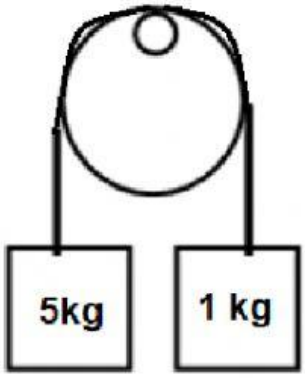
Newton laws worksheet 11

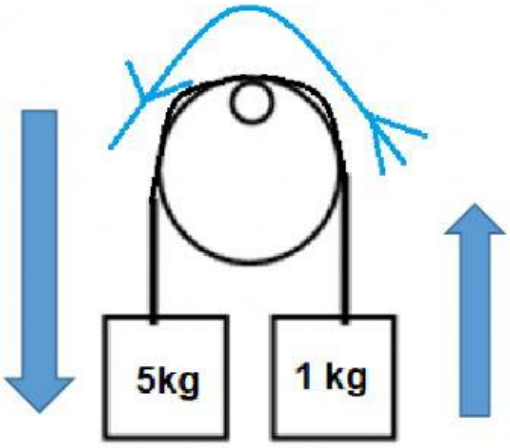
Objects not in a straight line

Eg 1. Calculate the (a) acceleration and (b) the tension in the string between the two boxes (F_T) of the system below



Look at this video first before starting the question

https://www.youtube.com/watch?v=kvCnjVSpuv0&t=308s



Firstly determine in what direction this system will move. Since the heavier object is the 5kg. The whole system will move in the direction of the 5kg block **(anti-clockwise)**

There is no normal force on the object, since it is not resting on a surface.

For acceleration – look at the system as a whole (add all the masses)

Fnet = m.a

$F_g(5kg) - F_g(1kg) = m.a$

m.g - m.g = m.a

5(9.8) - 1 (9,8) = 6.a

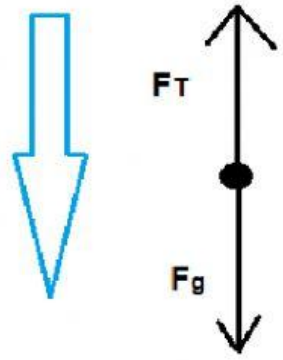
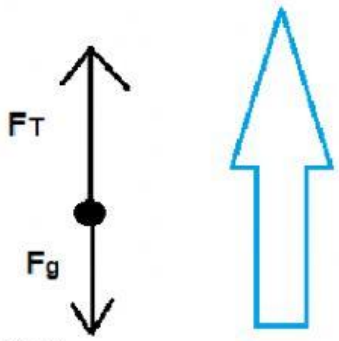
a = _____ $m.s^{-2}$ anti-clockwise

The only forces that are going to cause the system to move is gravity. There is

-no frictional force and

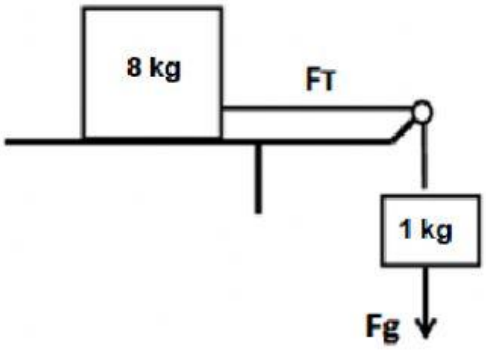
-remember that the tension cancels outs within the system

To calculate the tension – isolate all the blocks

5 kg object	1 kg object
Direction of motion 	
Fnet = m.a $F_g - F_T = m.a$ m.g – F_T = m.a 5 (9,8) – F_T = 5 (6,53) F_T = 16,35 N	Fnet = m.a $F_T - F_g = m.a$ F_T – m.g = m.a F_T – 1(9,8) = 1 (6,53) F_T = 16,33 N

Watch this video before looking at the next example

Eg 2. Calculate the (a) acceleration and (b) the tension in the string between the two boxes (F_T) of the system below



When determining the acceleration we usually look at the system as a whole – however:

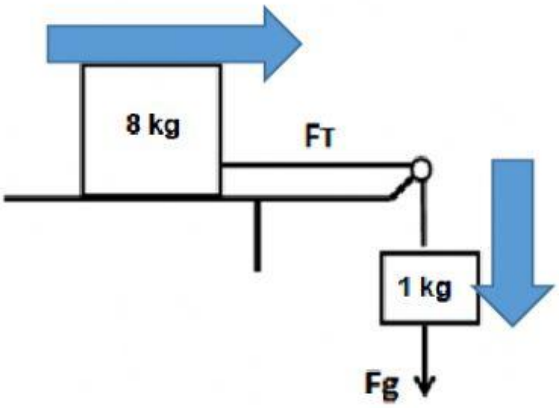
We are not allowed to in these situations, since the forces we objects are not moving in the same straight line

Fnet = m.a

Fg = m.a

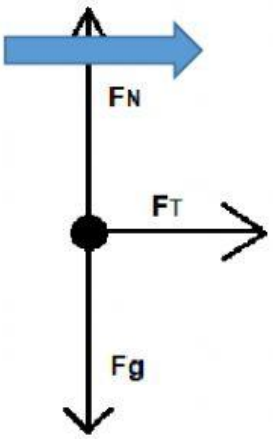
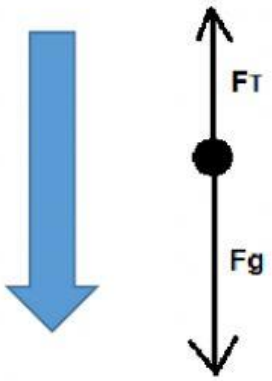
1(9,8) = (8+1).a

a = 1,09 $m.s^{-2}$



The 8 kg object is moving to the right and the 1 kg block is moving downwards.

Thus we need to break to objects up and then solve the equations simultaneously

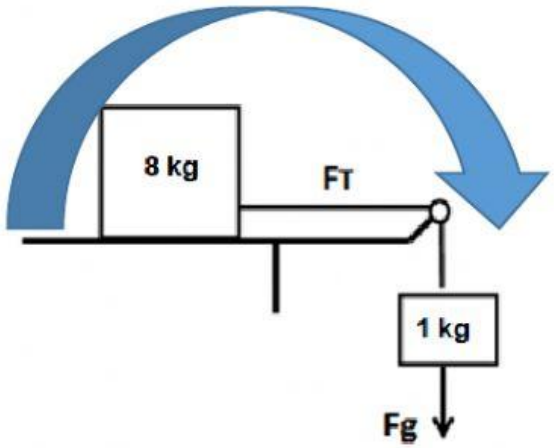
8 kg object	1 kg object
	
Fnet = m.a F_T = 8.a……1	Fnet = m.a $F_g - F_T$ = m.a m.g – F_T = m.a 1(9,8) - F_T = 1.a 1(9,8) – 1.a = F_T (get F_T by itself)……2

Now solve the equations simultaneously

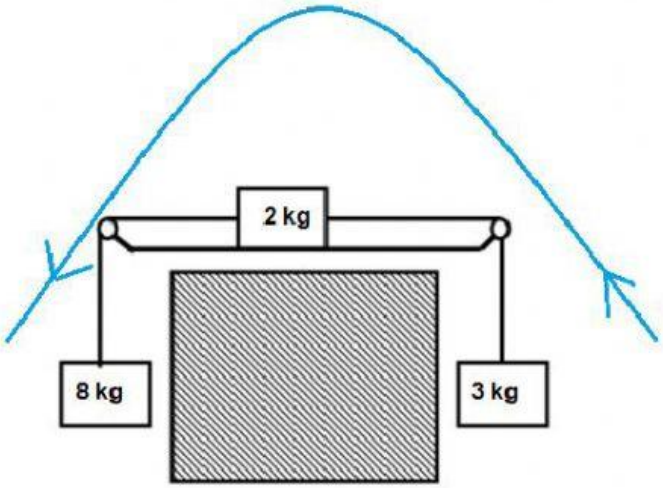
$8.a = 1(9,8) - 1.a$

$9.a = 9,8$

$a =$ _____ $m.s^{-2}$ clockwise



Eg 3 Calculate the acceleration of the system and the tension in both strings



The system will move anti-clockwise, since the heavier weight in on the left.

Remember that the system is frictionless at the moment, so you can imagine the system as laying on a block of ice.

For acceleration – we usually look at the system as a whole – however

We are not allowed to in these situations, since the forces we objects are not moving in the same straight line

Fnet = m.a

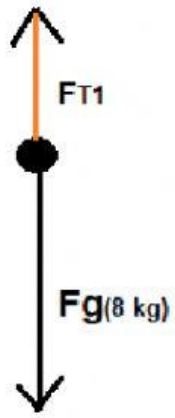
$F_{g8kg} - F_{g3kg} = m.a$

$m.g - m.g = m.a$

$8(9,8) - 3(9,8) = (8+3+2)a$

$a = 3,77\ m.s^{-2}$ anti-clockwise

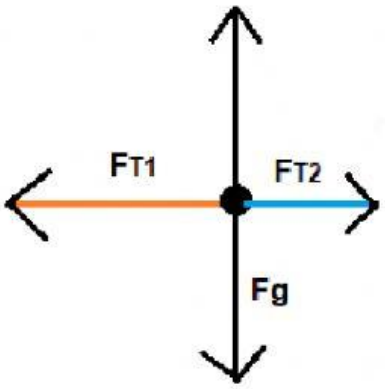
8 kg



Fnet = m.a
Fg – F_{T1} = m.a
m.g - F_{T1} = 8.a
8 (9,8) - F_{T1} = 8a

Get F_{T1} by itself
78,4 – 8.a = F_{T1}……..1

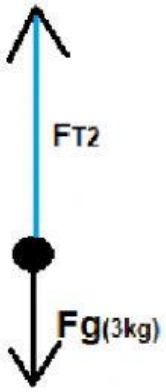
2 kg



Fnet = m.a
F_{T1} – F_{T2} = m.a
F_{T1} - F_{T2} = (2).a
F_{T1} - F_{T2} = 2.a

F_{T1} = 2.a + F_{T2}……..2

3kg



Fnet = m.a
F_{T2} – F_g = m.a
F_{T2} - m.g = 3.a
F_{T2}- 3(9,8) = 3.a

F_{T2} = 3(9,8) + 3.a…….3

78,4 – 8.a = F_{T1}……..1

F_{T1} = 2.a + F_{T2}……..2

Equate F_{T1} to F_{T1} first

78,4 – 8.a = 2.a + F_{T2}

F_{T2} = 3(9,8) + 3.a…….3

Then substitute the above into the F_{T2}'s place

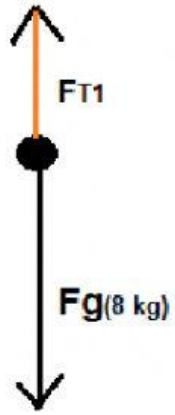
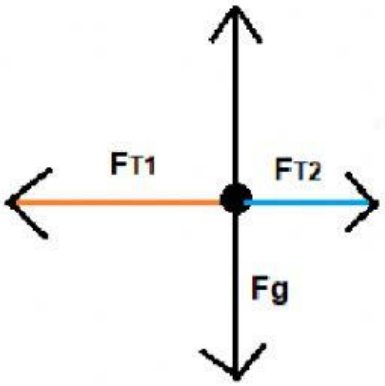
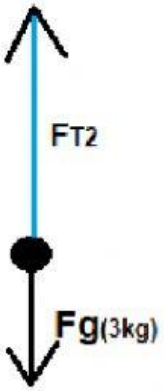
78,4 - 8.a = 2.a + 3 (9,8) + 3.a

49 = 13.a

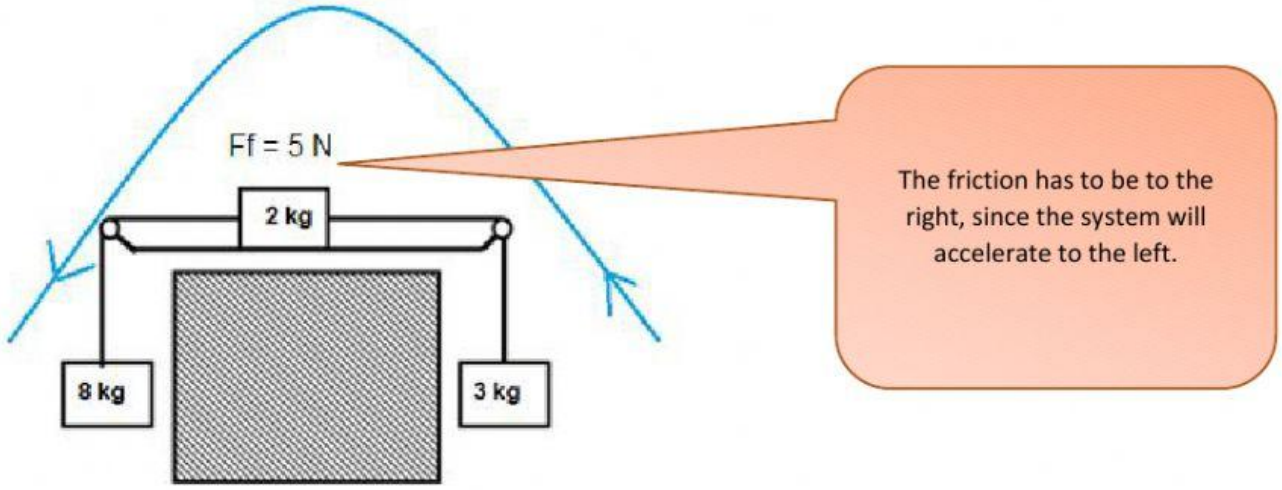
a = 3,77 $m.s^{-2}$ anti-clockwise

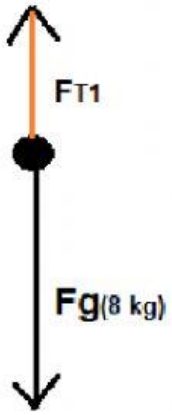
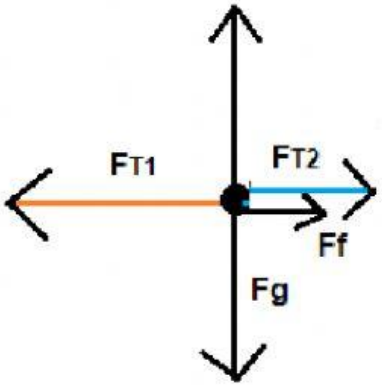
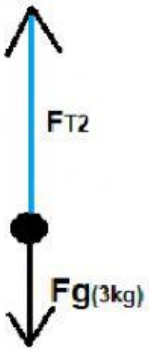
Label the tensions F_{T1} and F_{T2}, since it is 2 different strings with different tensions in them

Only now you can calculate the FT_1 and FT_2, by using any of the boxes below

8 kg	2 kg	3kg
		
Fnet = m.a Fg – F_{T1} = m.a 8(9,8) - F_{T1} = 8.(3,77) 78,4 – F_{T1} = 30,16 F_{T1} = 48,24 N	Fnet = m.a FT1 – FT2 = m.a F_{T1} - F_{T2} = (2).a F_{T1} - F_{T2} = 2.a F_{T1} = 2.a + F_{T2}……..2 I prefer not this block as I am missing both the tensions	Fnet = m.a F_{T2} – F_g = m.a F_{T2} - m.g = 3.a F_{T2}- 3(9,8) = 3.(3,77) F_{T2} = 3(9,8) + 3 (3,77) F_{T2} = 40,71 N

Eg 4. Let's look at the above example 3 again, but this time, let's add in friction into the question. Calculate the acceleration of the system and the tension in both strings



8 kg	2 kg	3kg
		
Fnet = m.a Fg – F_{T1} = m.a m.g - F_{T1} = 8.a _____ (9,8) - F_{T1} = 8a Get F_{T1} by itself 78,4 – 8.a = F_{T1}……..1	Fnet = m.a F_{T1} – F_{T2} = m.a F_{T1} - F_{T2} - Ff = ____.a F_{T1} - F_{T2} = 2.a F_{T1} = 2.a + F_{T2} + Ff……..2	Fnet = m.a F_{T2} – F_g = m.a F_{T2} - m.g = 3.a F_{T2}- 3(____) = 3.a F_{T2} = 3(9,8) + 3.a…….3

78,4 – 8.a = F_{T1}……..1

F_{T1} = 2.a + F_{T2} + Ff……..2

Equate F_{T1} to F_{T1} first

$78,4 - 8.a = 2.a + Ff + F_{T2}$

$F_{T2} = 3(9,8) + 3.a$ …….3

Then substitute the above into the F_{T2}'s place

$78,4 - 8.a = 2.a + 5 + 3\,(9,8) + 3.a$

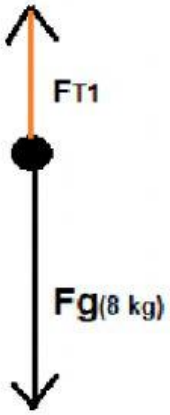
$44 = 13.a$

$a =$ _____ $m.s^{-2}$ anti-clockwise

Label the tensions F_{T1} and F_{T2}, since it is 2 different strings with different tensions in them

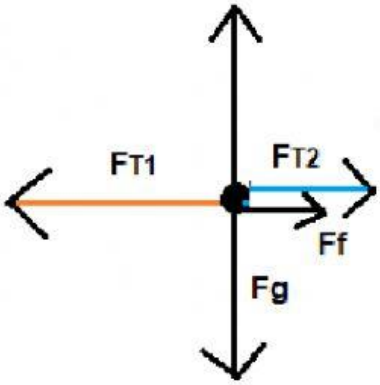
Then to calculate the tension:

8 kg

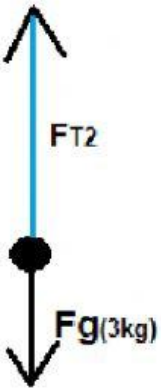


Fnet = m.a
$F_g - F_{T1} = m.a$
$8(9,8) - F_{T1} = 8.(3,38)$
$78,4 - F_{T1} = 30,16$
$F_{T1} =$ _____ N

2 kg



3kg



Fnet = m.a
$F_{T2} - F_g = m.a$
$F_{T2} - m.g = 3.a$
$F_{T2} - 3(9,8) = 3.(3,38)$

$F_{T2} = 3(9,8) + 3\,(3,38)$
$F_{T2} =$ _____ N