PRACTICAL EXERCISES

ON THE

WEATHER AND CLIMATE

OF

THE BRITISH ISLES AND NORTH-WEST EUROPE

BY

W. F. STACEY, F.R.G.S., F.R.MET.SOC.

CAMBRIDGE UNIVERSITY PRESS

PRACTICAL EXERCISES
ON THE
WEATHER AND CLIMATE
OF
THE BRITISH ISLES AND NORTH-WEST EUROPE

BY

W. F. STACEY, F.R.G.S., F.R.MET.SOC.

ASSOCIATE UNIVERSITY COLLEGE, READING; SOMETIME PROFESSIONAL ASSISTANT, FORECAST DIVISION METEOROLOGICAL OFFICE; EXAMINER IN GEOGRAPHY, OXFORD LOCALS; GEOGRAPHY MASTER, EASTBOURNE BOYS' SECONDARY SCHOOL

CAMBRIDGE
AT THE UNIVERSITY PRESS
1919

PREFACE

THE value of practical work in Geography is now so widely recognised that in all schools where the subject is efficiently taught practical work in all branches of the science that deals with the earth as the home of man forms no inconsiderable part of the syllabus.

A glance at the Geography Papers set in Public Examinations (e.g. Oxford and Cambridge Locals) within the last few years brings out the fact that more and more emphasis is being laid on practical work in connection with climate in general and weather in particular. Materials for exercises on the weather of the British Isles and North-west Europe are not perhaps readily accessible to most teachers and hence the writer feels that the following exercises may help to supply that want.

The chief aim of the present book is to present in as simple a manner as possible a series of exercises which bring out the main principles in that complicated subject—British Weather. The basis of the whole work is the actual construction of weather maps and these are indispensable to an appreciation of our weather.

All the data have been taken directly from the Daily Weather Reports published by the Meteorological Office.

SUGGESTIONS TO TEACHERS

1. The exercises are not arranged in the order in which they would be taken in school. Each pressure type is dealt with separately.

2. The writer has found from his experience as a teacher of Geography that the exercises provide material for work in every form of a Secondary School, and many of them could be taken in the upper standards of Elementary Schools. As a suggestion for Secondary Schools the following scheme may be of value.

Junior Forms. Exercises 1–4, 7, 20, 21, 46–51, 63–65, 144–146, 149, 150, 154, 155.

Middle Forms. Exercises 5, 6, 8, 10–16, 22, 23, 26–29, 53, 54, 55, 58, 61, 66–68, 70, 127–136, 138–142, 151–153, 156.

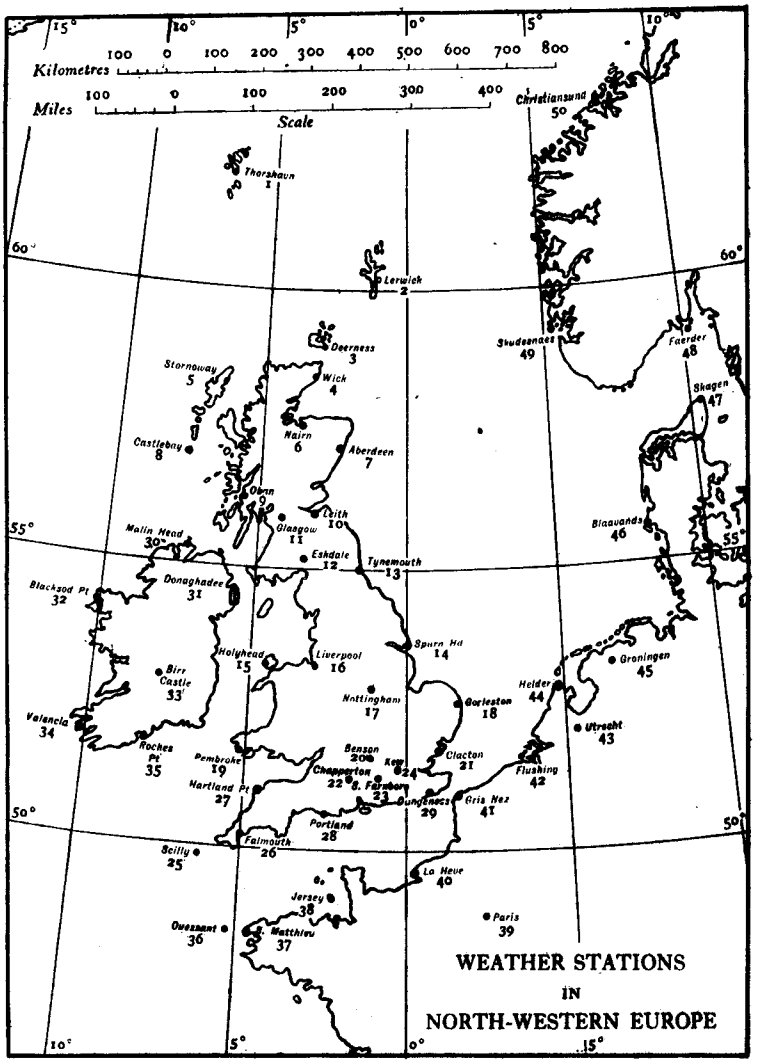
Upper Forms. Exercises 9, 17–19, 24, 25, 30–46, 52, 55, 59, 60, 62, 71–126, 137, 143, 147, 148, 157, 158, 159–162.

3. The worked exercises (and especially the maps) should be kept for reference, revision, and for working later exercises based on earlier ones.

4. In some cases the work can be shared among sets of pupils and the results of each set compared.

5. If there is not sufficient time given to Geography in the school certain exercises can be omitted but care should be taken that the omissions do not involve the omission of main principles.

6. For sake of economy loose blank maps should be obtained with the books. Thus the periodical renewal of blank maps will be all that is necessary.



Key Map of Stations

Enlarged copies of this map for class use can be obtained from the publishers or from any bookseller.

CONTENTS

WEATHER EXERCISES

INTRODUCTION

THE TABLES in this book contain particulars of barometric pressure expressed in millibars, wind direction in even points of the compass, wind force given in Beaufort numbers, and temperature and weather at the time of observation. A few tables have been added containing mean monthly maximum and minimum temperatures and rainfall. Before the student can use the various values in the manner in which they are intended to be used a general description of the form in which these values are expressed is necessary.

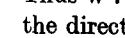
BAROMETRIC PRESSURE.

The student should always remember that in speaking of the pressure of the atmosphere he is dealing with a force. To suppose that the mere reading of a barometer in inches of mercury is an expression of the pressure of the atmosphere is quite wrong though from this reading the pressure can be computed when corrections for index error, gravity and temperature are taken into account. The reduction to mean sea level is necessary when, as in the case of weather maps, the pressures at various places are to be compared with one another. The unit of atmospheric pressure that is now used is the megadyne per square centimetre and is equivalent to a pressure of 750·1 millimetres (29·532 inches) of mercury at the freezing point of water in latitude 45°. The name "bar" has been given to this unit and air pressures are expressed in millibars (thousandths of a bar) so that one bar = 1000 millibars. As a general rule in this country pressures will always be between 940 mb. and 1060 mb., and very often between 970 mb. and 1040 mb. As that is

the case, for the sake of convenience the 9 or the 10 (i.e. the first or the first two figures) are omitted from tables of pressures. Thus a pressure of 984·7 mb. would be written 84·7 mb.; and 1023·8 mb. as 23·8 mb. In all the tables in this book the initial 9 or 10 has been omitted and for practice the student should take readings from the various tables and write them down in full. Thus on 2 July 1917, at 7.0 a.m. at Lerwick 25·5 mb. written in full is 1025·5 mb., and on 18 July 1917, at 6.0 p.m. at Eskdale 96·7 mb. written in full is 996·7 mb. In plotting the pressure values on the maps the student is advised to use the shortened form as given in the tables.

Wind Direction and Force.

The wind directions that are used in the tables are: N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW and NNW. By remembering that the meridians run true north and south and parallels east and west, the student will have no difficulty in plotting directions quickly and accurately.

Wind force has been given in Beaufort numbers, a full explanation of which appears below. In order that these forces may be read quickly they should be plotted in threes. Thus W 7 is plotted  and E 4 as  . The head of the direction line rests on the place of observation.

Temperature.

All temperatures are given in degrees Fahrenheit. As up to a certain altitude temperature decreases with height it is necessary to reduce temperatures to mean sea level before they are plotted on a weather map. In the tables all temperatures have been so reduced by adding 1° F. for every 300 feet above mean sea level.

The Beaufort Scale

Beaufort Number	Velocity in miles per hour	Limits of velocity in miles per hour	Specification of wind	Description of wind for use on land
0	0	Less than 1	Calm	Calm; smoke rises vertically
1	2	1–3	Light air	Direction of wind shown by smoke drift, but not by wind vanes
2	5	4–7	Slight breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind
3	10	8–12	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag
4	15	13–18	Moderate breeze	Raises dust and loose paper; small branches are moved
5	21	19–24	Fresh breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters
6	28	25–31	Strong breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
7	35	32–38	High wind	Whole trees in motion; inconvenience felt when walking against wind
8	42	39–46	Gale	Breaks twigs off trees; generally impedes progress
9	50	47–54	Strong gale	Slight structural damage occurs (chimney pots and slates removed)
10	59	55–63	Whole gale	Seldom experienced inland; trees uprooted; considerable structural damage occurs
11	68	64–75	Storm	Very rarely experienced; accompanied by widespread damage
12	Above 75	Above 75	Hurricane	

Weather.

The weather is described by means of symbols which are based on Beaufort's notation. They are easy to remember for in most cases they are the first letters of the names of the conditions for which they stand.

Weather Notation.

Beaufort Letter		Beaufort Letter	
b	Blue sky, cloudless or up to ½ clouded	r	Rain
bc	Blue sky, ½ clouded	rs	Sleet, i.e. rain and snow together
c	Generally cloudy, ¾ covered	s	Snow
d	Drizzling rain	t	Thunder
e	Wet air without rain falling	u	Ugly, threatening sky
f	Fog	v	Unusual visibility; horizon or distant hills unusually clear
g	Gloom		
h	Hail		
l	Lightning	w	Dew
m	Mist	x	Hoar frost
o	Overcast sky	z	Dust haze; turbid atmosphere of dry weather
p	Passing showers		
q	Squalls		

Rainfall.

Rainfall is given in millimetres. Glasses for measuring the amount of rain collected in a rain gauge are graduated in millimetres and tenths (0·1) of a millimetre. If the rainfall is less than 0·1 millimetre it is entered in the tables as Trace. 1 millimetre = 0·039 inch. The rainfall given in the tables is that for the twenty-four hours ending at 7.0 a.m. on the day of observation. Thus in the table for 2 July 1917, there is an entry against Scilly of 5·0 mm. which means that from 7.0 a.m. on 1 July until 7.0 a.m. on 2 July, 5·0 mm. of rain were collected in the rain-gauge at Scilly.

METHOD OF DRAWING ISOBARS AND ISOTHERMS.

Imagine that at the stations A, B, C, D, E, F the pressures are as given in Fig. 1, and it is required to draw isobars 1000, 1005, 1010 mbs. Join CD. Then as pressure at C is 2·5 mbs. *less* than 1000 mbs. and at D 2·5 *greater* than 1000 mbs. it can be assumed that at some point on the line CD the pressure will be exactly 1000 mbs. To get the distance of that point from C the line CD must be divided into 2·5 + 2·5 = 5 parts. Then 2·5 of those parts

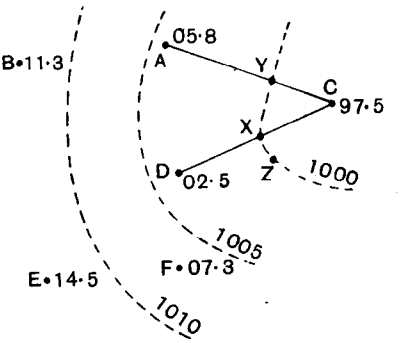


Fig 1.

from C (or D in this case) will give the point required (X). By the same reasoning it will be seen that the point on AC where the pressure is 1000 mbs. $= \frac{2·5}{2·5 + 5·8}$ from C. Let this point be Y. Through X and Y draw the isobar 1000. It can be shown as above that this isobar will pass through the point Z on CF. Similarly it can be shown that isobar 1005 will pass nearer A than B and D than E and that isobar 1010 must pass near and to the right of B. In practice the distance of an isobar from a given station is estimated, and with a little practice the student will soon find that he can estimate these distances quickly and accurately. The same principle is used in drawing isotherms.

TABLE I

Winter Cyclone

16 December 1917: 7.0 a.m.

Station number	Wind direction and force	Pressure in mbs.	Temperature ° F.	Weather	Station number	Wind direction and force	Pressure in mbs.	Temperature ° F.	Weather
1	N 5	18·7	20	o	26	NW 5	06·3	45	orq
2	NNW 3	13·8	30	bc	27	WSW 3	04·0	41	r
3	NNE 4	14·2	33	bc	28	SW 6	07·0	45	cr
4	E 4	13·9	37	o	29	SW 4	11·0	43	c
5	N 5	14·8	32	bc	30	ENE 8	05·8	33	omqs
6	Calm	14·4	32	ou	31	NNW 5	97·7	41	omqr
7	ENE 5	12·6	37	o	32	N 9	11·3	36	cqph
8	NNE 4	13·8	37	c	33	NW 8	02·5	38	o
9	NE 3	11·2	35	o	34	NNW 7	14·5	43	cph
10	E 5	08·1	38	o	35	NW 7	07·3	41	cq
11	NE 5	08·0	32	oqs	37	W 4	10·8	45	r
12	NE 4	05·8	31	os	38	S 5	11·2	41	o
13	S 3	07·2	33	o	39	S 1	16·0	30	o
14	S 3	08·1	36	od	40	S 5	13·2	43	o
15	S 7	93·2	39	oprsq	41	SW 5	13·1	42	o
16	W 4	99·8	41	cq	42	SSE 3	13·6	39	o
17	SSE 3	05·8	36	o	43	SW 3	13·5	34	o
18	SW 2	11·6	34	omx	44	WSW 3	11·8	39	c
19	WSW 7	00·2	44	cq	45	W 1	12·2	34	o
20	SSE 4	08·7	39	o	46	NW 3	07·8	37	bc
21	S 2	10·9	39	o	47	SSW 1	01·1	34	s
22	SW 4	08·8	37	omd	48	NNE 2	02·0	30	o
24	S 4	08·7	39	o	49	NNW 6	06·0	28	c
25	NW 9	08·6	45	o	50	Calm	01·9	27	b

TABLE II

Maximum and Minimum Temperatures and Rainfall 16 December 1917

Mean Maximum and Minimum Temperatures and Mean Rainfall for December

Station Number	Maximum Temperature		Minimum Temperature		Rainfall	
	16 Dec. 1917	Mean for Dec.	16 Dec. 1917	Mean for Dec.	16 Dec. 1917	Mean for Dec.
	° F.	° F.	° F.	° F.	mm.	mm.
2	37	43	25	36	6	113
3	35	43	31	36	1	106
4	37	43	—	34	1	76
5	34	44	26	35	4	151
6	34	43	25	32	3	51
7	37	43	26	34	2	79
8	37	—	27	—	Trace	—
10	39	45	28	35	2	50
11	33	43	25	35	2	102
12	38	—	33	—	—	—
13	39	44	28	34	10	57
14	39	43	30	36	10	47
15	41	47	32	40	23	100
16	42	44	29	36	10	65
17	37	44	27	33	5	55
18	41	43	34	35	4	57
19	45	48	39	41	8	106
20	40	44	30	34	14	55
21	41	43	34	35	5	42
22	40	45	30	32	14	89
24	41	44	33	35	11	51
25	47	50	39	44	9	108
26	45	48	35	41	9	148
27	45	49	39	42	6	107
28	45	48	34	41	15	68
29	44	46	33	37	11	63
30	40	46	34	39	3	80
31	43	46	33	37	12	78
32	41	48	—	40	1	148
33	39	46	—	34	—	78
34	43	50	39	41	2	161
35	45	49	39	40	1	131
38	45	48	34	40	16	98

EXERCISES

WINTER CYCLONE. TABLES I AND II

1. Plot the wind directions, forces, and pressures given in Table I, and draw isobars 995, 1000, 1005, 1010, and 1015 millibars.

2. What is the shape of most of the isobars? Write a short description of the distribution of pressure over the British Isles.

3. What do you notice with regard to wind directions and the direction of their nearest isobars?

4. Select several wind-directions in different parts of your map and imagine you are standing with your back to the wind. On which side of you is the lower pressure?

5. Compare the distance apart of the isobars 1005 and 1010 mbs. in Ireland and in England. In which country are they closest together? In which country are there the strongest winds?

6. At 7.0 a.m. on 16 December the centre of the cyclone was 25 miles sw of Holyhead, at 6.0 p.m. on the same day the centre was over Guernsey. Mark these two places with a × and join them by a straight line. This line marks the path of the cyclone. [Note: cyclones do not often travel in this direction.] Draw another line at right angles to the path and passing through the centre near Holyhead. This is the trough line. By these two lines the cyclone is divided into four parts—that to the east of the path and south of the trough line is the left front, that to the west of the path and south of the trough line is the right front; those parts to the north of the trough line are the rear of the cyclone. Describe the wind directions in the different parts of the cyclone.

7. At which places are the winds blowing with gale force? In which parts of the seas surrounding the British Isles is there the most danger from wind to ships, in which parts the least?

8. The trough line passes near Holyhead (15) and Liverpool (16). What do you notice about the wind directions at these two places?

9. Just as we can measure the gradient on a contoured map so we can measure the pressure gradient on an isobaric map. Place a piece of tracing paper over the cyclone and make a tracing of the isobars. Mark the centre of the cyclone on your tracing. Draw a line from the centre of the cyclone through Malin Head (30). This line, which is known as the gradient line, cuts tangents to isobars 1010, 1005, 1000 and 995 at right angles. On your kilometre scale measure the distance along the gradient line between isobars 1010 and 1005. There is a decrease in pressure of 5 millibars in the number of kilometres you have just measured. Calculate what would be the decrease in 100 kilometres. It is usual to express the gradient as so many millibars per 100 kilometres. [Note: You need only carry your calculation correct to the second place of decimals.] Draw a line from the centre of the cyclone through Tynemouth (13) and again calculate the gradient between isobars 1010 and 1005. Which of the two gradients is the steeper? In the region of steeper gradient are isobars 1010 and 1005 closer together or further apart than in the region of less steep gradient? At which place are the stronger winds blowing? You will now understand that, *given the same barometric interval* (i.e. the same difference in millibars between two consecutive isobars) the closer the isobars the steeper the gradient and the stronger the winds.

10. On the same map plot the temperatures given in Table I. It will be an advantage if these are plotted in red ink. Draw isotherm 40°. This line can be taken as dividing the warmer (above 40°) from the colder air (below 40°). In which part of the cyclone is it warmest and which coldest? Is the temperature higher in front or in rear of trough?

11. Do southerly winds always bring high temperatures? Can you account for the low temperatures with southerly winds in east England?

12. Can you find any connection between wind direction and temperatures?

13. On the same map plot the weather symbols given in Table I, and mark with a black dot all places against which you have the symbols *r*, *p*, or *d*. You will then see clearly at which places it is raining.

Is rain equally distributed over the whole cyclone? Which are the wet and which the dry parts?

14. Does the rainy area near the middle of the cyclone extend far to the rear?

15. Notice the places against which you have the symbol *p*. How are they situated with regard to the trough of the cyclone?

The passing of the trough of a cyclone is often accompanied by sharp showers of rain known as clearing showers.

16. In which parts of the cyclone do you find the finest weather (*b* and *bc*), and which are the cloudy parts (*c* and *o*)?

17. Examine Table II. Were the temperatures on 16 December above or below the means for the month?

18. Aberdeen (7), Malin Head (30), Kew (24) and Scilly (25) can be taken as typical of the left rear, right rear, left front, and right front respectively. In each case calculate the deviations from normal maximum and minimum temperatures, the range of temperature for 16 December, and the mean range of temperature for December. Set out your results in the following form.

Part of Cyclone	Deviation from Mean Max.	Deviation from Mean Min.	Range for 16 Dec.	Mean range for Dec.	Main wind directions	Conclusions
	° F.	° F.	° F.	° F.		
Left rear (7)	−6	−8	11	9	E and NE	Cold winds from N. Europe lower temperature considerably
Right rear (30)						
Left front (24)						
Right front (25)						

The figures for station 7 have been inserted as an example of the method of completing the table. The deviations from mean maximum and minimum are the differences between the maximum and minimum temperatures for 16 December and for the month of December (the minus sign indicates that the maximum and minimum temperatures for the day were lower than the means for the month), the range for 16 December is the difference between the maximum and minimum temperatures for that day and the mean range is the difference between the mean maximum and minimum temperatures for the month. The wind direction column should be filled up from a study of the whole of the wind directions in that part of the cyclone under