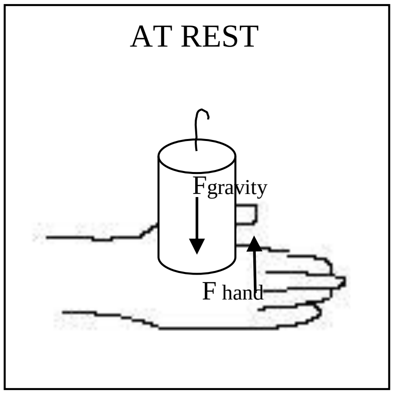
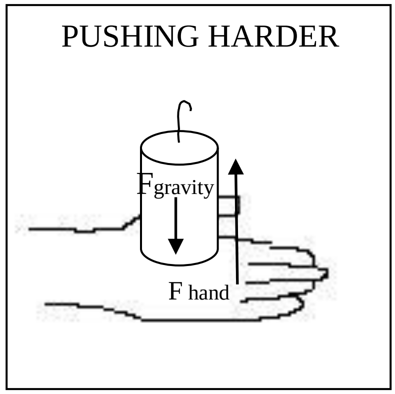
FINDING THE FORCES A THRU Z

NAME________________________________ DATE _________ HOUR ______ /234

SYSTEM A

Get a 500 gram (4.9 N) hooked mass (we will call it HM, here after). Have someone hold it "at rest" in their outstretched hand. Use arrows to indicate all the forces acting on the HM by labeling a "free body diagram". Care must be taken in all these activities to distinguish between the object that the force acts on and the source of the force.





1. What happens to the HM if you "push harder" (exert more force) with your hand?

____

____

2. Which arrow (force) changes when you push harder?

____

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3. How is the arrow affected? (How did it change?)

____

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4. Which picture above shows balanced forces`?

____

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5. What would happen to the HM if you quickly removed your hand from under it?

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6. Which arrow (force) changes when you remove your hand?

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7. How was the arrow affected? (How did it change?)

____

____

8. How was the free body drawing changed to show this?

9. Did the gravity arrow increase when the hand was taken away?

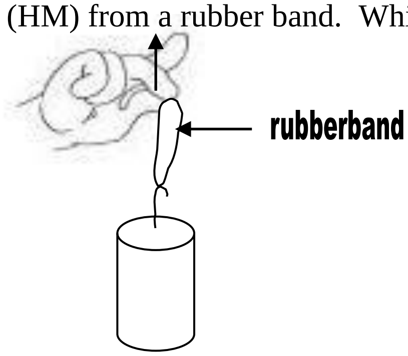
10. Name at least four parts of this system that are interacting (acting together) (4pts)

11. Are there any contact (touching) forces in this system? List all combinations. (For example, the hand and the HM interact) (3pts)

12. Are there any forces acting at a distance (not touching)? Explain (2pts)

SYSTEM B

Hang the hooked mass (HM) from a rubber band. While you do this, watch the shape of the rubber band.



13. Draw the vectors (arrows) to indicate the directions of the forces acting on the HM on the free body diagram. The hand vector arrow has already been drawn for you. (1pt)

14. What happens to the rubber band when the HM is attached to it? (Describe the way the rubber band looks)

15. The rubber band goes back to its original shape after you remove it from the HM. What property of matter is this? (check your vocabulary list)

16. List at least two other vocabulary words that can describe what is happening to the rubber band. (2pts)

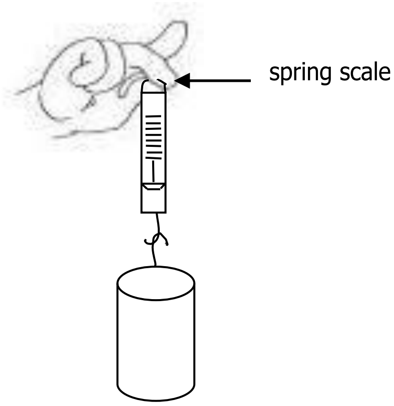
17. What are the similarities (at least 2) and differences (at least 2) between system A and system B? (4pts)

similarities: 1 ______________________________ 2 ______________________________

differences: 1 ______________________________ 2 ______________________________

SYSTEM C

Hang the HM from a **spring scale** calibrated in **Newtons**. While you do this watch the shape of the spring.



18. Use vectors to show the directions of the forces acting on the HM. (Complete the free body diagram with all the arrows it needs) (2pts)

19. What must the spring do in order to exert (put) a force on the HM? (use a vocabulary word)

____

____

20. What is the **magnitude of the force** according to the spring scale reading? (2pts)

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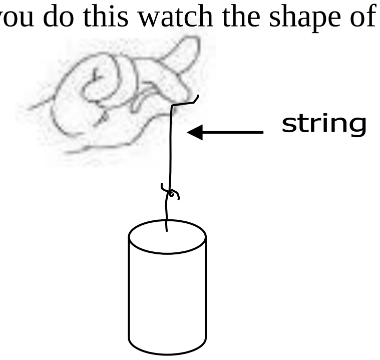
21. What are the units of force? (What do we label force numbers with?)

____

SYSTEM D

Hang the HM from a string. While you do this watch the shape of the string.



22. Place vectors on the free body diagram to show the directions and magnitudes of force. (2pts)

23. What does the HM do to the string? (use a vocabulary word in your sentence)

____

____

24. What is similar about the items (hand, hand and rubber band, hand and spring scale, hand and string) in systems A B C and D above? (name at least 2)

1 ____

2 ____

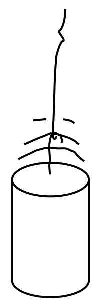
25. What can the spring scale do that the hand, rubber band, and string **cannot** do?

____

____

SYSTEM E

Imagine releasing the string and dropping the HM. (Don't really do it because it will dent the HM and bend its hook.)



26. Place vectors on the free body diagram. (2pts)

27. As the HM falls, what does it touch on the way down?

____

____

28. Is the bouyant force of the air strong enough to hold it up? Be sure to place vectors on the diagram to show the air forces in an upward direction.

____

____

29. Looking at your diagram, are the vectors the same **magnitude** (amount or length)? Which vector should be longer? (who wins in the push of war between the HM and air?)

____

____

30. Are the forces **balanced**? (exactly the same)

____

____

31. What happens when an unbalanced force acts on the HM? (Air's magnitude is much less than the HM's magnitude, therefore we have **unbalanced forces**.)

____

____

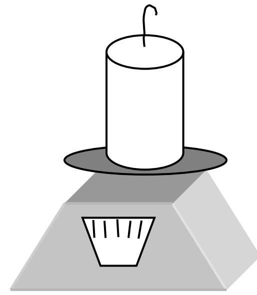
32. What force acting on the HM changed when you released the string? What vector disappears?

____

____

SYSTEM F

Place the HM on a platform scale.



33. Add all the vectors to the free body diagram to represent the forces acting on the HM and the force the HM puts on the scale. (2pts)

34. What is the common name for gravitational force acting on an object? (Hint: when you are interested in finding out how hard gravity pulls you down, you step on a scale to find out your what?)

____

35. What are the units of gravitational force in the SI system?

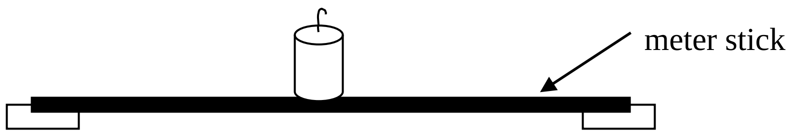
____

SYSTEM G

Place two wood blocks about 1 meter apart and lay a meter stick across them making a bridge. Let 2cm of the meter stick rest on the block. Use a metric ruler to measure from the tabletop to the top of the meter stick at the 50 cm mark. Record your measurement in millimeters. Now place the HM on the meter stick at the 50 cm mark and re-measure in mm.

without HM [ ]

with HM [ ]



36. Put vectors (2) on the free body diagram, and be sure to enter your measurements for "without the HM" and "with the HM." (4pts)

37. What was the difference in the two measurements made with the ruler? (Your answer should be a number with a proper label.)

____

38. What is the conclusion for this experiment? Use evidence to prove your answer(2pts)

____

____

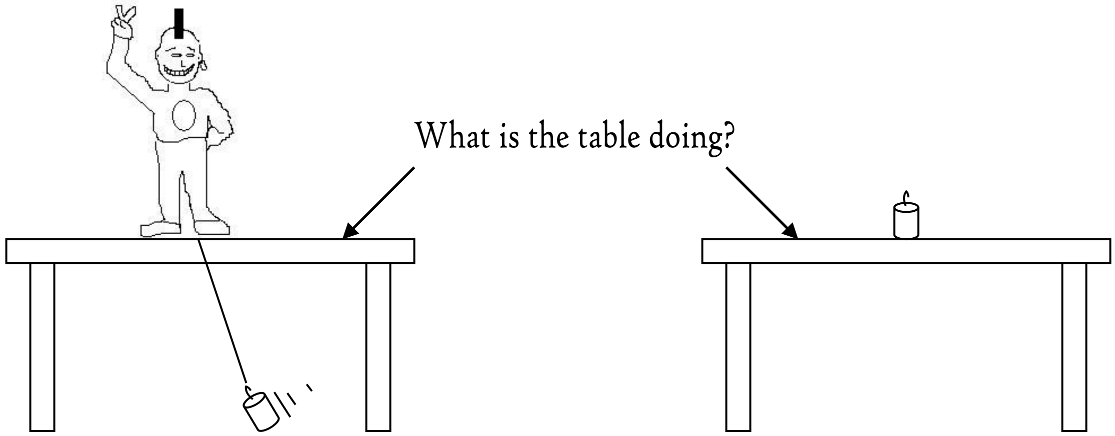
39. What if the meter stick was a thick steel beam…would the steel beam deflect (flex downward)? Why or why not? (2pts)

____

____

SYSTEM H

This activity is designed to show the deflection of an apparently rigid support like the steel beam mentioned in activity G. Make a pendulum by hanging a weight from a string. Suspend the pendulum over the long edge of a strong table. When the pendulum swings it should just miss the floor. While the pendulum swings slightly, have a group member stand on the table at the place where the pendulum is suspended.



40. Place vectors on the free body diagram. (both tables) (4pts)

41. When the person stands on the table, what does the table experience? Use a vocabulary word in your answer.

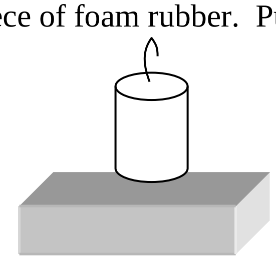
42. What is your evidence that the table is flexing?

43. Do you think the table will flex when the HM is the only thing on it? Why or why not? (2pts)

44. The platform scale, the meter stick, and the table are all similar in what way?

SYSTEM I

Place the HM on a soft sponge or piece of foam rubber. Push the HM with a light vertical $\downarrow$ force. (Push down on the HM)



45. Place vectors on the free body diagram (2pts)

46. What evidence do you have that the HM interacted with the sponge?

47. What type of stress is happening to the sponge? (use a vocabulary word)

____

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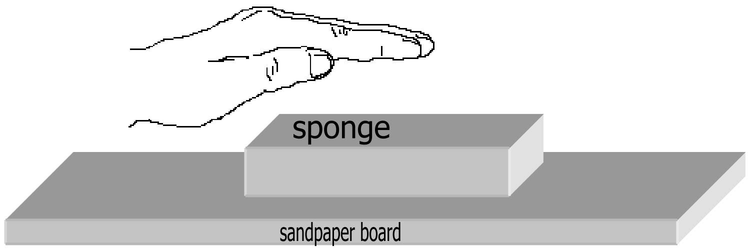
SYSTEM J

Place the foam on the board with sandpaper. Put your palm on top of the foam and push it horizontally. → Don't let the sandpaper board move while you do this. Observe what your hand does to the foam.



48. Place vectors on the free body diagram (2pts)

49. What type of stress is happening to the foam now? (use a vocabulary word)

____

50. What force is keeping the foam from sliding?

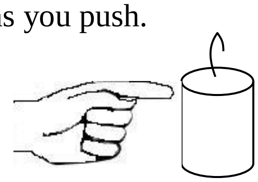
____

51. Where is this force located? Be sure to add this vector to your drawing if you forgot it in question 48

____

SYSTEM K

Place the HM on the table. Using your finger push it horizontally but be careful to not actually move the HM. Look at the end of your finger as you push.



52. Place vectors on the free body diagram (2pts)

53. What is the name of the force that is counteracting (going against) your push?

____

54. What direction is it compared to the direction your finger is pushing? (make sure the vector is in the right location and in the right direction)

____

55. Is it greater than, less than, or equal to the push of your finger? (make sure the vector is the right size)

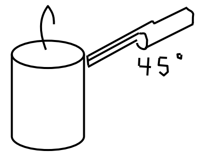
____

56. What evidence do you have that there is a force acting on your finger? What is happening to your finger up close? (Use a vocabulary word).

____

SYSTEM L

Now exert a force on the HM using a strip of plastic (pen cap) instead. Hold it at a 45-degree angle.



57. Place vectors on the free body diagram (2pts)

58. What do you notice happening to the plastic strip? (use a vocabulary word)

____

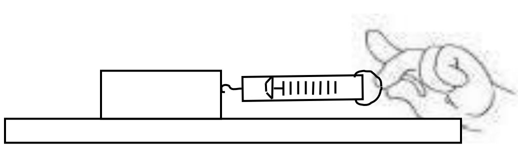
59. What happens to the HM when the force from the plastic pen cap is great enough?

____

SYSTEM M- THIS TRIAL IS YOUR EXPERIMENTAL CONTROL. SYSTEMS N, O, P, AND Q WILL BE COMPARED TO IT

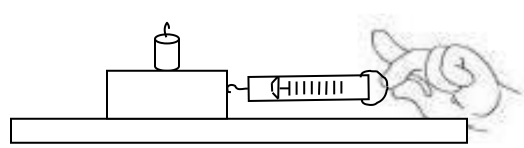
Place a wooden block flat on a wood board. Pull the block with a spring scale parallel to the wood board at constant speed. Now place the HM on the block and repeat the measurement.

a. wooden block on board



Force in newtons ____________ (1pt)

b. wooden block and HM



force in newtons ____________ (1pt)

60. Place vectors on the free body diagram. Do not forget to put friction vectors in the diagram. (4pts)

61. Write a claim for this experiment. Don't forget to include evidence to prove your claim to be true.

____

____

62. What is your reasoning as to why the second system needed a higher force to move the block?

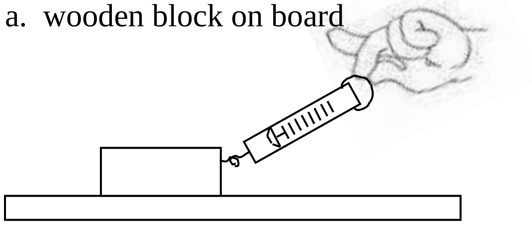
____

____

SYSTEM N

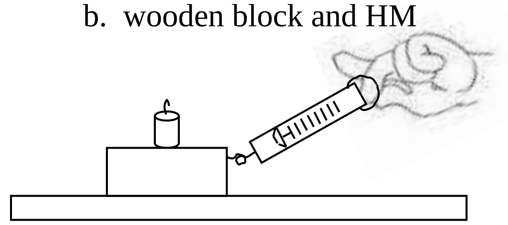
Pull the wooden block (sandpaper side down) as in M above, but at a 45-degree angle instead of parallel.

a. wooden block on board



Force in newtons ____________ (1pt)

b. wooden block and HM



Force in newtons ____________ (1pt)

63. Place vectors on the free body diagram. Do not forget to put friction vectors in the diagram. (4pts)

64. How did pulling at an angle change the spring scale reading? (Is it more or less than when you pulled it sideways?)

____

65. How could you check to see if other angles would affect the reading?

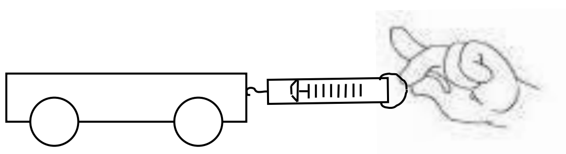
____

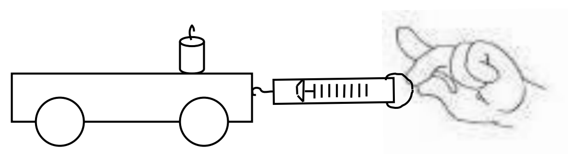
66. Conduct your experiments now. What did you find?

____

SYSTEM O

Place a wooden block with wheels down on the table. Pull the block with a spring scale at a constant speed. Place the HM on the block with wheels and pull it at a constant speed. (**Use the blue spring scale**)





Force in Newtons ___________ (1pt)

Force in newtons ___________ (1pt)

67. Place vectors on the free body diagram. Do not forget to put friction vectors in the diagram. (4pts)

68. What differences did you observe in the two systems M and O? (name at least 2)

1 ____

2 ____

69. Which system moved the block with the least amount of effort force? (M or 0?)

____

70. What change between the two systems caused the change in results?

____

____

71. What claim can you make after observing system O compared to system M?

____

____

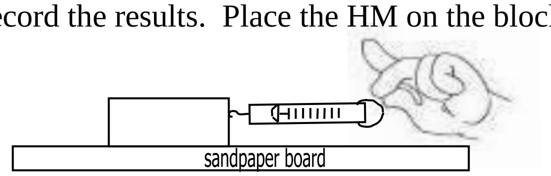
72. What is your reasoning as to why system O needed such small forces compared to system M?

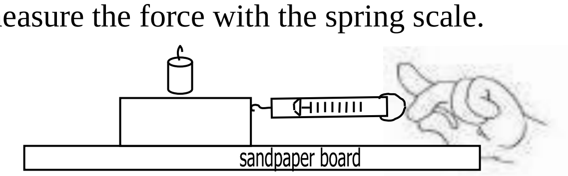
____

____

SYSTEM P

Place the wooden block on a sandpaper board. Pull the block at a constant speed with the spring scale and record the results. Place the HM on the block and re-measure the force with the spring scale.





Force in newtons _______ (1pt)

Force in newtons _______ (1pt)

73. Place vectors on the free body diagram. Do not forget to put friction vectors in the diagram. (4pts)

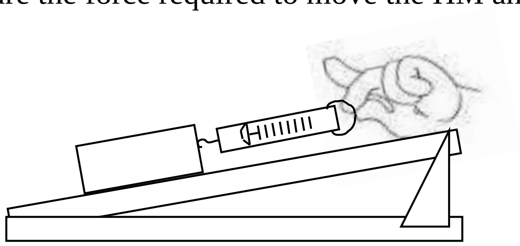
74. Where are forces greater, on system M (smooth surface) or system P (sandpaper)?

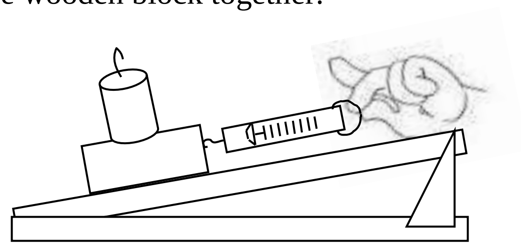
75. What is your reasoning as to why sandpaper causes forces to be higher?

76. Why does the HM on the board make the forces higher than the system without it?

SYSTEM Q

Place a wooden block flat side down on a board inclined at about 15 degrees. Pull the wooden block up the slope at a constant speed, using a spring scale. Record your results. Place the HM on the wooden block and re-measure the force required to move the HM and the wooden block together.





Force in newtons ____________ (1pt) force in newtons ____________ (1pt)

77. Place vectors on the free body diagrams. Do not forget to put friction vectors in the diagram. (4pts)
78. What is the main difference between systems M and Q?

79. What claim can you make after observing system Q compared to system M?

80. What evidence do you have that proves your claim above?

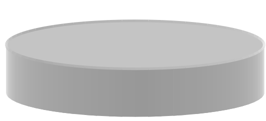
81. What is your reasoning as to why system Q needed greater forces compared to system M?

82. In this experiment (Q) you were not only fighting friction going sideways, but what other force were you fighting?

SYSTEM R

Turn on the air table and snap the puck sideways. Observe. Turn off the air table and snap the puck sideways.

TABLE ON



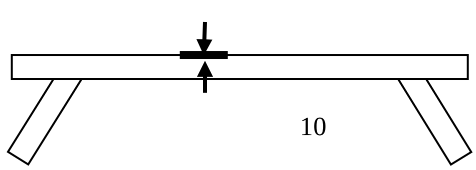
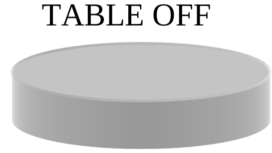


TABLE OFF



83. Place vectors on the puck showing the snap with the air on and with the air off. Don't forget friction (4PTS)

84. What did the puck do when the air was on?

____

____

85. When the air was off?

____

____

86. What is your reasoning as to why there is such a big difference between the puck movement when the table is on and when it is off? **BUOYANT** should be in your answer

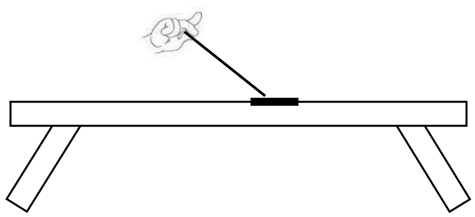
____

____

SYSTEM S

Attach a string to a low friction air puck so that it runs in a circle at a constant speed on the air table.

Note!! Some people call a force that keeps an object in a circle with constant speed a centripetal force. Centripetal, however, is the name of a direction (toward the center), not the name of a kind of force. So you should not label any of your arrows centripetal force. Use the name of a kind of force, such as a hand force or the force of gravity.



87. Place vectors on the free body diagram, one for the puck, one for the hand. They should be diagonal (2pts)

88. What are the similarities in system R and S? (name at least 2)

1 ____

2 ____

SYSTEM T

Drop a marble into a graduated cylinder nearly filled with colorless liquid soap. Observe how fast the marble falls. Drop a similar marble into a graduated cylinder filled with water. Observe how fast the marble falls.

89. Place vectors on the free body diagram (one on each marble, and vectors in the liquids- 4pts)

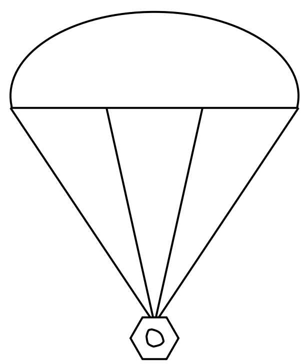
90. What similarities did you observe between the liquid soap and the water system? (name at least 2)

91. What differences did you observe between the liquid soap system and the water system? (name at least 2)

92. What is your reasoning as to why there is such a big difference between the liquid soap system and the water system? **BUOYANT** should be in your answer

SYSTEM U

Make a parachute from a piece of plastic and tiny string. Use a nut or other item to make the paratrooper. Drop the parachute several times and pay attention to how it falls.



93. Place vectors on the free body diagram (2pts)

94. What happens if the chute doesn't open?

95. Why does it happen?

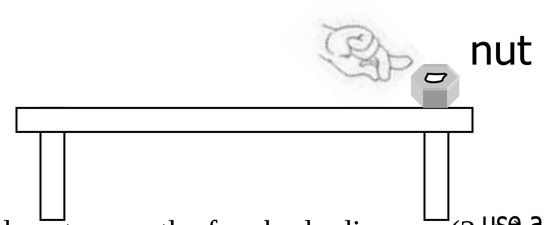
96. What pushes up on the plastic?

97. Which vector is bigger, the air vector or the paratrooper vector? (fix your vectors now if you did them wrong)

98. What was similar between systems T and U? (name at least 2)
1
2

SYSTEM V

Place a nut at the edge of the table. Give it a flick with your finger so that it hits the floor some distance away.



99. Place gravity and hand vectors on the free body diagram (2pts) use a dotted line to show the path of the washer (1pt)

100. What forces were common in systems V and E? (at least 3) (3 pts)

____

____

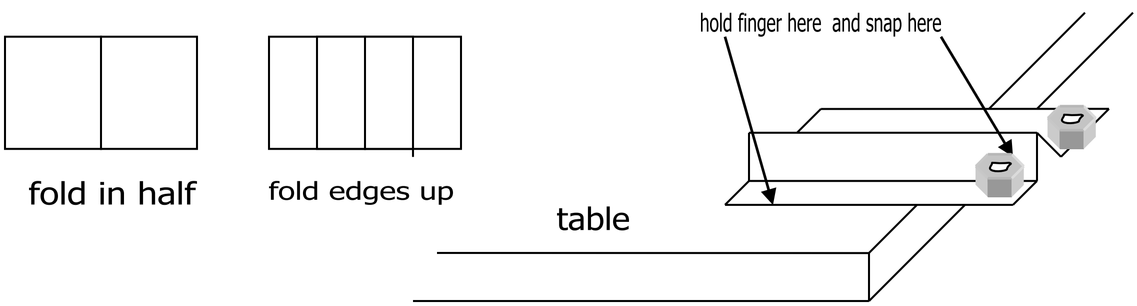
101. What is a more scientific statement for “flicking with your finger”?

____

____

SYSTEM W

Out of a 3 x 5 card make a device that allows you to flick one nut at the same time you drop a second nut. See diagram below.



102. Place gravity and snap vectors on the nuts in the free body diagram. (3pts)

103. Draw a dotted line to show the paths of the two nuts. (2pts)

104. What differences do you observe in the path taken by the two nuts?

____

____

105. Why did the nuts take two different paths?

____

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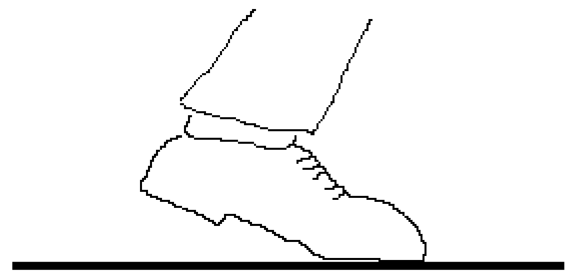
SYSTEM X

Place your right foot to the back and pretend you are about to start a race. Push hard against the ground, but don't let the foot slip backward.

Right foot pushing:

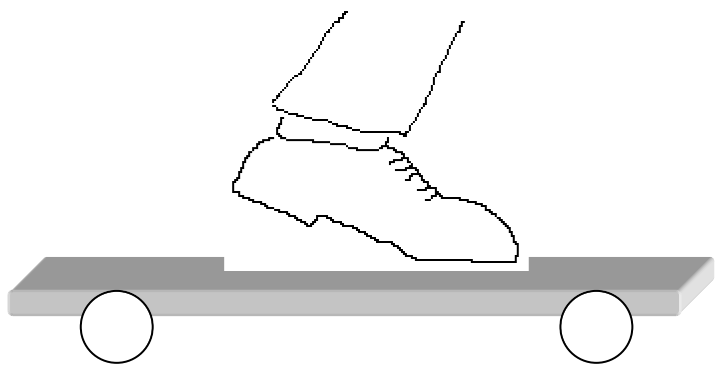


106. Draw vectors on the free body diagram. The vectors here shouldn't be straight down or straight back. It should be a combination (diagonal) Don't forget the ground pushing back, and don't forget friction. (3pts)

107. What clues does your foot give you about the forces coming from the floor? What does your foot feel?

SYSTEM Y

Now, stand on a skate board instead of the floor and push backward in the same way.



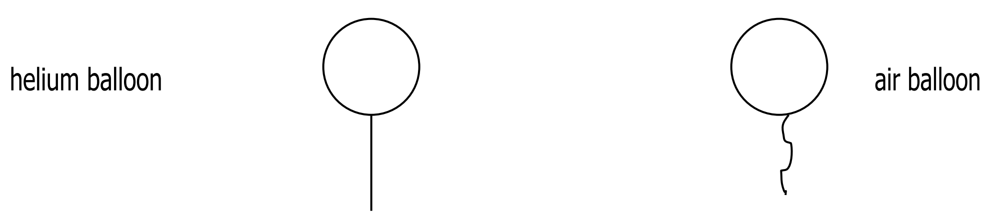
108. Place vectors on the free body diagram (foot, skateboard, and 2 friction) (4pts)

109. What happened to the skate board as you pushed backward with your right foot?

110. Why did your foot go backward so easily with the skateboard, but stay in place while on the floor? What was different?

SYSTEM Z

Imagine a helium filled balloon next to an air filled balloon. Using your knowledge of how helium balloons behave, imagine what it would be like to let go of the helium balloon and to let go of the air balloon.



111. a) Are there molecules in air? b) In helium? (2pts)
a) b)

112. a) Does air have weight? b) Does gravity pull down on air? (2pts)
a) b)

113. a) Does helium have weight? b) Does gravity pull down on helium? (2pts)
a) b)

114. Does air push up on each balloon equally?

115. Does gravity pull down on the helium balloon with the same force as it pulls down on an air balloon?

116. Now place vectors on the free body diagram. One on each balloon and 2 buoyant vectors. (4pts)

117. What were the differences between the helium and air systems? (2pts)
1
2

118. What is the unbalanced force called that results in the balloon rising?

NOTE: The densities of helium and air at 0 degrees C and atmospheric pressure at sea level are:
HELIUM—0.179 g/liter AIR—1.297 g/liter

119. Explain how the different densities of helium and air caused different results.

SYSTEM BB

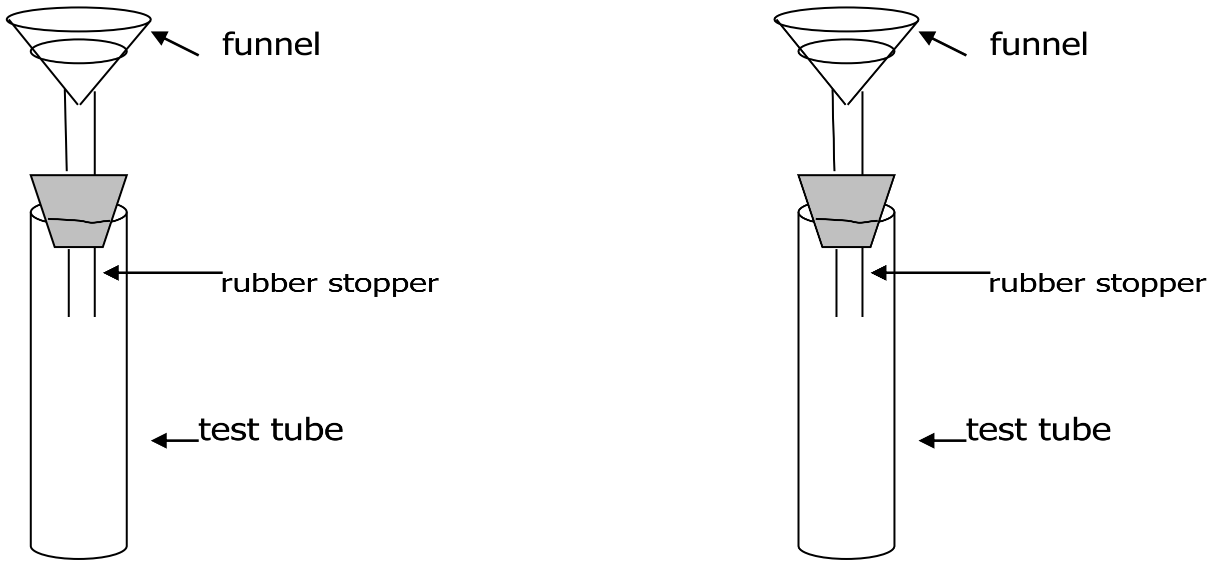
Obtain a funnel that has been inserted in a rubber stopper. Insert the rubber stopper tightly into the bottle or test tube provided. Pour water into the funnel. Observe the results. Now carefully remove the rubber stopper while holding the funnel steady and keeping it loosely in place. As you do this, pay attention to any changes in the system.

120. Describe the movement of water through the system while the stopper was in place.

121. Describe the movement of water through the system while the stopper was loosened.

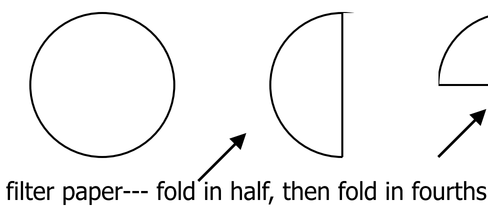
122. How can you account for the results? (why did it happen this way?)

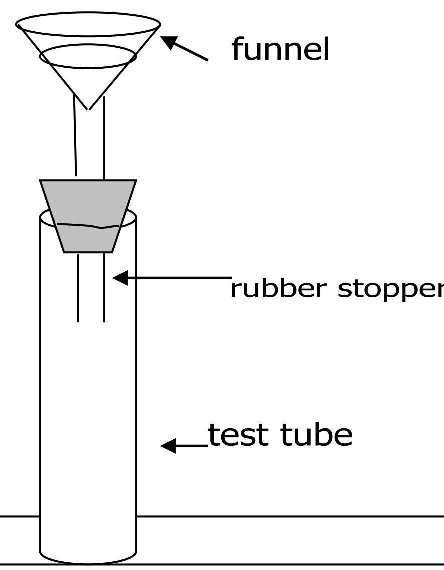
123. Place vectors on the free body diagram for when the stopper was in place (LEFT) and for when the stopper was loosened (RIGHT). (4pts)



<u>SYSTEM CC</u>

Now, while keeping the rubber stopper and funnel loosened, alter the system by putting a piece of filter paper into the funnel. Fold the filter paper as shown below. Pull out one edge of the folded filter paper and insert the cone into the funnel. Put water into the funnel one more time and observe the results.





124. Did the filter paper exert any force on the water? Give evidence to support your answer. (2pts)

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125. Put vectors on the free body diagram showing the water trying to go in, and the effect of the filter paper. (2pts)

126. We have been studying several systems. What are the parts of the filtering system AND What is the function of each part? (There are 5 parts) (10pts)

1 ____
2 ____
3 ____
4 ____
5 ____

Up until this point we have studied several forces including gravity, forces made by a hand, and air and liquid buoyant forces. There are much smaller forces that act at the molecular level. Forces between molecules of the same kind are called **cohesive forces**. Forces between molecules of different kinds are called **adhesive forces**. For example: tape molecules stick to paper molecules (different types of molecules) and this is an adhesive force. The plastic molecules stick to all the other plastic molecules in the back of your chair (so it stays in one piece). These are cohesive forces.

127. What are the molecular forces that occur in the filtering system? Give 2 adhesive examples and 2 cohesive examples. (4pts)

ADHESIVE: ____

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COHESIVE:

____

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