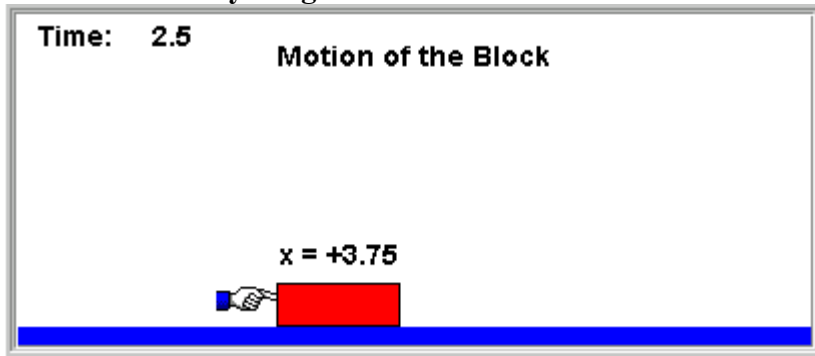


# Worksheet: Newton's 3rd Law and Free Body Diagrams

## Part I: Free Body Diagrams



An 8-kg block is pushed across the floor at a constant speed.

1. Sketch a possible free-body diagram for the block:

2. What is the acceleration of the block? \_\_\_\_\_

(Reminder:  $a = \Delta v / \Delta t$ )

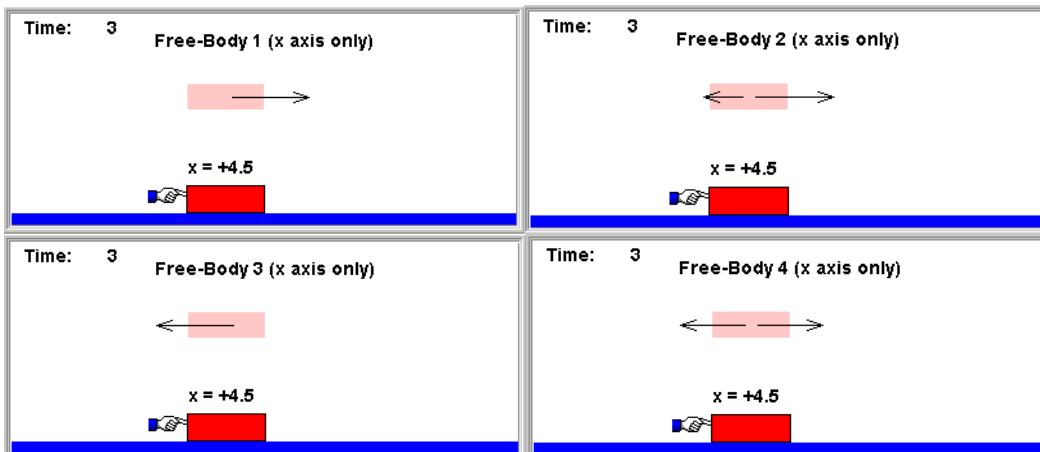
How do you know?

3. Therefore, the net force (sum of all the forces) in the x-direction = \_\_\_\_\_

(Reminder: Net  $F = ma$  or  $\Sigma F = ma$ )

4. Similarly, the net force (sum of all the forces) in the y-direction = \_\_\_\_\_

5. Consider the forces in the x-direction (horizontal forces). Consider each of the four possible free-body diagrams below (each diagram is above the block). The length of the vector represents the magnitude of the force.

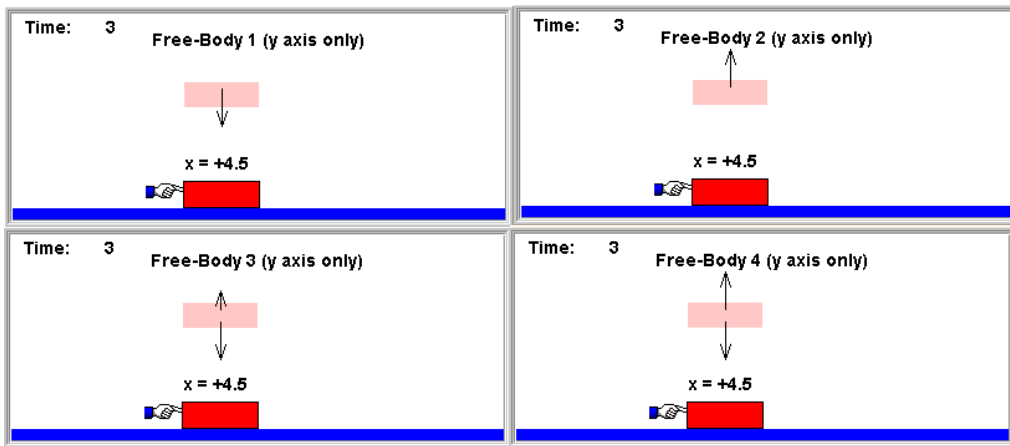


Only one is a possible free-body diagram. For each one, indicate why it is or is not a possible force diagram:

Horizontal components:

	Possible force diagram?	Reason:
Free-Body 1x		
Free-Body 2x		
Free-Body 3x		
Free-Body 4x		

6. Vertical components:

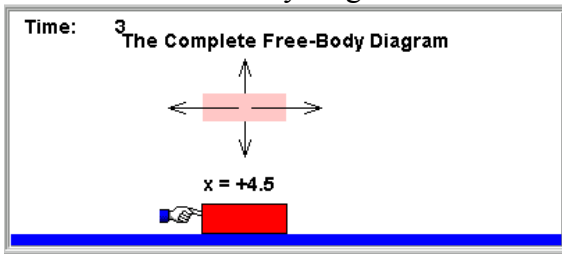


	Possible force diagram?	Reason:
Free-Body 1y		
Free-Body 2y		
Free-Body 3y		
Free-Body 4y		

7. Based on this, sketch a complete free-body diagram below:

8. Explain any differences with your original sketch.

Consider the free-body diagram below:

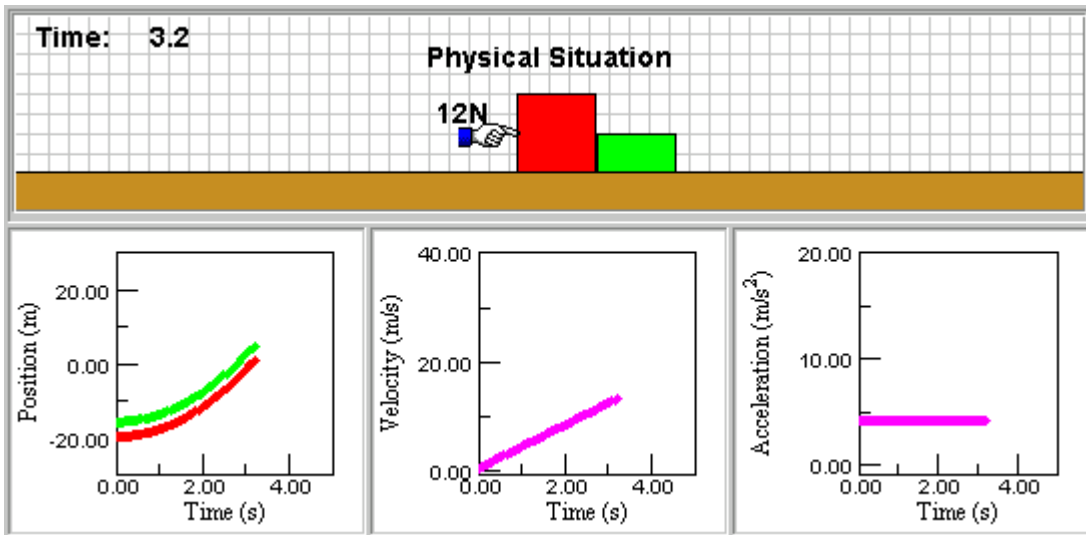


9. Does it agree with your sketch above? If not, explain why this one (and not your drawing) shows the correct free-body diagram.

Note that in this case, there is a frictional force, but the form of the frictional force will be addressed later in this course.

### Part II: Newton's 3<sup>rd</sup> Law

This exercise shows graphs of position, velocity and acceleration versus time for a 12-N force pushing a 2-kg red block in contact with a 1-kg green block on a **frictionless surface**.



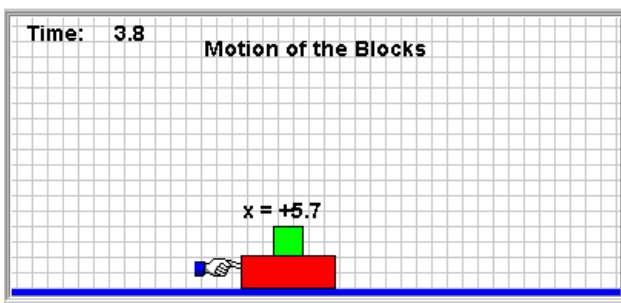
1. What is the acceleration of the red block? \_\_\_\_\_
2. What is the acceleration of the green block? \_\_\_\_\_
3. Sketch a free-body diagram for the two blocks (assuming that they together make one 3-kg mass system). Indicate the values for each of the forces in your diagram:



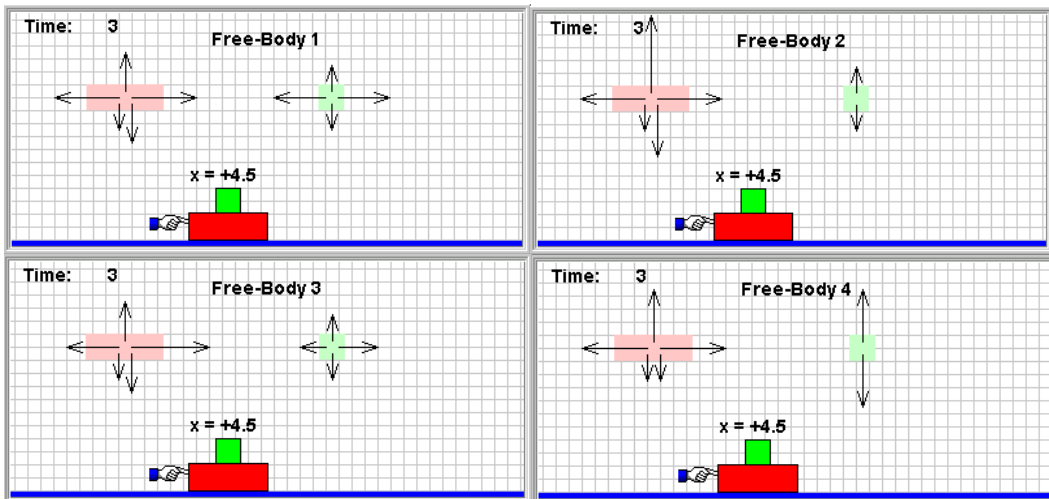
For the red block (2-kg) to have an acceleration of  $4\text{m/s}^2$ , what must the net force (sum of all the forces) be on it? \_\_\_\_\_ Since it has 12-N to the right, what must the force to the left be? \_\_\_\_\_ It should be equal and opposite (Newton's 3<sup>rd</sup> Law) for the force that the red block exerts on the green block. Is it?

### Part III: Free Body Diagrams and Newton's 3<sup>rd</sup> Law

A red block is pushed and moves at a constant speed. In addition, a green block sits on the red block and moves with it.



1. What is the acceleration of the two blocks? \_\_\_\_\_ How do you know?
2. Consider the following four free-body diagrams. Which free-body diagram is correct? Give reasons why the other three are incorrect:



	Correct free-body diagram?	Reason:
Free-Body 1		
Free-Body 2		
Free-Body 3		
Free-Body 4		

2. How would your answers to (1) change if the blocks did not move?