MODULE 1: FORCES AND MOTION

Activities

Activity Number	Activity Title
1	Forces on Objects at Rest
2	Balance of Forces
3	Investigating Inertia
4	Force and Acceleration
5	Action-reaction

Name: ______________________________ Team: ______________ Score:

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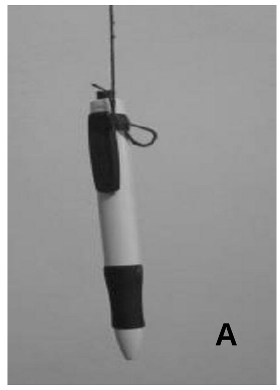
Activity 1
FORCES ON OBJECTS AT REST

Objectives:
After performing this activity, you should be able to identify the forces acting on an object at rest.

Materials:
pen pair of scissors
string book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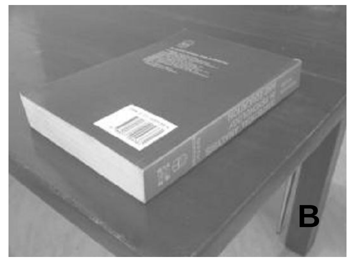
B

Procedure

Situation 1
1. Hang a pen by a piece of string as shown in the Figure a.

Q1. Is the pen at rest or in motion?

Q2. Are there forces acting on the pen? If yes, draw the forces. You may use arrows to represent these forces.

2. Cut the string with a pair of scissors.

Q3. What happens to the pen? What could have caused the pen's motion?

Situation 2
1. Place a book on top of a table as shown in Figure b.

Q4. Is the book at rest or in motion?

Q5. Are there forces acting on the book? If yes, draw the forces acting on the book.

2. Let one member of your group push the book in one direction and another member push it in the opposite direction at the same time with the same amount of push (force).

Q6. Did the book move? How will you make the book move?

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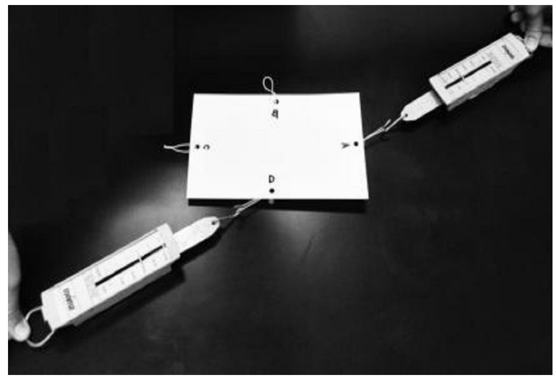
Activity 2
BALANCE OF FORCES

Objectives:
After performing this activity, you should be able to:

1. examine the conditions when two forces balance, and
2. explain the effect of balanced forces on the state of motion of an object.

Materials:
4 sets spring balance
1 piece of sturdy cardboard
Threads



Procedure:
1. Bore four holes around the cardboard as shown. Label the holes A, B, C, and D.

2. Attach threads to the holes.

3. Attach a spring balance to thread A and another one to thread D. Hold the cardboard to keep it still. Pull the balances along the same line such that when released, the cardboard remains at rest.

4. When the cardboard is at rest, examine the magnitudes and directions of the two forces by reading the spring balance.

5. Draw the line of action of the forces acting on the cardboard. Extend the lines until they intersect. Mark the point of intersection and draw arrows starting at this point to represent the forces acting on the cardboard.

6. Repeat steps 3 to 5 for pair B and C.

Q7. When the cardboard is at rest, how do the magnitudes and directions of the pair of forces acting on it compare?

7. Now here is a challenge. Find out the directions of all the forces such that when all the threads were pulled with the same amount, the cardboard will not move or rotate when released.

Q8. If you draw the lines of action of all the forces acting on the board and extend the lines, what will you get?

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Activity 3
INVESTIGATING INERTIA

Objective:
At the end of this activity, you should be able to demonstrate Newton's first law of motion.

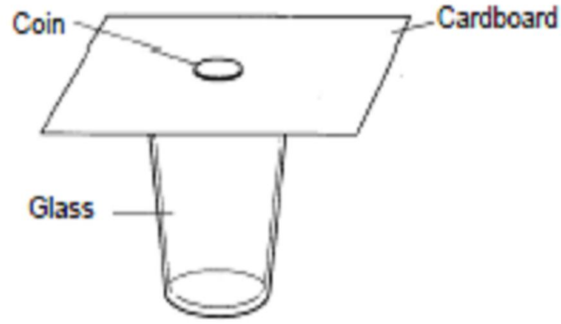

Figure 7. Cardboard and coin

Materials:
empty glass 5-peso coins (5 pcs or more)
cardboard plastic ruler
1 peso coin

Procedure

Coin Drop
1. Arrange the setup as shown in Figure 7.

2. Slowly pull the cardboard with your hand and observe what happens.

3. Arrange again the setup as shown. This time, quickly flick the cardboard with your finger. Observe again what happens.

Q9. What happens when you slowly pulled the cardboard? Explain.

Q10. What happens when you flicked the cardboard? Explain.

Stack of Coins
4. Stack the coins on a flat level surface.

5. Quickly hit the coin at the bottom with the edge of the ruler.

Q11. What happens when you hit the coin at the bottom? Why is this so?

Name: ______________________________	*Team:* ______________	Score:
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Activity 4
FORCE AND ACCELERATION

Objective:
After this activity, you should be able to describe how the net force acting on an object affects its acceleration.

Procedure:
Consider this situation below:

A group of students conducted an experiment to determine the relationship between the force acting on the object and its acceleration. They used identical rubber bands to pull the cart as shown in Figure 8. They varied the number of rubber bands to vary the force acting on the cart. They started with 1 rubber band, then with 2, 3, and 4 rubber bands, making sure that they stretched the rubber bands to the same length every time they pull the cart. They used a ticker tape timer to determine the acceleration of the cart. A ticker tape was connected to the cart such that when the cart was pulled, the paper tape will be pulled through the timer. And as the paper tape was pulled through the timer, small dots are formed on the tape.

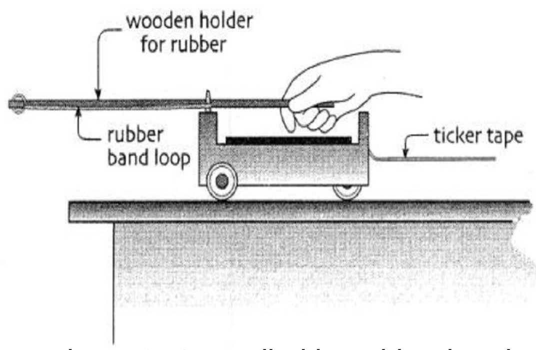

Figure 8. Car pulled by rubber bands

Starting with the tape for 1 rubber band, they marked the first clear dot and every 6th dot thereafter and cut the tape along these points (Figure 9). Then they pasted the strips side by side in order on a graphing paper to produce the tape chart for F=1 unit. They did the same for the other tapes to produce tape charts for F=2 units, F=3 units, and F=4 units.

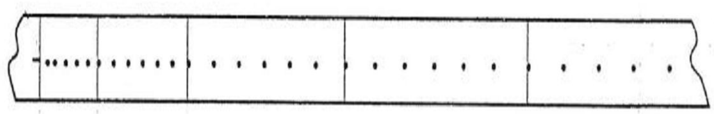

Figure 9. Sample tape.

A. Tape chart analysis

1. Obtain from your teacher the copies of the tape charts produced by the students for the 4 runs.

Q12. Compare the charts. What similarities and differences have you noticed among them?

The length of strip in each chart represents the total distance travelled by the cart over a time interval of 0.10 seconds. Recall that the total distance travelled over a unit time gives the average velocity of the moving body, or speed when travelling in straight line. Hence, *each strip represents the average velocity of the cart over a time interval* of 0.10 seconds.

2. Examine the tape chart for F=1 unit.

Q13. What does the increase in the lengths of the strips suggest? What can you say about the motion of the cart - is it moving in uniform motion or is it accelerating? Is this also true with the other runs?

Q14. How do you compare the increase in length of the strips in F= 1 unit? What does this tell you about the change in the velocity of the cart? Is this also true with the other tape charts?

Q15. How do you compare the increase in length of the strips among the four tape charts? Which tape chart shows the greatest increase in the length of the strips? Which tape chart shows the least increase in the length of the strips?

3. Draw a line that passes through all the dots at the ends of the strips in F=1 unit. Do the same for the other tape charts.

Q16. Describe the line formed. Does the same pattern exist for the other tape charts?

B. Quantitative analysis

You can also use the tape chart to compute for the average velocity (**v**ave), change in velocity (Δ**v**), and acceleration (**a**) of the cart for each run. Work only on the tape chart assigned to your group. Other groups will be working on the other charts. You may follow the simple instruction below.

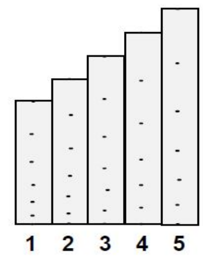

Figure10: Sample tape chart

4. Label each strip 1,2,3,4, and 5 as shown in Figure 10.

5. Compute for the average velocity of the cart over each time interval by measuring the length of the strip and dividing it by the time covered to travel such distance. Example, if the length of the strip is equal to 2.5 cm, then the average velocity during that time interval will be:

$$v_{ave} = 2.5\ cm / 0.10 sec$$
$$= 25\ cm/s$$

Q17. How do the values of v_{ave} compare? What does this tell you about the motion of the cart?

6. Next, determine the difference in the average velocities of the cart between two successive time intervals. Example, you can get the difference in $\mathbf{v}_{ave}$ between strips 1 & 2, between strips 2 & 3, and so on.

Q18. How do the computed values of Δv compare? What does this tell you about the motion of the cart?

7. Recall that acceleration is defined as the change in velocity per unit of time. To get the acceleration of the cart, divide your computed values of Δ**v** in step 6 by 0.10 seconds, the unit of time. Have at least three computed values of ***a***.

Q19. How do your computed values of *a* compare?

8. Compute for the average acceleration $\mathbf{a}_{ave}$.

9. Ask from the other groups the values of $\mathbf{a}_{ave}$ for the other tape charts. Record them all in Table 1 below.

Table 1. Computed values of acceleration

Tape chart	# of rubber bands	***a**ave*
F = 1 unit	1	
F = 2 units	2	
F = 3 units	3	
F = 4 units	4	

Q20. In this activity, the number of rubber bands represents the magnitude or amount of the force acting on the cart. How is acceleration of the cart related to the amount of force acting on it?

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Score:

Activity 5
ACTION-REACTION

Objective:
In this activity, you should be able to state Newton's Third Law of Motion.

Materials:
2 spring balances
string

Procedure:
1. Connect 2 spring balances with their hooks. Ask your partner to hold one end of the balance while you hold the other end horizontally. Pull the spring balance while your partner just holds the other end. Record the reading on each balance.

Q21. What is the reading on your balance and that of your partner? What do these values represent?

Q22. How do you compare the direction of your partner's and your force?

2. Pull the spring balance harder. Be careful not to exceed the maximum reading on the spring balance.

Q23. What is the reading on your balance and that of your partner?

Q24. How do you explain your observation?

3. Attach one end of your spring balance to the wall, while the other end is connected to the second spring balance. Ask your partner to pull the spring balance. Observe the reading on each balance.

Q25. What is the reading in each balance?

Q26. Compare the direction of the forces exerted on the two ends of the connected spring balance.