LESSON PLAN

Title Introduction to Anticyclones, Depressions and Fronts

Key Stage 4 - GCSE

Subject Geography

Syllabus Relevance
AQA Geography Spec A 9.6
AQA Geography Spec C 9.6a
OCR Geography Spec B 2.1, 2.2
OCR Geography Spec C 1b
Edexcel Geography Spec A 4.1

Length 1 lesson

Teaching Objectives/Learning Outcomes

By the end of the lesson, pupils will know and understand:
Characteristics of depressions and fronts and the sequence of associated weather
Characteristics of anticyclones and the contrast between those in summer and in winter.

Resources Required

Access to Internet (http:///www.metoffice.com/education).
Alternatively if Internet access is not available, printed copies can be made.

Prior Knowledge Required

A basic knowledge of weather and climate

Teaching Activities

Students can visit the following web pages to gain a basic background to the topics covered
http://www.metoffice.com/education/curriculum/leaflets/weathermaps.html
http://www.metoffice.com/education/curriculum/leaflets/charts.html

Exercises

4 worksheets with exercises are provided to consolidate learning.

A series of extension exercises are provided for more able students, or those who have already studied the topics covered in more detail prior to this lesson.

Plenary – A quiz is available either online or in paper format, which brings together all the topics covered. The can be used to examine whether the objectives of the lessons have been met.

Suggestions for Home Work

Any of the worksheet activities can be completed as homework.

PART A – ANTICYCLONES AND DEPRESSIONS

High Pressure Systems

A high pressure system, also known as an anticyclone occurs when the weather is dominated by stable conditions. Under an anticyclone air is descending, forming an area of higher pressure at the surface. Because of these stable conditions, cloud formation is inhibited, so the weather is usually settled with only small amounts of cloud cover. In the Northern Hemisphere winds blow in a clockwise direction around an anticyclone. As isobars are normally widely spaced around an anticyclone, winds are often quite light.

Anticyclones can be identified on weather charts as an often large area of widely spaced isobars, where pressure is higher than surrounding areas.

Winter Anticyclones

In winter the clear, settled conditions and light winds associated with anticyclones can lead to frost and fog. The clear skies allow heat to be lost from the surface of the earth by radiation, allowing temperatures to fall steadily overnight, leading to air or ground frosts. Light winds along with falling temperatures can encourage fog to form; this can linger well into the following morning and be slow to clear. If high pressure becomes established over Northern Europe during winter this can bring a spell of cold easterly winds to the UK.

Summer Anticyclones

In summer the clear settled conditions associated with anticyclones can bring long sunny days and warm temperatures. The weather is normally dry, although occasionally, very hot temperatures can trigger thunderstorms. An anticyclone situated over the UK or near continent usually brings warm, fine weather.

Low Pressure Systems

A low pressure system, also known as a depression occurs when the weather is dominated by unstable conditions. Under a depression air is rising, forming an area of low pressure at the surface. This rising air cools and condenses and helps encourage cloud formation, so the weather is often cloudy and wet. In the Northern Hemisphere winds blow in anticlockwise direction around a depression. Isobars are normally closely spaced around a depressions leading to strong winds.

Depressions can be identified on weather charts as an area of closely spaced isobars, often in a roughly circular shape, where pressure is lower than surrounding areas. They are often accompanied by fronts.

What to do next

Using this information on pressure systems you should now be able to complete worksheet 1. Then you can move on to extension exercise 1 or worksheet 2.

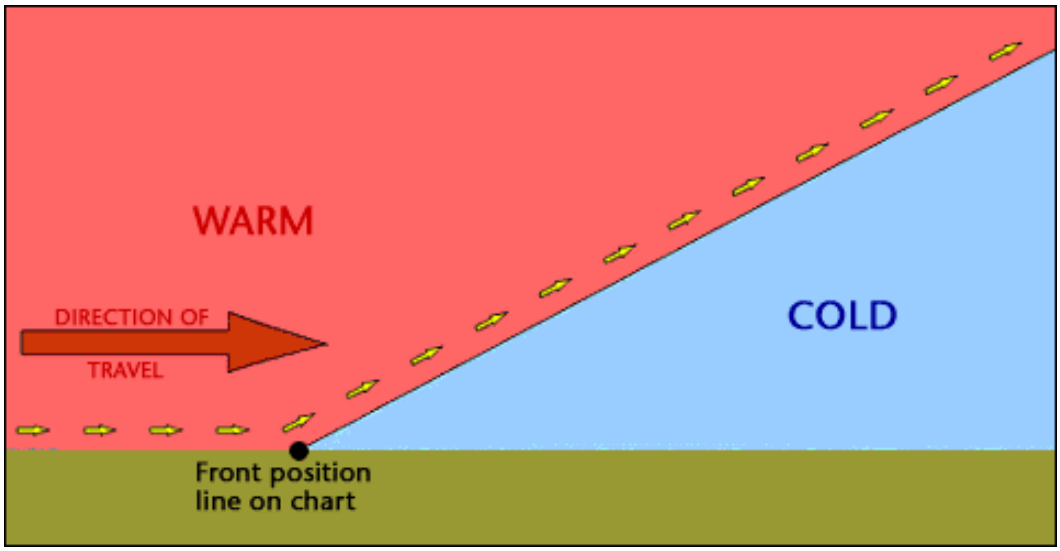
PART B – FRONTS

A front is a boundary between two different types of air masses, these are normally warm moist air masses from the tropics and cooler drier air masses from polar regions. Fronts move with the wind so over the UK they normally move from west to east. The notes below provide information about the most common types of fronts. The descriptions given apply to active well developed fronts, weaker fronts may not display all the characteristics or they may be less well defined.

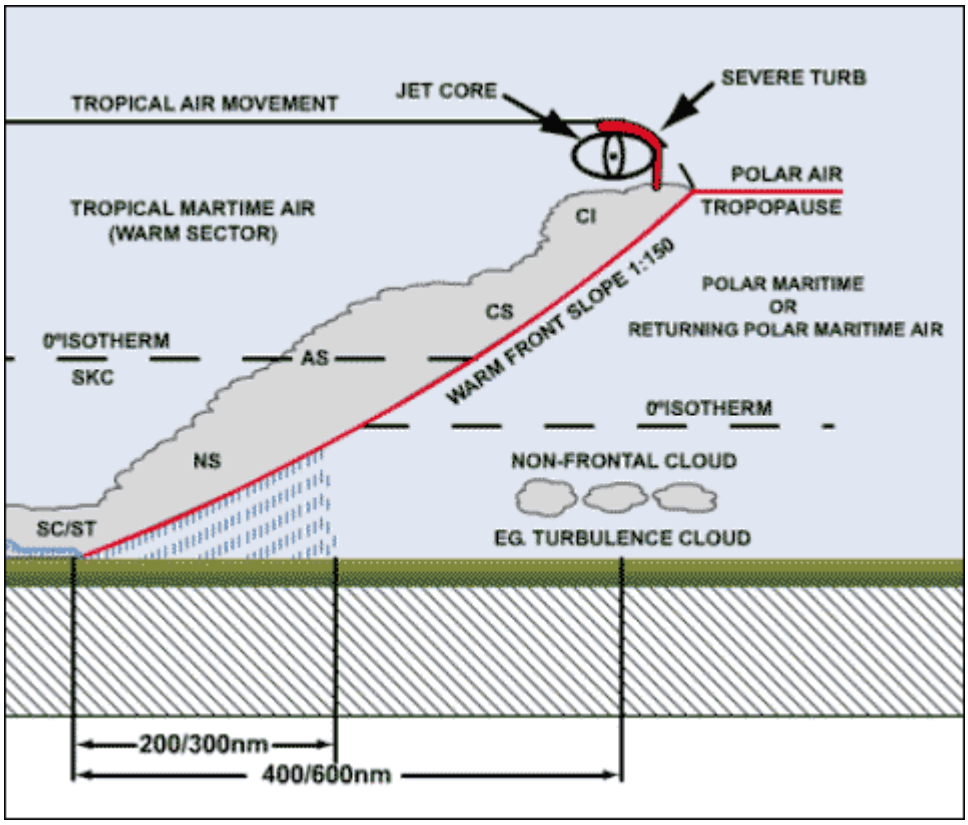
Warm Fronts

A warm front indicates that warm air is advancing and rising up over the colder air. This is because the warm air is 'lighter' or less dense, than the cold air. Therefore warm fronts occur where warmer air is replacing cooler air at the surface. As the warm front approaches there is a gradual deterioration in the weather. Clouds gradually lower from higher cirrus, through altostratus, to stratus and nimbostratus at the front. There is often a prolonged spell of rainfall which is often heavy. Behind the warm front the rain becomes lighter, turns to drizzle or ceases, but it remains cloudy. Temperatures rise behind the warm front and winds turn clockwise, also known as a wind 'veer'. Pressure falls steadily ahead of and during the passage of the warm front, but then rises slowly after its passage.

The following diagram shows the formation of a warm front in diagrammatic form.



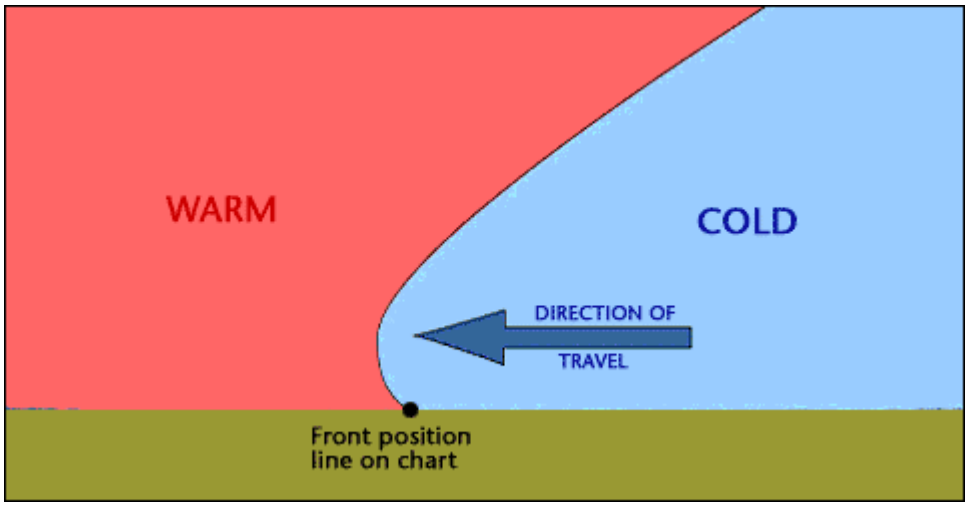
The following diagram shows a cross section through a warm front, with associated cloud, temperature and weather changes.



Cold Fronts

A cold front indicates that cold air is advancing and pushing underneath warmer air at the surface. This occurs because the cold air is 'heavier' or denser than the warm air. Therefore cold fronts occur where cooler air is replacing warmer air at the surface. The passage of weather associated with a cold front is much shorter lived than that with a warm front. As there is often a lot of cloud in the warmer air ahead of the cold front, there is often little indication of the approaching cold front. As the front passes temperatures fall and there is often a short spell of very heavy rain, sometimes with inbedded thunderstorms and cumulonimbus clouds. Behind the front the weather is much brighter with broken clouds but occasional showers. Winds veer with the passage of the cold front and are often strong and gusty, especially near showers. Pressure rises throughout the approach and passage of the cold front.

The followingdiagram shows the formation of a cold front in diagrammatic form.



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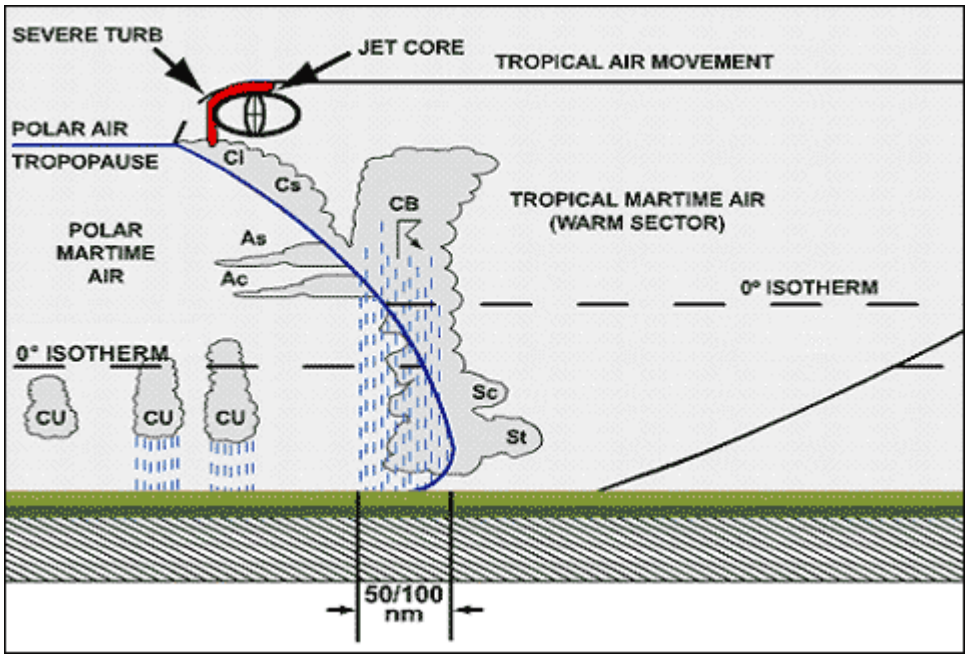
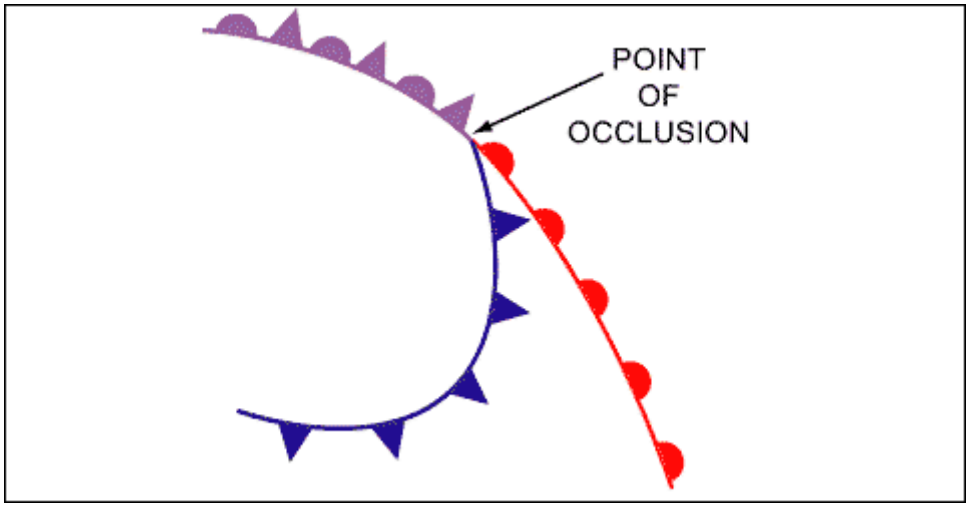
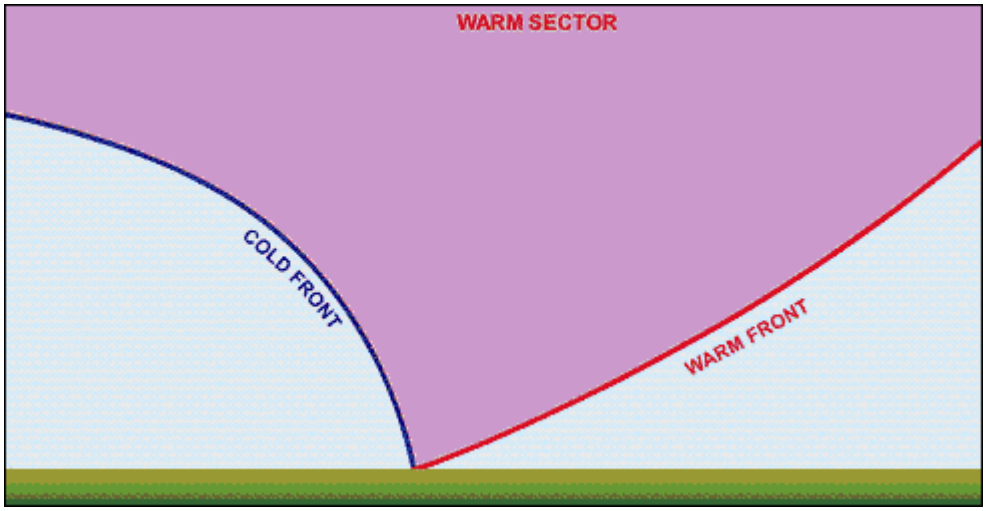


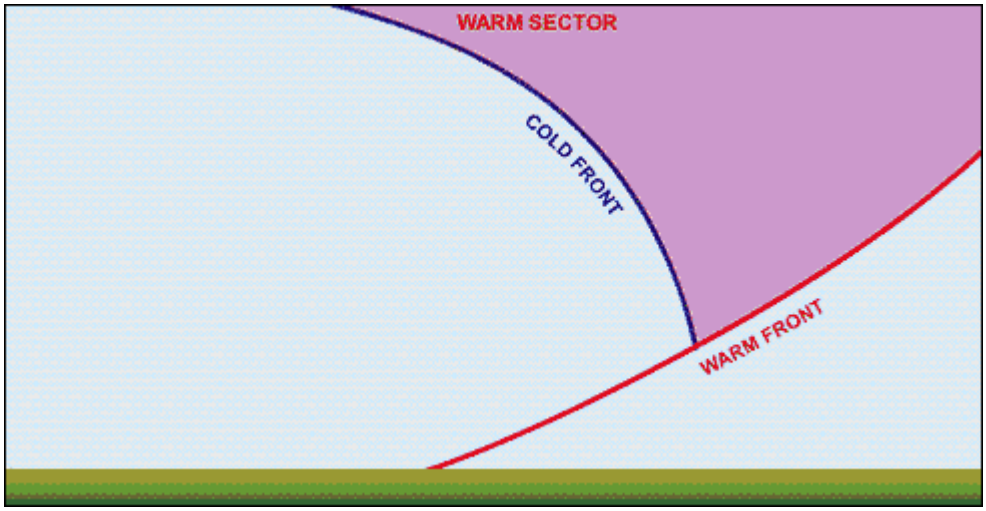
Occlusions

In a mature depression the warm front normally precedes the cold front. Cold fronts generally travel much quicker than warm fronts, and eventually it will catch up with the warm front. Where the two fronts meet, warm air is lifted from the surface and an occlusion is formed. An occlusion can be thought of as having similar characteristics to both warm and cold fronts. The weather ahead of an occlusion is similar to that ahead of a warm front, whilst the weather behind is similar to that behind a cold front.

The following diagrams depict the formation of an occlusion







What to do next

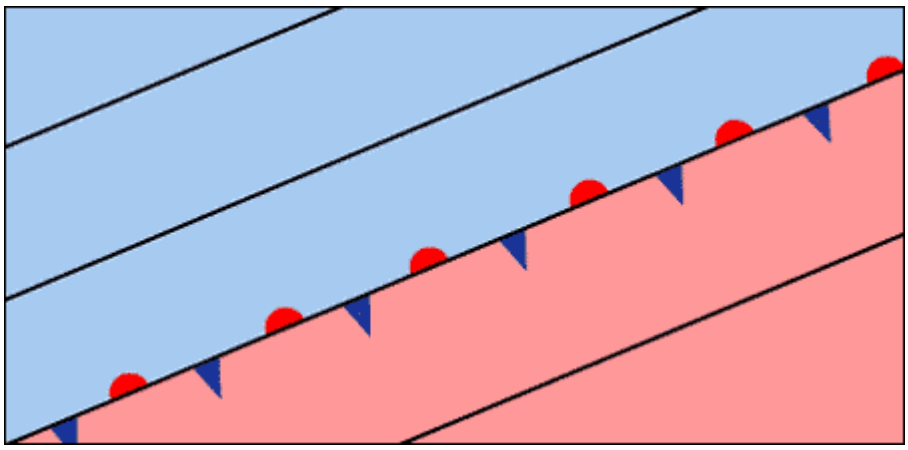
You can now move on to Part C - Life Cycle of a Depression.

PART C – LIFE CYCLE OF A DEPRESSION

A Norwegian scientist called Vilhelm Bjerknes devised a simple model which described how depressions developed from the meeting of warm and cold air. The model had four stages which are detailed below.

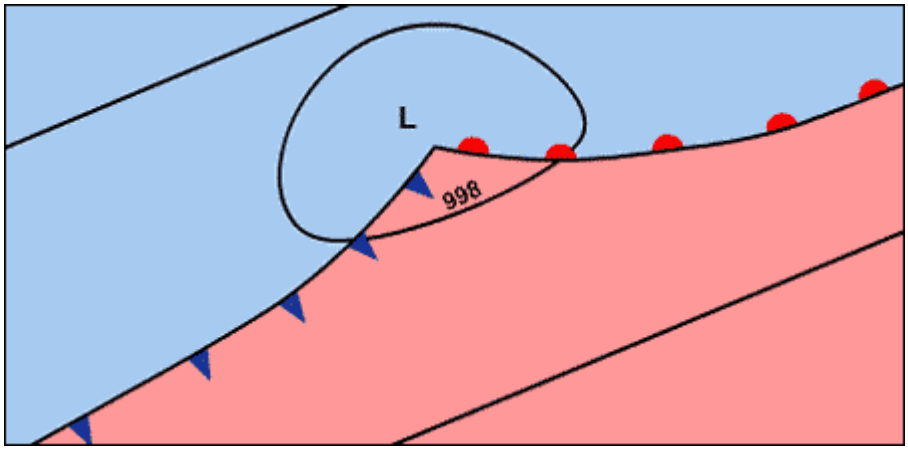
Origin and Infancy

Initially a warm air mass such as one from the tropics, meets a cooler air mass, such as one from the polar regions. Depressions which affect the UK normally originate over the Atlantic Ocean.



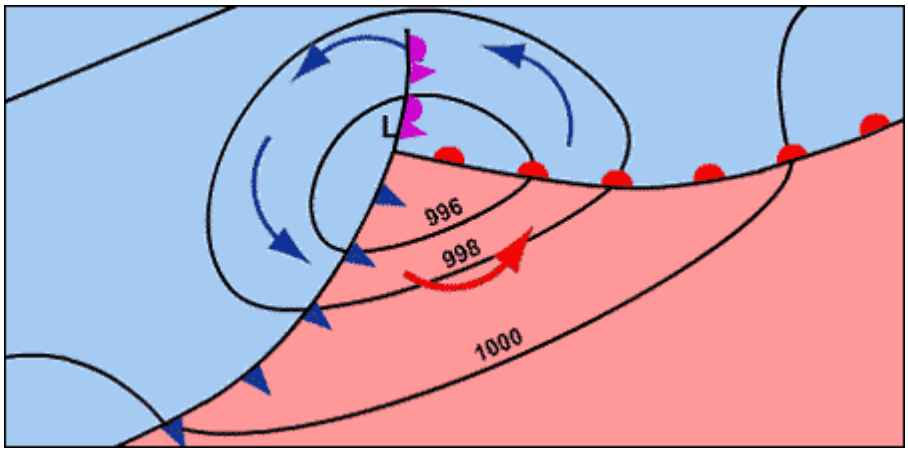
Maturity

The warm air rises up over the colder air which is sinking. A warm sector develops between the warm and cold fronts. The mature stage of a depression often occurs over the UK.



Occlusion

The cold front travels at around 40 to 50 miles per hour, compared to the warm front which travels at only 20 to 30 miles per hour. Therefore the cold front eventually catches up with the warm front. When this occurs an occlusion is formed.



Death

Eventually the frontal system dies as all the warm air has been pushed up from the surface and all that remains is cold air. The occlusion dies out as temperatures are similar on both sides. This stage normally occurs over Europe or Scandinavia.

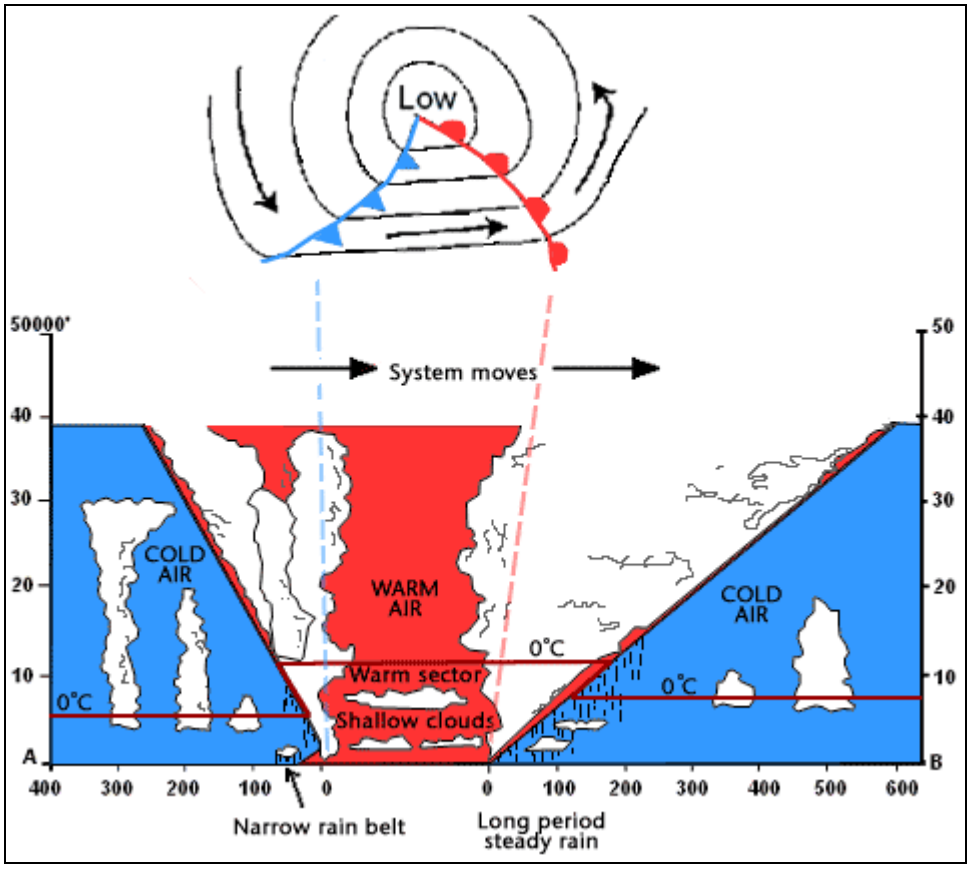
What to do next

You can now move on to Part D – Depression cross-section and weather sequence

PART D – DEPRESSION CROSS SECTION AND WEATHER SEQUENCE

Cross-section through a Classic Depression

Most depressions have a warm and cold front, more mature depressions may also have an occluded front. The diagram below shows a cross-section through a depression, showing the warm and cold fronts and an indication of the associated weather.



WEATHER ASSOCIATED WITH THE PASSAGE OF A CLASSIC DEPRESSION					
	Ahead of the warm front	Passage of the warm front	Warm sector	Passage of the cold front	Cold sector
Pressure	starts to fall steadily	continues to fall	steadies	starts to rise	continues to rise
Temperature	quite cold, starts to rise	continues to rise	quite mild	sudden drop	remains cold
Cloud cover	cloud base drops and thickens (cirrus and altostratus)	cloud base is low and thick (nimbostratus)	cloud may thin and break	clouds thicken (sometimes with large cumulonimbus)	clouds thin with some cumulus
Wind speed and direction	speeds increase and direction backs	veers and becomes blustery with strong gusts	remain steady, backs slightly	speeds increase, sometimes to gale force, sharp veer	winds are squally
Precipitation	none at first, rain closer to front, sometimes snow on leading edge	continues, and sometimes heavy rainfall	rain turns to drizzle or stops	heavy rain, sometimes with hail, thunder or sleet	showers

What to do next

Using this information on the passage of depressions you should now be able to complete worksheet 3 and work sheet 4.

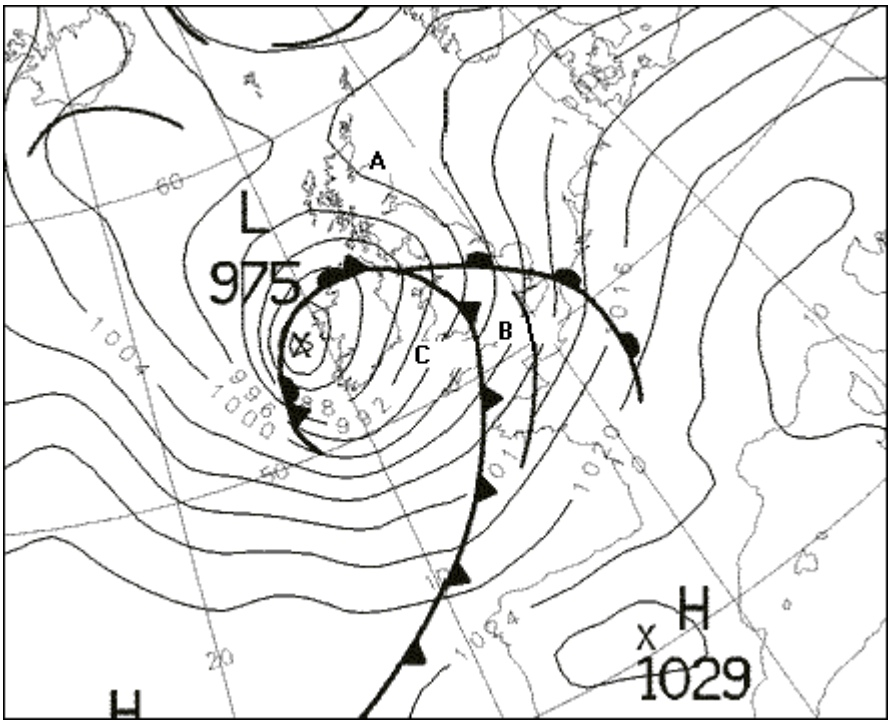
Worksheet 1 – Contrasting Weather Associated with Anticyclones and Depressions

The charts below are synoptic charts showing typical situations of an anticyclone and a depression affecting the UK. On each map several locations are marked. For each of these locations, complete the table below to show the general conditions which could be expected.

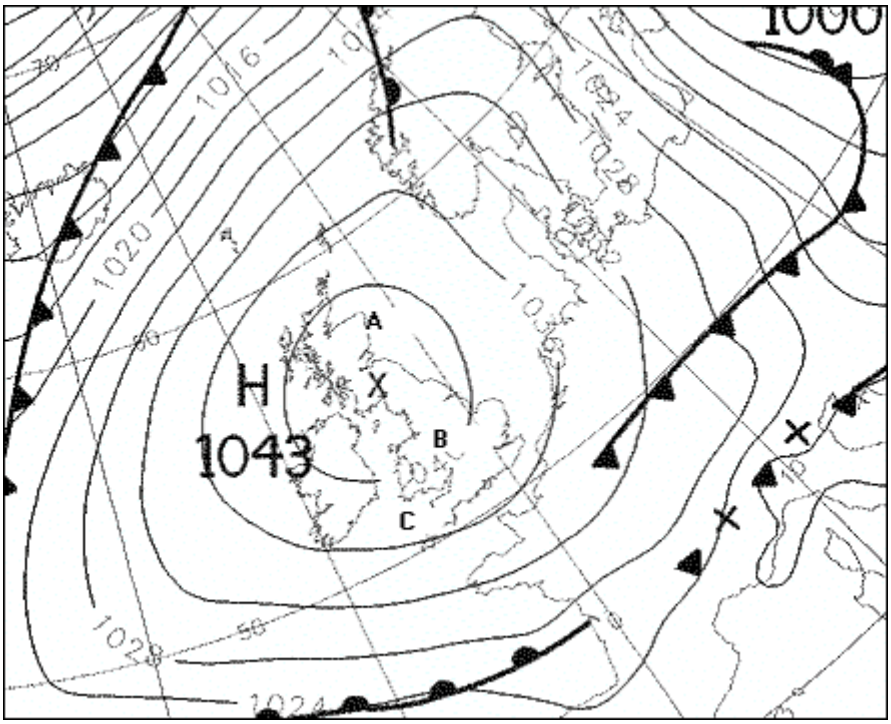
Also briefly describe the reasons for the variations you have highlighted at each location, in relation to air masses, position of fronts etc.

	Location A		Location B		Location C	
Element	**Anticyclone**	**Depression**	**Anticyclone**	**Depression**	**Anticyclone**	**Depression**
Temperature						
Wind speed						
Wind direction						
Pressure						
Cloud amount						
Weather						

Give your reasons for the differences highlighted in your table.



Depression



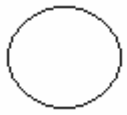
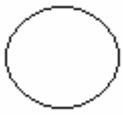
Anticyclone

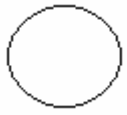
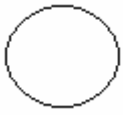
What to do next

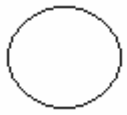
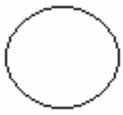
Now you can complete extension exercise 1 or go on to worksheet 2.

Extension Exercise 1

Using your answers from worksheet1, construction station circle plots for each of the 3 locations, for both the anticyclone and depression situation.

Location A Depression  Anticyclone 

Location A Depression  Anticyclone 

Location A Depression  Anticyclone 

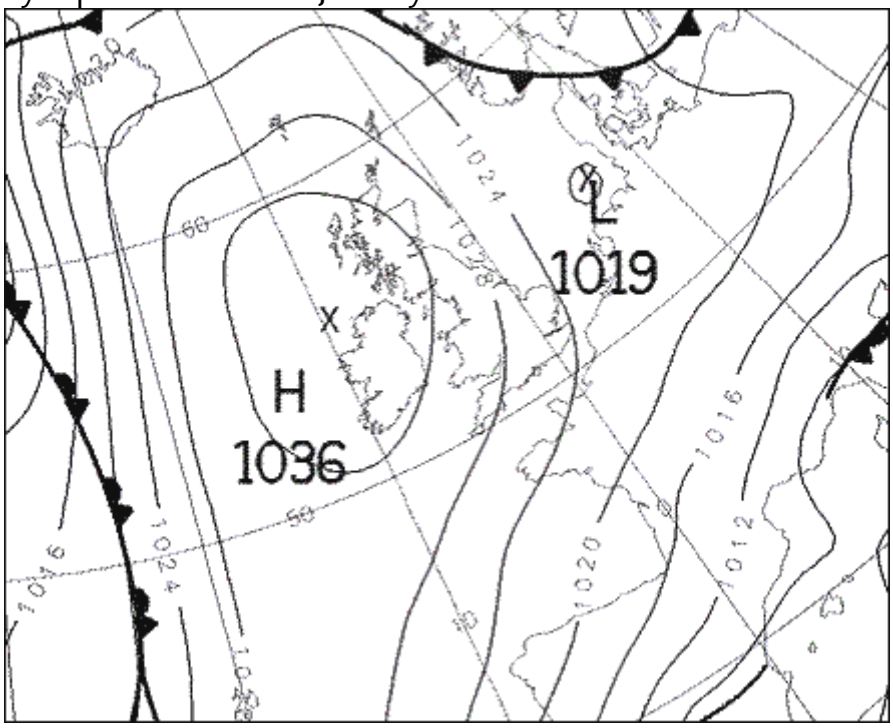
Worksheet 2 – Anticyclones

The charts below show two synoptic charts of two anticyclones affecting the UK at different times of year.

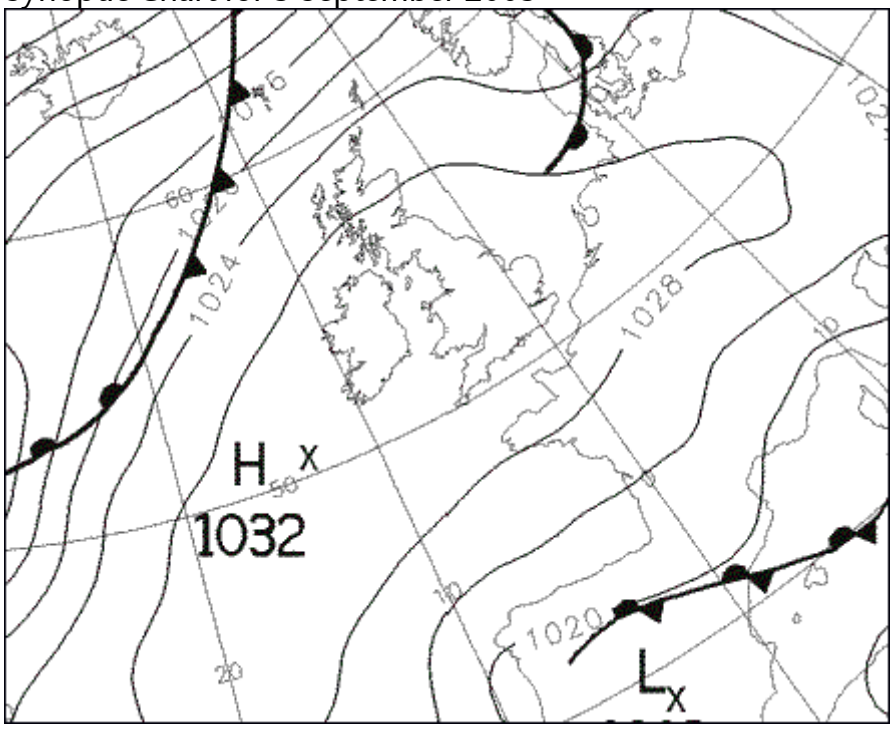
Describe the differences in weather which might be experienced in Birmingham between the two charts. Make sure you include temperature, weather and cloud cover.

Explain why these differences might occur.

Synoptic Chart for 10 January 2003



Synoptic Chart for 3 September 2003



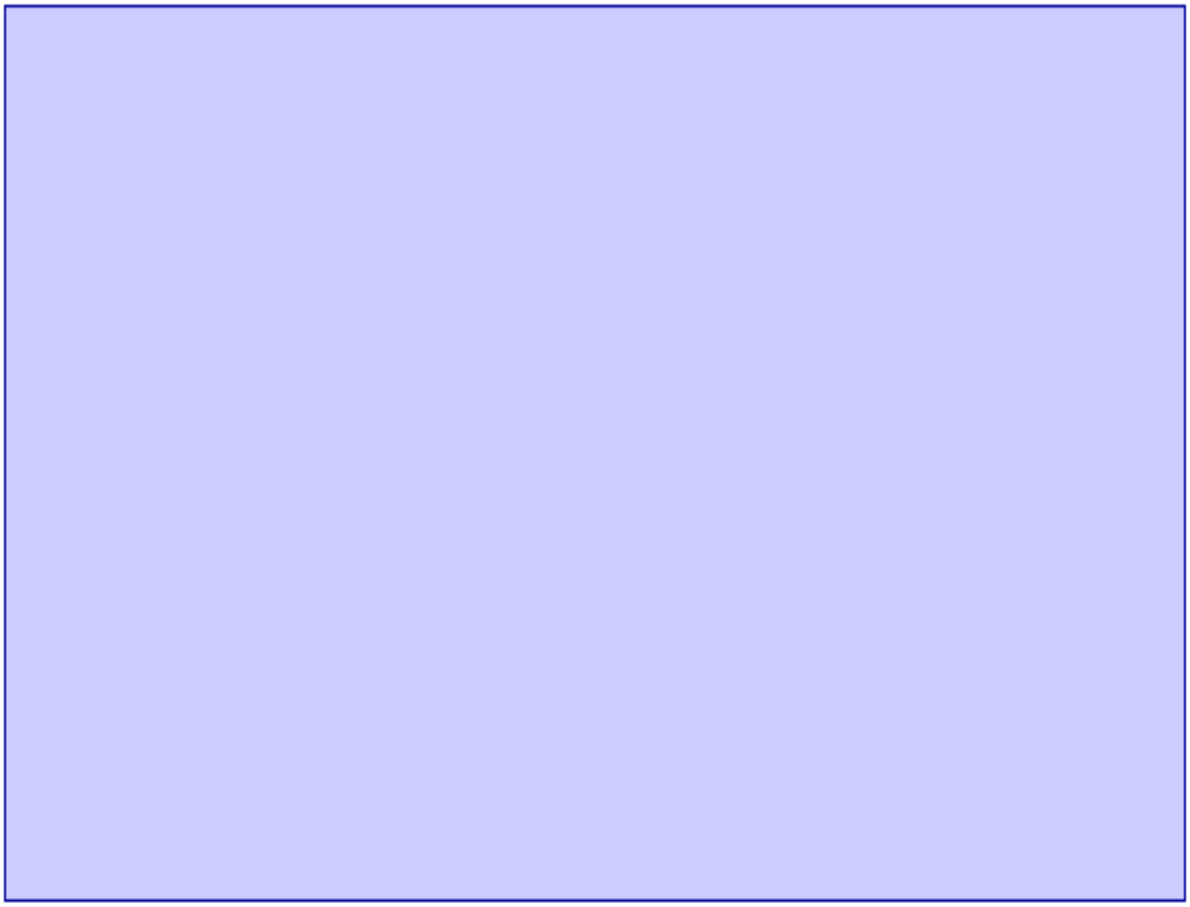
What to do next

Now you can now move on to Part B – Fronts.

Worksheet 3 – Cross-section of a Depression

In the space below construct a cross section through a classic depression. Your cross-section should include all of the following :

Warm Front
Cold Front
Warm Sector
Areas of precipitation
Areas of convective cloud
Areas of layer cloud
Temperature profile.



What to do next

Now you can complete worksheet 4.

Worksheet 4 – Weather Changes During the Passage of a Depression

Using your knowledge of the weather changes which occur during the passage of a frontal depression, draw graphs of the following elements to indicate the changes which would occur at a station as the depression passed overhead. You should include the approach and passage of the warm front, the warm sector and approach and passage of the cold front.

1. Temperature
2. Rainfall
3. Pressure
4. Wind Speed

You should include the approach and passage of the warm front, the warm sector and approach and passage of the cold front. Ensure your graphs have a key, title and axis labels.

On each of the graphs you have produced, label the warm front, cold front and warm sector.

Temperature

Rainfall

Pressure

Wind speed

What to do next

You can now move on to Part E– Final Quiz.

PART E – FINAL EXERCISE

You should now have achieved all the learning objectives of this lesson and be ready to complete our quiz.

Study the multiple choice questions below and indicate which is the correct answer.

Question 1

In the Northern Hemisphere, winds blow clockwise around

a) anticyclones b) depressions c) anticyclones and depressions

Question 2

In the Northern Hemisphere, winds blow anticlockwise around

a) anticyclones b) depressions c)anticyclones and depressions

Question 3

Isobars are lines joining areas of equal

a) rainfall b)wind speed c) pressure

Question 4

On a weather chart what would this symbol indicate  ?

a) a warm front b) an occlusion c) a cold front

Question 5

On a weather chart what would this symbol indicate  ?

a) a warm front b) an occlusion c) a cold front

Question 6

On a weather chart, an occlusion would be indicated by which symbol ?

a)  b)  c) 

Question 7

What is the wind direction indicated on this station plot? 

a) Southwesterly b) Northwesterly c) Northeasterly

Question 8

What is the wind speed indicated on this station plot? 

a) 5 knots b) 15 knots c) 25 knots

Question 9

What is the wind speed indicated on this station plot? 

a) equipment faulty b) calm c) too windy to measure

Question 10

Which of the following symbols shows 6/8th of cloud cover?

a)  b)  c) 

Question 11

What is the weather like at a station with this symbol  ?

a) snow b) rain c) drizzle

Question 12

Snow showers are indicated by which symbol?

a)  b) c) 

Question 13

Isobars that are very close together indicate an area with?

a) light winds b) no wind c) strong winds

Question 14

Which of these is not normally experienced when a cold front passes over?

a) fall in temperature b) change to showers c) wind backs

Question 15

Which of these is not normally experienced when a warm front passes over?

a) band of rain b) rise in temperature c) clear skies

Congratulations you have now completed the final exercise.