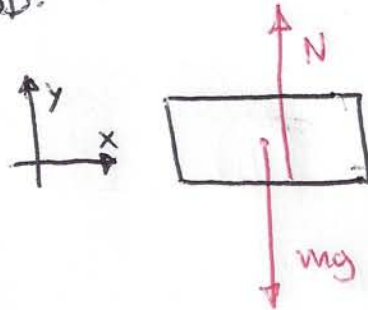
$$\boxed{a_y = -g}$$

$$\boxed{a_y = -g = -9.8 \text{ m/s}^2}$$

A 10kg box on the floor



FBD:



x-dir  
 $\Sigma F_x = m a_x$   
 $\boxed{0 = 0} \quad (a_x = 0)$

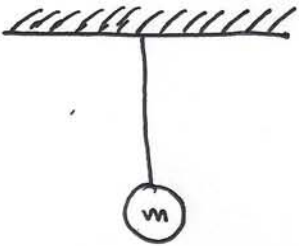
y-dir  
 $\Sigma F_y = m a_y$   
 $\boxed{N - mg = 0} \quad (a_y = 0)$   
eq (1)

Solve (1)

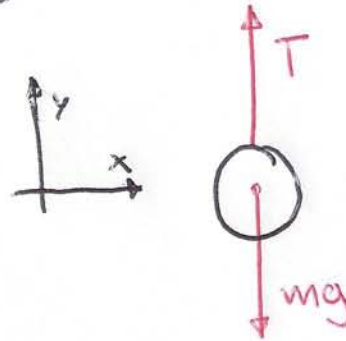
$$N = mg = (10)(9.8) \\ = 98 \text{ N}$$

$$\boxed{N = 98 \text{ N}}$$

A 10kg ball hanging from a rope



FBD:



x-dir

$$\sum F_x = ma_x$$

$$\boxed{0 = 0} \quad (a_x = 0)$$

y-dir

$$\sum F_y = ma_y$$

$$T - mg = 0 \quad (a_y = 0)$$

$$\boxed{T = mg}$$

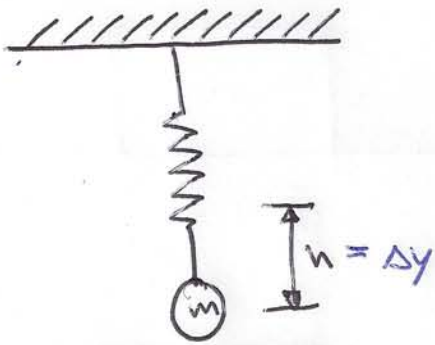
eq. (i)

solve (i)

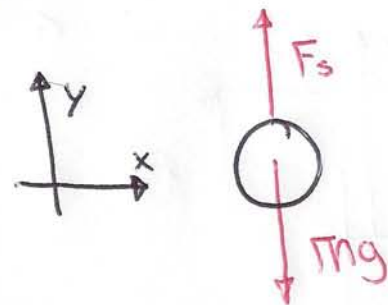
$$T = mg = (10)(9.8) = 98$$

$$\boxed{T = 98 \text{ N}}$$

A 10kg ball hanging from a spring ( $k=100 \text{ N/m}$ )



FBD:



x-dir

$$\sum F_x = ma_x$$

$$\boxed{0 = 0} \quad (a_x = 0)$$

y-dir

$$\sum F_y = ma_y$$

$$F_s - mg = 0 \quad (a_y = 0)$$

$$-k\Delta y - mg = 0$$

$$\boxed{\Delta y = -\frac{mg}{k}}$$

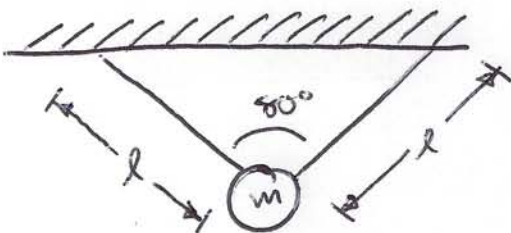
eq (1)

Solve (1)

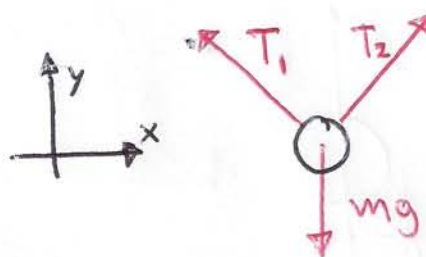
$$\Delta y = h = -\frac{mg}{k} = -\frac{(10)(9.8)}{100} = -0.98 \text{ m}$$

$$\boxed{h = -0.98 \text{ m}}$$

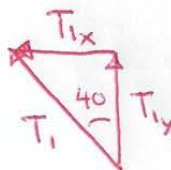
A 10kg mass hanging from 2 ropes



FBD:

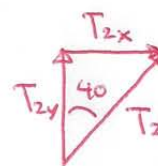


Trig:



$$T_{1x} = T_1 \sin 40$$

$$T_{1y} = T_1 \cos 40$$



$$T_{2x} = T_2 \sin 40$$

$$T_{2y} = T_2 \cos 40$$

x-dir

$$\sum F_x = ma_x$$

$$-T_1 \sin 40 + T_2 \sin 40 = 0 \quad (a_x = 0)$$

$$\boxed{T_1 = T_2 = T}$$

make equal  
to "T"

eq (2)

y-dir

$$\sum F_y = ma_y$$

$$\boxed{T_1 \cos 40 + T_2 \cos 40 - mg = 0}$$

eq (1)

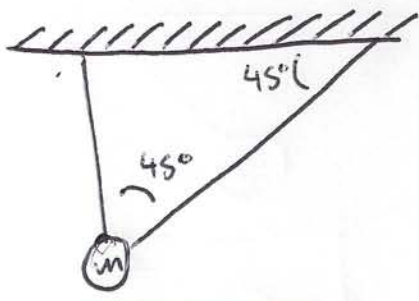
sub (2) into (1) and solve

$$T \cos 40 + T \cos 40 - mg = 0$$

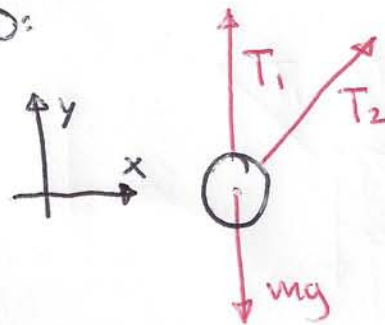
$$T = \frac{mg}{2 \cos 40} = \frac{(10)(9.8)}{2 \cos 40} = 63.96 \text{ N}$$

$$\boxed{T = 64 \text{ N}}$$

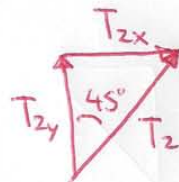
A 10kg mass hanging from 2 ropes



FBD:



Trig:



$$T_{2x} = T_2 \sin 45$$
$$T_{2y} = T_2 \cos 45$$

x-dir

$$\sum F_x = m a_x$$

$$T_2 \sin 45 = 0 \quad (a_x = 0)$$

$$\boxed{T_2 = 0} \quad \text{eq (2)}$$

y-dir

$$\sum F_y = m a_y$$

$$\boxed{T_1 + T_2 \cos 45 - mg = 0} \quad (a_y = 0)$$

eq (1)

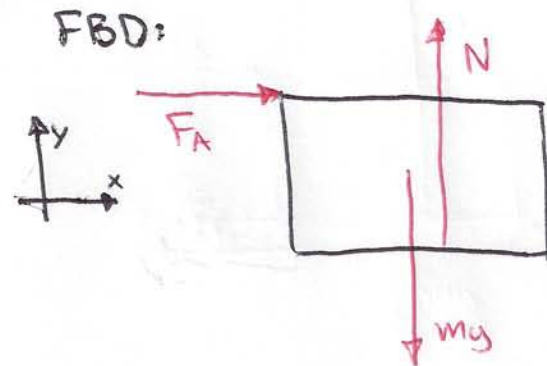
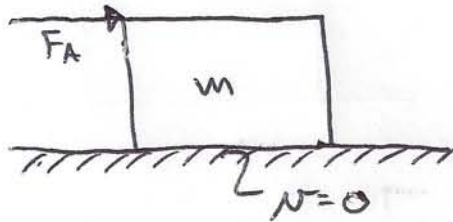
sub (2) into (1) and solve

$$T_1 + 0 - mg = 0$$

$$T_1 = mg = (10)(9.8) = 98 \text{ N}$$

$$\boxed{T = 98 \text{ N}}$$

Pushing a 1000kg mass with a force of 1000N on a frictionless surface ( $\mu=0$ )



x-dir

$$\sum F_x = ma_x$$

$$F_A = ma_x$$

$$\boxed{a_x = \frac{F_A}{m}} \quad \text{eq (2)}$$

y-dir

$$\sum F_y = ma_y$$

$$N - mg = 0 \quad (a_y = 0)$$

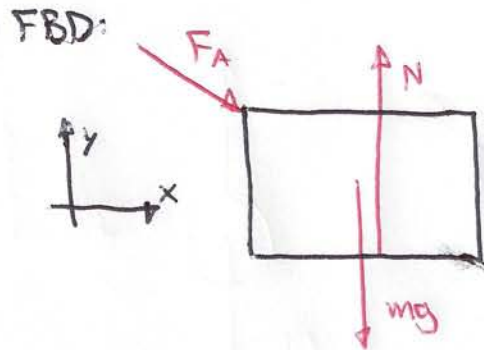
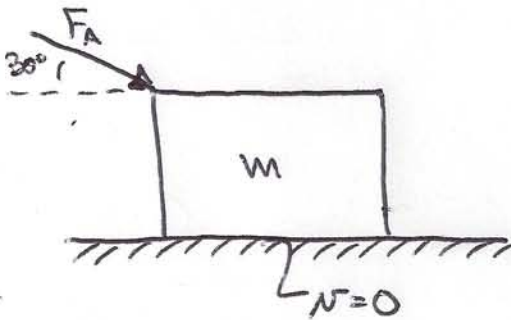
$$\boxed{N = mg} \quad \text{eq (1)}$$

solve (2)

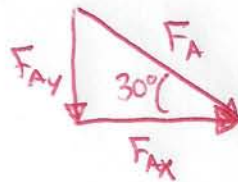
$$a_x = \frac{F_A}{m} = \frac{1000}{1000} = 1$$

$$\boxed{a_x = 1 \text{ m/s}^2}$$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  downward on a frictionless surface ( $\mu=0$ )



Trig:



$$F_{Ax} = F_A \cos 30$$

$$F_{Ay} = F_A \sin 30$$

x-dir

$$\sum F_x = ma_x$$

$$F_A \cos 30 = ma_x$$

$$a_x = \frac{F_A \cos 30}{m}$$

eq (2)

y-dir

$$\sum F_y = ma_y$$

$$N - mg - F_A \sin 30 = 0 \quad (a_y = 0)$$

$$N = mg + F_A \sin 30$$

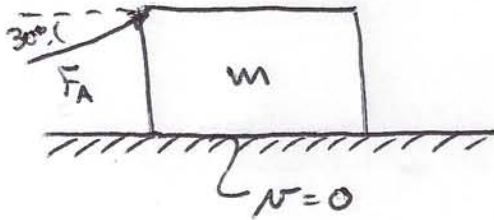
eq (1)

Solve (2)

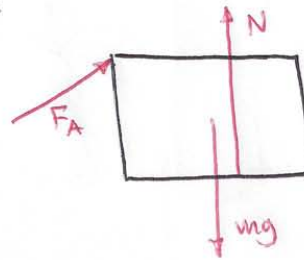
$$a_x = \frac{F_A \cos 30}{m} = \frac{1000 \cos 30}{1000} = 0.87 \text{ m/s}^2$$

$$a_x = 0.9 \text{ m/s}^2$$

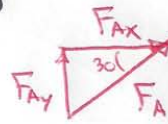
Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  upward on a frictionless surface ( $\mu=0$ )



FBD:



Trig:



$$F_{Ax} = F_A \cos 30$$

$$F_{Ay} = F_A \sin 30$$

x-dir

$$\sum F_x = m a_x$$

$$F_A \cos 30 = m a_x$$

$$a_x = \frac{F_A \cos 30}{m} \quad \text{eq (2)}$$

y-dir

$$\sum F_y = m a_y$$

$$N - mg + F_A \sin 30 = 0 \quad (a_y = 0)$$

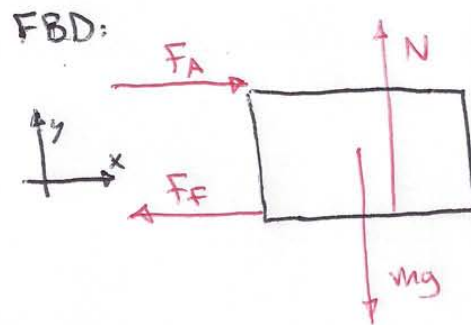
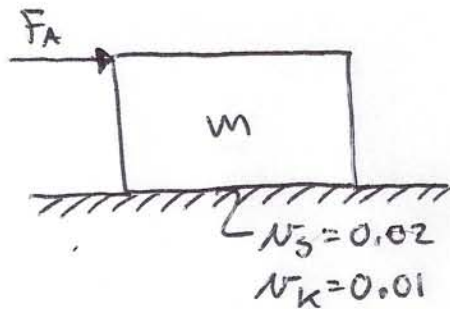
$$N = mg - F_A \sin 30 \quad \text{eq (1)}$$

solve (2)

$$a_x = \frac{F_A \cos 30}{m} = \frac{1000 \cos 30}{1000} = 0.87 \text{ m/s}^2$$

$$a_x = 0.9 \text{ m/s}^2$$

Pushing a 1000kg mass with a force of 1000N on a surface with friction



x-dir

$$\sum F_x = ma_x$$

$$F_A - F_f = ma_x$$

$$a_x = \frac{F_A - F_f}{m}$$

$$\boxed{a_x = \frac{F_A - \mu N}{m}} \quad \text{eq. (2)}$$

y-dir

$$\sum F_y = ma_y$$

$$N - mg = 0 \quad (a_y = 0)$$

$$\boxed{N = mg} \quad \text{eq. (1)}$$

sub (1) into (2) and solve

$$a_x = \frac{F_A - \mu(mg)}{m} = \frac{F_A - \mu mg}{m}$$

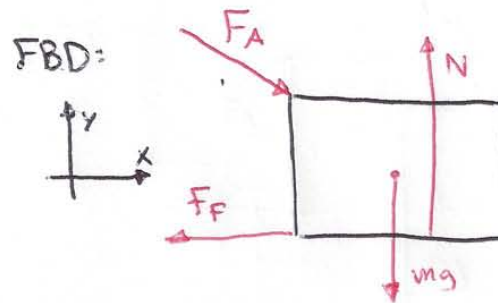
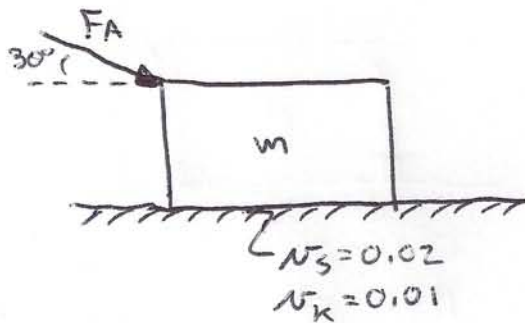
$$a_x = \frac{1000 - (0.02)(1000)(9.8)}{1000} = 0.8 \text{ m/s}^2$$

= +ive

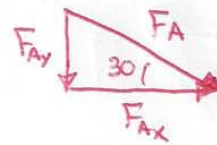
$$a_x = \frac{1000 - (0.01)(1000)(9.8)}{1000} = 0.9 \text{ m/s}^2$$

$$\boxed{a_x = 0.9 \text{ m/s}^2}$$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  downward on a surface with friction



Trig:



$$F_{Ax} = F_A \cos 30$$

$$F_{Ay} = F_A \sin 30$$

x-dir

$$\sum F_x = ma_x$$

$$F_A \cos 30 - F_F = ma_x$$

$$a_x = \frac{F_A \cos 30 - F_F}{m}$$

$$\boxed{a_x = \frac{F_A \cos 30 - \mu N}{m}} \quad \text{eq (2)}$$

y-dir

$$\sum F_y = ma_y$$

$$N - mg - F_A \sin 30 = 0 \quad (a_y = 0)$$

$$\boxed{N = mg + F_A \sin 30} \quad \text{eq. (1)}$$

sub (1) into (2) and solve

$$a_x = \frac{F_A \cos 30 - \mu (mg + F_A \sin 30)}{m}$$

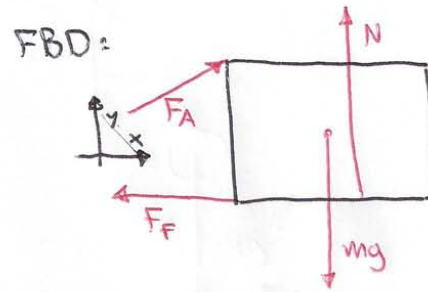
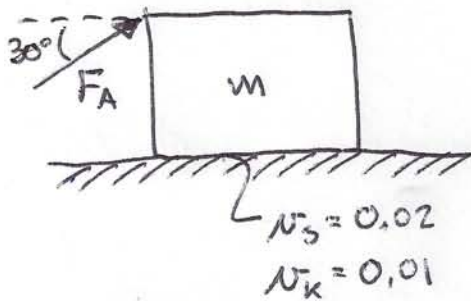
$$a_x = \frac{1000 \cos 30 - 0.02 (1000 \cdot 9.8 + 1000 \sin 30)}{1000} = 0.66 \text{ m/s}^2$$

= +ive

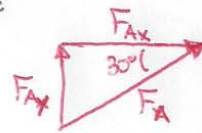
$$a_x = \frac{1000 \cos 30 - 0.01 (1000 \cdot 9.8 + 1000 \sin 30)}{1000} = 0.76 \text{ m/s}^2$$

$$\boxed{a_x = 0.8 \text{ m/s}^2}$$

Pushing a 1000kg mass with a force of 1000N at  $30^\circ$  upward on a surface with friction



Trig:



$$F_{Ax} = F_A \cos 30$$

$$F_{Ay} = F_A \sin 30$$

x-dir

$$\sum F_x = ma_x$$

$$F_A \cos 30 - F_f = ma_x$$

$$a_x = \frac{F_A \cos 30 - F_f}{m}$$

$$a_x = \frac{F_A \cos 30 - \mu N}{m} \quad \text{eq(2)}$$

y-dir

$$\sum F_y = ma_y$$

$$N - mg + F_A \sin 30 = 0 \quad (a_y = 0)$$

$$N = mg - F_A \sin 30 \quad \text{eq(1)}$$

sub (1) into (2), and solve

$$a_x = \frac{F_A \cos 30 - \mu (mg - F_A \sin 30)}{m}$$

$$a_x = \frac{1000 \cos 30 - 0.02 (1000 \cdot 9.8 - 1000 \sin 30)}{1000} = 0.68 \text{ m/s}^2$$

= +ive.

$$a_x = \frac{1000 \cos 30 - 0.01 (1000 \cdot 9.8 - 1000 \sin 30)}{1000} = 0.77 \text{ m/s}^2$$

$$a_x = 0.8 \text{ m/s}^2$$