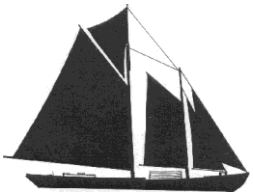


Schooner *Adventure*
Water and Energy

Harnessing Energy from the Ocean: Investigating Ocean Wind and Water Currents

I. What Causes Wind and Wind Currents?

How Winds Are Made
- Investigate movement of warm and cold air and its pressure

Classifying Winds
- Match descriptions with name on Beaufort Wind Scale.

Curious Wind Currents
- Investigate how wind divides to pass around an object then rejoins on the other side

II. What Causes Ocean Currents?

How Can You Layer Liquids?
- Investigate how differences in salt content can create layers in water

Do Cold and Hot Water Mix?
- Investigate movement of different temperatures of water when they meet

Thermocline activity
- Explain why cold water sinks and warm water remains at surface

III. Using Ocean Wind and Currents

- Demonstrate how wind makes circular currents
- Map and label Atlantic currents – compare with global wind patterns
- Getting from point A to C through point B using wind and water currents
- Square rigging versus fore and aft rigging

Supply List

Air Has Weight – Investigate How Adding Air Adds to the Weight

- string
- rod
- 2 balloons

Air Moves from High Pressure to Low

- balloon

How Winds Are Made – Investigate Movement of Warm and Cold Air

- quart jar with cap
- cardboard scraps
- matches
- cooler with ice
- heat source

What Happens to Air When Heated?

- Bottle
- balloon

Blow Ye Winds In The Morning (Or Noon Or Night)

- cardboard box
- paper towel
- cellophane
- candle
- scotch tape
- matches

Classifying Winds – Using the Beaufort Wind Scale

- Worksheet (pencils)
- Beaufort Wind Scale
- Anemometer

Make Own Beaufort Wind Scale Wheels

- copies of 2 wheel patterns
- fastening brads (scissors)

Curious Wind Currents – Investigate How Wind Divides to Pass Around an Object Then Rejoins On The Other Side

- bottle
- candle
- matches

Mapping Atlantic Wind and Ocean Patterns

- Map of global wind patterns
- Map of global ocean currents

Making Surface Currents – Surface Currents Match Wind Currents

- Large, round pan/pool of water
- 3 battery-powered fans
- Plastic confetti

Getting From Here to There Using Natural Forces – Getting From Point A To C Through Point B Using Wind And Water Currents

- Large, round pan of water
- 3 battery-powered fans
- Toy or clay boats

Square-Rigging Versus Fore-And-Aft Rigging

- Large, round pan of water
- 3 battery-powered fans
- Wood or clay hulls with stiff rudder
- Rods/sticks for masts
- Paper or foam sails – square rigged and fore-and-aft

How Can You Layer Liquids? – Investigate How Differences In Salt Content Can Create Layers In Water.

- Newspaper
- ruler
- marker
- spoon
- straw
- plastic cups
- salt
- food coloring

Do Cold and Hot Water Mix? – Investigate Movement Of Different Temperatures Of Water When They Meet.

- Ruler
- marker
- straw
- plastic cups
- blue ice water
- red hot water
- newspaper

Thermocline Activity – Why Does Cold Water Sink And Warm Water Remain At Surface?

- Clear plastic box
- water
- mesh basket
- white paper/foam
- blue colored ice cubes

Harnessing Energy from the Ocean: Investigating Ocean Wind and Water Currents

Learning Goals

- Students will make predictions and carry out experiments to test their predictions.
- Students will identify important properties that may affect wind and water movement
- Students will design specific experiments to determine the effect of changing the factors
- Students will come to their own working definition of the causes of wind and water movement

Background Information

I. What causes wind and wind currents?

A. Air has weight and mass and can be affected by temperature

B. Wind = moving air

1. Wind caused by high pressure moving into low pressure

2. Pressure differences caused by temperature differences

a. Lower temperature = heavier air = higher air pressure

b. Higher temperature = lighter air = lower air pressure

C. Wind Currents = wind patterns caused by temperature differences in air masses moving in certain directions when they meet

1. Warmer temperature air mass near equator moves up and over

2. Colder temperature air mass near poles moves down and under

3. Creates circular patterns on oceans used by sailing ships to cross

II. What causes ocean currents?

A. Surface currents caused by wind patterns pushing surface water in same direction

1. Both wind currents and resulting surface currents make a clockwise circular pattern in the Northern Atlantic Ocean

B. Deep water currents caused by differences of temperature and salinity

1. colder water sink while warmer water moves above

2. saltier water sinks while less salty water moves above

III. Using Ocean Wind and Currents

A. Wind makes circular ocean surface currents

B. Atlantic currents compare with global wind patterns

C. Navigation uses wind and water currents

D. Square rigging versus fore and aft rigging allows different ship movement

I. What causes wind and wind currents?

Air Has Weight
Investigate How Adding Air Adds to the Weight

Materials:

- string
- rod
- 2 balloons

Procedure:

1. Tie string to center of rod so that it will balance when hung.
2. Attach empty balloons to each end to observe equal weight.
3. Fill one balloon with air and reattach to rod.
4. Note how the rod balances now.

Inquiry discussion

1. What difference did you notice after one balloon had air added to it?
2. How did adding air to a balloon affect the weight?
3. How does this prove that air has weight?

(source: Syrocki, John; *Science Activities for the Elementary Grade*s, Parker Publishing Company, Inc. p.120)

Air Moves from High Pressure to Low

Materials:

- balloon

Procedure

1. Fill balloon with air and hold closed but don't tie.
2. Let air out slowly – note the force of the wind
3. Refill balloon
4. Let air out quickly – note the difference in the force of the wind

Inquiry Discussion

1. Where was there more air pressure, inside the balloon or outside?
2. Why did the air come out of the balloon?
3. What causes differences in the strength of the wind coming from the balloon?

I. What causes wind and wind currents?

How Winds Are Made
Investigate Movement of Warm and Cold Air

Materials:

- quart jar with cap
- cardboard scraps
- matches
- cooler with ice
- heat source

Procedure:

1. Light piece of cardboard with match and drop inside jar
2. Put lid on so jar fills with smoke
3. Open jar inside cooler with ice – note how the smoke moves
4. Refill jar with smoke
5. Open jar near heat source – note how the smoke moves

Inquiry discussion

1. Where did the smoke go when it met cold air?
2. Where did the smoke go when it met warm air?
3. Why do you think the smoke moved in these directions?
4. What do you think happens when a large cold air mass meets a large warm air mass?

(source: Wyler, Rose; *The First Book of Science Experiments*, Franklin Watts, Inc. p.19)

What Happens to Air When Heated?

Materials:

- bottle
- balloon
- hot water

Procedure:

1. Place balloon over the opening of the bottle.
2. Place bottle with balloon in hot water.

Inquiry discussion:

1. What happens to the balloon? Why?
2. If you let the bottle cool, what happens to the balloon then?
3. What does this tell us about the movement of air when heated?

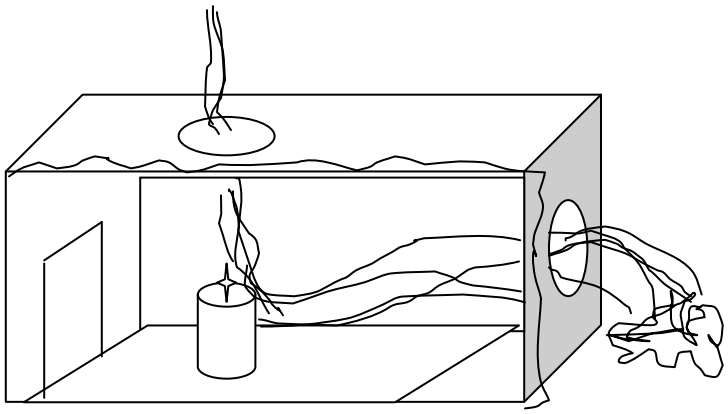
I. What causes wind and wind currents?

Blow Ye Winds In The Morning (Or Noon Or Night)

Objective:
Students will explore the process that forms wind. Wind is air in motion caused by differences in air pressure, which may be the result of differing air temperatures. Currents generally move from high pressures toward low pressures. The earth's rotation also has an effect on the formation of winds and the directions they take.

Materials:
- cardboard box
- paper towel
- cellophane
- candle
- scotch tape
- matches

Procedure:
1. Remove the cover of the box. Cover the top with cellophane, fastening it into place with scotch tape.
2. Cut out one end of the box to make a hinged door. Set the box on its side and place a short candle inside near one end.
3. Cut a hole the size of a quarter directly over the candle and another one the same size in the middle of the far end.
4. Light the inside candle and close the door.
5. Dampen a paper towel slightly and set it on fire for a moment. Blow out the dampened paper and it will give off smoke. Hold the paper near the hole in the door.
6. The smoke moving through the air will trace the current of air. The cooler, heavier air rushes in and fills the space that was occupied by the lighter, warmer air, which rises and flows out the opening at the top.



Inquiry discussion:
1. Where was the warmer air? Where did it go?
2. Where was the cooler air? Where did it go?
3. Why did the air move this way?

(Adapted from *Science Activities for Elementary Children* by Nelson and Lorbeer)

I. What causes wind and wind currents?

Classifying Winds
Using the Beaufort Wind Scale

Materials:

- Worksheet
- Beaufort Wind Scale
- Anemometer

Procedure:

1. Match descriptions on worksheet with name on Beaufort Wind Scale
2. Using anemometer, measure and identify winds in harbor

Answer Key:

1. #2; 4-7 mph, light wind
2. #0; less than 1 mph; calm
3. #9; 47-54 mph; strong gale
4. #10; 55-63 mph; whole gale
5. #5; 19-24 mph; fresh breeze
6. #12; 73+ mph; hurricane
7. #1; 1-3 mph; light air
8. #6; 25-31 mph; strong breeze
9. #8; 39-46 mph; fresh gale

(source: Fredericks, Anthony; *Think About It! Science Problems of the Day*, Ideal School Supply Company, p.38)

*EXTENSION:

Make Own Beaufort Wind Scale Wheels

Materials:

- copies of 2 wheel patterns
- fastening brads

Procedure:

1. Cut out the 2 circles and fasten together with brad.

(source: http://www.miamisci.org/hurricane/windscale.html)

Weekly Challenge

In 1806, Sir Francis Beaufort created the Beaufort Wind Scale for sailing ships. Since then it has been adapted for use by meteorologists.

For each number on the scale of 0-12, there is given a weather term, a wind speed measured in miles per hour, and the typical effects of the wind on land.

Use the clues given in the table. Fill in the appropriate Beaufort number, the approximate wind speed, and the weather term.

	Clues	Beaufort Number, Wind Speed, Weather Term
1	As you walk out the door, you can feel the wind on your face.	#2 4–7 mph Light breeze
2	The smoke from the chimney next door is going straight up.	
3	As you turn the corner, you see roof tiles blowing off an apartment house.	
4	After the storm, you find that one of the trees on your street was uprooted.	
5	As you pass the pond, you notice white waves on it.	
6	When you return home after the storm, you find that many buildings have been devastated.	
7	Everything seems very still, but you notice that smoke from a chimney is drifting.	
8	As you look out the window, you notice that large branches are moving.	
9	When you leave home, you have some difficulty walking against the wind.	

Beaufort Wind Scale

Developed in 1805 by Sir Francis Beaufort of England

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	

Beaufort Wind Scale

Instructions

1. CUT OUT each Beaufort wind scale along the outside circle.
2. COLOR each Beaufort wind scale if desired.
3. CUT OUT both shaded areas on Beaufort wind scale #1.
4. With a sharpened pencil, PUNCH a hole through the black dot in the center of each circle.
5. PLACE Beaufort wind scale #1 on top of Beaufort wind scale #2.
6. PUSH the brad fastener through the center hole of both circles.
7. FLIP your Beaufort wind scale over and spread open the fastener.
8. SPIN the wheel to make sure it moves freely.
9. USE your new Beaufort wind scale to see how fast the outside wind is moving .

Beaufort wind scale #1

Beaufort wind scale #2

I. What causes wind and wind currents?

Curious Wind Currents:
Investigate How Wind Divides to Pass Around an Object
Then Rejoins On The Other Side

Materials:

- bottle
- candle
- matches

Procedure:

1. Light candle and place behind the bottle
2. Blow hard against the front of the bottle

Inquiry Discussion

1. What happened to the flame on the candle?
2. Why do you think this happened?
3. What does this say about the movement of wind when it encounters and object?

(source: *Simple Science Experiments,* Hans Jurgen Press p.68)

II. What causes ocean currents?

How Can You Layer Liquids?
Investigate How Differences In Salt Content Can Create Layers In Water.

Materials:

- newspaper
- ruler
- marker
- spoon
- straw
- plastic cups
- salt
- food coloring

Procedure:

1. Spread newspaper over working area
2. Fill 4 cups half full of water
3. Add yellow food coring and 1 teaspoon of salt to 1 cup
4. Add red food coloring and 2 teaspoons of salt to another cup
5. Add blue food coloring and 3 teaspoons to 3rd cup
6. Mark the straw every centimeter starting at the bottom
7. Gently place straw 1 cm below the surface of the blue liquid. Seal straw with finger and lift out of cup.
8. Move straw with blue liquid 2 cm into 4th cup of clear water. Lift finger and then put it back resealing the straw.
9. Observe what happens in the straw.
10. Empty straw into empty cup.
11. Repeat activity with the other colored liquids to make 4 layers.

Inquiry Questions

1. What happens when you put two different liquids in the straw?
2. What would be the order of layers with all 4 liquids?
3. Why do some layers mix while others form layers?
4. Which is heavier fresh or salt water?
5. How did the different amounts of salt affect the properties of the water?

(Source: *Earth's Oceans*, Macmillan/McGraw-Hill School Publishing Company. p. 16)

II. What causes ocean currents?

Do Cold and Hot Water Mix?
Investigate Movement Of Different Temperatures Of Water When They Meet.

Materials:

- ruler
- marker
- straw
- plastic cups
- blue ice water
- red hot water
- newspaper

Procedure:

1. Mark straw 5 cm and 10 cm from the bottom.
2. Place blue ice water cup and red hot water cup on newspaper
3. Place straw down to the 5 cm mark in the blue ice water. Put finger over top end of straw and lift out of cup.
4. With finger still on straw, put straw into red hot water up to the 10 cm mark.
5. Lift finger letting water in the straw rise. Put finger back on straw and lift out.
6. Observe the 2 colors of water and record observations
7. Release water into an empty cup.
8. Repeat activity using the red hot water first then the blue ice water.
9. Observe what happens with the different ordering.

Inquiry discussion:

1. What happened the first time? The second time?
2. Why do you think there was a difference in the reactions?
3. Which water do you think is heavier? Lighter?
4. How does order affect the experiement?
5. What would happen in the ocean if deep ocean water became warmer than the water above it?

(Source: *Earth's Oceans*, Macmillan/McGraw-Hill School Publishing Company. p. 26)

II. What causes ocean currents?

Thermocline Activity
Why Does Cold Water Sink And Warm Water Remain At Surface?

Materials:

- clear plastic box
- water
- mesh basket
- white paper
- blue colored ice cubes

Procedure:

1. Place plastic box on white paper and fold paper up against one side.
2. Fill box almost to top with water.
3. Place mesh basket with blue colored ice cubes into the water at one end of box.

Inquiry discussion:

1. How does the blue color flow through the water?
2. How does the blue water compare in temperature to the water in the plastic box?
3. Why does the blue colder water stay near the bottom?

*EXTENSION:
Repeat experiment using thermometers attached the sides of the box at various distances from the mesh basket of blue ice cubes. Record the temperature differences every 30 seconds for a 5 minute period.

(Source: *Charting Our Course: The Massachusetts Coast at an Environmental Crossroad*, p.12)

*Extension: videos about environmental energy sources (ie. seas, earth, sun)
Environmental Defense Fund
257 Park Avenue South, New York, NY 10010

http://www.edf.org/page.cfm?tagID=22638

III. Using Ocean Wind and Currents

Mapping Atlantic Wind and Ocean Patterns

Materials:

- Map of global wind patterns
- Map of global ocean currents

Procedure:

1. Look at global wind patterns; trace the circular route around the Northern Atlantic.
2. Compare with global ocean current patterns.

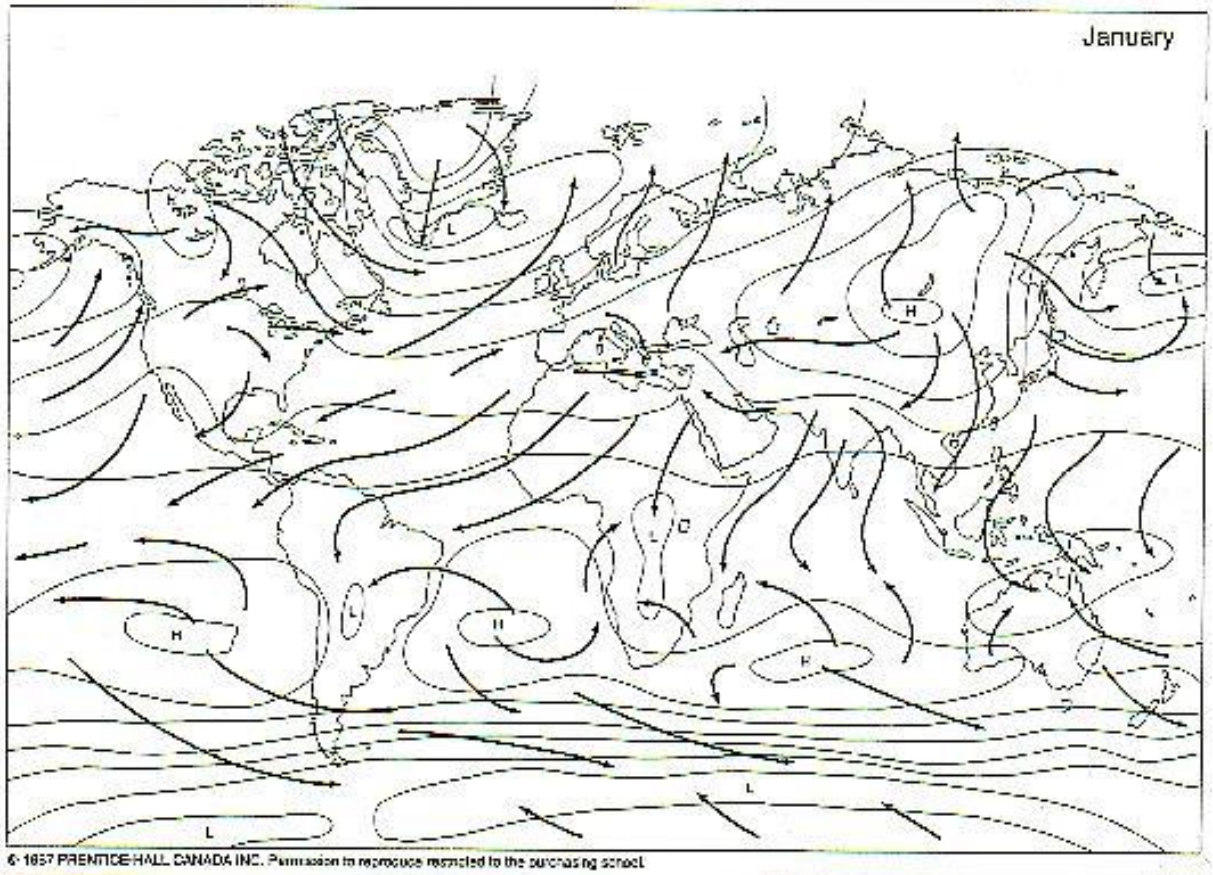
Inquiry discussion:

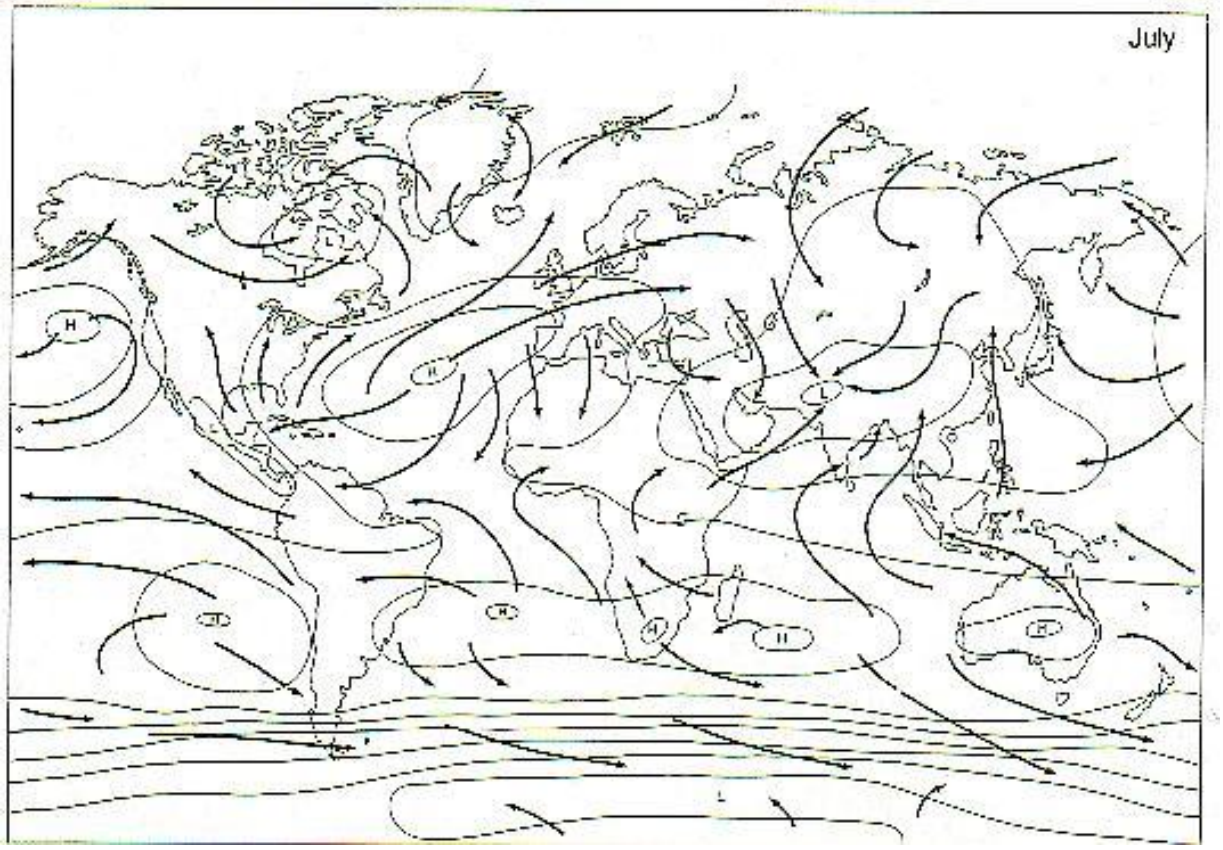
1. How might wind patterns affect weather, most notably hurricanes?
2. How might the wind and water current patterns relate to each other?

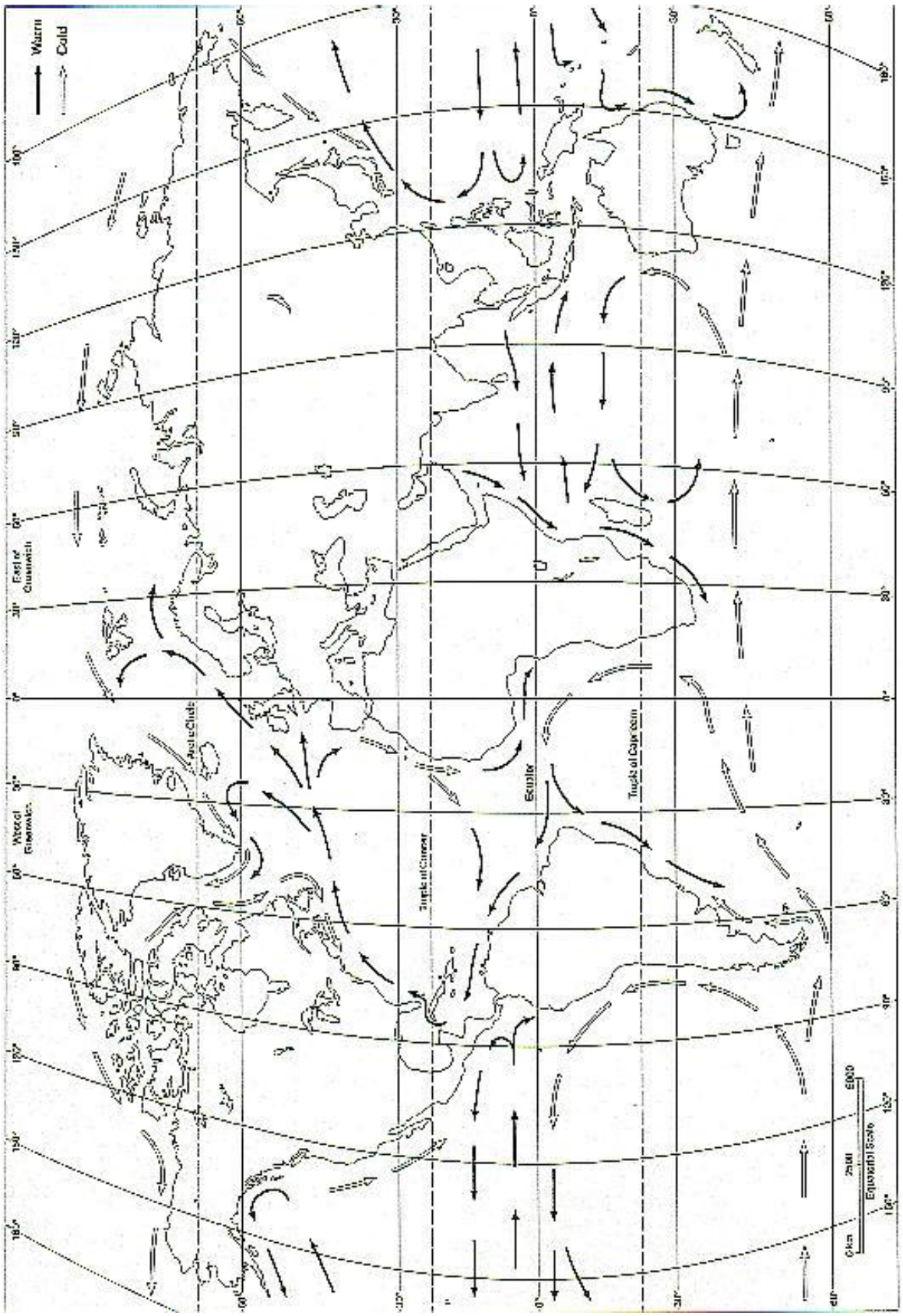
For further study- Research and label Northern Atlantic currents

*EXTENSION:
– interactive website showing winds and explorer routes
http://www.ucalgary.ca/applied_history/tutor/eurvoya/index.swf

42. World—Pressure and Wind







Global Ocean Currents

III. Using Ocean Wind and Currents

Making Surface Currents
Surface Currents Match Wind Currents

Materials:

- Large, round pan/pool of water
- 3 battery-powered fans
- Plastic confetti

Procedure:

1. Demonstrate how wind makes circular currents by positioning the 3 fans in a 12:00, 4:00 and 8:00 position.
2. Aim fans towards the next fan clockwise, blowing over the water surface.
3. Sprinkle confetti in water to view water movement caused by fans.

Inquiry discussion:

1. In what direction do you see the water currents moving? What's causing that?
2. How would this pattern affect sailing boats in the Northern Atlantic Ocean?
3. Historically, how did explorers and merchants use these patterns?

Getting From Here to There Using Natural Forces
Getting From Point A To C Through Point B Using Wind And Water Currents

Materials:

- Large, round pan of water
- 3 battery-powered fans
- Toy boats

Procedure:

1. Using same pool set-up as Activity 1, label the 3 fan positions – A, B, and C. clockwise.
2. Using toy boats, investigate how a boat could use the currents to make the circular route commonly used for various early triangle trades.

Inquiry discussion:

1. Were the boats able to follow the circular patterns?
2. How does this match with the historic trade routes?

III. Using Ocean Wind and Currents

Square-Rigging Versus Fore-And-Aft Rigging

Materials:

- Large, round pan of water
- 3 battery-powered fans
- Styrofoam or clay hulls with stiff rudder
- Rods/sticks for masts
- Paper sails – square rigged and fore-and-aft

Procedure:

1. Make simple boat hulls that will float
2. Compare sailing directions of square rigged versus boat with fore-and-aft rigging.
3. Move fore-and-aft rigging to see if you can get the boat to move in a direction different from where the wind is blowing.

Inquiry discussion:

1. Why do you think most ocean crossing sailing ships used the square rigged sails?
2. Why did the fishing boats need the fore-and-aft system instead?

MASSACHUSETTS FRAMEWORKS **Physical Sciences (Chemistry and Physics),**		
Grades PreK–2	Grades 3–5	Grades 6–8
4. Demonstrate that the way to change the motion of an object is to apply a force (give it a push or a pull). The greater the force, the greater the change in the motion of the object.		8. Differentiate between mixtures and pure substances. 11. Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed. 14. Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system. 15. Explain the effect of heat on particle motion through a description of what happens to particles during a change in phase. 16. Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.
Position and Motion of Objects		
3. Objects can move in various ways. 4. Change the motion of an object by applying a force. The greater the force, the greater the change in motion. 5. Objects can be balanced under some conditions.		11. An object's motion can be described by its position, direction of motion, and speed.
Earth Processes and Cycles		
	10. Water on earth cycles in different forms and locations.	

Energy in the Earth System		
3. Weather changes from day to day and over the seasons. 4. The sun supplies heat and light to the earth and is necessary for life.	8. Global patterns influence local weather, which can be measured.	3. Radiation, conduction, and convection transfer heat through the earth's system. 4. Energy provided by the sun, global patterns of atmospheric movement, and temperature differences among water, land, and atmosphere are related.
Materials and Energy Resources		
2. Air is a mixture of gases all around us and wind is moving air.		
Forms of Energy		
	4. Basic forms of energy, which cause motion or create change. 5. Energy can be transferred from one form to another.	14. Temperature change results from adding or taking away heat energy from a system. 16. Heat moves in predictable ways, from warmer to cooler objects until reaching equilibrium.
Heat Energy		
		14. Temperature change results from adding or taking away heat energy from a system. 15. The effect of heat on particle motion during a change in phase. 16. Heat moves in predictable ways, moving from warmer to cooler objects until reaching equilibrium.