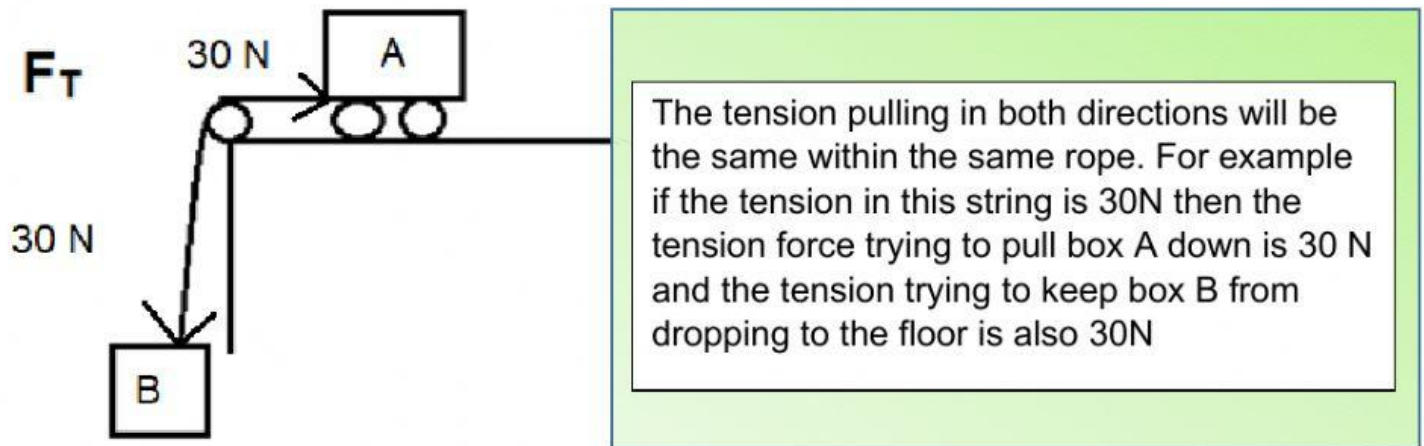


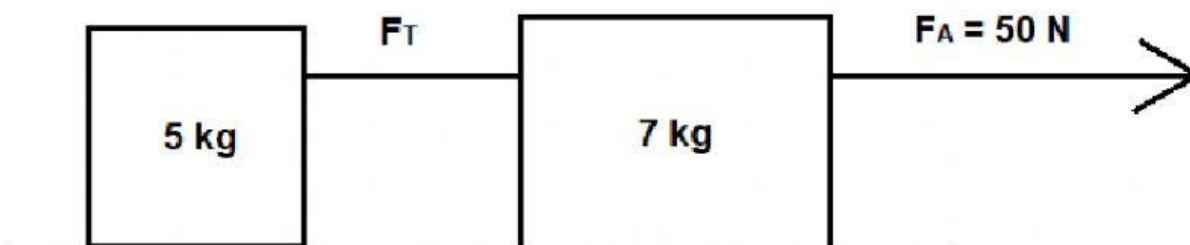
Newton laws worksheet 10

Questions including tension forces (2 or more objects)

When calculating tension force between 2 objects remember:



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



To calculate the acceleration of a system like this it is often useful to think of it as one object.

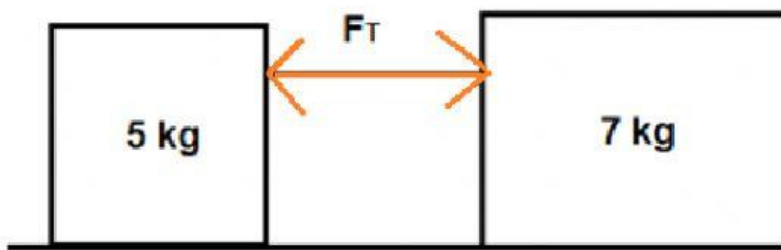
$$F_{\text{net}} = m \cdot a$$

$$*F_A = m \cdot a$$

$$50 = (5 + 7) \cdot a$$

$$50 = 12 \cdot a$$

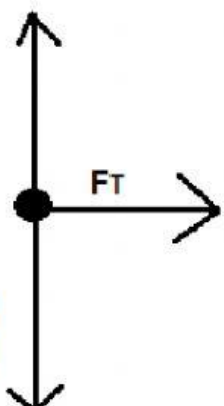
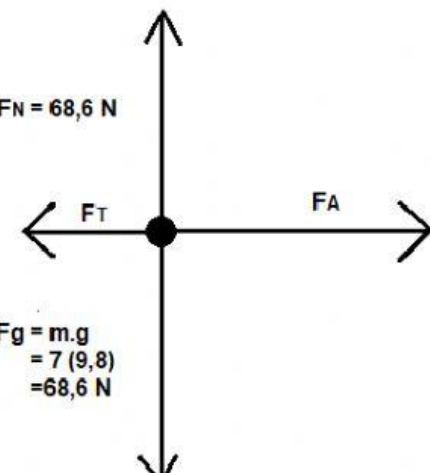
$$a = 4,17 \text{ m} \cdot \text{s}^{-2} \text{ right}$$



*The F_T is not included when you look at the whole system since the tension in the string (F_T) pulling the 5 kg to the right and the tension pulling the string pulling the 7 kg to the left is equal, and thus they would just cancel out.

However, when you are asked to calculate the tension in-between the boxes, then you will have to look at the boxes individually.

It's most useful here to break the system up and draw a free body diagram for each box separately.

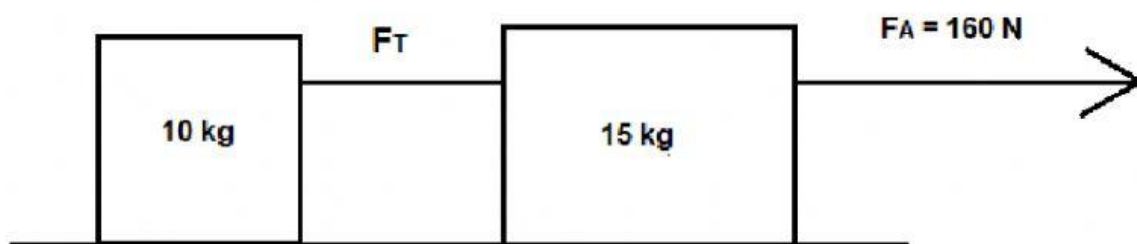
5 kg $F_N = 49 \text{ N}$ $F_g = m \cdot g$ $= 5(9,8)$ $= 49 \text{ N}$  Or The F_g and the F_N equal to each other and it is not necessary to calculate them. But we'll show them on the worksheets just to give more examples of calculating F_N. $F_{net} = m \cdot a$ $F_T = m \cdot a$ $F_T = 5(4,17)$ $= \underline{20,85 \text{ N right}}$	7 kg $F_N = 68,6 \text{ N}$ $F_g = m \cdot g$ $= 7(9,8)$ $= 68,6 \text{ N}$  $F_{net} = m \cdot a$ $F_A - F_T = m \cdot a$ $50 - F_T = 7(4,17)$ $F_T = \underline{21,81 \text{ N left}}$
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Notice the 2 answers are pretty much the same. If we hadn't rounded off the acceleration in (a) then the answers would have been the same.

Thus you do not need to calculate the tension for both boxes- it'll always be the same (perhaps with a decimal difference)

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

Try this one yourself first, before looking at the answer.



$$F_{\text{net}} = m \cdot a$$

$$160 = (10 + 15) \cdot a$$

$$160 = 25 \cdot a$$

$$a = 6,4 \text{ m} \cdot \text{s}^{-2} \text{ right}$$

10 kg Or The F_g and the F_N equal to each other and it is not necessary to calculate them. But we'll show them on the	15 kg $F_{\text{net}} = m \cdot a$ $F_A - F_T = m \cdot a$ $160 - F_T = 15(6,4)$
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worksheets just to give more examples of calculating FN.

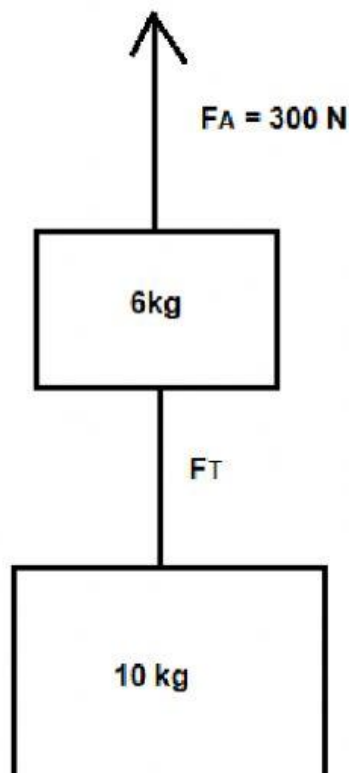
$$F_{\text{net}} = m \cdot a$$

$$F_T = m \cdot a$$

$$F_T = 10 (6,4) \\ = \underline{64 \text{ N right}}$$

$$F_T = \underline{64 \text{ N left}}$$

Eg 3. Calculate the (a) acceleration and (b) the tension in the string between the two boxes (F_T) of the system below



a) For the acceleration look at the system as a whole

$$F_{\text{net}} = m \cdot a$$

$$F_A - F_{g(6\text{kg})} - F_{g(10\text{kg})} = m \cdot a$$

$$300 - m \cdot g - m \cdot g = m \cdot a$$

$$300 - 6(9,8) - 10(9,8) = 16 \cdot a$$

$$143,2 = 16 \cdot a$$

$$a = 8,95 \text{ m} \cdot \text{s}^{-2} \text{ right}$$



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

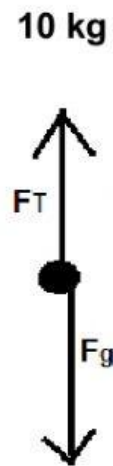
$$F_{\text{net}} = m \cdot a$$

$$F_A - F_T - F_g = m \cdot a$$

$$300 - F_T - m \cdot g = m \cdot a$$

$$300 - F_T - (6)(9,8) = 6(8,95)$$

$$F_T = 187,5 \text{ N}$$



$$F_{\text{net}} = m \cdot a$$

$$F_T - F_g = m \cdot a$$

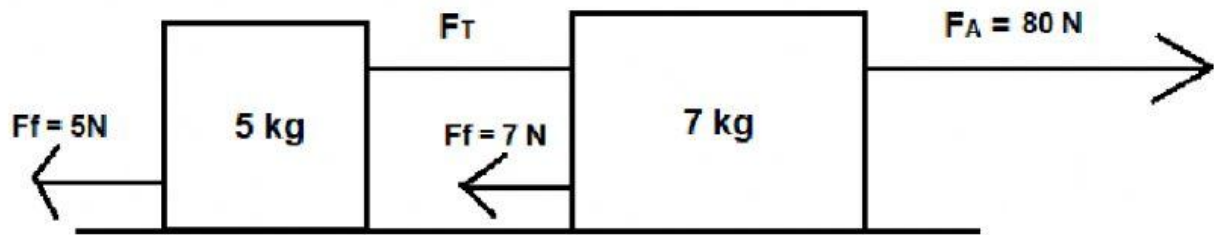
$$F_T - m \cdot g = m \cdot a$$

$$F_T - (10)(9,8) = 10(8,95)$$

$$F_T = 187,5 \text{ N}$$

Since you don't know the value for F_T yet, you can't exactly draw that force to scale yet. Thus you don't need to draw F_T to scale here.

Eg 4. Calculate the (a) acceleration and (b) the tension in the string between the two boxes (F_T) of the system below



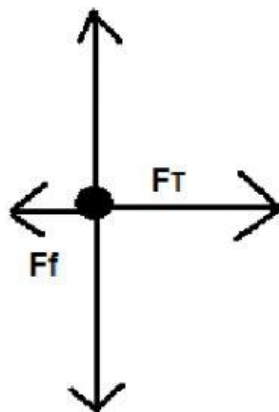
a) $F_{\text{net}} = m \cdot a$

$$F_A - F_{f_{5\text{kg}}} - F_{f_{7\text{kg}}} = m \cdot a$$

$$80 - 5 - 7 = 12 \cdot a$$

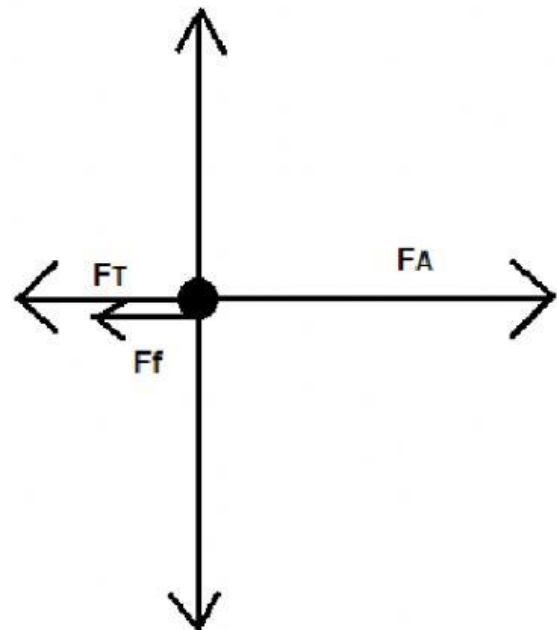
$$a = 5,67 \text{ m} \cdot \text{s}^{-2}$$

5 kg



Or

7 kg



$$F_{\text{net}} = m \cdot a$$

$$F_T - F_f = m \cdot a$$

$$F_T - 5 = 5(5,67)$$

$$= \underline{33,35 \text{ N right}}$$

$$F_{\text{net}} = m \cdot a$$

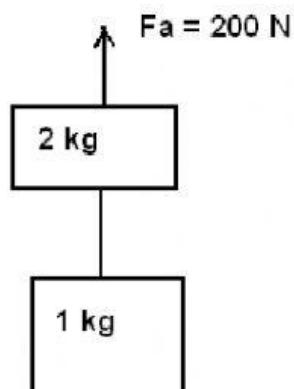
$$F_A - F_T - F_f = m \cdot a$$

$$80 - F_T - 7 = 7(5,67)$$

$$F_T = \underline{33,31 \text{ N left}}$$

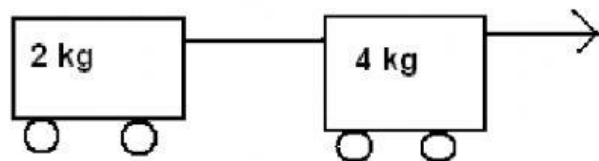
Exercise 8:

1. Calculate the acceleration of the system on the right.
(Ignore air resistance)



$a =$ _____

2.



If a 30 N force is applied to the 4 kg trolley to the right, calculate:

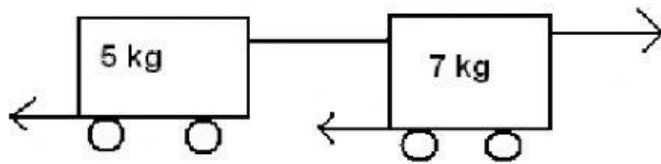
2.1 The acceleration of the system

$a =$ _____

2.2 the tension in the string

$F_T =$ _____

3.



A force of 80 N is applied to the 7 kg trolley to the right. The 5 kg trolley experiences a frictional force of 1 N and the 7 kg trolley experiences a frictional force of 1,5 N. Determine the:

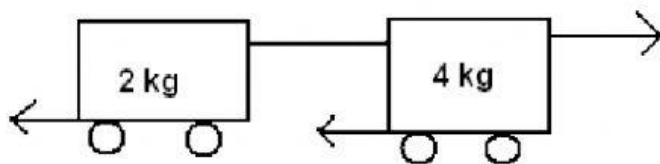
3.1 acceleration of the 7 kg trolley

$a =$ _____

3.2 the tension in the cable

$F_T =$ _____

4.



If a the system experiences an acceleration of 4m.s^{-2} , and the 2 kg trolley experiences a frictional force of 2 N and the 4 kg trolley experiences a frictional force of 4 N, calculate the applied force on the 4 kg trolley.

$F_A =$ _____