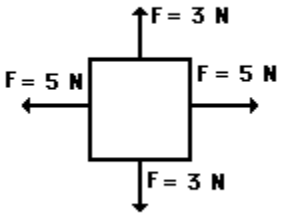
# Student Activity Sheets: Answer Key

Background Information and Activity Sheet for Students 1.3b

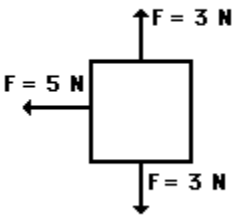
**Practice Problems**

1. Free-body diagrams for four situations are shown below. For each situation, determine the net force acting upon the object.

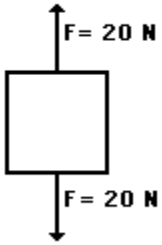
Situation A



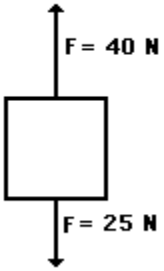

Situation B




Situation C



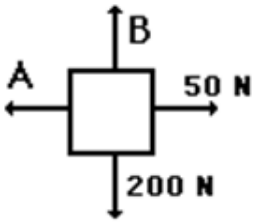

Situation D




$F_{net} = (F_1 + F_2 + F_3 \ldots)$

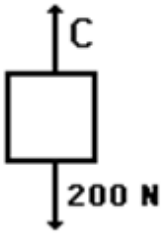
$F_{net} = 3N + 5N - 3N - 5N = 0N$ $F_{net} = 3N - 3N - 5N = -5N$ $F_{net} = 20N - 20N = 0N$ $F_{net} = 40N - 25N = 15N$

2. Free-body diagrams for four situations are shown below. The net force is known for each situation. However, the magnitudes of a few of the individual forces are not known. Analyze each situation individually and determine the magnitude of the unknown forces.



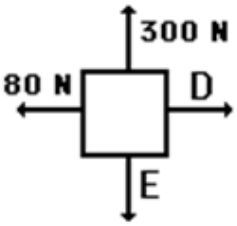

$F_{net} = (F_1 + F_2 + F_3 \ldots)$
$F_{net} = B - 200N + 50N - A = 0N$
$A = -50N$
$B = 200N$

$F_{net} = 0$ N




$F_{net} = (F_1 + F_2 + F_3 \ldots)$
$F_{net} = C - 200N = 900N, up$
$C = 1100N$

$F_{net} = 900$ N, up

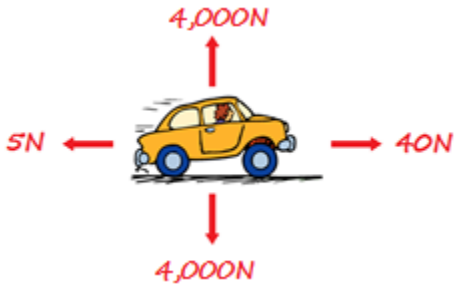



$F_{net} = (F_1 + F_2 + F_3 \ldots)$
$F_{net} = 300N - E + D - 80N = 60N, left$
$D = 20N$
$E = 300N$

$F_{net}$ = 60 N, left

3. A skydiver is descending with a constant velocity. Consider air resistance. Draw a free-body diagram for this situation.

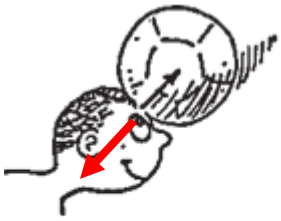

4. A 4,000N car is coasting to the right with a force of 40N and slowing down do to a resistance force of 5N. Draw a free-body diagram for this situation. Include at least 4 forces and their magnitudes.




Background Information and Activity Sheet for Students 1.3d

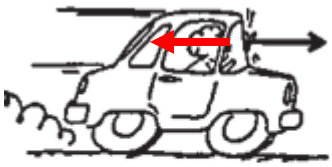
**Practice Problems**

1. In the example below, the action-reaction pair is shown by the arrows (vectors), and the action-reaction is described in words. In (a) through (g) draw the other arrow (vector) and state the reaction to the given action. Then make up your own example in (h).



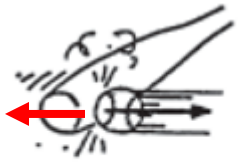
Head bumps ball

a. *Ball bumps head*



Windshield hits bug

b. *Bug hits windshield*

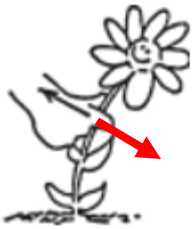


Bat hits ball

c. *Ball hits bat*

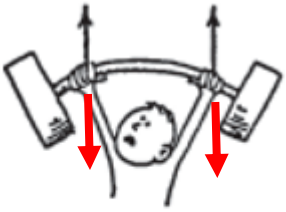
Hand touches nose

d. *Nose touches hand*



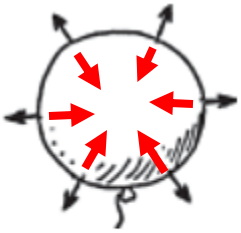
Hand pulls on flower

e. *Flower pulls on hand*



Athlete pushes bar upward

f. *Bar pushes downward on athlete*

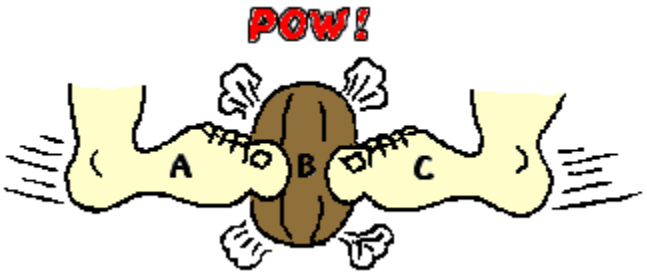


Compressed air pushes balloon surface outward

g. *Balloon surface pushes compressed air inward*

h. Answers vary: ensure that students have correctly identified action reaction forces.

2. Consider the interaction depicted below between foot A, ball B, and foot C. The three objects interact simultaneously (at the same time). Identify the <u>two pairs</u> of action-reaction forces. Use the notation "foot A", "foot C", and "ball B" in your statements. Click the button to view the answer.




Foot A pushes on Ball B

Ball B pushes on Foot A

Foot C pushes on Ball B

Ball B pushes on Foot C

Practice Problems Student Activity Sheet 1.4

1. A is 36 inch lever with a fulcrum in the middle is sitting on a table. If a 60 g hex nut sits three inches from the fulcrum, where must a 25 g hex nut be placed to balance the lever?

$m_1 l_1 = m_2 l_2$

$60g \times 3in = 25g \times l_2$

$\frac{60g \times 3in}{25g} = 7.2in$

2. What mass of a single hex nut must be placed at the end of the lever in problem 1 to make the 60 g hex nut balance?

$m_1 l_1 = m_2 l_2$

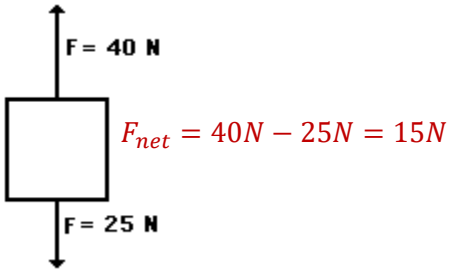
$60g \times 3in = m_2 \times 18in$

$\frac{60g \times 3in}{18in} = 10g$

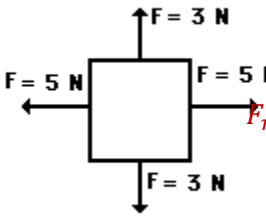
1. How much work is done when a 5N force is used to move a lever 3 meters to raise an 8kg mass?
   $W = Fd = 5N \times 3m = 15J$
2. How much force does Purdue Pete exert doing 4,000 $N \cdot m$ of work moving a gigantic drum 20 meters?
   $F = \frac{W}{d} = \frac{4{,}000N \cdot m}{20m} = 200N$
3. How high does Purdue Pete lift his sledge hammer if he uses a force of 25 Newtons to lift the hammer while doing 50 Joules of work?
   $d = \frac{W}{F} = \frac{50N}{25J} = 2m$
4. A machine uses an input force of 200 N to produce an output force of 800 N. What is the mechanical advantage of this machine?
   $MA = \frac{F_{output}}{F_{input}} = \frac{800N}{200N} = 4$
5. A machine is designed to lift an object with a weight of 12 N. If the input force for the machine is set at 4 N, what is the mechanical advantage of the machine?
   $MA = \frac{F_{output}}{F_{input}} = \frac{12N}{4N} = 3$
6. What is the mechanical advantage of a lever that has an input arm of 3 meters and an output arm of 2 meters?
   $MA = \frac{L_{input}}{L_{output}} = \frac{3m}{2m} = 1.5$
7. You lift a 45 N bag of mulch 1.2 m and carry it a distance of 10 m to the garden. How much work was done?
   $W = W_{picking\ up} + W_{carrying} = (45N \times 1.2m) + (45N \times 10m) = 504J$

*Levers Practice Quiz Answer Key*

1. Free-body diagrams for four situations are shown below. For each situation, determine the net force acting upon the object.

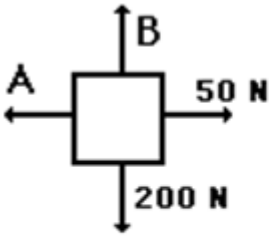



$F_{net} = 40N - 25N = 15N$



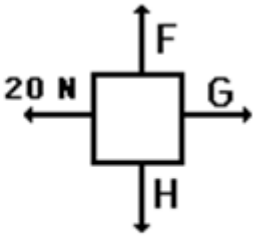

$F_{net} = 3N + 5N - 3N - 5N = 0N$

2. Free-body diagrams for four situations are shown below. The net force is known for each situation. However, the magnitudes of a few of the individual forces are not known. Analyze each situation individually and determine the magnitude of the unknown forces.




$F_{net} = 0$ N

$F_{net} = (F_1 + F_2 + F_3 \ldots)$
$F_{net} = B - 200N + 50N - A = 0N$
$B = 200N \qquad A = -50N$




$F_{net} = 30$ N, right

$F_{net} = F - H + G - 20N = 30N, right$
$F - H = 0N \qquad G = 50N$

3. How much work does Purdue Pete do while moving a gigantic drum 20 meters with a pulling force of 200N?

   $W = Fd = 200N \times 20m = 4{,}000J$

4. A machine uses an input force of 200 N to produce an output force of 800 N. What is the mechanical advantage of this machine?

   $MA = \frac{F_{output}}{F_{input}} = \frac{800N}{200N} = 4$

5. A is 42 inch lever with a fulcrum in the middle is sitting on a table. If a 60 g hex nut sits 7.5 inches from the fulcrum, where must a 25 g hex nut be placed to balance the lever?

   $m_1 l_1 = m_2 l_2$

   $60g \times 7.5in = 25g \times l_2$

   $\frac{60g \times 7.5in}{25g} = 718in$

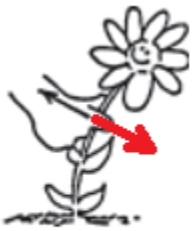
6. What mass of a single hex nut must be placed at the end of lever in problem 5 to make the 60 g hex nut balance?

   $m_1 l_1 = m_2 l_2$

   $60g \times 7.5in = m_2 \times 21in$

   $\frac{60g \times 7.5in}{21in} = 21.4g$

7. Draw the missing arrow (vector) and state the reaction to the given action.



Hand pulls on flower

a. *Flower pulls on hand*