NEWTON LAWS WORKSHEET 8

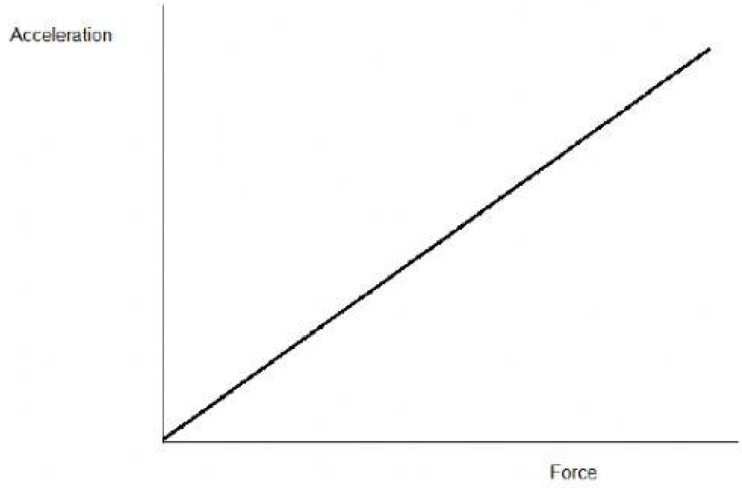
Newton's second law

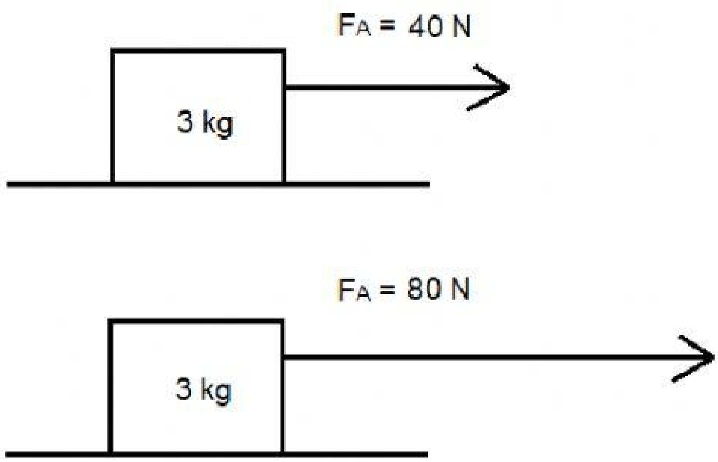
If a net (resultant) force acts on an object, the object will accelerate in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

Acceleration and force

a α Fnet

If a bigger net force is exerted on an object, then the acceleration of the object will be greater.





The object with the 80 N force exerted on it will have a greater acceleration than the object with the 40 N force on it. The Fnet is directly proportional to the acceleration.

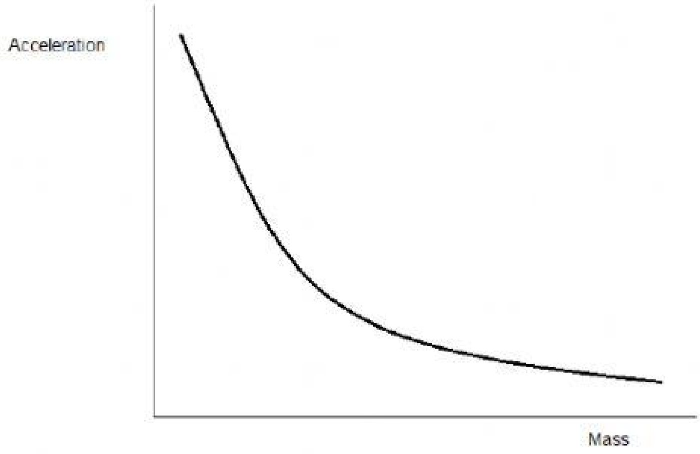
Remember that there is a mathematical relationship with variables when they are directly proportional.

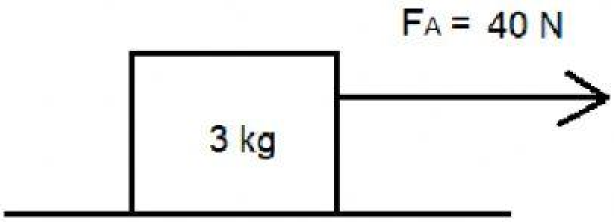
Thus if the Fnet doubles, then the acceleration will double.

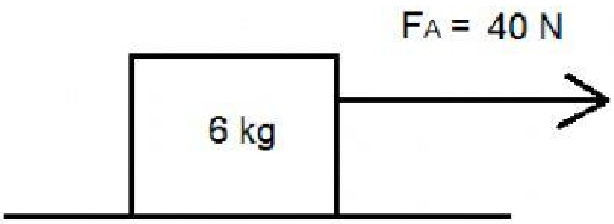
That is only if the 3^{rd} variable stays constant. In this case, the mass needs to stay constant.

Acceleration and mass

$a \propto \frac{1}{m}$







If the mass of the object increases, then the acceleration of the object will decrease.

If the mass doubles, the acceleration will halve, since the 2 variables are inversely proportional.

But only if the net force on both objects is the same.

If you put these two relationships together – you get this formula:

Thus $a = \frac{Fnet}{m}$

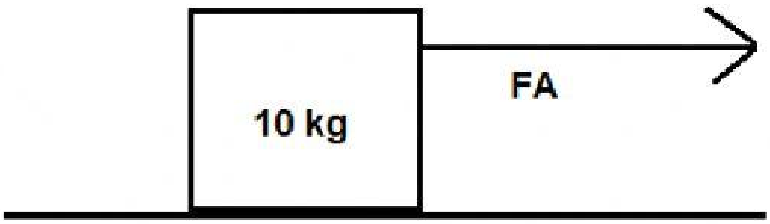
Fnet = m.a

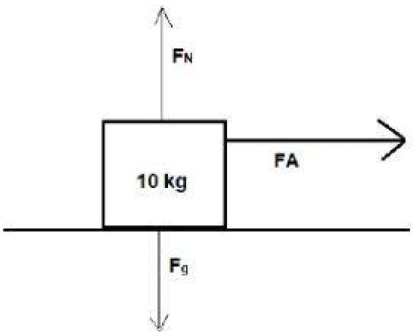
Examples

Calculate the acceleration of the following objects

1. A 10kg box is pulled to the right with a force of 300 N. Calculate the acceleration of the box.

Step 1: always draw a force or free body diagram of the situation.





You can assume that the $F_N = F_g$ are equal when the object is resting on a surface. Thus, unless they ask us to calculate it, you don't need to calculate these.

Step 2: write the formula

Fnet = m.a

Bigger – smaller force = 10.a

In this case there is only one horizontal force

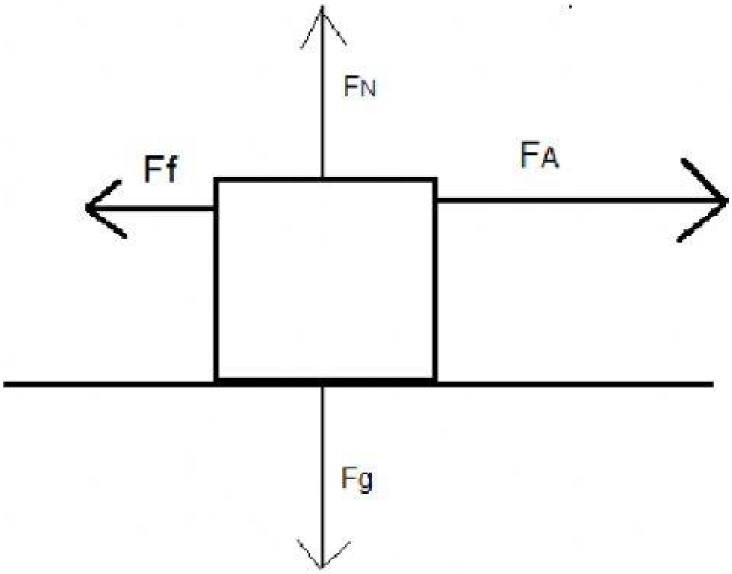
$F_A = 10.a$

300 = 10.a

$\frac{300}{10} = \frac{10}{10}.a$

a = 30m.s^{-2} to the right (since the bigger force is to the right)

2. A 20 kg box is pulled to the right with a force of 100 N and there is a frictional force of 30 N on the box.



Once again you can assume the $F_g = F_N$

Friction is always in the opposite direction as the motion of the object.

Fnet = m.a

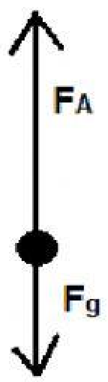
$F_A - F_f$ = 20 (a)

_______ –__ _____ = ______a

_____ = ______a

a = _______m.s^{-2} __________ {direction}

3. A 2 kg object is pulled up with a force of 40 N



Notice that there is no normal force on the object, since the object is not resting on a surface

Fnet = m.a

$F_A - F_g$ = m.a

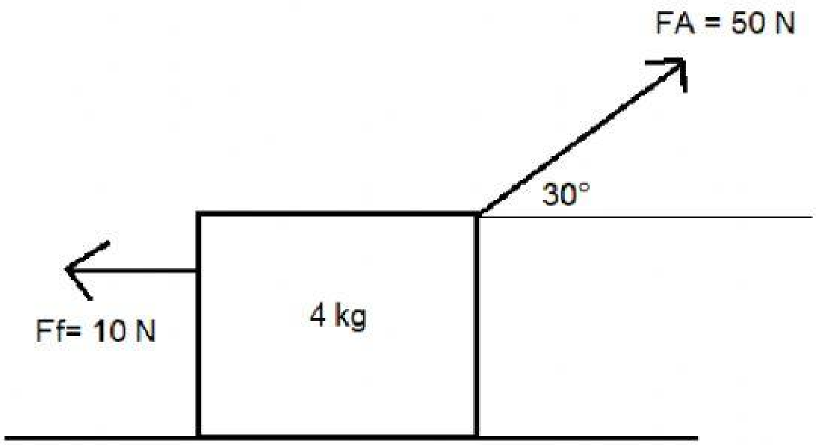
F_A – m.g = m.a

______ – _____ = _____.a

______ = _____.a

a = ______ $m.s^{-2}$ _________

4. A force of 50 N is applied at an angle to an object. There is a frictional force of 10 N on the object.



If the force acts at an angle – remember to calculate the components first

Horizontal forces:

Fx = F.cos Θ

= 50 (cos30)

=_________ N _______

Ff = 10 N left

Fnet = m.a

Fx – Ff = m.a

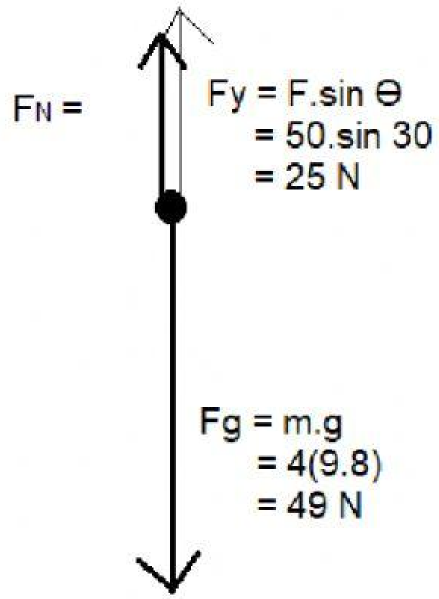
43,3 – 10 = 4.a

a = 8,33 $m.s^{-2}$ _______________ {direction}

Vertical forces

In this section they when an object is on a surface you can assume the vertical forces balance out.

But let's just calculate them to practise.

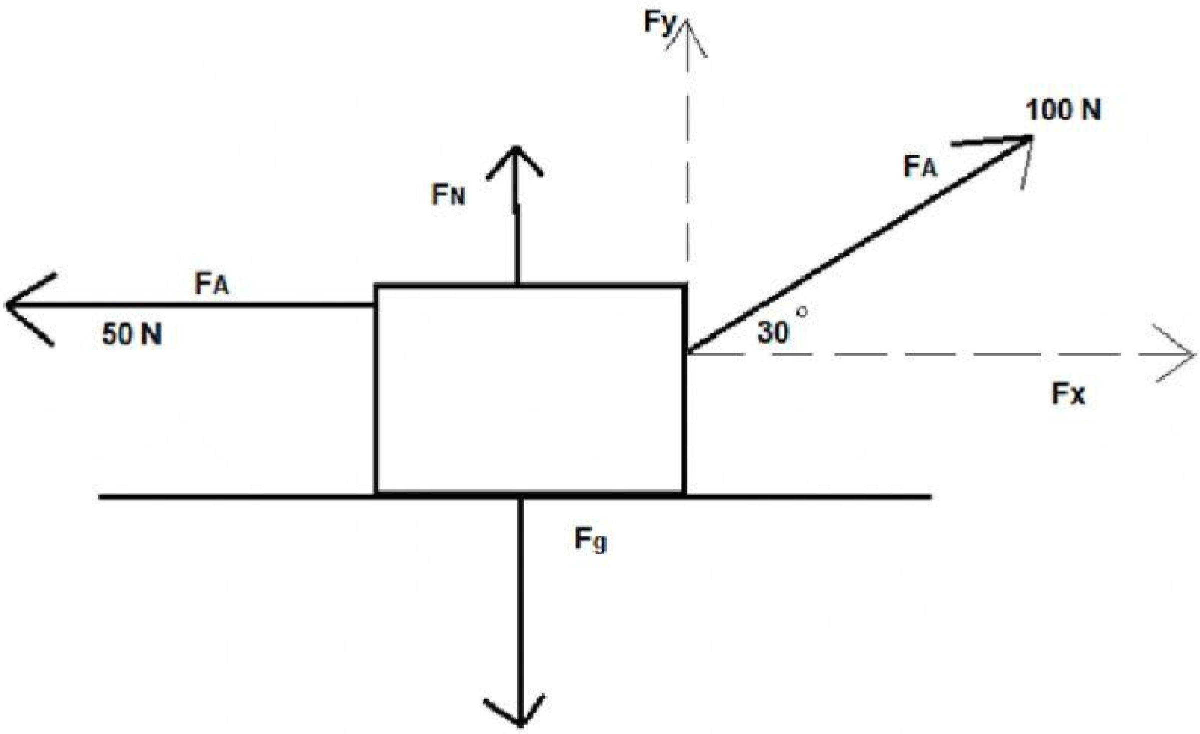


$F_N + Fy = Fg$

$F_N + 25 = 49$

$F_N = 24$ N upwards

5. A 7kg object is pulled to the right with a force of 100 N and at an angle of 30° to the horizontal and to the left with a force of 50 N.

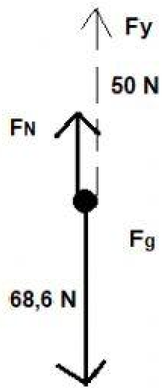


If you pull an object at an angle you need to calculate the Fx and Fy components first

Fx = F.cos Θ

= 100. Cos 30

= ______ N right



The force to the right is greater than the force to the left.

You can assume here that the vertical forces balance out

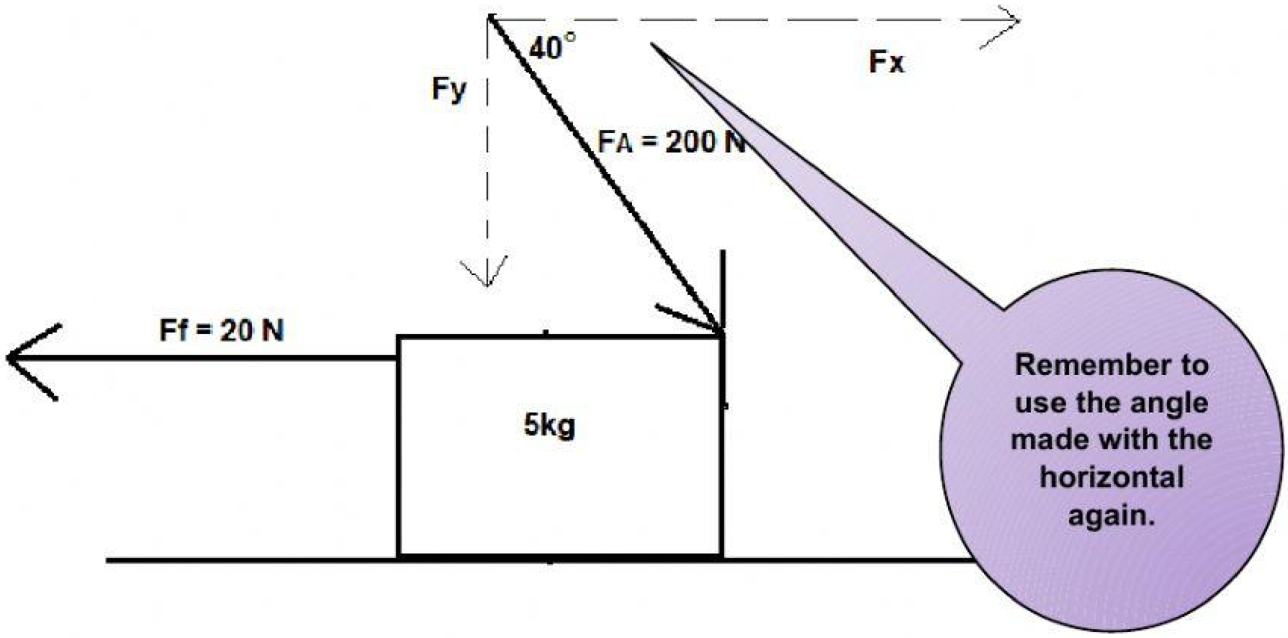
and thus the object doesn't move vertically

The vertical forces balance out and the object just ends up:________ _________

{choose from accelerating right, accelerating left, constant velocity or stationary)

6. A 5kg box is pushed down with a force of 200 N at an angle of 40° to the horizontal.

There is a frictional force of 20 N on the box to the left.



Horizontal forces:

Fx = F.Cos ϴ

= 200 (cos 40)

= ________ N _________

Ff = 20 N

Thus Fxnet = Fx – Ff

= 153,21 – 20

= _________ N

The object : _____________ _________________

{choose from accelerating right, accelerating left, constant velocity or stationary)

Vertical forces balanced out for interest sake