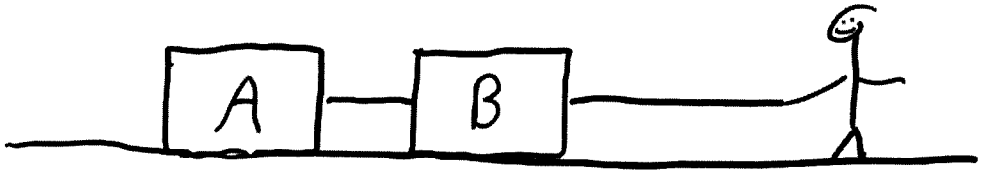
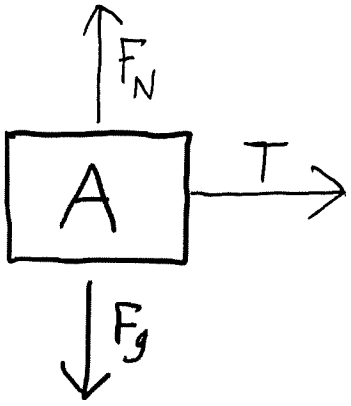
Tension Practice

Name:_____

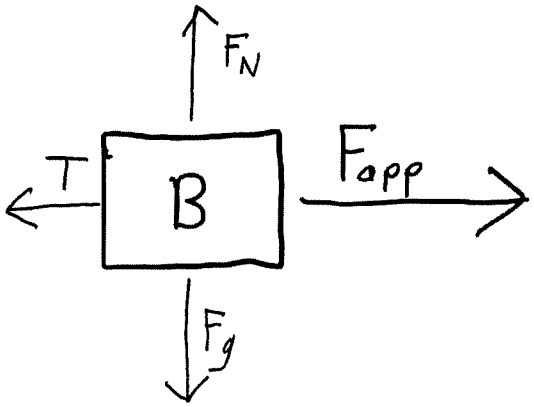
1. A person pulls two blocks connected by a rope over a flat frictionless surface, causing them to accelerate. Complete the FBDs for each block showing the forces acting on it.



BLOCK A:



BLOCK B:



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2. A person pulls two blocks which have a combined mass of 25 kg with a force of 34 N over a frictionless surface. What will the acceleration of the blocks be?

$$F_{net} = ma \rightarrow a = \frac{F_{net}}{m} = \frac{34N}{25kg} = 1.4 m/s^2$$

3. A person pulls two blocks which have a combined mass of 25 kg with a force of 34 N over a surface, a total friction force of 12 N acts on the blocks.
   a. What is the net force acting on the blocks?

$$F_{net} = \text{winners} - \text{losers}$$
$$= 34N - 12N$$
$$= 22N$$

   b. What is the acceleration of the blocks?

$$a = \frac{F_{net}}{m} = \frac{22N}{25kg} = 0.88 m/s^2$$

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4. A person pulls two blocks one with a mass of 14 kg and the other with a mass of 21 kg over a surface with $\mu = 0.14$ at a constant velocity.

   a. What is the acceleration of the blocks? $0 m/s^2$

   b. What is the net force acting on the blocks? 0

   c. What is friction force acting on the 14 kg block?

$$F_{fric} = \mu F_N = \mu F_g = \mu mg = 0.14 \times 14kg \times 9.8 m/s^2$$
$$= 19.208 N$$
$$\approx \boxed{19 N}$$

   d. What is the friction force acting on the 21 kg block?

$$F_{fric} = \mu mg = 0.14 \times 21kg \times 9.8 m/s^2$$
$$= 28.812 N \approx \boxed{29 N}$$

   e. What is the total friction acting on the blocks?

$$\text{Total friction} = 19.208N + 28.812N$$
$$= \boxed{48N}$$

   f. What is the force the person is pulling with?

Since $F_{net} = 0$ they must cancel out friction, so $F_{app} = \boxed{48N}$

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5. A person pulls two blocks one with a mass of 18 kg and one with a mass of 14 kg over a frictionless horizontal surface with a force of 22 N.

a. What is the total mass of the blocks?

$18\,kg + 14\,kg = 32\,kg$

b. What is the net force acting on the blocks?

Only horizontal force is 22N since there is no friction

$F_{net} = 22\,N$ to the right

c. What is the acceleration of the blocks?

$F_{net} = ma \rightarrow a = \frac{F_{net}}{m} = \frac{22\,N}{32\,kg} = 0.6875\,m/s^2$

$= 0.69\,m/s^2$

d. The only horizontal force affecting the 18 kg block is tension. Determine the tension force acting on that block.

$T = F_{net} = ma = 18\,kg \times 0.6875\,m/s^2$

$= 12\,N$

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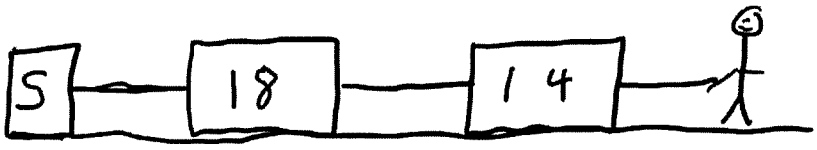
6. A person pulls three blocks one with a mass of 5kg, one with a mass of 18 kg, and one with a mass of 14 kg over a frictionless horizontal surface with a force of 22 N.



a. What is the total mass of the blocks?

$5kg + 18kg + 14kg = 37kg$

b. What is the net force acting on the blocks?

Only force horizontally is 22N

c. What is the acceleration of the blocks?

$a = \frac{F_{net}}{m} = \frac{22N}{37kg} = 0.5946\ m/s^2$ to the right

d. The only horizontal force affecting the 5 kg block is tension. Determine the tension force acting on that block.

$T = F_{net} = ma = 5.0kg \times 0.5946 m/s^2$

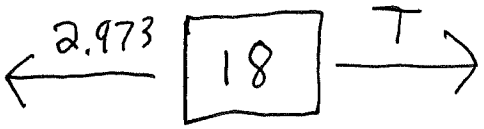
$= 2.973N = 3.0N$

e. Determine the net force acting on the 18 kg block using Newton's 2nd Law.

$F_{net} = ma = 18kg \times 0.5946 m/s^2 = 10.7028N$

$\approx 11N$

f. Determine the tension between the 18kg block and the 14 kg block.



$F_{net} = 10.7028N$ right

T is the winning force

so $10.7028N + 2.973N$

$= T = 13.6758$

$\approx 14N$

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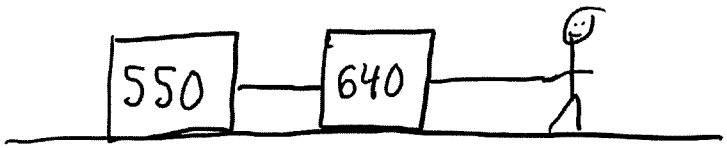
7. A 550 kg and 640 kg block are connected with a rope and pulled with a force of 7500 N over a surface with μ of 0.22.



a. What is the total mass of the blocks?

$550\,kg + 640\,kg = 1190\,kg \approx (1200\,kg)$

b. What is the total friction force of the blocks?

$F_{fric} = \mu F_N = \mu F_g = \mu mg = 0.22 \times 1190\,kg \times 9.8\,m/s^2$
$= 2565.64\,N$
$\approx (2600\,N)$

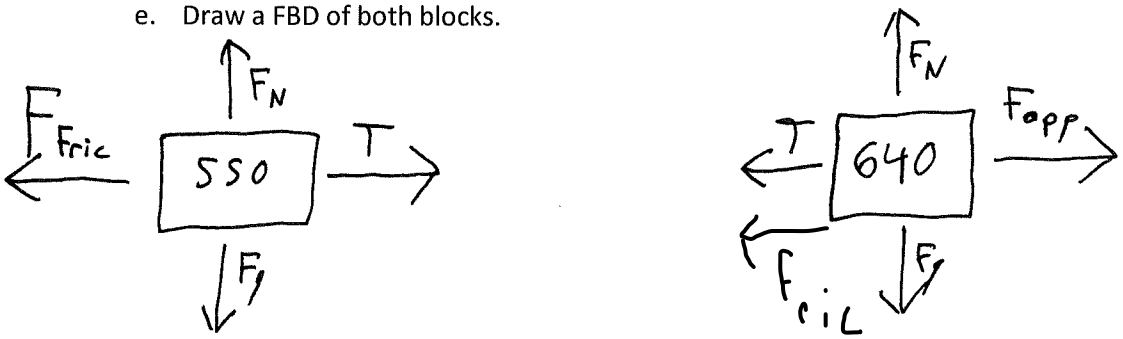
c. What is the net force of the system?

$F_{net} = 7500\,N - 2565.64\,N = 4934.36\,N$
$\approx (4900\,N)$

d. What is the acceleration of the blocks?

$a = \frac{F_{net}}{m} = \frac{4934.36\,N}{1190\,kg} = 4.1465\,m/s^2$
$\approx (4.1\,m/s^2)$

e. Draw a FBD of both blocks.



f. Determine the tension in the rope connecting the two blocks.

Use 550kg block: $F_{net} = ma = 550 \times 4.1465\,m/s^2$
$= 2281\,N$

$F_{fric} = \mu mg = 1186\,N$

T is winning Force it is 2281 more

$2281 + 1186 = (3500\,N)$

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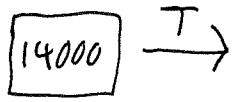
8. A 14 000 kg train car is connected to a 22 000 kg engine with a coupler. The engine causes the train to accelerate at 0.65 m/s^2 along a frictionless track. What is the tension in the coupler?

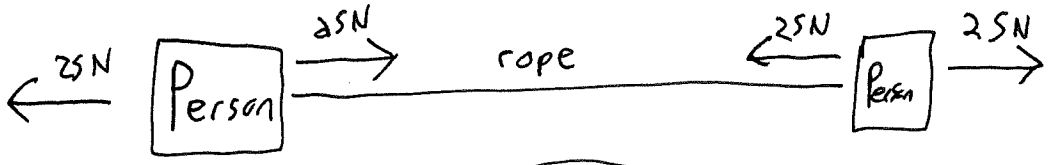
Only force causing the 14 000 kg train car to accelerate is tension



$F_{net} = T. \rightarrow T = ma = 14000kg \times 0.65m/s^2$

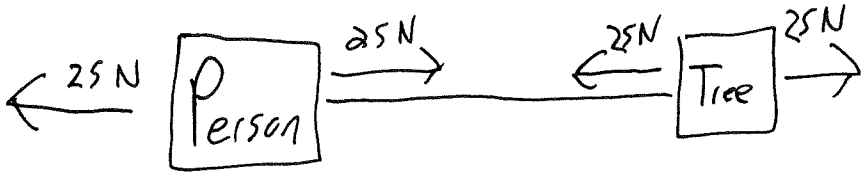
$= 9100N$

9. A rope is pulled in opposite directions by two people, each pulling with a force of 25 N. What is the tension in the rope?



T = 25N

10. A rope is tied to a tree and pulled by one person with a force of 25 N. What is the tension in the rope?



T = 25N

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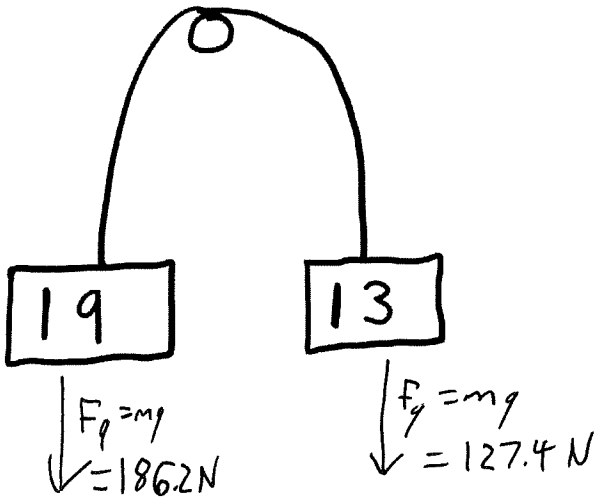
11. A 19 kg mass and a 13 kg mass are hung on opposite sides of a frictionless pully. Then the masses are allowed to fall freely.



a. What will happen to the 19 kg mass?

It will fall

b. What will happen to the 13 kg mass?

It will be lifted

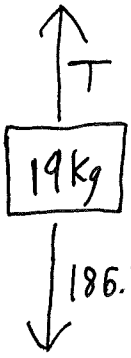
c. What is the net force acting on the system?

F_{net} = Winners − losers
$= 186.2 - 127.4 = 58.8N \approx (59N)$

d. What is the acceleration of the system?

$a = \frac{F_{net}}{m} = \frac{58.8N}{(19+13)} = \frac{58.8N}{32kg} = 1.8375\ m/s^2$
$\approx 1.8\ m/s^2$ in 19kg block direction

e. What is the tension in the rope?



$F_{net} = ma = 19kg \times 1.8375 m/s^2$
$= 34.9125N$

F_g is winner, it is 34.9125N more than T

so $T = 186.2N - 34.9125N = 151.29N \approx (150N)$

f. If the 19 kg mass starts 1.0 m above the ground, how long will it take until it hits the ground?

Use $d = v_0 t + \frac{1}{2}at^2$

$t = 1.04 \approx (1.0\ sec)$

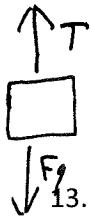
$a = -1.8375 m/s^2$
$v_0 = 0$
$d = -1.0\ m$
$t = ?$

12. A 46 kg Spider Man jumps off a tall building, falls for 1.0 seconds, then shoots a web and uses it to slow himself to a stop vertically in 0.50 seconds. What is the tension in the web?

① What is velocity after falling 1 sec?
$v_0 = 0$, $a = -9.8\ m/s^2$, $t = 1.0$ use $v_f = v_0 + at$
$v_f = -9.8\ m/s$

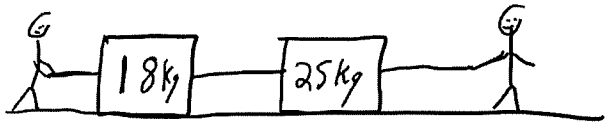
② What is accelerating while slowing $a = \frac{\Delta v}{\Delta t} = \frac{+9.8\ m/s}{0.50\ sec}$
$= 19.6\ m/s^2$

③ What is $F_{net} = ma$
$= 46\ kg \times 19.6\ m/s^2$
$= 901.6\ N$

④ 

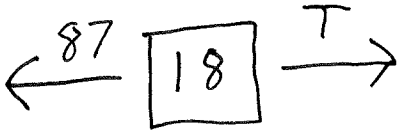
T is winner, it is 901.6N more than $F_g = mg = 450.8N$
$T = 1352.4N \approx (1400N)$

13. An 18kg and a 25 kg block are connected with a rope. One person pulls the 18 kg block to the left with a force of 87 N, another person pulls the 25 kg block to the right with a force of 46 N. What is the tension in the rope connecting the two blocks?



$F_{net} =$ winners − losers $= 87N - 46N$
$= 41\ N$ to the left

$a = \frac{F_{net}}{m} = \frac{41N}{(18+25kg)} = \frac{41N}{43kg} = 0.9535\ m/s^2$ left



For 18 kg block applied is the winning force
$F_{net} = ma = 18\ kg \times 0.9535\ m/s^2$
$= 17.16N$

$T = 87 - 17.16 \approx 69.84N \approx 70N = (7.0 \times 10^1\ N)$

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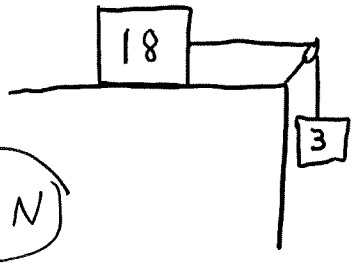
14. A 3.0 kg block hangs over the edge of a table, it is connected to an 18 kg block on the table. The coefficient of friction between the table and the 18 kg block is 0.11.



a. What is the gravitational force pulling the blocks downward?

$F_g = 3.0\,kg \times 9.8\,\frac{m}{s^2} = 29.4\,N \approx (29\,N)$

b. What is the frictional force slowing the motion of the blocks?

$F_{fric} = \mu F_N = \mu F_g = \mu mg = 0.11 \times 18\,kg \times 9.8\,m/s^2$
$= 19.404 \approx (19\,N)$

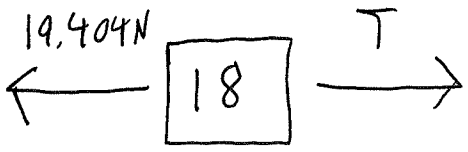
c. What is the net force acting on the blocks?

$F_{net} = F_g - F_{fric} = 29N - 19N = 10\,N$
$\approx (1.0 \times 10^1\,N)$

d. What is the acceleration of the blocks?

$a = \frac{F_{net}}{m} = \frac{10\,N}{21\,kg} = 0.4762\,m/s^2$
$\approx (0.48\,m/s^2)$

e. What is the tension in the rope?



$F_{net} = ma = 18kg \times 0.4762\,m/s^2$
$= 8.571\,N$

T is winning force so $T = 19.4 + 8.57$
$= (28\,N)$

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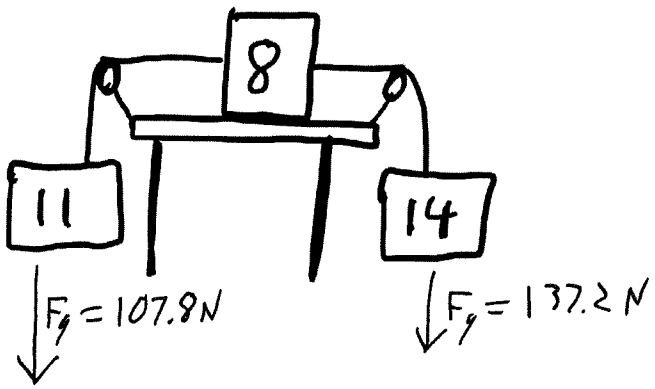
15. An 8.0 kg block is on a table connected to a free hanging 11 kg mass, and a free hanging 14 kg mass on opposite sides of the table. What is the minimum coefficient of friction of the table and block if the blocks do not move?



F_{net} without friction is $137.2 - 107.8 = 29.4N$

So if it doesn't move F_{fric} must be

$29.4N$

$$F_{fric} = \mu F_N = \mu mg$$

$$\frac{F_{fric}}{mg} = \mu$$

$$\frac{29.4N}{8kg \times 9.8m/s^2} = 0.375 \approx 0.38$$