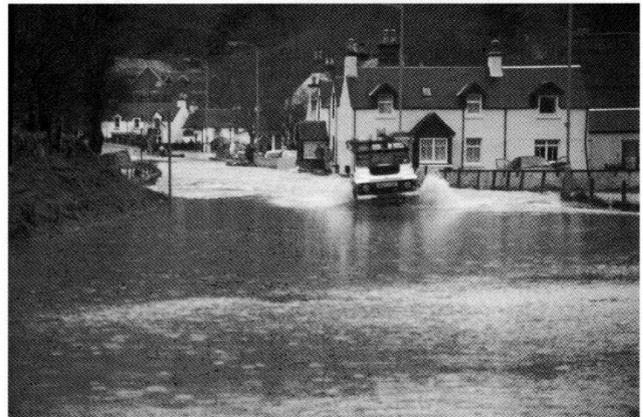


WEATHER: Measuring the weather

Weather is the state of the atmosphere at a local level, observed and measured on a time scale from minutes to months. Weather studies emphasise the aspects of the atmosphere which affect human activity (Fig.106). These elements of weather include temperature, precipitation, sunshine, air pressure, wind, cloud and visibility. The study of weather, the science of **meteorology**, (Figs.107-108) involves the daily observation and measurement of weather elements from a large network of 'weather stations' - some at sea, most on land. The British Meteorological Office (at Bracknell, near London) collates weather data using computers and skilled experts. Weather studies and forecasting have recently been greatly advanced through the use of satellites.

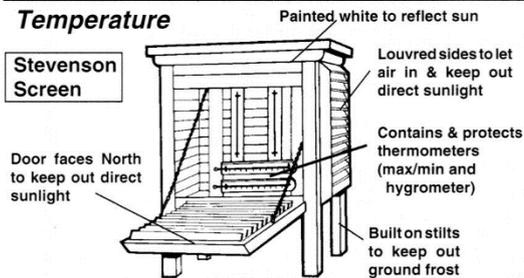
Fig.106 River in spate after heavy rain floods a road



MEASURING & RECORDING THE WEATHER

Fig.107

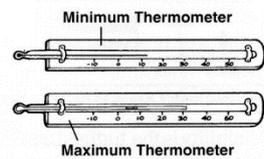
Temperature



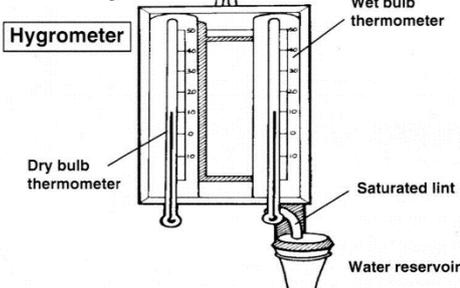
Temperature is measured using thermometers. **Maximum and Minimum thermometers** are used to give daily highest and lowest readings and therefore the daily or **diurnal** range and average. The thermometers are usually stored in the **Stevenson Screen**, well protected from direct sunlight and frost, as well as interference from people or animals. Temperature readings are shown using **line graphs** and described using the following scale:

Temp ^o C	25	20	15	10	5	0	-5	-15
Description	Very Hot	Hot	Warm	Mild	Cool	Cold	Freezing	Very Cold

THERMOMETERS



Humidity

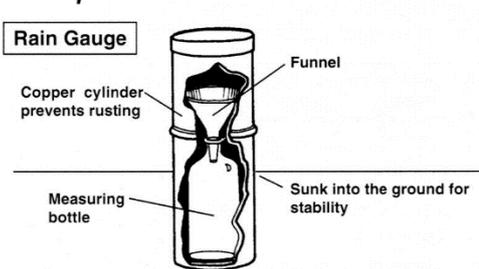


Humidity is the amount of water vapour or moisture in the air. Warm air holds more moisture than cold air. When air holds all the moisture it can, the air is said to be **saturated**. If temperatures then fall slightly **condensation** will occur and water droplets will form resulting in cloud or fog. This temperature is known as the **Dew Point**. Precipitation only occurs in saturated air. Meteorologists are interested in the amount of water in the air relative to the amount in saturated air. This is known as the **Relative Humidity** and is given as a percentage. A relative humidity of 100% means saturated air and a high probability of precipitation. Meteorologists use a Relative Humidity table for calculating the Relative Humidity.

Dry Bulb Temp. °C	Depression of the wet bulb							
	5	1.0	1.50	2.0	2.5	3.0	3.5	4.0
0	91	82	73	65	56	48	39	31
1	91	83	75	66	58	50	42	34
2	92	84	76	68	60	52	45	37
3	92	84	77	69	62	54	47	40
4	92	85	78	70	63	56	49	42
5	93	86	79	72	65	58	51	45
6	93	86	79	73	66	60	53	47
7	93	87	80	74	67	61	55	49
8	94	89	81	75	69	63	57	51
9	94	88	82	76	70	64	58	53
10	94	88	82	76	71	65	60	54

To calculate the Relative Humidity, subtract the wet bulb from the dry bulb temperature (the depression of the wet bulb) and use the table to calculate the Relative Humidity %.
* (Only part of the Relative Humidity table shown)

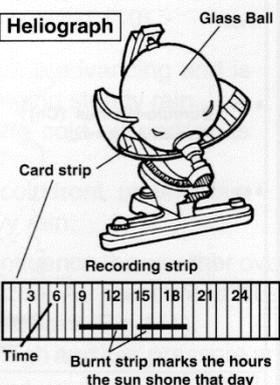
Precipitation



Precipitation is moisture falling from the sky and is measured by using a **Rain Gauge**. Rainfall, snowfall, hail and sleet, etc. are captured and fed into the measuring bottle from the funnel. The Rain Gauge is sunk into the ground for stability and is usually located away from shelter, e.g. trees, buildings, walls, etc. Precipitation is measured in millimetres and illustrated by **bar graph** and described using the following scale:-

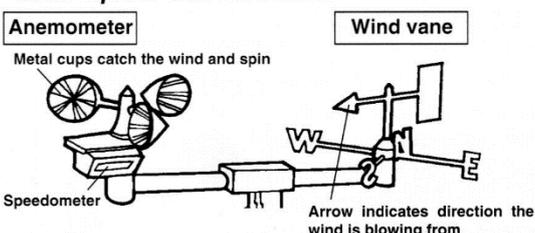
PPT in one day (mm)				
12	6	3	1	0
Heavy	Long Periods of ppt	Showers	Light Drizzle	Trace Dry

Sunshine



The amount of sunshine is measured by a **Sunshine Recorder** (or a Heliograph). The amount is given in hours read from the recording strip through which the sun's rays were magnified and burnt on to a strip of card.

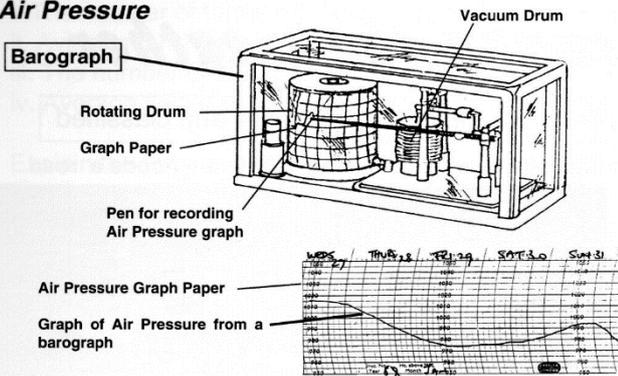
Wind Speed and Direction



Wind speed can be measured very accurately with an **Anemometer** and is given in knots, km/hr or force. The **Beaufort Scale** is used to estimate the force of the wind. Wind direction is measured using a **Wind Vane**. Wind direction is given as the direction **from which** the wind blows and is usually given as a compass direction, e.g. South-West. Both wind instruments are usually sited several metres above ground away from shelter such as trees, buildings or walls.

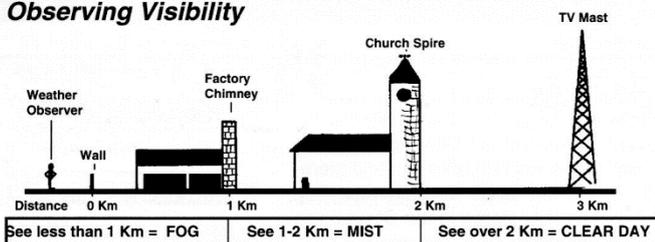
Fig.108

Air Pressure



Air Pressure is the weight of air pressing down upon the surface of the Earth. The instruments used to measure air pressure are **barographs** and **barometers** and they are very sensitive to slight changes in pressure. A barograph measures and records air pressure all the time. A pen traces air pressure on a graph which revolves once a week. Air pressure is measured in **hectopascals** (formerly millibars) and the instruments are usually kept indoors away from inclement weather or interference.

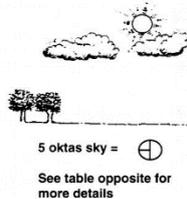
Observing Visibility



Visibility is the furthest distance that can be seen and is given in kilometres. Measured by eye, visible distances are fixed on landmarks or tall buildings.

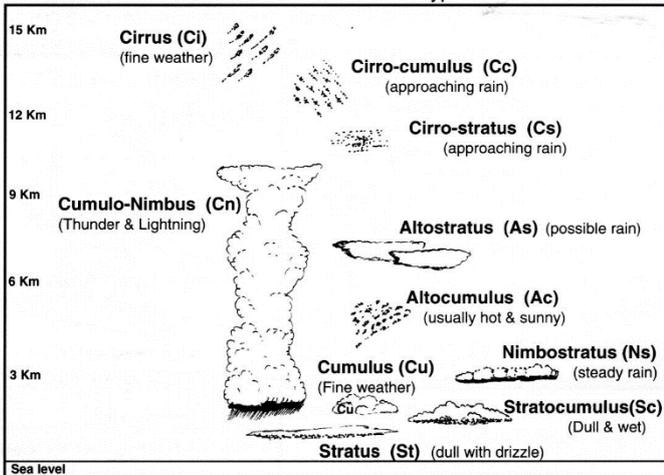
Observing Cloud Cover

Cloud cover is the amount of cloud obscuring the sky. It is calculated according to how many eighths of the sky, or **oktas**, are covered in cloud. For example, 0 oktas means the sky is completely clear, 8 oktas means the sky is completely covered 4 oktas means the sky is half covered with cloud.



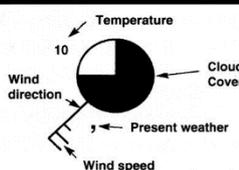
Observing Cloud Type

Clouds consist of millions of ice crystals which form when condensation occurs. The many different types of cloud can be classified into 3 main groups - High, Medium and Low level clouds. Each is formed under different circumstances and is associated with different types of weather.



Weather Station Symbols

Station Symbols are used as a short-hand summary of the weather recorded at a weather station and have the following coded meaning. In the case of this weather station
Temperature 10°C, Wind SW, speed 25 knots, Weather drizzle, 6 oktas cloud cover



Weather Symbols

- Intermittent slight rain
- Continuous slight rain
- Intermittent moderate rain
- Continuous moderate rain
- Intermittent heavy rain
- Continuous heavy rain
- ☉ Drizzle
- * Snow
- ∞ Haze
- * Sleet
- △ Hail
- ≡ Mist
- ≡ Fog
- ⚡ Thunderstorm
- ▽ Rain shower
- ⚡▽ Sleet shower
- ⚡▽ Snow shower
- ▽ Hail shower

Cloud Coverage

- 0 oktas
- ◐ 1 okta
- ◑ 2 oktas
- ◒ 3 oktas
- ◓ 4 oktas
- ◔ 5 oktas
- ◕ 6 oktas
- ◖ 7 oktas
- ◗ 8 oktas
- ⊗ sky obscured

Low Cloud (CL)

- Symbols for low cloud are
- ◡ Small Cumulus
 - ◢ Large Cumulus
 - ⊞ Cumulonimbus
 - Stratocumulus
 - Stratus
 - Broken Stratus

The symbol for low cloud is found below the station circle.

Wind Speed

- Calm
- 1 - 2 knots
- 3 - 7 knots
- 8 - 12 knots
- 13 - 17 knots
- 18 - 22 knots
- 23 - 27 knots
- 28 - 32 knots
- 33 - 37 knots
- 38 - 42 knots
- 43 - 47 knots
- 48 - 52 knots

Medium Cloud (CM)

- There are only three types of medium level clouds used in station models -
- ∠ Altostratus
 - ∕∕ Nimbostratus
 - ∪ Altocumulus

High Cloud

- Symbols for high cloud are
- ∩ Cirrus
 - ∪ Cirrostratus

Assignment Twenty-One

- 1 What kinds of problem could result from the flood in figure 106 ?
- 2 List six elements of weather.
- 3 Explain the meaning of the following terms :- weather, relative humidity, precipitation, air pressure, cloud cover, visibility.
- 4 Using the information given in Figs.107-108, complete a larger version of the following table:-

Weather Element	Instrument used	Units of measurement	Location of instrument

- 5 Copy the table below and calculate the Relative Humidity using Fig.107

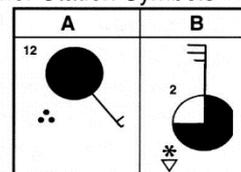
Dry Bulb Temp C	Wet bulb Temp C	Relative Humidity %
6	5	
10	6.5	

- 7a Decode the following Weather Station Symbols

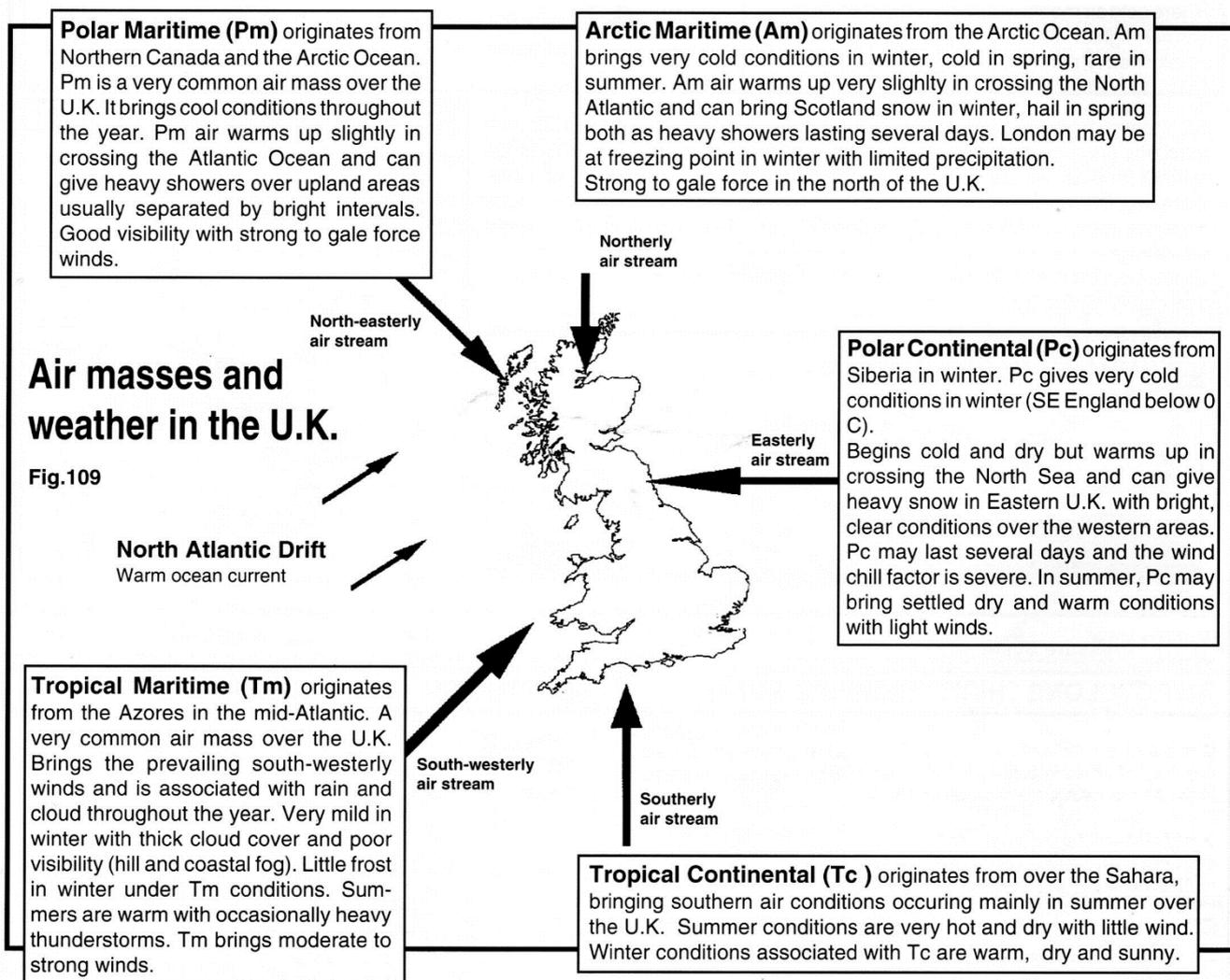
- 7b Draw Station Symbols for the following data:

C. Temp. 22 C, Rain, 6 oktas
 Wind SW, 15 knots

D. Temp. -5 C, Fog, Sky Obscured, Calm



WEATHER: Streams and fronts



The weather in the U.K. is directly affected by the winds which blow over the country. These winds originate from **air masses** - areas of almost stationary air that tend to assume the temperature and humidity characteristics of the areas they lie over.

When an air mass moves to another area it becomes an **air stream**- carrying with it the temperature and humidity of its source area. Air streams are named after their source areas (Fig.109). Five air streams influence weather in the U.K. :-

Pm	Polar Maritime	Cold & Wet
Am	Arctic Maritime	Very Cold & Wet
Pc	Polar Continental	Cold & Dry
Tc	Tropical Continental	Warm & Dry
Tm	Tropical Maritime	Warm & Wet

The U.K. lies at the confluence of these five air streams and as a result, has a very variable weather pattern. When one air stream meets another they do not readily mix because they have different temperatures and humidity. The junction between air streams is known as a **front**.

The warmer, lighter air stream always rises over the colder, denser air stream. As the warmer air rises it cools and any water vapour condenses into water droplets forming clouds. There are three main types of front (Fig.110) :-

Warm Front - where warm air is advancing and is forced to rise over cold air bringing steady rain.

Cold Front - where advancing cold air undercuts warm air bringing heavy rain.

Occluded Front - where a cold front undercuts a warm front bringing very heavy rain.

The winds and air streams that influence the weather over the U.K. depend upon air pressure. Air pressure is illustrated on weather maps using **isobars** (Fig.111). Isobars indicate where areas of high and low pressure are located.

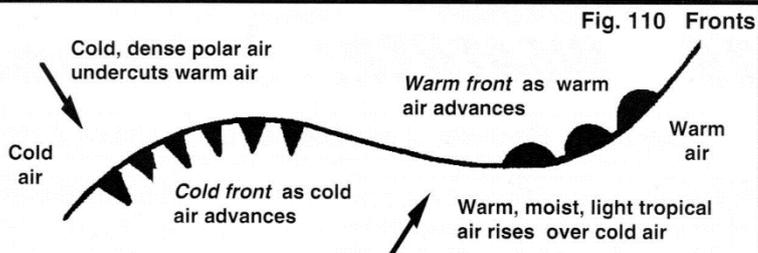
Anticyclones - high pressure (above 1013 hp), where falling air circulates outwards, in a clockwise direction.

Depressions low pressure (below 1013 Hp), where rising air circulates inwards in an anticlockwise direction.

COLD AND WARM FRONTS

Wherever warm air meets colder air it always rises over the colder, denser air producing a **Warm Front** (& usually prolonged rain).

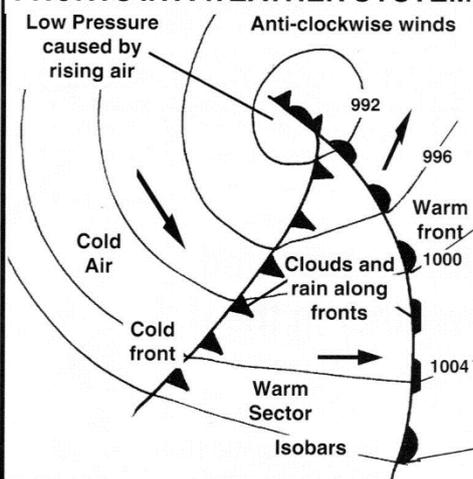
Where cold air meets warmer air it undercuts the warmer, lighter air producing a **Cold Front** (& usually heavy rain followed by showers).



Air streams from both Polar and Tropical areas converge upon the U.K. with regularity creating frontal situations such as those illustrated here. Where the warmer tropical air dominates, low pressure develops as warm air rises, lessening the weight of air pressing down on the surface of the Earth. Low pressure systems slowly develop creating an anti-clockwise windflow, rain and low cloud.

Winds blow from High pressure areas to Low pressure areas at an angle due to the rotation of the Earth

FRONTS IN A WEATHER SYSTEM



FRONTS AND SECTORS

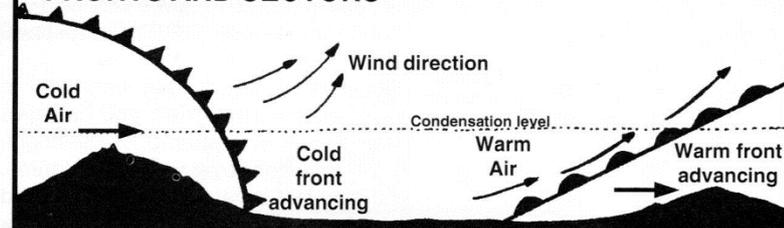
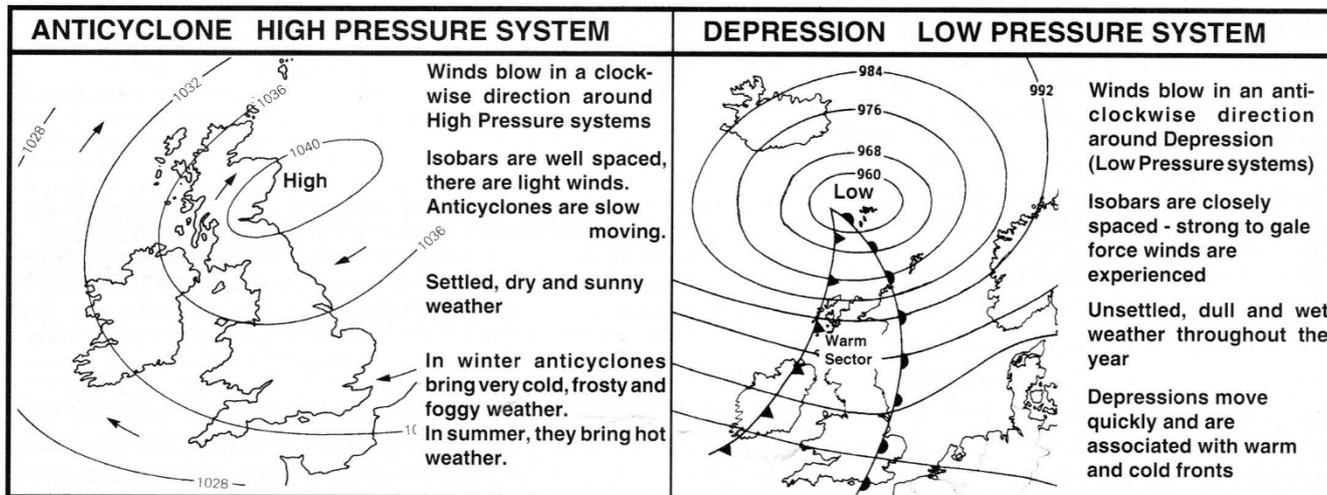
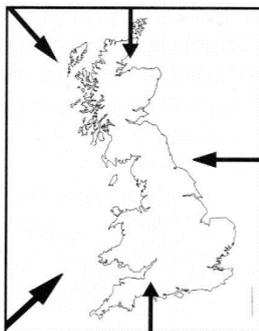


Fig.111 Pressure Systems



Assignment

- What are the main influences on the weather of the U.K. ?
- Explain the meaning of each of the following terms:- air mass, air stream, front, isobar, depression.
- Using a simple outline map, prepare a summary of the main air streams and their associated weather over the U.K.
- Explain the weather brought to the U.K. by
 - Arctic Maritime (Am)
 - Tropical Maritime (Tm)
 - Polar Continental (Pc) air streams
- Explain each of the following:-
 - Gale force winds in a depression
 - Drought in an anticyclone
 - Falling barometers in a depression
 - An occluded front
 - Lack of frost in a depression
- 6a When do depressions form and why ?
6b When do anticyclones form and why ?
- For any day of your choice, research and collect weather data (from station readings, media sources, satellite photos, weather maps (synoptic charts), etc). Identify and explain the main influences on the U.K. weather that day.



WEATHER: Development of a depression

Depressions develop along the junction between the Tropical and Polar air streams between latitudes 40° and 45° N. This junction is known as the Polar Front (Fig.112).

Warm, southerly air wedges under the colder, northerly air and as it does so warm air rises creating a drop in air pressure. Winds circulate around the low pressure in an anti-

clockwise direction. Pressure continues to decrease as first a warm front and later a cold front sweep across the U.K. from west to east, bringing associated weather in a series of stages. Eventually the cold front catches the warm front as the depression fills and an occluded front forms. Figure 112 illustrates the passage of a depression over the U.K.

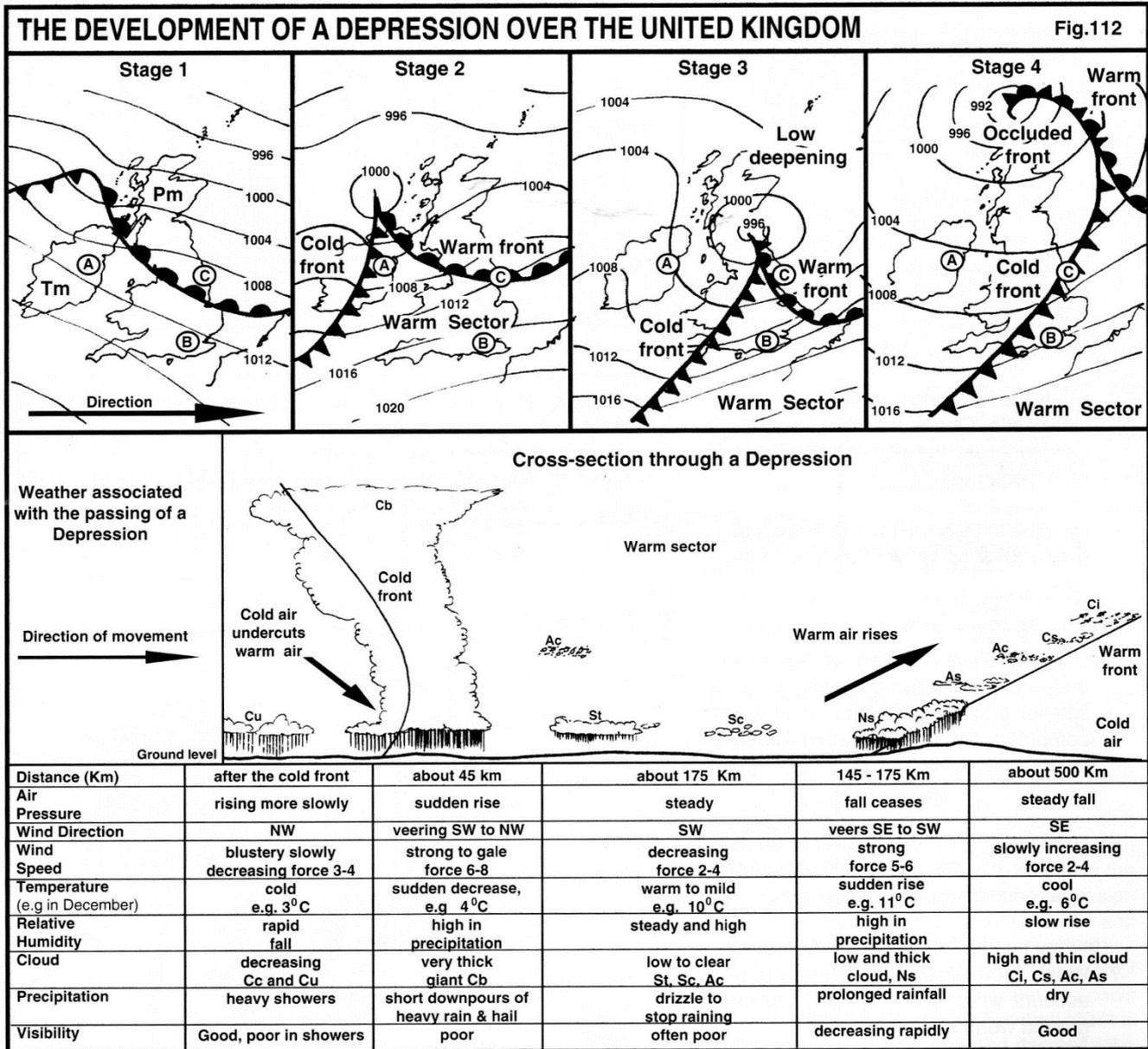
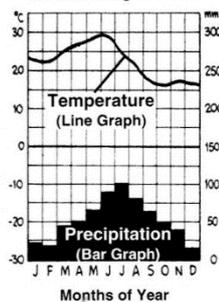


Fig.113 Climate Graph annual average weather



Climate and Weather

Weather is concerned with daily atmospheric changes.

Climate is the average weather recorded over a period of thirty years. The average weather for any place on the planet can be illustrated using an annual climate graph showing details of the temperature and precipitation pattern.

Assignment

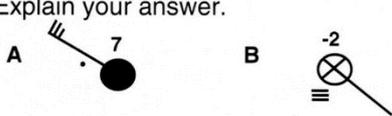
- Describe the development of a Depression over the U.K.
- Study Fig.112.
 - State the relationships between the passage of fronts and:
 - air pressure
 - precipitation.
 - Compare the weather experienced at A and C throughout the passing of the depression.
 - Explain the difference in weather experienced.
- Write a weather forecast for B for Stages 1-4.
- Describe the relationship between weather and climate.

EXAM STYLE QUESTIONS

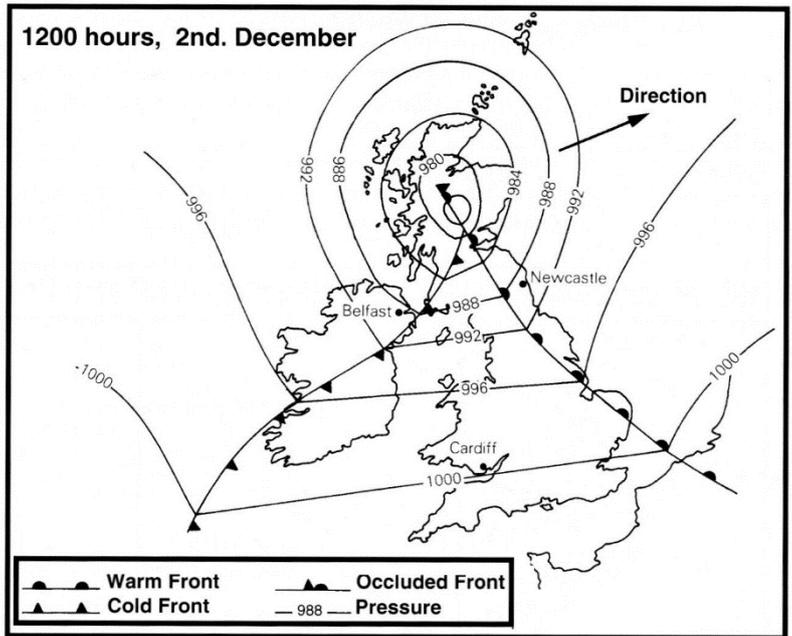
WEATHER

1 Explain in detail the difference in weather conditions being experienced at **Belfast** and **Newcastle** at the time the synoptic chart was constructed.

2 Which of the following station circles is most likely to be a summary of the weather at Belfast. Explain your answer.



3 The weather system shown over the British Isles is moving rapidly North East. Describe what is likely to happen to the weather in **Cardiff** in the 24 hours after the chart was drawn.



4 Study the following weather forecasts for Newcastle. One is for 1200 hours on 2 December and the other is for 1200 hours on 4 December.

Forecast A : Prolonged rain, heavy in places, overcast , moderate southeasterly winds, cool, maximum temperature 8°C.

Forecast B : Showery conditions, generally light, occasional bright spells, northwesterly winds, cool, maximum temperature 6°C.

Match each forecast to the correct day, giving reasons for your choice in each case.

5 Describe ways in which various recent meteorological developments such as satellite photography, radar images and computers can make weather forecasting more accurate.

6 Name the five weather instruments labelled on the diagram and indicate what each instrument measures.

7 What factors should be taken into account when considering a site for a ground weather station?

8 An anticyclone is a high pressure weather system.

Describe the weather anticyclones tend to bring to Britain in

- winter
- summer

