Free-body diagrams, Weight, and Normal force

Name:

Group Members:

Date:

TA's Name:

Learning Objectives:

I. Learn to identify forces acting on objects and apply Newton's third law to identify action-reaction pairs.
II. Understand the difference between normal force and weight.

Apparatus: two blocks, two flat weighing scales, hanging weight, two spring scales

Part A: Forces between two spring scales

1. Take two identical, yellow spring scales and attach the hooks together. Call one of them scale 1 and the other scale 2. Now have two people each pulling on one of them. Don't pull so hard as to max out the scale. What is applying the force that results in the reading on scale 1?

2. What is applying the force that results in the reading on scale 2?

3. Now pull so that one of the scales reads about 10 N while the other reads about 30 N. What did you need to do to accomplish this task?

4. Explain what you can conclude from the experiment above.

Part B: Forces between a block and a scale

5. Place weighing scale on the table. Place a small black block on the weighing scale. Record the scale reading. ________________

6. When you did this were you recording the mass or the weight of the block?

7. Determine the weight of the small black block including units. Show any calculations you perform.

8. Identify the forces acting on the block.

9. Is the block in equilibrium? How do you know?

10. Identify the forces acting on the scale.

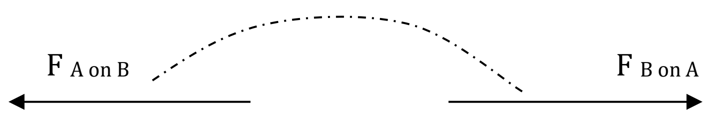
11. Is the scale in equilibrium? How do you know?

12. First draw a free body diagram for the block. Here you consider the block as your system of interest. Everything else is external. Then draw a free body diagram for the scale. Here you consider the scale as your system of interest. Everything else is external. Remember that the length of force vectors is proportional to magnitude.

Free body diagram for block **Free body diagram for scale**

13. Identify all the action-reaction pairs in the two free-body diagrams. To do this connect the forces with a dotted line:

Ex:



14. Remember that the two forces that comprise an action-reaction pair act on different objects. Do you need to revise your answer to question 6?

15. Are there forces acting on the block and scale, which are not part of one of the action-reaction pairs you identified? If so identify them and explain. Is there a reaction force? If so, why is it not on our diagrams?

16. Now consider the forces acting on the scale. The scale reading shows the value of one of those forces. Which is it?

17. Do you see the same force acting on the block as well? If so, which one?

18. Based on the observations 8 and 9 what is your conclusion about "what is measured by the scale"?

Part C: Normal force and weight

Lightly press the block down and observe what happens to the scale reading.

19. What kind of change do you see a change in scale reading when you press the block down?

20. Draw a new free-body diagram for the block for this situation.

21. In part B, the normal force on the block was equal to the weight of the block; does this observation mean that the weight of the block was increased when you pressed on it? Explain which forces changed when you pressed on the block and which forces didn't.

22. Write down Newton's Second Law (either vector equation or x and y components) then fill in the forces from your free-body diagram and whatever you know about the acceleration.

Part D: Normal force and weight II

23. Make a prediction.   If you put a 500 g object on the scale what will be the normal force on the object?

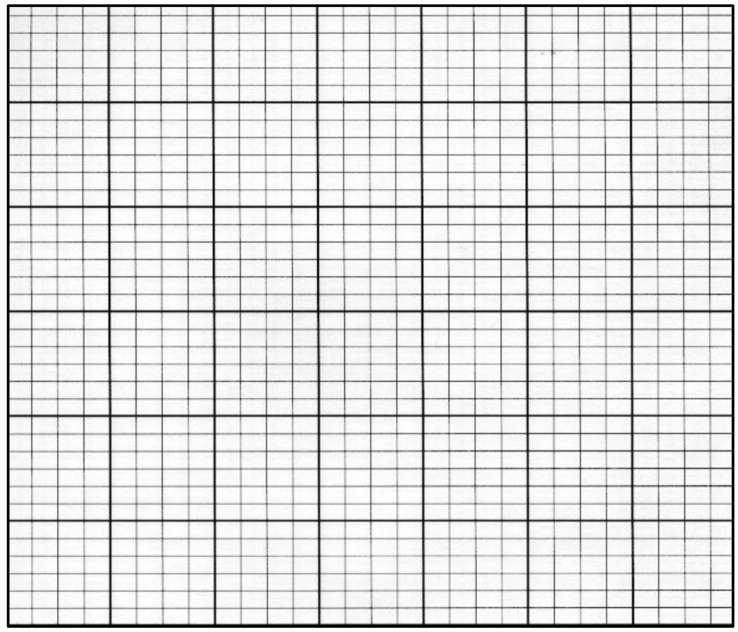
24. Test your prediction using the 500 g object (the one with the hook). What did you find?

25. Say that you applied a 2N force in the upward direction on the object. Then what would the normal force on the object be? To answer the question, draw the free body diagram for the object in this situation. Then apply Newton's second law and do your calculations. Make your prediction.

26. Now test your prediction by using any of the provided equipment. First come up with a procedure and make a sketch showing how you use the equipment. There is no need to describe the procedure. Using your method, increase the applied force from 0.0 N to 5.0 N in 1.0 N increments and measure the normal force for each applied force. Show your data below. Also include the weight in your table and calculate the net force using Newton's Second Law as you wrote it above.

Applied Force (N)	**Normal Force (N)**	**Weight (N)**	**Net Force (N)**

27. Make a graph of normal force versus applied force.



28. Explain the relationship between the applied and normal forces and why you have that relationship in this experiment.

29. From your graph, what will the applied force need to equal in order to have the normal force equal zero?

Part E: Conclusion

30. Using Newton's Second Law, write a conclusion about what determines the magnitude of the normal force.