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III. WIND: THE VEHICLE FOR CHANGE IN WEATHER

AIR MOVEMENT ASSOCIATED WITH HEATING AND COOLING

IDEAS TO BE DEVELOPED

1. Wind is the movement of air over the earth's surface. It is due, primarily, to the uneven heating of the earth's surface. As air is warmed, it rises. Cooler adjacent air flows in to take its place.

2. Areas of the earth's surface which are dark in color absorb more solar radiation than light colored areas. Subsequently, dark colored surfaces radiate more heat to the atmosphere than adjacent areas which are lighter in color and/or more reflective.

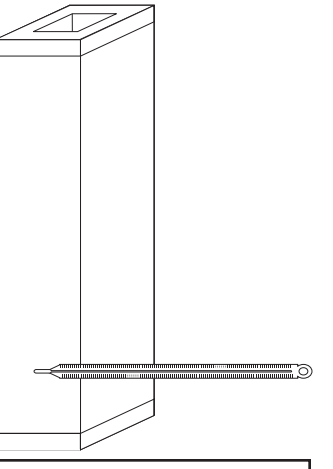
3. As air at the earth's surface is warmed it rises. Warm air rises because its weight is less than the Buoyant Force exerted by the cooler air which rushes in to replace it. As air cools it becomes more dense and sinks.

INVESTIGATIONS

MATERIALS REQUIRED:

Thermal Energy Detector
Thermometer, 0-230˚ F
*Watch that registers seconds

*(Needed but not included in kit)



1. AIR TEMPERATURES ABOVE SURFACES WHICH DIFFER IN COLOR AND TEXTURE

This investigation needs to be conducted outdoors on a "mostly sunny" day. Time required is 40 to 45 minutes.

Procedures

a. Insert the thermometer in the hole 4 inches above the base of the Thermal Energy Detector. **NOTE:** For this investigation, the base of the detector is removed **both ends** of the unit are open.

b. Set the unit, in a vertical position, directly on top of the surface being investigated.

c. Read and record the air temperature at the "START" and then once each minute for a total of five minutes.

d. Repeat steps 2 and 3 for each surface tested. If it can be arranged, **SAFELY**, it would be nice to visit a lake or river to measure air temperature over water.

e. While holding the Energy Detector in a horizontal position, about four feet above the ground, measure the "outdoor" air temperature.

2. SIMULATION OF AIR MOVEMENT DUE TO HEATING AT THE EARTH'S SURFACE

MATERIALS REQUIRED:

Metal cylinder 11" × 3" dia.
Candle
Pinwheel, 4" dia.
Map pin
Wood dowel, 9" × ¼" dia.
*Facial Tissue
*Transparent tape

*(Needed but not included in kit)

Procedures

a. The Flow of Heated Air

i. Cut out the pinwheel. Punch a pin hole through the center of the 3½" disc. Cut inward along each dotted line.

ii. While pressing thumb and forefinger TIGHTLY over the small inner circle of the disc, give each vane a slight twist, twist each vane in the same direction.

iii. Use the map pin to attach the pinwheel to the end of the 9" dowel. **NOTE:** The hole in the disc needs to be large enough to permit "free spinning" but not so large as to cause excessive "wobble". While the pinwheel is attached to the wood dowel, store the unit in a vertical position.

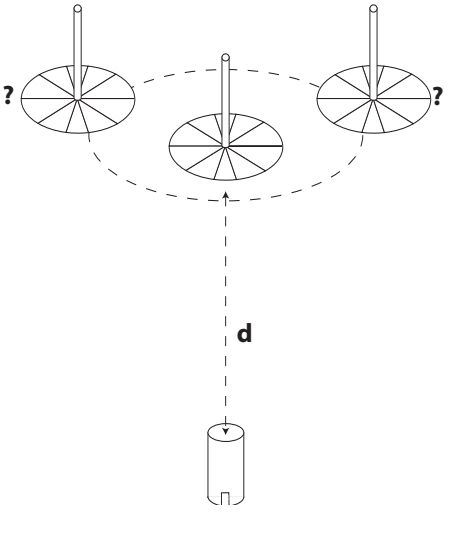
iv. Place the metal cylinder over the lighted candle.

v. Hold the dowel in a vertical position, pinwheel suspended BENEATH the dowel. (See diagram). Pass the unit, very slowly, back and forth about 2" above the cylinder. Report any evidence of vertical position.

vi. Set the candle and cylinder on the floor. About 2 ft. above the top of the cylinder, pass the pinwheel slowly back and forth. Look for evidence of vertical and sideward air movement.

vii. Repeat at a height of 3 ft. above the cylinder.

viii. Determine the maximum height above the cylinder at which vertical air movement can be detected.



b. The Flow of Adjacent, Cool Air.

i. Cut two strips of facial tissue, 2" × ½". (Separate two ply into single pieces)

ii. Attach transparent tape to each tissue (See Figure 1) . Tape the tissues above the openings at the base of the metal cylinder. The tissue must be able to swing freely in and out of the opening without touching the sides or dragging along the bottom.

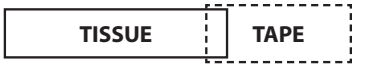


Figure 1

iii. Place the cylinder over the lighted candle. Avoid burning the tissue by keeping the candle close to the edge of the cylinder, between the two cut outs.

iv. Center the candle within the cylinder. Describe any evidence of sideward air movement.

NAME _____

DATA SHEET

WIND: THE VEHICLE FOR CHANGE IN WEATHER

AIR MOVEMENT ASSOCIATED WITH HEATING AND COOLING

1. Air Temperatures Above Surfaces Which Differ in Color and Texture

DATE: _____ **AIR TEMP., 4 FT. ABOVE GROUND** _____

AIR TEMPERATURES		SURFACES TESTED					
		CONCRETE	GRASS	GRAVEL	BLACKTOP	BARE SOIL	WATER
	START						
	1 MIN						
	2 MIN						
	3 MIN						
	4 MIN						
	5 MIN						

ALL TEMPERATURES MEASURED 4" ABOVE SURFACE AREA

2. A Simulation of Air Movement Due to Heating by the Earth's Surface

a. The flow of heated air.

HEIGHT OF PINWHEEL ABOVE THE CYLINDER	EVIDENCE OF AIR MOVEMENT	
	VERTICAL	SIDEWARD
2"		
2 FT.		
3 FT.		
_____ FT./(MAX)		

(yes/no)

b. The flow of adjacent cool air.

Observations: _____

_____

SUMMARY

1. Suppose that you were to observe the motion of a weather vane mounted on top of a building located near the shore of a lake.

a. During the afternoon of a sunny summer day, I would expect that the direction of the WIND would be from the _____ toward the _____. About 2 hours after sunset, the breeze would be off the _____ toward the _____.

b. Describe the events which cause this effect.

i. During the day; _____

ii. In the evening; _____

2. During hot summer days the air temperature in a metropolitan, at a specific time, is frequently 4 to 5 degrees warmer than that in surrounding suburban areas. What would account for this difference? _____

_____

_____

_____

III. WIND: THE VEHICLE FOR CHANGE IN WEATHER

MEASURING THE BUOYANT FORCE WHICH CAUSES WARM AIR TO RISE

INVESTIGATION

MATERIALS REQUIRED:

Wood support stand, 16"
Lever arm, 40 cm × 1 cm
Axle, (use collimating guide rod)
Weight set (washers and paper clips)
Large round balloon
Metal cylinder, 11" × 3" dia.
Candle
Metal can, 5" × 4" dia.

PROCEDURES

1. Set up the unequal arm balance as shown. Bend one large and one small paper clip to form the weight hangers.

2. Use washers and the adjustable metal clip to balance the lever in a horizontal position. **NOTE:** When checking for horizontal alignment always set the lever arm into motion and allow it to come to rest on its own.

3. Attach 1 small paper clip to the RF hanger. Determine how many small paper clips need to be attached to the EF hanger to balance the lever arm. Calculate the AMA for the balance.

4. Remove all small paper clips. Set the balance on top of the metal can.

5. Blow up the balloon and release the air. Do this several times to stretch it out. Blow up the balloon to a diameter of 7" or 8". Tie it shut. Attach it to the RF hanger.

6. Add washers and paper clips as required to balance the balloon and lever arm in a horizontal position.

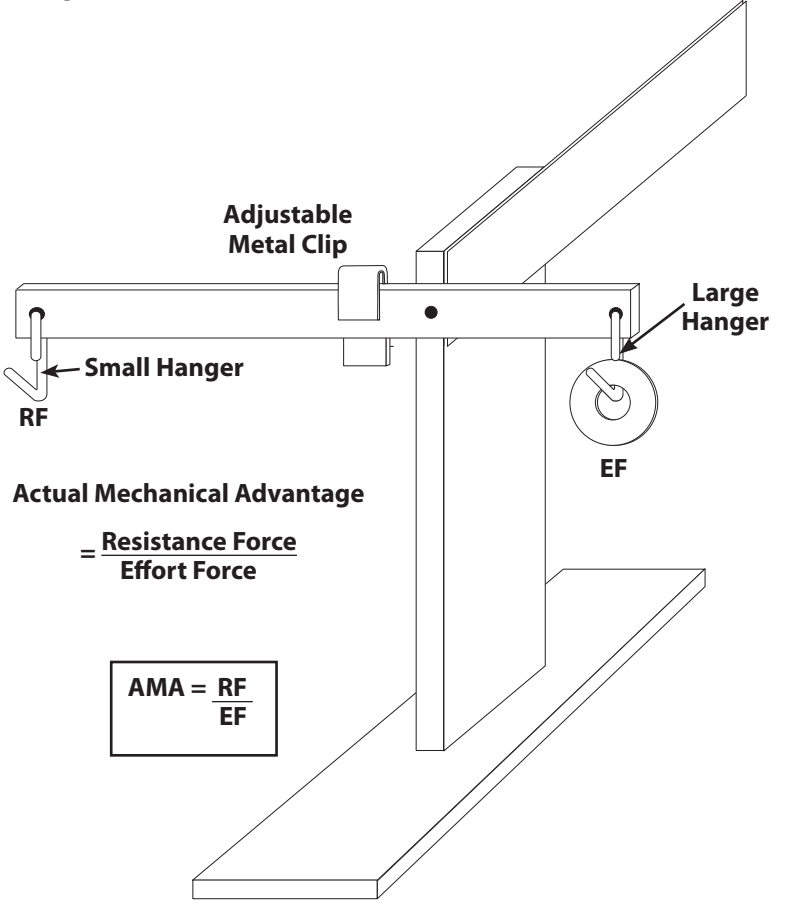
7. Set the metal cylinder over the lighted candle. Position the cylinder directly under the balloon. Observe the effect on the balloon.

8. Pull down on the balloon so as to hold it against the top of the metal cylinder.

9. After 2 or 3 minutes, while still holding the balloon down, REMOVE just enough weight from the EF hanger to balance the balloon. **NOTE:** The weight removed is 3 times greater than the additional Buoyant Force produced as the balloon expanded. (MECHANICAL ADVANTAGE IS 1 TO 3)

10. Record the type and number of paper clips removed.

11. Remove the metal cylinder. Extinguish the candle. Allow the air inside the balloon to cool to room temperature. Observe the effect on the lever.



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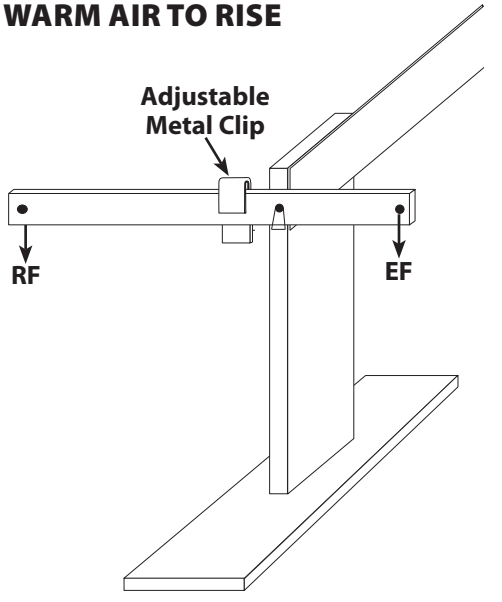
MEASURING THE BUOYANT FORCE WHICH CAUSES WARM AIR TO RISE



Actual Mechanical Advantage = Resistance Force / Effort Force

1. _____ paper clips at EF needed to balance 1 paper clip at RF.

1 lg paper clip = 1.5 g 1 sm paper clip = 0.5 g 1 plastic cup = 0.1 g

2. The actual mechanical Advantage of the "UNEQUAL" ARM BALANCE = $\frac{RF}{EF}$

AMA = $\frac{\text{\_\_\_\_\_ g}}{\text{g}}$ = [ ]

1 gram of force at RF is equal to _____g at EF

3. # of paper clips, at EF, **REMOVED** to balance INCREASE IN BUOYANT FORCE due to the expansion of heated air in balloon;

# of PAPER CLIPS REMOVED

_____ large = _____ g

_____ small = _____ g

_____ plastic = _____ g

Total DECREASE in EF = _____ g

AMA = $\frac{RF}{EF}$;

RF = AMA • EF ;

INCREASE IN BUOYANT FORCE = [ ] g

4. As the temperature of the air inside the balloon became warmer; the balloon _____

SUMMARY

1. When the air inside the balloon became warmer; the balloon _____. (increased/decreased/remained the same)

a. The average distance between the molecules of air _____

b. Volume occupied by the air _____

c. The number of molecules of air inside the balloon _____

d. The weight of the air and balloon _____

e. The balloon moved upward because the Buoyant Force exerted by surrounding air _____

2. As air at the earth's surface is warmed, the air will _____, (contract/expand) its DENSITY will _____ , (increase/decrease) and it will _____. (sink/rise)

3. Warm air _____ (sinks/rises) because its weight is _____ (more/less) than the BUOYANT FORCE exerted by the cooler surrounding air.

4. Warm air will continue to _____ (rise/sink) until its DENSITY is _____ (greater/less/same) as/than the surrounding air.