Name_____ Class_____ Date_____

EXERCISE 48

CLIMATIC FACTORS: LATITUDE AND TEMPERATURE

Purpose: To see how the year-round temperatures of a city are related to its latitude.

Background: Latitude is defined as distance in degrees north or south of the Equator. Because of the earth's spherical shape, the angle of the sun's rays and the length of daylight are different for different latitudes at any given moment. Because of the earth's revolution around the sun, these two factors—angle of the rays and length of daylight—constantly change through the year. In this exercise we shall see how the month-by-month average temperatures of four different cities appear to be related to their latitudes. (All four cities are less than 500 feet above sea level.)

Materials: 1) Graph or cross-section paper 2) wall map of the world.

PROCEDURE

Beginning with the first **vertical** line on the graph paper, let every fifth vertical line represent one **month of the year,** from January through January. Label these below the base line. Use abbreviations.

To the left of the base line, write "0°F." Ten small spaces higher, write "10°F." Continue upwards until you reach 90°F. (Each small box represents 1°.)

Plot the temperatures for Singapore, joining the thirteen points with a smooth curve. Label the curve. Do the same for the other three cities.

At the top of the graph paper, place the title "Latitude and Temperature." Below the base line write "Months of the Year." In the left margin write "Temperature."

Average Monthly Temperatures (Degrees Fahrenheit)

	Singapore, Malaya Lat. 1°N, Long. 104°E	*Calcutta, India* 23°N, 88°E	*Washington, D. C.* 39°N, 77°W	*Moscow, U.S.S.R.* 56°, 37°E
January	80	67	36	12
February	80	71	37	15
March	81	80	46	24
April	82	85	55	38
May	82	86	65	53
June	81	85	74	62
July	81	84	78	66
August	81	83	76	63
September	81	83	70	52
October	81	81	58	40
November	81	73	48	28
December	80	67	38	17
January	80	67	36	12
Year's Average	81	79	57	39
Year's Range				

QUESTIONS

1) Fill in the year's range (difference between warmest and coldest months) for each city, in the last line of the table.

2) State the relation shown by the table between **latitude** and **average annual temperature.**

---

3) State the relation shown by the table between **latitude** and **temperature range** for the year.

---

4) How do the temperature curves in your graph show the **range** of temperature?

---

5) Why are Singapore's temperatures so uniformly high throughout the year?

---

6) Why is Calcutta so much warmer from March through October than from November through February? (Refer to angle of sun's rays and length of daylight.)

---

7) In which months is Calcutta warmer than Singapore?

Why?

---

8) Which is the warmest month in both Washington, D. C., and Moscow?

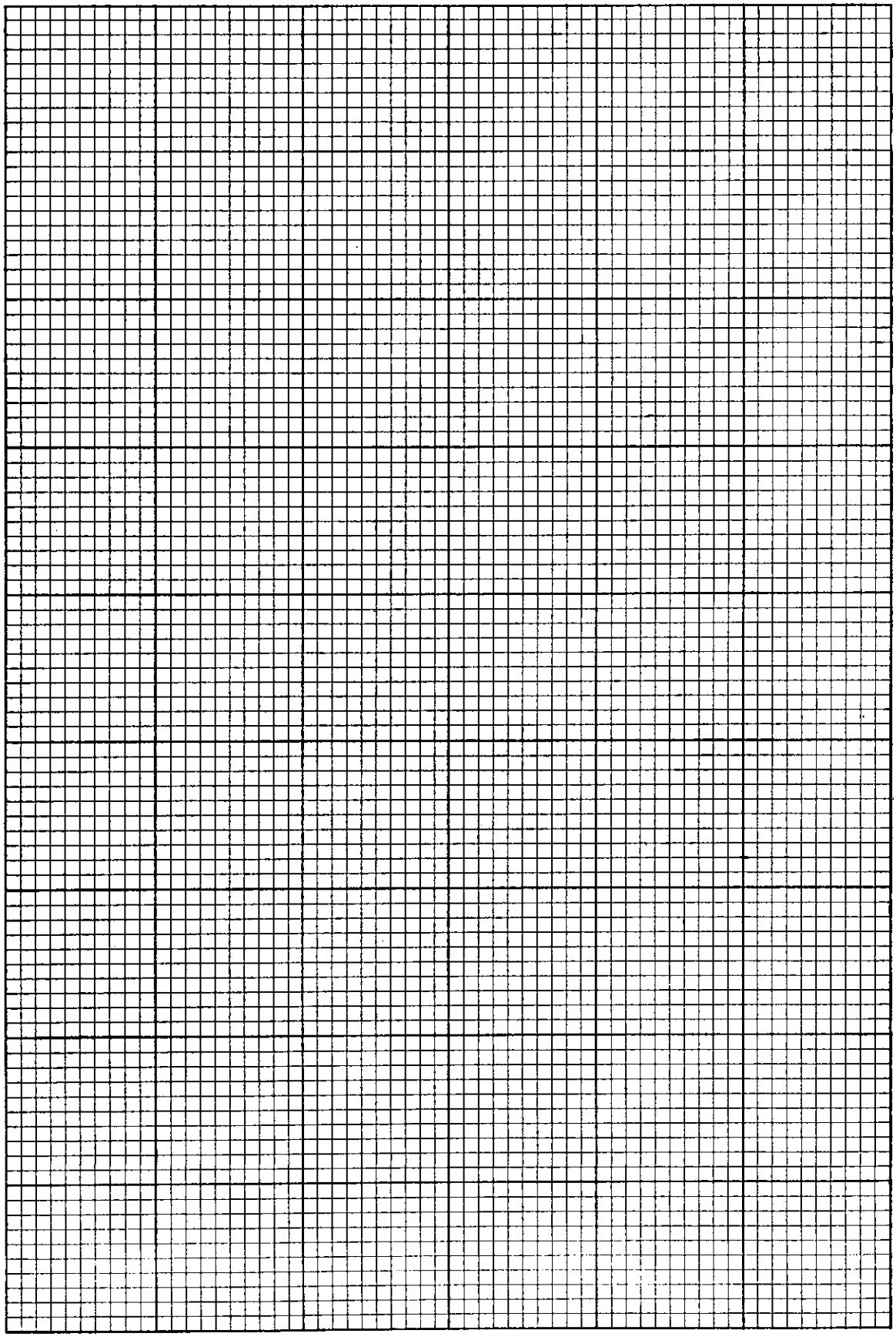
Why?

---

9) Which is the coldest month in both Washington, D. C., and Moscow?

Why?

Name..... Class..... Date.....



Name_____ Class_____ Date_____

EXERCISE 49

CLIMATIC FACTORS: ALTITUDE AND TEMPERATURE

Purpose: To see how the year-round temperatures of a city are related to its altitude.

Background: In order to study the effects of altitude on temperature, it is necessary for us to exclude other factors such as latitude, distance from the sea, etc., from our examples. In other words, we must compare places which are as much alike as possible in all respects affecting temperature **except altitude.** Then, if there are differences in temperature, we can attribute them largely to differences in altitude.

In this exercise we shall study two pairs of cities. The first pair, Singapore, Malaya, and Quito, Ecuador, are both on the Equator. Singapore is 10 feet above sea level, while the altitude of Quito is 9350 feet.

The second pair of cities, Denver, Colorado, and Kansas City, Missouri, are both at about 39° north latitude in interior United States. The elevation of Kansas City is 750 feet, while Denver is 5290 feet above sea level.

Materials: 1) Graph or cross-section paper 2) wall maps of World, Asia, South America, United States.

PROCEDURE

Prepare the graph paper as in the preceding exercise (on Latitude and Temperature), marking months of the year along the base line at 5-space intervals, and temperatures from 0°F to 90°F at 10-degree intervals (1° per space) upwards along the left margin.

Average Monthly Temperatures (Degrees Fahrenheit)

City	*Singapore, Malaya*	*Quito, Ecuador*	*Kansas City, Mo.*	*Denver, Colo.*
Latitude	2°N	0°	39°N	40°N
Altitude	10 feet	9350 feet	750 feet	5290 feet
January	80	55	30	31
February	80	55	35	34
March	81	55	44	39
April	82	55	56	49
May	82	55	65	57
June	81	55	75	67
July	81	55	81	74
August	81	55	79	72
September	81	55	71	64
October	81	55	60	53
November	81	54	44	41
December	80	55	34	34
January	80	55	30	31
Year's Average	81	55	59	50
Year's Range				

A. Plot the temperature curves, month by month, for **Singapore and Quito.** Label the curves. Print the title of the exercise at the top of the paper.

QUESTIONS

1) Compare the average annual temperatures of Singapore and Quito. Is the difference due to latitude or altitude?_____

_____

State the relation indicated between altitude and average temperature._____

_____

2) Compute the year's range (difference between warmest and coldest months) for Singapore and Quito. Enter these in the table. Is the difference between the ranges of the two cities large or small?_____ Does altitude appear to have much effect on range in this case?_____ What accounts for the very small range in both of these cities?_____

_____

_____

3) How much lower is the average yearly temperature of Quito than that of Singapore?

_____

How much higher above sea level is Quito?_____

Calculate the difference in average annual temperature per 1000 feet of elevation for these two cities?_____

How does this compare with the normal lapse rate of the atmosphere?_____

_____

_____

B. If time permits, plot the temperature curves for **Denver** and **Kansas City.**

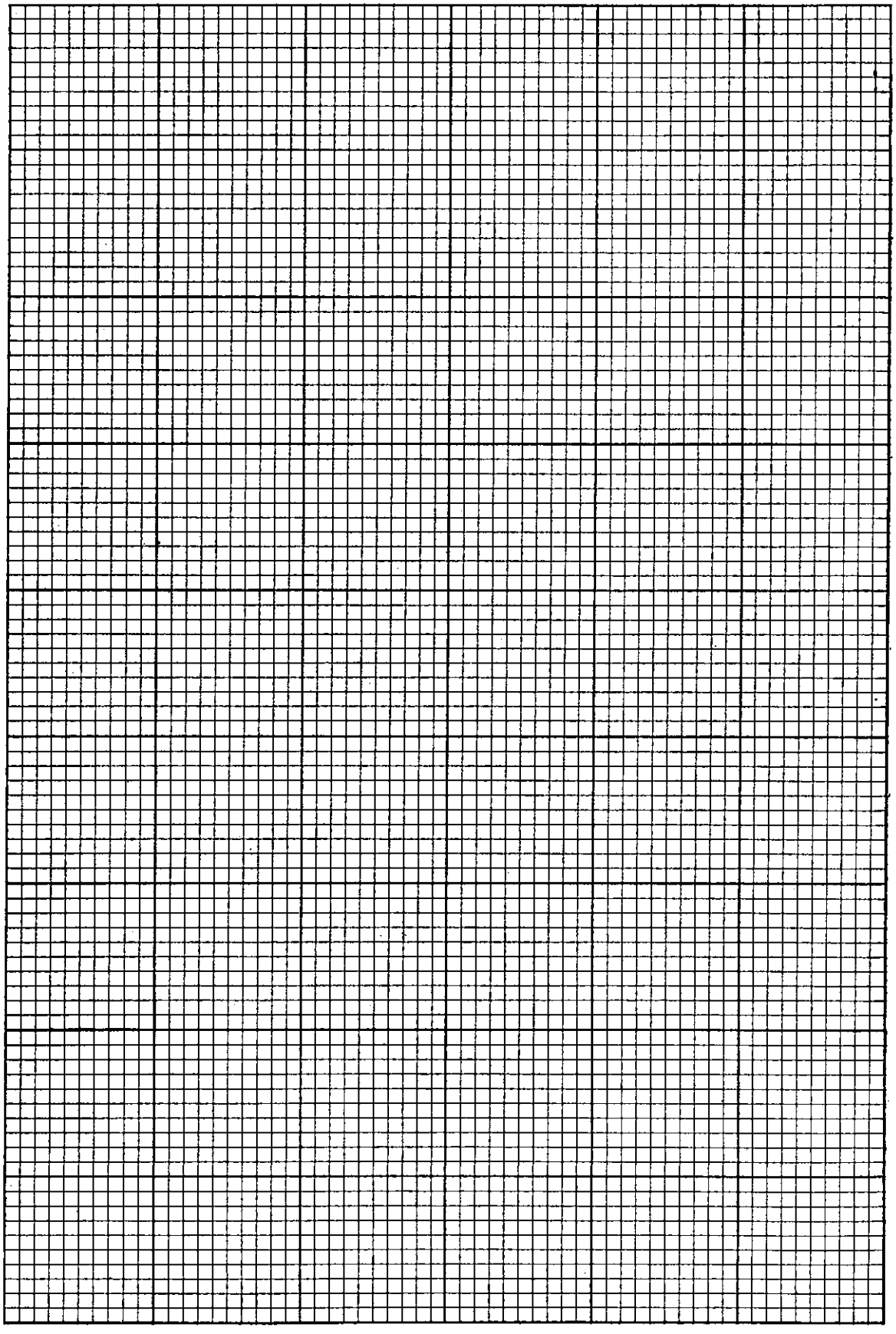
QUESTIONS

1) Compare the average annual temperatures of Denver and Kansas City. What relation between altitude and average temperature is indicated?_____

_____

2) Compute the year's range for the two cities. Which has the larger range?_____

Name _____ Class _____ Date _____



What relation between altitude and temperature range is indicated?_____

_____

Can you explain why?_____

_____

_____

3) How much lower is the average yearly temperature of Denver?_____ How much higher above sea level is Denver?_____ Calculate the difference in average temperature for these two cities per 1000 feet of elevation._____

_____

4) In which season are the temperatures of Denver and Kansas City almost identical (for three months)?_____

_____

Name the months._____

5) What possible explanation can there be for January in Denver actually being slightly warmer than January in Kansas City?_____

_____

_____

Name_____ Class_____ Date_____

EXERCISE 50

CLIMATIC FACTORS: MARINE INFLUENCE ON TEMPERATURE

Purpose: To see how winds from the sea affect the year-round temperatures of a city.

Background: San Francisco has a latitude of 38°N, and is located on the Pacific coast of California. St. Louis, Cincinnati, and Indianapolis all have about the same latitude and altitude, but they are far from the Pacific. All four cities are in the belt of prevailing southwesterlies. A study of their monthly average temperatures reveals, however, a striking difference between San Francisco and the other three cities. In this exercise, we shall plot the temperature curves of San Francisco, representing a "marine" climate, and Indianapolis, representing a "continental" climate. Then we shall study them to see what differences are produced by the nearness of San Francisco to the Pacific Ocean.

Materials: 1) Graph or cross-section paper 2) wall map of the United States.

PROCEDURE

Prepare the graph paper as in Exercise 48 on Latitude and Temperature, marking months of the year along the base line at 5-space intervals, and temperatures from 0°F to 90°F at 10-degree intervals (1 degree per space) upwards along the left margin.

Plot the temperature curves, month by month, for both cities. Label the curves. Letter the title of the exercise at the top of the graph paper.

Average Monthly Temperatures (Degrees Fahrenheit)

City	*San Francisco, Cal.*	*Indianapolis, Ind.*	*St. Louis, Mo.*	*Cincinnati, Ohio*
Location	38°N, 122°W	40°N, 87°W	39°N, 90°W	39°N, 85°W
January	50	31	33	35
February	53	33	37	36
March	55	42	45	44
April	56	53	56	55
May	57	63	66	65
June	59	73	76	74
July	59	78	81	78
August	59	76	79	76
September	62	69	71	70
October	61	58	61	59
November	57	44	46	46
December	52	33	36	37
January	50	31	33	35
Average for the Year	57	55	57	56
Range for the Year				

QUESTIONS

1) From the table of monthly temperatures, compare the **average temperatures** for the year for the four cities shown. How can you explain the remarkably close agreement of these four temperatures?

2) Compute the year's range (difference between warmest and coldest months) for each city. Enter these figures in the table.

3) Compare San Francisco's range with those of the other three cities.

4) Compare San Francisco's summer temperatures—July, August, September—with those of the other three cities.

5) Compare the winter temperature of San Francisco—December, January, February—with those of the other three cities.

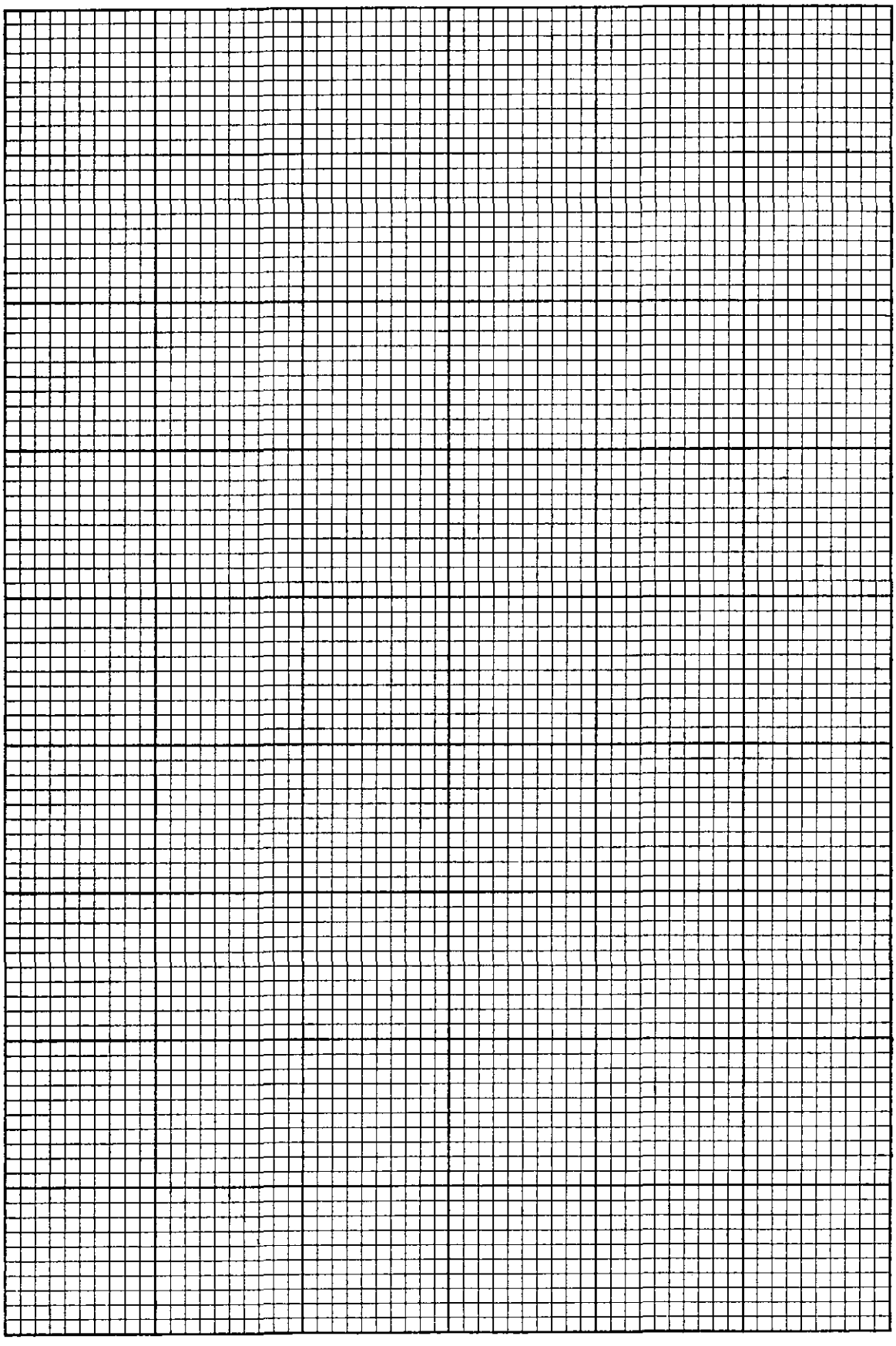
6) Summarize the differences between the marine climate of San Francisco and the continental climate of the other cities with respect to: **a)** temperature range

b) summer temperatures

c) winter temperatures

7) All four cities are in the prevailing southwesterlies. What, then, explains the differences in their temperatures? (Where do westerlies of San Francisco come from, land or sea? Where do the winds of the other three cities come from, land or sea? How do ocean and land temperatures compare in summer and winter?)

Name_____ Class_____ Date_____



8) Which is the warmest month in San Francisco?_____ Warmest month in Indianapolis?_____ Why is the warmest month in San Francisco later?_____

_____

_____

Name_____ Class_____ Date_____

EXERCISE 51

CLIMATIC FACTORS: LATITUDE AND RAINFALL IN THE TROPICS

Purpose: To show how the amount and distribution of rainfall change from the Equator to 30° north latitude.

Background: The doldrums belt is an equatorial belt of high temperature and heavy rainfall. The adjacent trade winds both north and south of the doldrums are dry regions except where the trades rise over mountains. Beyond the trades lie the dry high-pressure belts known as the horse latitudes. As the sun's rays shift during the year, the doldrums, trades, and horse latitudes also shift north and south with the sun. Places close to the Equator may be in the wet doldrums all year. Places 25 to 35 degrees from the Equator may be in the dry trades and horse latitudes all year. Places in between may be in both doldrums and trades as the wind belts shift, thus having both wet and dry seasons.

In this exercise we shall study the rainfall of four places in the tropics of eastern Africa. All four are in about the same **longitude,** but they range in **latitude** from 0° (on the Equator) to 30°N, well beyond the Tropic of Cancer.

Materials: 1) Special graphs on page 179 2) wall map of Africa.

PROCEDURE

On the blank graph provided for this exercise, plot the rainfall of Entebbe in the form of a bar graph. (The rainfall for July has been plotted for you as a sample.) Estimate tenths of inches of rain as closely as possible. Each box represents 0.5 of an inch of rain. After you complete the Entebbe graph do the same for Mongalla, El Obeid, and Cairo.

Average Monthly Rainfall (in Inches)

Month	*Entebbe, Uganda* Lat. 0°N, Long. 32°E	*Mongalla, Sudan* 5°N, 32°E	*El Obeid, Sudan* 14°N, 30°E	*Cairo, Egypt* 30°N, 31°E
January	2.6	0.1	0.0	0.4
February	3.6	0.8	0.0	0.2
March	5.8	1.5	0.1	0.2
April	9.8	4.2	0.0	0.2
May	8.5	5.4	0.4	0.0
June	5.1	4.6	1.2	0.0
July	3.0	5.2	3.6	0.0
August	3.0	5.8	4.5	0.0
September	3.1	4.9	3.4	0.0
October	3.5	4.3	0.7	0.0
November	4.9	1.8	0.0	0.1
December	5.1	0.3	0.0	0.2
Year's total				

QUESTIONS

1) Using the table, add up the monthly rainfall to find total rainfall for the year for the following places:

a) Entebbe_____ b) Mongalla_____

c) El Obeid_____ d) Cairo_____

2) What seems to be the relation between latitude and total rainfall, from the Equator to 30°N?_____

_____

_____

3) Explain why total yearly rainfall is greatest in Entebbe._____

_____

4) Why is Cairo so dry all year? (See "Background.")_____

_____

_____

5) Why does Mongalla have a wet season and a dry season? (See "Background.")_____

_____

_____

6) Why is the wet season so much shorter at El Obeid than at Mongalla?_____

_____

7) Explain why the wet season at El Obeid comes during July, August, and September.

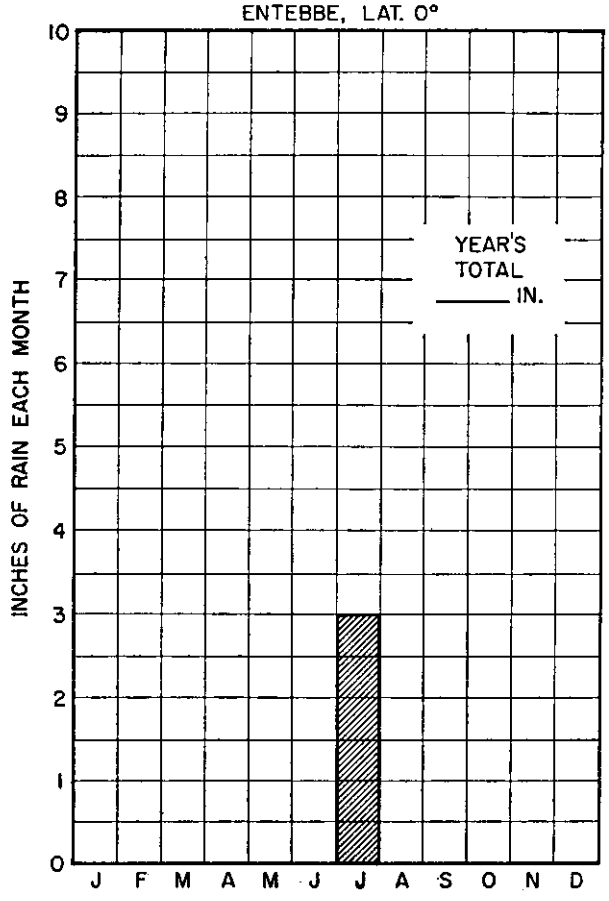
_____

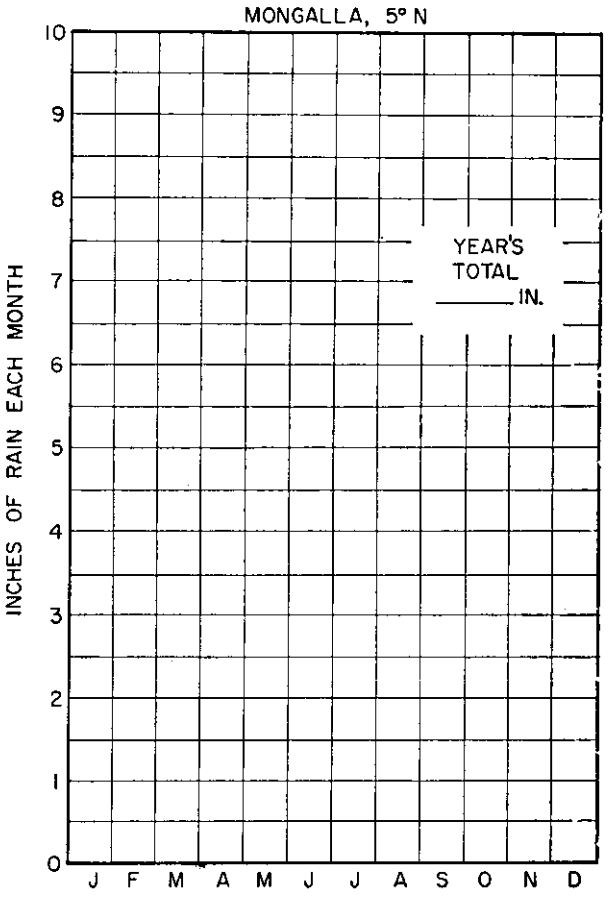
8) Why does Cairo have no wet season like that of El Obeid?_____

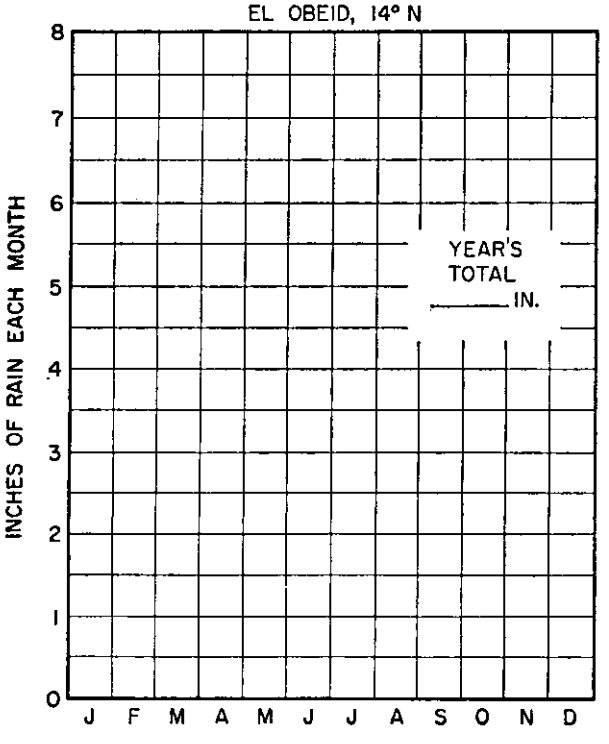
_____

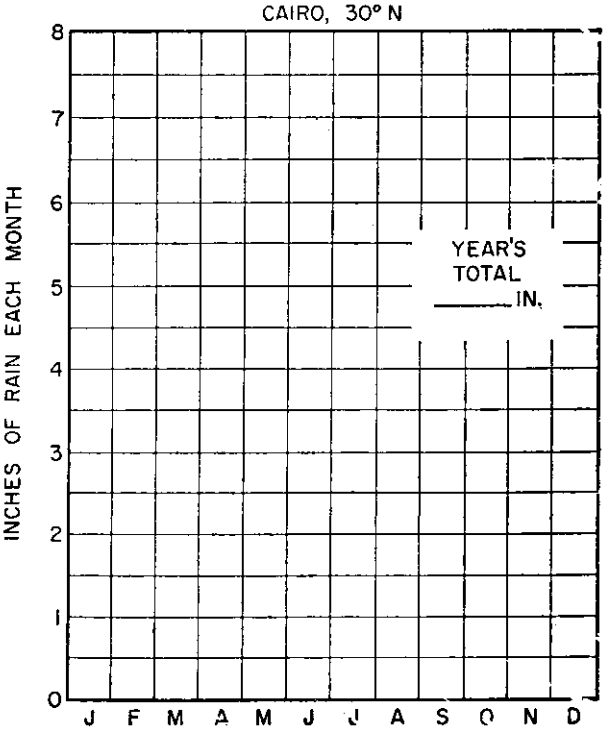
Name _____ Class _____ Date _____

RAINFALL IN THE TROPICS









Name_____ Class_____ Date_____

EXERCISE 52

CLIMATIC FACTORS: MOUNTAINS AND RAINFALL

Purpose: To compare the rainfall on the windward and leeward sides of a mountain range.

Background: Seattle, Washington and Spokane, Washington are in almost exactly the same latitude—about 48° North, in the prevailing southwesterly wind belt. Seattle, nearer the Pacific, is about 200 miles west of Spokane, and separated from it by the north-south running Cascade Mountains. Seattle is on the western or windward side of the mountain range. Spokane is on the eastern or leeward side.

Materials: 1) Special graphs on page 183 2) wall map of the United States, northwestern United States, or Washington.

PROCEDURE

On the blank graphs provided for this exercise, plot the rainfall of both Seattle and Spokane as bar graphs, like those you did in the preceding exercise on latitude and rainfall. Estimate tenths of inches of rain as closely as possible. Each box represents 0.5 of an inch of rain.

Average Monthly Rainfall (in Inches)		
Name	*Seattle, Washington*	*Spokane, Washington*
Location	48°N, 122°W	48°N, 118°W
January	4.5	1.7
February	3.7	1.5
March	3.1	1.3
April	1.9	1.0
May	1.6	1.0
June	1.2	1.2
July	0.5	0.4
August	0.9	0.5
September	1.6	0.9
October	3.1	1.3
November	4.5	1.9
December	5.3	2.2
Total for the Year		

QUESTIONS

1) Using the table, add up the monthly rainfall to find the total rainfall for the year: For Spokane_____ For Seattle_____ Enter these totals in both the table and the graph.

2) Which side of the mountain, windward or leeward, receives greater rainfall?

3) Why should more rain fall on the windward side of a mountain than on the leeward side?

4) Which six months are rainiest in Seattle?

What seasons do these include?

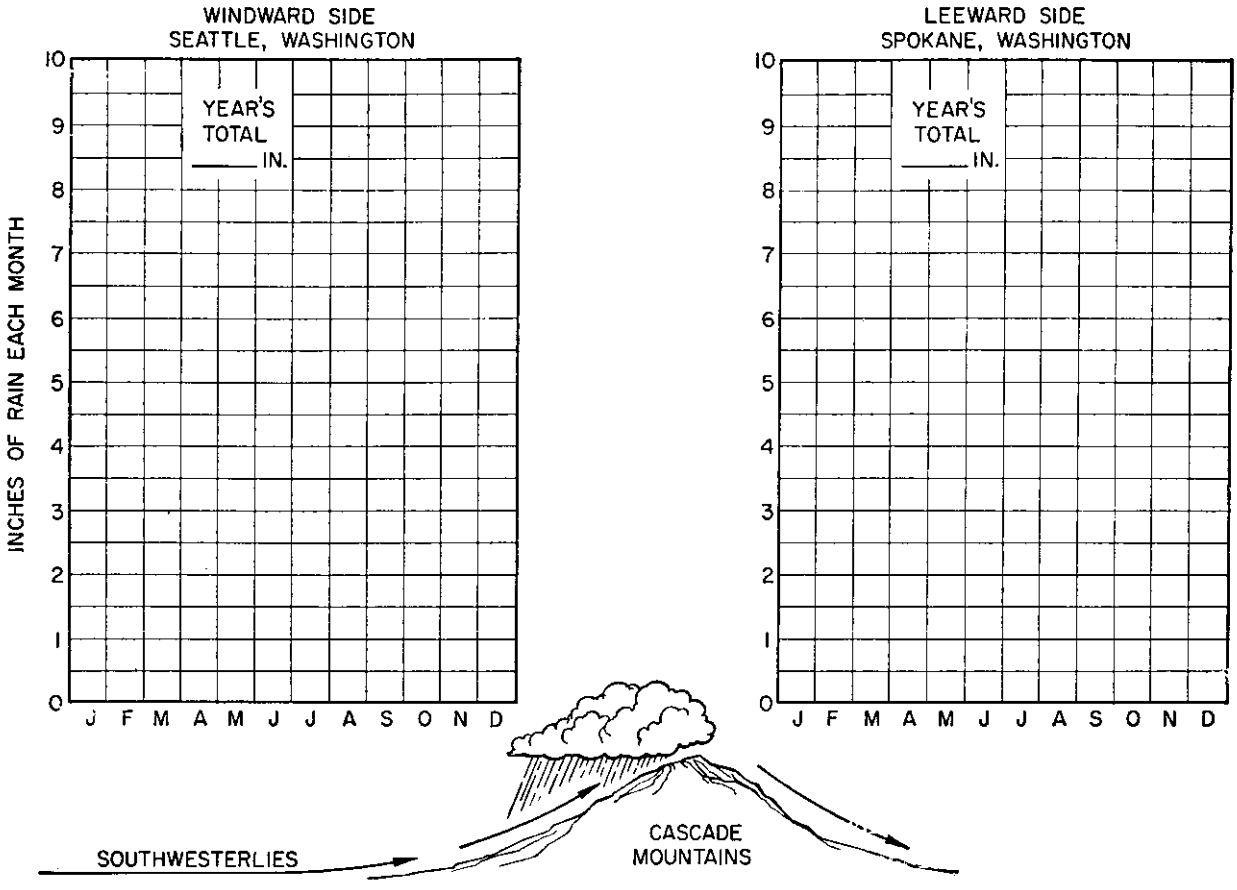
Why are these seasons rainier than the other two? (Compare temperatures of land and sea.)

5) Though Spokane's rainfall is much less than that of Seattle, its distribution through the year parallels Seattle's. Why should this be?

6) What factor, other than the Cascade Mountains, might be cited to explain why Spokane gets less rain than Seattle?

Name_____ Class_____ Date_____

MOUNTAINS AND RAINFALL



Name_____ Class_____ Date_____

EXERCISE 53

CLIMATIC FACTORS: WARM AND COLD OCEAN CURRENTS

Purpose: To see how warm and cold ocean currents affect the temperatures of sea coasts.

Background: Hebron, 58°N, is a small city on the northeast coast of Labrador. Westmanna, even farther north at 63° latitude, is on a small island just off the southern coast of Iceland. Both places are at about the same altitude—nearly at sea level—and both are on the Atlantic Ocean. The prevailing winds are from the west. With conditions so nearly alike, it might be expected that Hebron and Westmanna would have similar temperatures throughout the year, with Westmanna a little colder because of its higher latitude.

In one important respect, however, conditions are different. Hebron's coast is washed by the cold Labrador Current. Westmanna is washed by the warm Gulf Stream. Let us see how this difference affects their temperatures through the year.

Materials: 1) Graph or cross-section paper 2) wall maps of North America and Europe or of the world.

Average Monthly Temperatures (Degrees Fahrenheit)

Name	*Hebron, Labrador*	*Westmanna, Iceland*
Location	58°N, 63°W	63°N, 20°W
Altitude	49 feet	43 feet
Ocean Current	Labrador Current	Gulf Stream
January	−6	35
February	−5	35
March	6	36
April	18	40
May	32	45
June	40	50
July	47	53
August	48	52
September	41	47
October	31	42
November	19	37
December	4	35
January	−6	35
Average for the Year	23	42
Range for the Year		

PROCEDURE

Prepare the graph paper as in Exercise 48 on Latitude and Temperature, marking months of the year along the base line at 5-space intervals and temperatures from **minus 10°F** to 60°F at 10-degree intervals (1° per space) upwards along the left margin.

Plot the temperature curves, month by month, for both places. Label the curves. Letter the title of the exercise at the top of the graph paper.

Study the table and graph for the answers to the following questions:

1) How much higher is the year's average temperature in Westmanna than in Hebron?

---

2) Why would Westmanna normally be expected to be colder rather than warmer than Hebron?

---

3) How do you explain this great difference in the average temperature of two cities so much alike in latitude, altitude, and location?

---

4) Calculate the year's temperature range (difference between warmest and coldest months) for both cities. Enter these figures in the table.

How does the graph show a large range?

A small range?

---

5) Compare the winter temperatures at Hebron—December, January, February—with those of Westmanna.

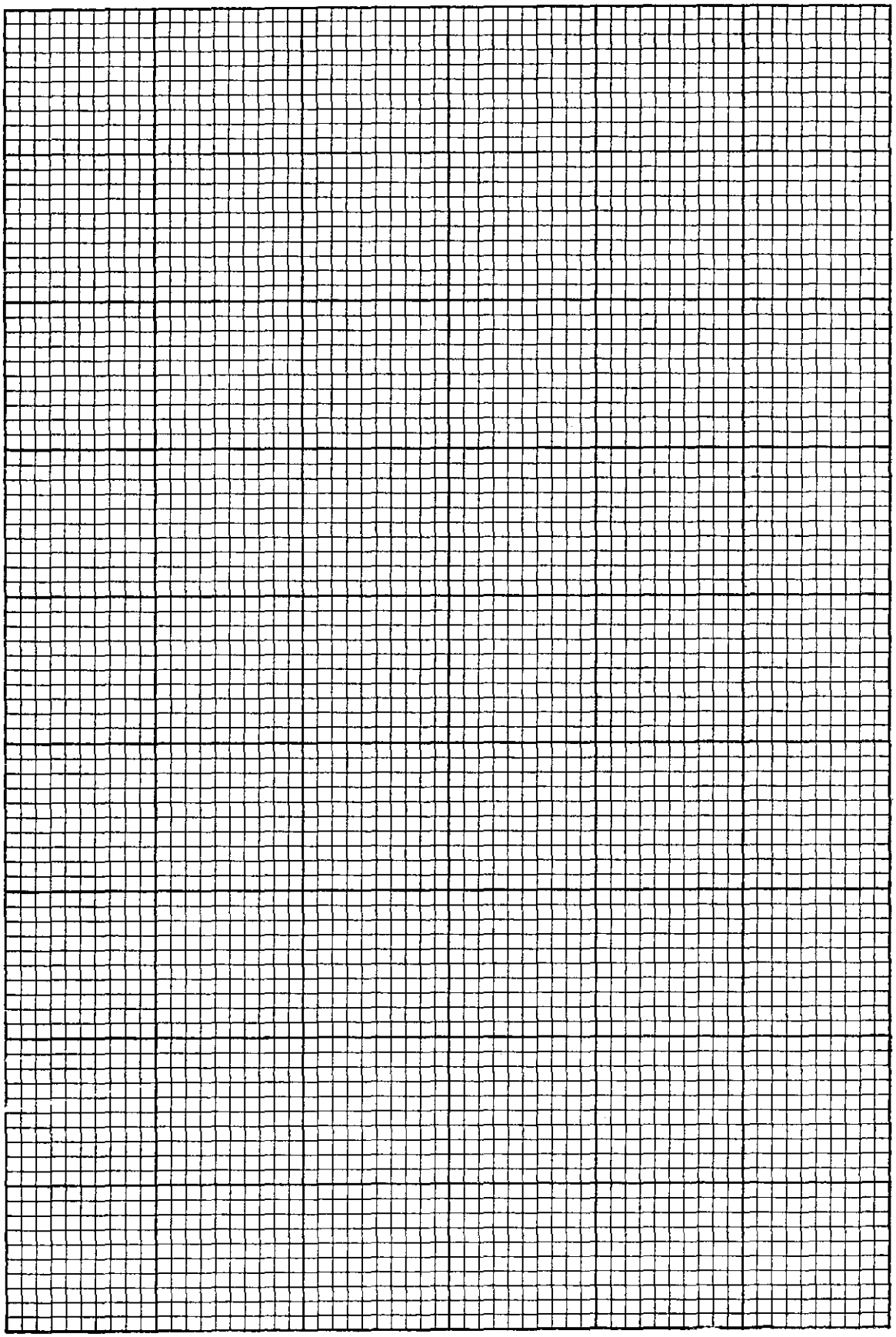
---

6) (The waters of the Labrador Current have a temperature of about 27°F.) How can you explain Hebron's low winter temperatures? (Where do its winds come from?)

---

7) Why is Westmanna so much warmer than Hebron in winter?

Name_____ Class_____ Date_____



8) Compare the summer temperatures—July, August—of the two places.

9) Why is Hebron cooler in summer than Westmanna?

10) Why is there less difference between their summer temperatures than between their winter temperatures?

11) Summarize the differences between the climates of Hebron, Labrador, and Westmanna, Iceland, with respect to: a) year's average temperature

b) year's temperature range

c) winter temperatures

d) summer temperatures

e) cause of difference