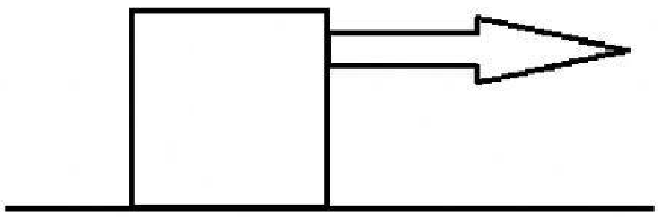
Newton worksheet 2

Drawing force and free body diagrams

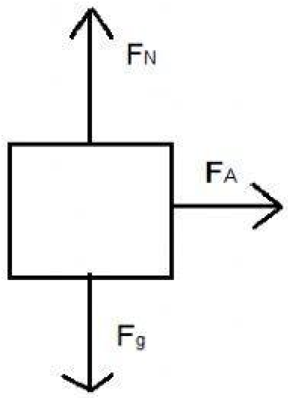
Examples

Draw a force diagram and then a free body diagram for the following

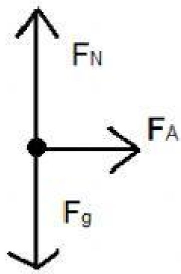
1. Sam exerts a 200 N force to the right, on a box which is lying on the floor. The surface is frictionless.



Force diagrams
(A box is always used to show the object)



Free body diagrams
(A dot is always used to show the object)



When you draw a force or free body diagram - you must have a key to show what all the symbols mean

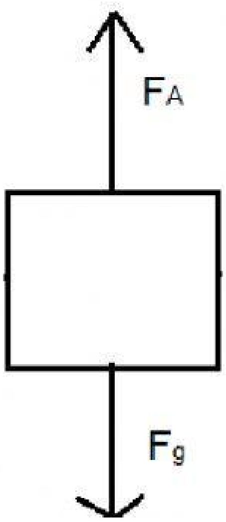
F_N : normal force

F_A : applied force

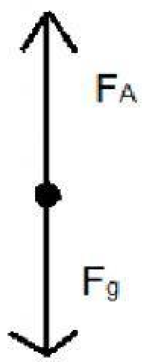
F_g : gravitational force

2. Luhle picks a box up and exerts a force of 200 N to do so. Ignore air friction.

Force diagrams



Free body diagrams



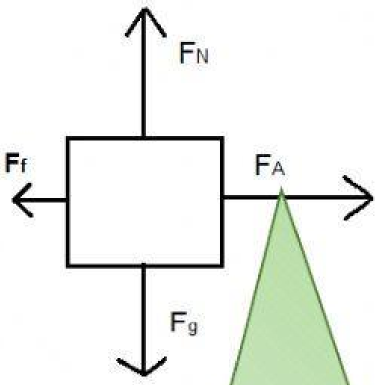
F_A : applied force

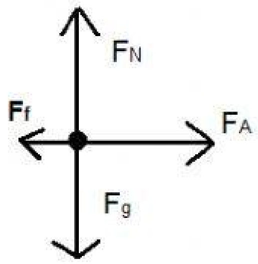
F_g : gravitational force

3. Olly pushes a pushes a box with a force of 150 N along a rough horizontal surface, which exerts a frictional force of 50 N on the box.

Force diagrams
(A box is always used to show the object)

Free body diagrams
(A dot is always used to show the object)





The size of the arrow lines are important. Notice the size of F_A in the question is 3 times the size of the F_f. Thus the arrow should be 3 times the length. It does not need to be measured. You can just estimate that size.

When you draw a force or free body diagram - you must have a key to show what all the symbols mean

F_N : normal force

F_A : applied force

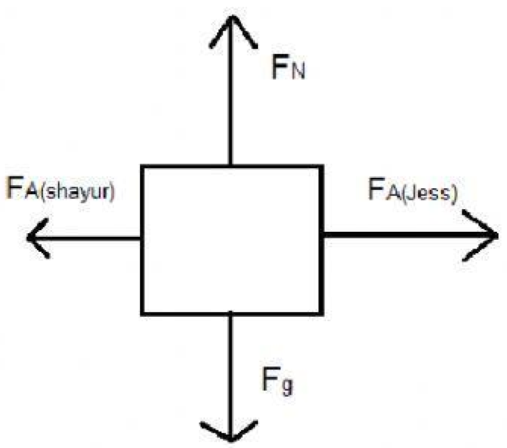
F_g : gravitational force

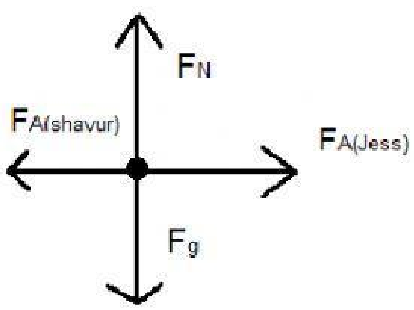
Ff : Frictional force

4. Jess exerts a force of 300 N on a box to the right and Shayur exerts a force of 200 N to the left.

Force diagrams

Free body diagrams





$F_{A(Jess)}$: Force applied by Jess

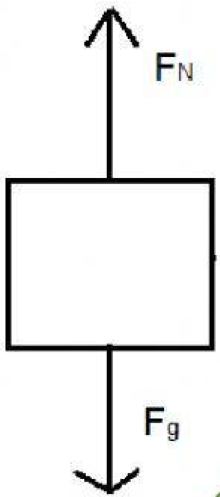
$F_{A(shayur)}$: Force applied by Shayu

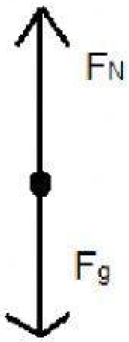
F_N : normal force

F_g : gravitational force

5. A box is stationary on the floor.

Force diagrams **Free body diagrams**





F_N : normal force

F_g : gravitational force

When an object is stationary then the forces acting on the object must be balanced. Thus the force of gravity pulling the box down and the normal force of the surface pushing up on the box is equal.

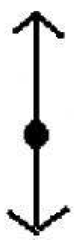
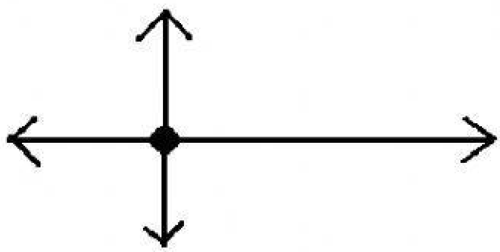
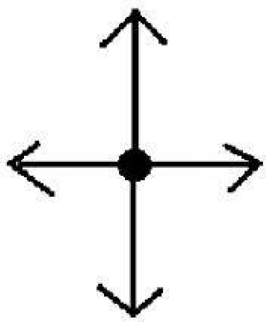
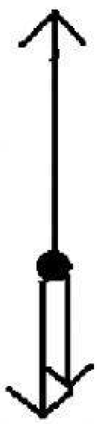
Thus you must ensure the length of the arrow lines are equal.

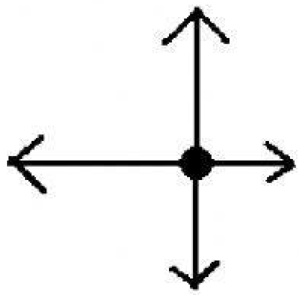
Exercise 2

Match the following **free bod**y diagram with the correct descriptions

Next to the description only type: A, B, C, D or E

Assume, unless otherwise stated, that the boxes are resting on a horizontal surface

A	
B	
C	
D	

E	

(You may only use each letter once in your answers)

2.1 A box is pulled to the right with a force of 80N and to the left with a force of 40 N

2.2 A box is pulled held stationary mid-air with a force of 50N

2.3 An object is pulled to the left with a force of 20 N and a frictional force of 5 N acts on it.

2.4 An object is pushed down onto the floor with a force of 100 N.

2.5 A force of 50N is exerted on a box to the left and a force of 50 N is exerted to the right.

Notice that when the horizontal and vertical forces are balanced the object is stationary.

When the forces are unbalanced the object moves (and accelerates) in the direction of the bigger force.

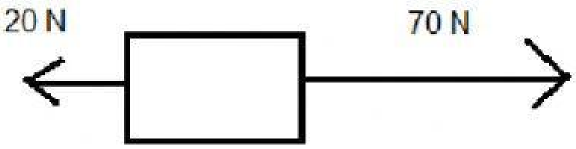
Exercise 3:

Calculating net/resultant force on the object

Leave no spaces between the answer value and units

Use the first one as an example

3.1 An object is pulled to the right with a force of 70 N and to the left with a force of 20 N



Fnet = 70 – 20

= 50N right (since the bigger force is to the right)

3.2 Two people pull an object is pulled to the left with a force of 30 N and 50 N.

A third person pulls the box to the right at 10N

= __________ _________

3.3 A box is pulled to the right with a force of 35 N and to the left with a force of 60 N to the right

= __________ _________

3.4 A box is pulled up with a force of 150 N to the left and with a force of 50 N to the right.

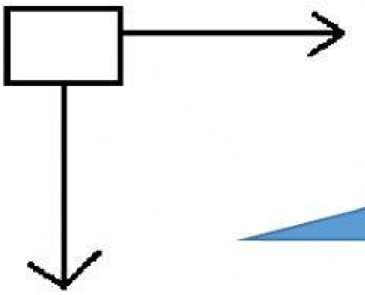
= __________ _________

What if the forces are not acting in a straight line?

Forces not acting in a straight line

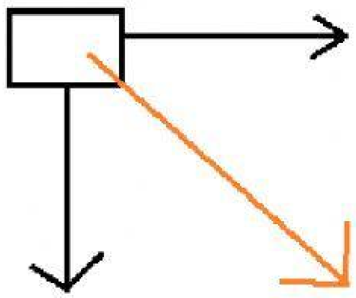
Eg 1. An object is pulled to the right at 60N and pushed down at 30N

Calculate the net/resultant force acting on the box



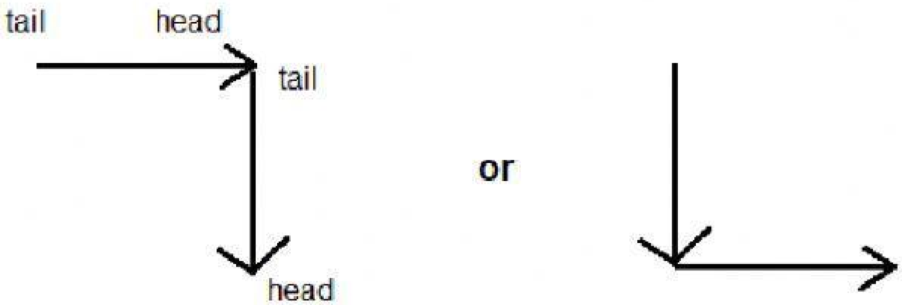
Think back to how you calculated displacement in gr 10 (displacement was the resultant distance a person would move.)

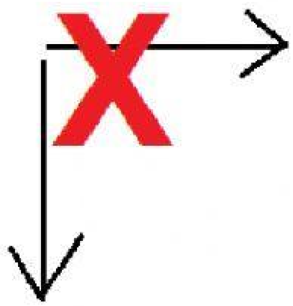
If you push a box down and to the right- you can imagine that'll end up moving somewhere in between those 2 directions. (As indicated by the orange line below)

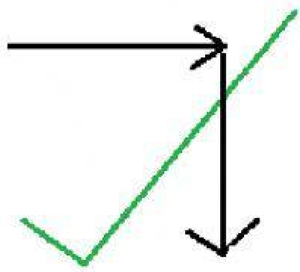


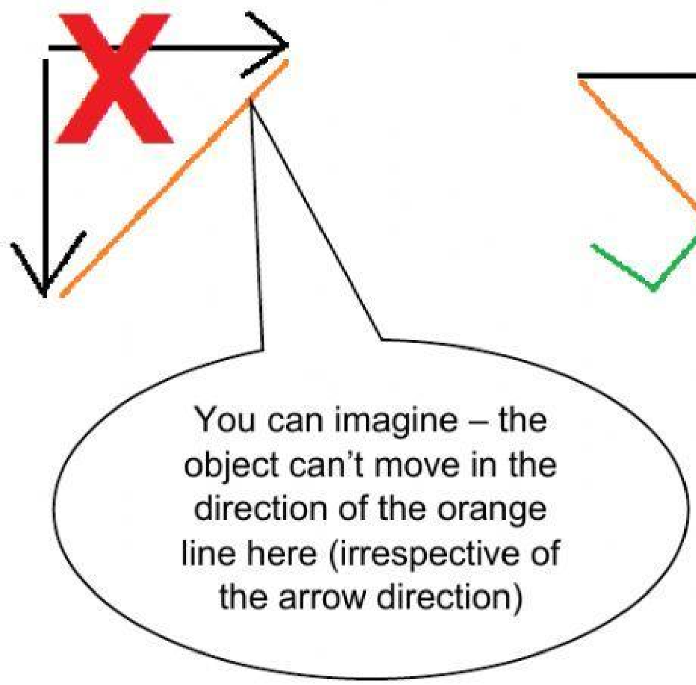
- In order to redraw the forces into a triangle that will actually give this orange line, we must draw the arrows head to tail.

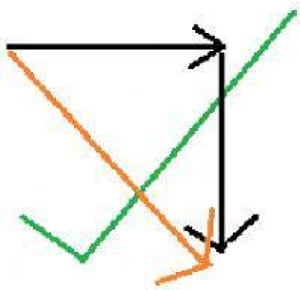
In other words, where the first arrow ends, the next arrow will start





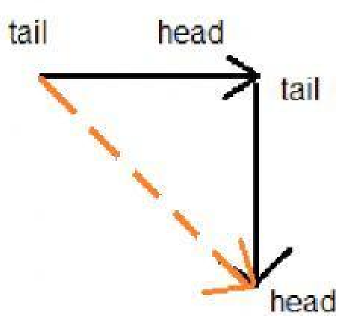




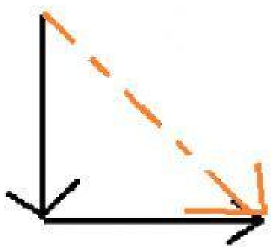


- Then join the tail of the first arrow to the tail of the last arrow. This will give you the net/resultant force. In other words it will show you the final direction the object will move in as a result of the 2 forces put together.

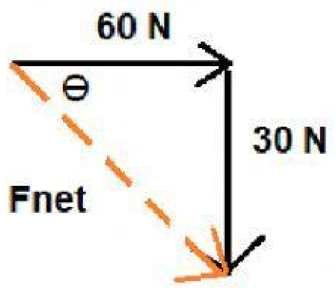
You can assume the angle is 90° since the forces were perfectly down and to the right



or



Then use Trig or Pyth to calculate the net force and the angle (if it is a right angled triangle)



Fnet = $F_1 + F_2$

= $60^2 + 30^2$

= $\sqrt{450}$

= 67,08 N

Remember that force is a vector and thus need a direction

You now need to calculate the direction in which the net force acts

Θ = ?

Soh Cah Toa

Sin Θ $= \frac{o}{h}$

cos Θ $= \frac{a}{h}$

tan Θ $= \frac{o}{a}$