GCSE Geography

Ice on the Land

Revision Booklet

How this guide works…

This guide is the ice on the land revision guide and should be used alongside the exam question booklet you got last term. Together it gives you a full and detailed guide of everything you're expected to know – fun right?

Remember – everything in this booklet (along with the other five!) you need to know about, and we've already done at least once in class. The activities I've included in this book will help you, but are not exam questions, they are designed to encourage you to get thinking about revision / do revision!

You should therefore attempt exam questions from your exam booklet as you go along to really help you. As always remember – you do them, I mark them, you respond / improve and then I remark.

If you should lose this booklet (naughty you), then you can easily download and print off a new copy from the homework section of the CTS website. Simple… There is no excuse for not having your revision / exam question books on you – or for not doing revision,

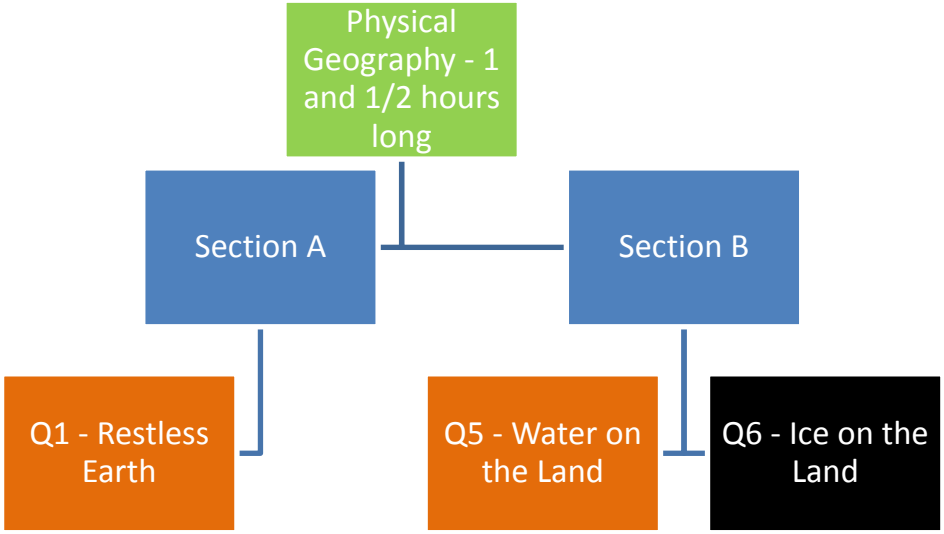
The next six pages are the best places to start they talk about what the exam will look like, what the exam board say you should know for this unit, a small guide to the types of questions there are on GCSE geography exams and how to answer them and finally a list of command words.

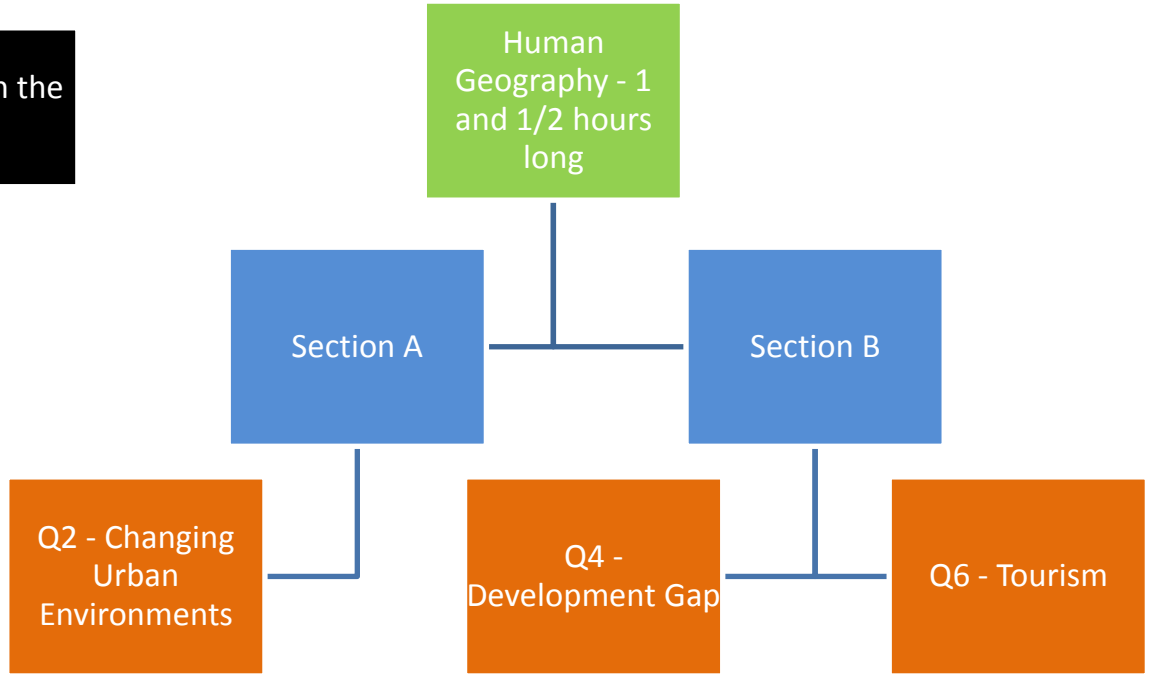
Any questions at all…

…please ask!

What will my exam look like?

You will have two exams, both will last 1 and a half hours and will be made up of 2 sections – the helpful diagram below will explain everything.





What does the exam board expect me to know for the Ice on the Land Section?

You should know and understand:	✓
When and how far did ice cover in the northern hemisphere.	
Where is ice cover currently	
Differences in ice cover over time and evidence for this	
What a glacial budget is	
What accumulation and ablation is	
A case study of a glacier – how it has retreated, causes and evidence of this	
Seasonal shifts in temperature and glacier advancement and retreat	
What freeze thaw weathering is	
What the processes of erosion are – abrasion and plucking	
What the processes of movement and transportation – rotational slip and bulldozing	
What deposition is and the reasons for it	
Landforms that happen because of erosion – characteristics and formation of corries, arêtes, pyramidal peaks, truncated spurs, glacial troughs, ribbon lakes and hanging valleys	
Landforms that happen because of transportation and deposition – drumlins, lateral, medial, ground and terminal moraine.	
A case study of an Alpine area for winter sports an area for sightseeing of glaciers – the attractions for tourists; economic, social and environmental impact. The need for management and the management strategies used and their level of success.	
The hazards that an avalanche brings	
The impact of retreat and unreliability of snowfall in some resorts. The economic, social and environmental impact including the concept of fragile environments.	

The *really* helpful bit

In GCSE geography there are two types of questions – short answer questions (worth 1, 2 or 3 marks) and longer answer questions (worth 4, 6 or 8 marks). This help guide should help you recognise the difference between the two and how to answer each type of question.

Short Answer Questions (worth 1, 2, or 3 marks)

These questions are point marked. This means that the examiner will give you a mark for each point that you make and explain (if the question asks for it).

Before answering the question you should read it carefully. It might be worth highlighting or circling what the command words are and then underline what topic the question actually is asking for.

A few quick points:

- **Make sure you give / answer the correct number of points for the marks that the question is worth.**
- **Make sure you introduce your answer – it only takes a few words and shows the examiner you know what you're talking about. Avoid starting any sentence with words like it or they. A better example would be "An MDC is a more developed country"**

Long Answer Questions (worth 4, 6, or 8 marks)

These questions are level marked. This means that the examiner will read all of your answer and then decide on a level to give you. In 4 or 6 mark questions the maximum level you can get is level 2, in an 8 mark questions the maximum level is level 3.

On your human geography paper for your 8 mark questions there is 3 extra marks awarded for your spelling punctuation and grammar. The table below shows what you need to do to get these extra marks.

Threshold performance (1 mark)	- You spell, use punctuation and use the rules of grammar with reasonable accuracy. - Any mistakes do not stop the examiner understanding what you meant in your response. - You use a limited range of key words appropriately.
Intermediate performance (2 marks)	- You spell, use punctuation and use the rules of grammar with considerable accuracy - The examiner has a good idea of what you mean in your answer. - You use a good range of key words appropriately.
High performance (3 marks)	- You spell, use punctuation and use the rules of grammar with consistent accuracy. - The examiner has no trouble understanding what you mean in your answer. - You use a wide range of specialist terms adeptly and with precision.

The examiner is looking for what are called 'linked statements' to give you the higher levels, and therefore higher marks.

Linked statements are sentences with developed explanation, statistics or examples in your answer that prove your point.

What the examiner is looking for at each level is shown in the table below along with some example sentences to help.

Level 1	Level 2	Level 3
Basic knowledge with little or no detail showing very simple understanding. There is little organisation of the answer and few key words.	Clear knowledge with clear and developing understanding and explanation shown. Some examples are used along with key words.	Detailed knowledge with clear and detailed understanding and explanation. Examples are used to answer the question with explanation and a wide range of key words are also used.
Lots of people die in poorer countries die in earthquakes.	Lots of people die in earthquakes in LDCs *because* there is likely to be less emergency services.	Lots of people die in earthquakes in poorer countries *because* there is likely to be less effective emergency services. This is *because* there is less money to pay for training for them, or give them good equipment. This *means that* less people will be saved and *therefore* more people will die.

A good 4 step plan to remember when writing a longer answer essay question is:

One - Make your point

Two - Explain what you mean

Three - Give an example!

Four - Link it back to the question

Exam Command Words

These are sometimes called trigger words – they should trigger you into knowing what the question is asking of you. But sometimes people can get confused as to what they need to do to answer the question effectively.

The table below shows you the most often used command words and what they mean. They are in an order with most often used ones first.

Command Word	Definition
Describe	Give a detailed version of what happens / has happened.
Give	Use words like *because* in your answer as you will be explaining how or why something is that way.
Discuss	Explore the subject by looking at its advantages and disadvantages (i.e. for and against). Attempt to come to some sort of judgement.
Explain	Describe, giving reasons and causes.
Define	Give the meaning. This should be short.
Outline	Concentrate on the main bits of the topic or item. Ignore the minor detail.
Evaluate / Assess	Give an opinion by exploring the good and bad points. It's a bit like asking you to assess something. Attempt to support your argument with expert opinion.
Factors	Not strictly a command word – but it can come up – where a question asks about factors it means give the facts, reasons or circumstances that can make something happen.
Identify	Recognise, prove something as being certain.
Compare / Contrast	Show the similarities / Show the differences (but you can also point out the other side of the argument).
Analyse	Explore the main ideas of the subject, show they are important and how they are related.
Comment	Discuss the subject, explain it and give an opinion on it.
Justify	Give a good reason for offering an opinion.

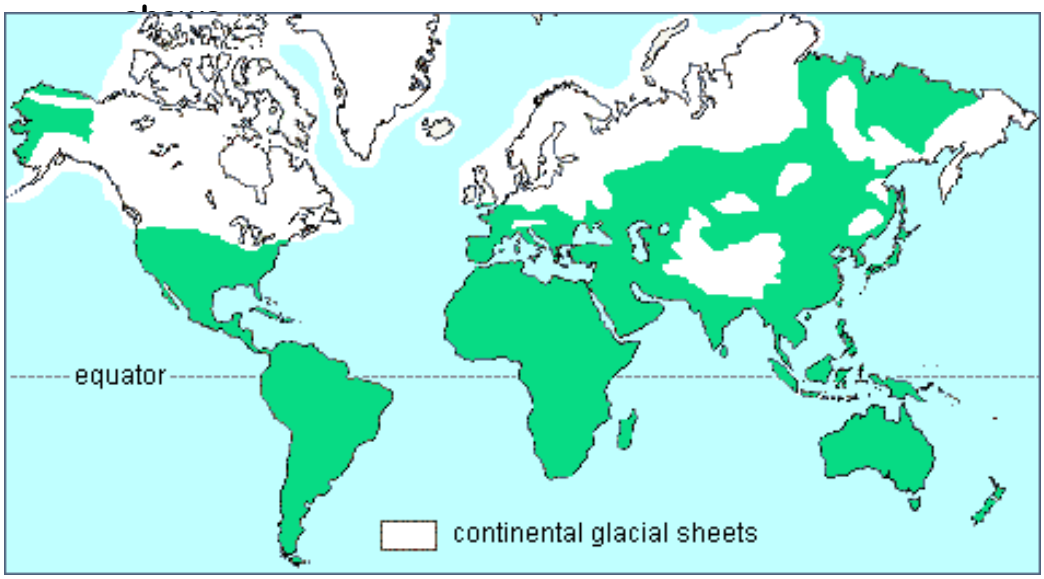
So let's get started then…

When and How Far did Ice Cover in the Northern Hemisphere

Ice is a wonderful thing, if you like cold, frozen water with an enormous power to be able to carve out huge great big valleys and leave behind steep, dangerous walls capable of killing people within seconds. (More on that later under landforms and avalanches of course!)

The amount of ice in the world has changed hugely over time, because of global temperatures. We are currently in the Holocene time period, where the amount of ice is decreasing, as temperatures are rising. This doesn't mean that there is no ice, just that there is less of it, it is restricted to cold places.

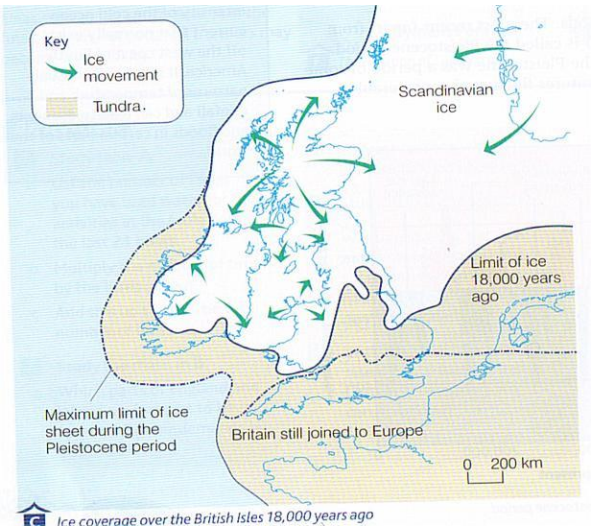
In the previous ice age, about 10,000 years ago known as the Pleistocene time period, there was much more ice around in Northern Europe, as the following map



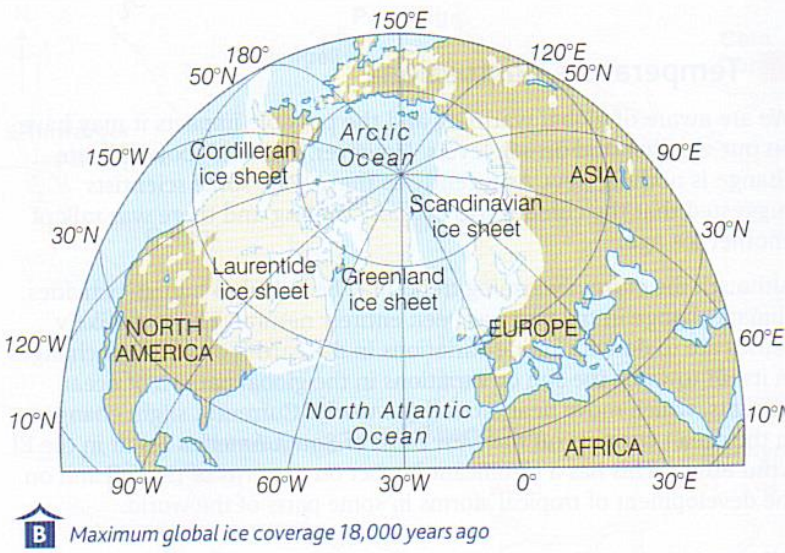
Important things to note about the map here –

1) Bits shown in white are covered in ice here, not snow.

2) This map to the left is a map of the world not just Northern Europe, the map to the bottom left shows just the UK and Northern France and the one below part of the Northern Hemisphere.

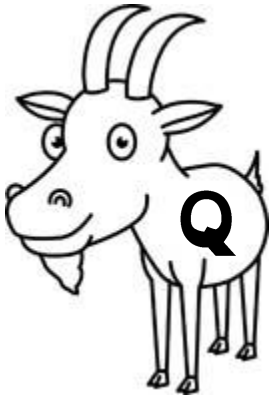


Ice coverage over the British Isles 18,000 years ago



Maximum global ice coverage 18,000 years ago

As you can see from the maps on the previous page in the Pleistocene time period the amount of ice in Northern Europe was much bigger than it is now (if you're not sure where ice is found now, look at the next section, there's a map there too). In fact it extended across most of Scotland, Ireland and Northern England not extending as far as the South or South West of England. In Europe it covered the majority of Northern Europe including countries like the Netherlands, parts of Germany, Switzerland, Iceland and the Scandinavian countries of Norway, Finland, Sweden and Denmark. The ice cover extended further west covering the majority of Northern Western Russia too.



Questions for you to have a go at are:

1) Using the map on the previous page and the information above, describe in your own words the location of the ice cover during the Pleistocene time period in Northern Europe.

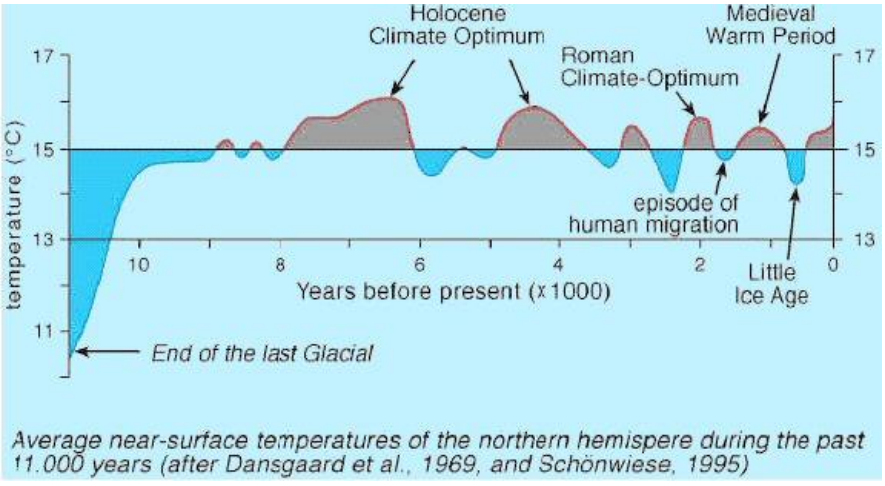
2) Which ice sheet was it that extended over most of the UK Northern Europe? (HINT – One of the maps tells you this answer…look carefully!)

Where is Ice Cover Currently?

Differences in Ice Cover over Time and Evidence for this

Fast forward 10,000 years to the present day and you've got a very different picture – there is significantly less ice around in Northern Europe as the map on the next page shows.

The cause of this is changes (also known as fluctuations) in temperature which occur naturally over time, as the graph below shows. It might only seem like a small temperature change, shown the left hand side (the y axis), but it's enough to have a big impact on the amount of ice created.



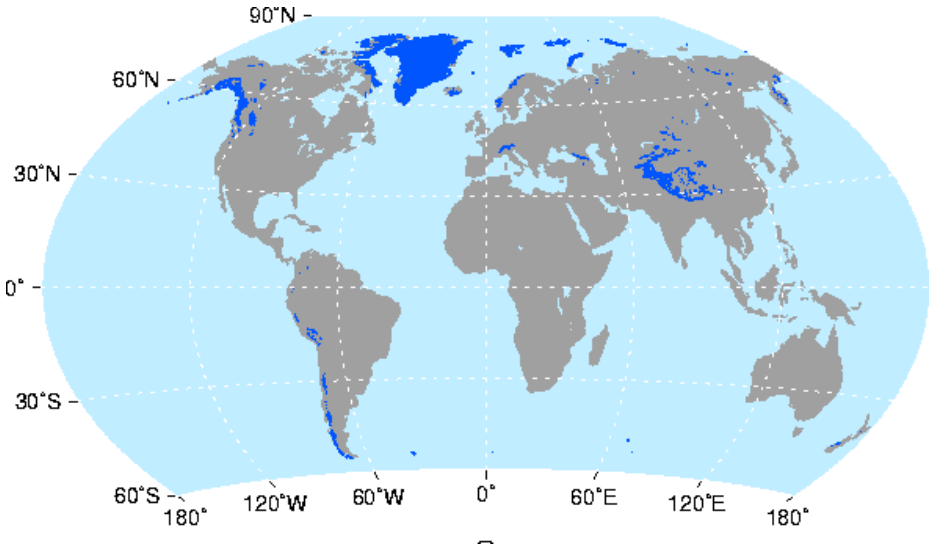
Average near-surface temperatures of the northern hemispere during the past 11.000 years (after Dansgaard et al., 1969, and Schönwiese, 1995)

You should be able to see on the graph to the left where the present day is. It's on the far right hand side of the graph – where the 0 is.

Current temperature changes are often linked to human activities, but global temperatures have been changing over millions of years (before humans)

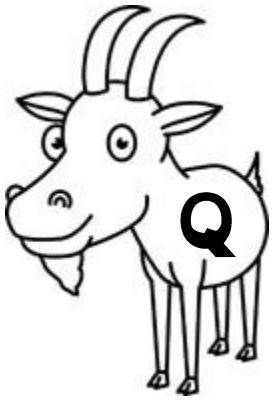
Natural causes of temperature fluctuations are due to slight changes in the earth's orbit/axis tilt, and changes to ocean currents (which transfer heat around the globe)

The El Niño effect may also be to blame. This is a periodic blip in the usual global climate caused by a short-term warming of the cold ocean current that normally exists off the west coast of South America. It results in unusually patterns of temperature and rainfall and can lead to droughts and floods in certain parts of the world.



According to the map on the left, ice has all but disappeared in Northern Europe, found only in the Alps region of Northern Italy, Switzerland and Austria, some of Iceland, very small parts of Northern Russia and the very Northern tips of Norway.

REMEMBER – this is a global map, so there is always the possibility of talking about other countries outside of Northern Europe – it depends what the exam question is asking of you! If you need to brush up on your country knowledge – there's a world map at the back of this guide.



Questions for you to have a go at are:

3) Using the map and the information above, describe in your own words the location of the ice cover during the current (Holocene) time period in Northern Europe.

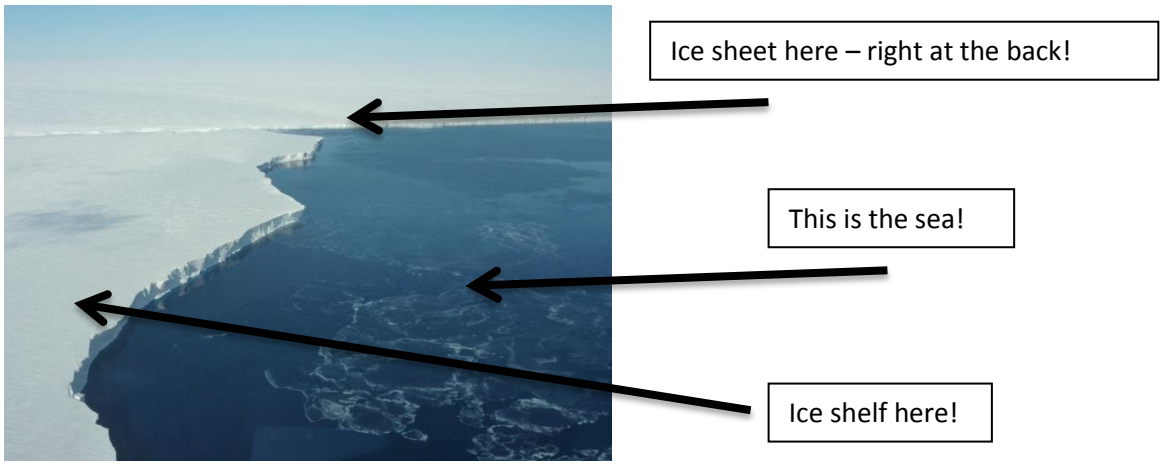
4) How has the ice cover changed from the Pleistocene time period to now? Can you describe how?

5) Why has the amount of ice changed? Explain one or two reasons why.

Types of Ice Formation

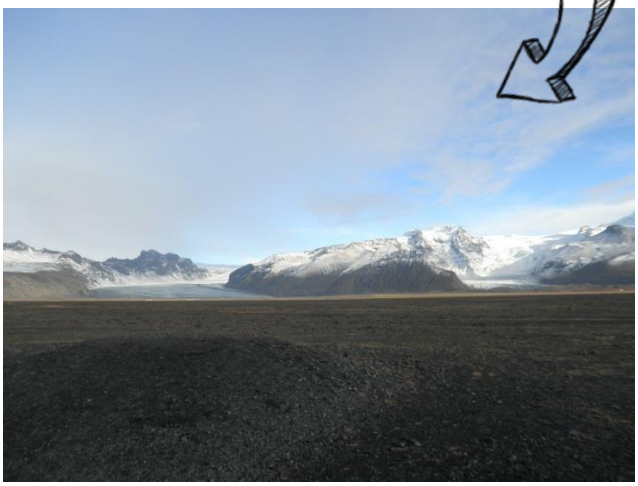
Ok – so not specifically mentioned in your unit guide back on page three, but something you need to know as a geographer (and a good human being).

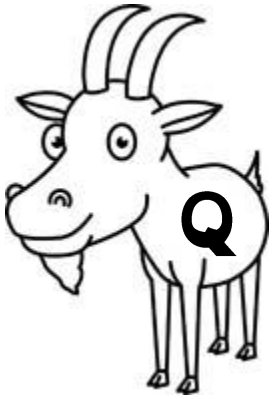
Ice sheet / Ice shelf - An ice sheet is a large body of ice bigger than 50,000km^2 over land. An ice shelf is just as big but it goes out over water.



Ice Cap - An ice cap is a smaller body of ice smaller than 50,000km^2 normally found in mountainous areas.

Glaciers - Smaller 'rivers' of ice usually extending downhill from an ice cap. They normally occupy a valley.

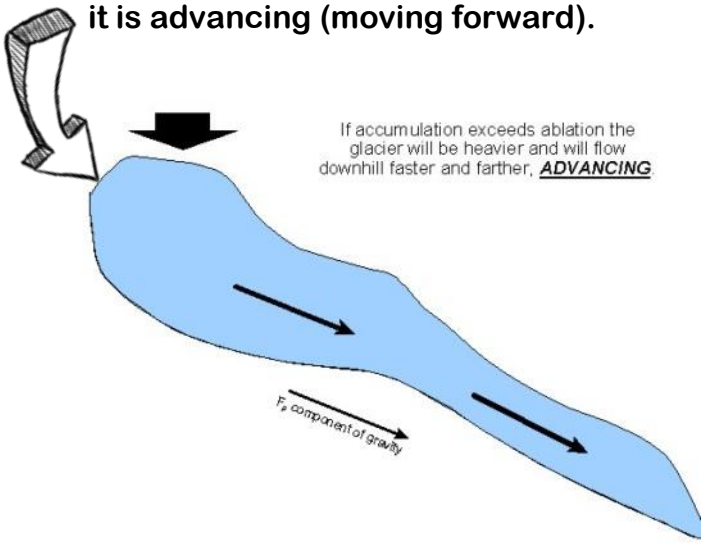




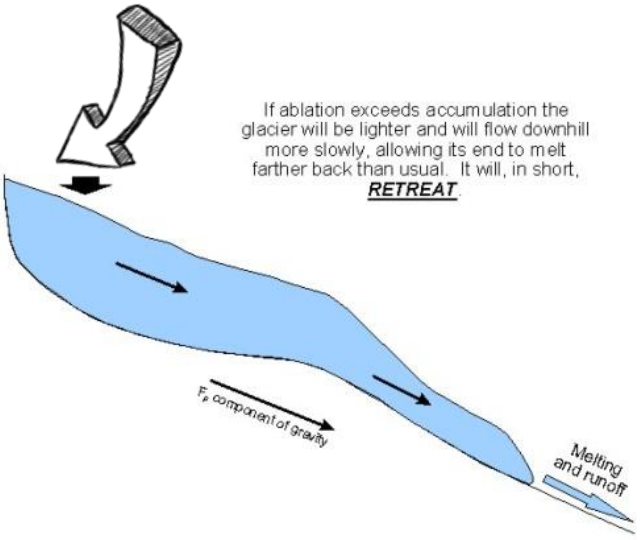
6) You could try and find a named example of each type of ice formation.

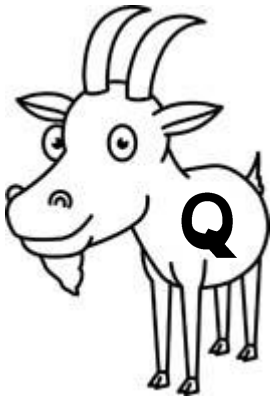
What is accumulation and ablation?

Glacial ice is formed through a process called accumulation. This happens when snow falls and it settles to the ground, and as long as the temperature remains cold it will remain there. As further snow layers fall on top of old snow it compresses the original snow down, pushing the oxygen out of it and over about 50 – 70 years creates glacial ice. Gravity will pull this heavy ice down the valley hill creating the glacier appearance we saw above. This makes the glacier appear like it is advancing (moving forward).



At the end of the glacier (called its snout) – the ice is relatively thin, and the temperatures are much warmer, this causes melting, or loss of glacial ice – known as ablation. This makes the glacier appear like it is moving backwards (it isn't, there's just less ice because it is melting away) so we say the glacier is retreating.





Some questions for you to have a go at are:

7) **Can you explain what accumulation is? How does it create a glacier?**

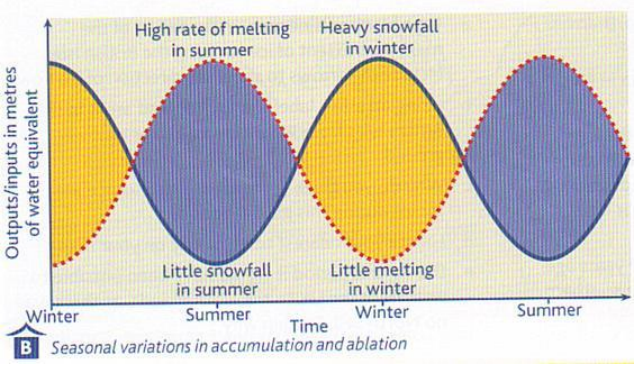
8) **How does a glacier retreat? What is ablation? What causes it?**

9) **Draw a step by step flow diagram of how a glacier is created.**

What is a Glacial Budget?

Seasonal shifts in temperature and glacier advancement and retreat

A glacial budget is a bit of a tricky thing to get your head around, but worth knowing as it is the amount and difference between the amount of ice created (accumulation – an input!), and the amount of ice lost (ablation - an output!)

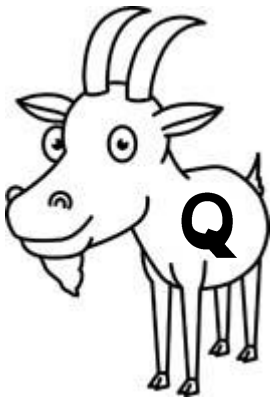


If accumulation (ice created) exceeds ablation (ice melted) over several years then the glacier will advance.

If ablation (ice melted) exceeds accumulation (ice created) over several years then the glacier will retreat.

The glacier budget varies between seasons as accumulation rates are higher in winter, and ablation rates are higher in summer.

The graph above shows the idea of a changing glacial budget, the areas that are yellow show a positive glacial budget when more ice is being created, the areas in purple show a negative glacial budget, when more ice is melting throughout the glacier.



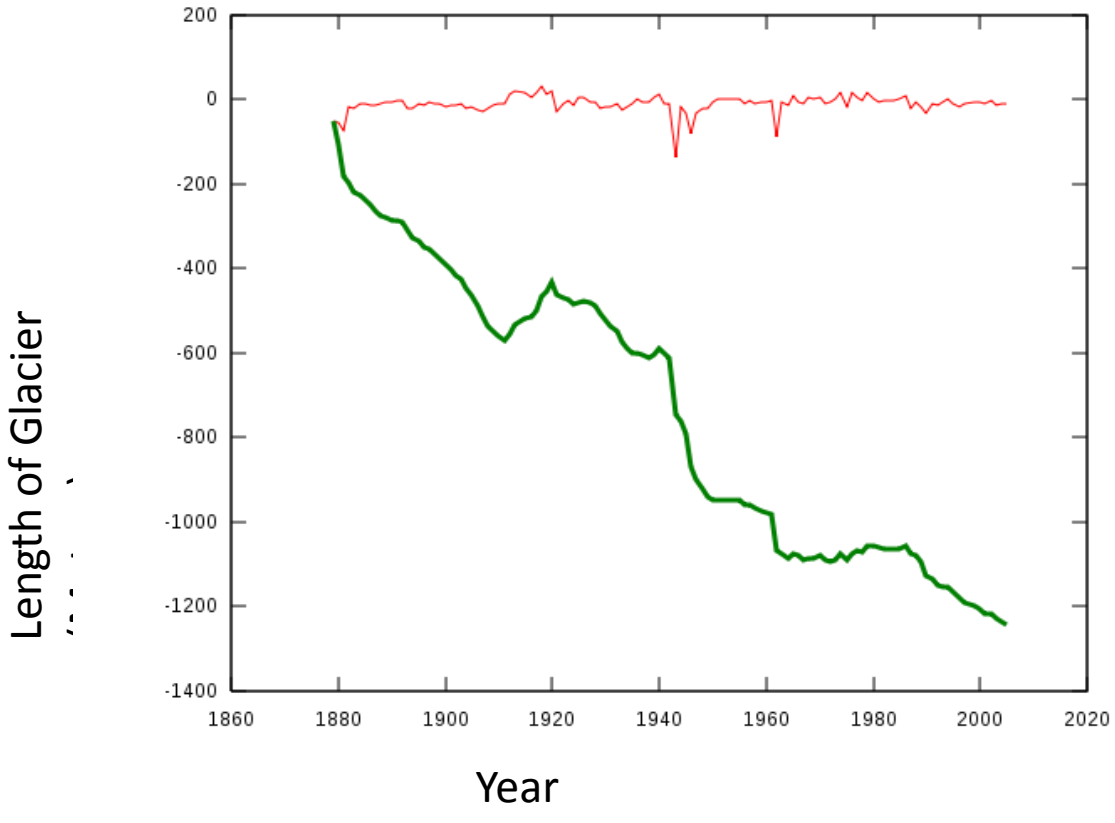
10) Something you could have a go at here, and keep going with throughout this guide is starting a glossary of key words. Some helpful soul has highlighted some of them in red….

A case study of a glacier – how it has retreated, causes and evidence of this

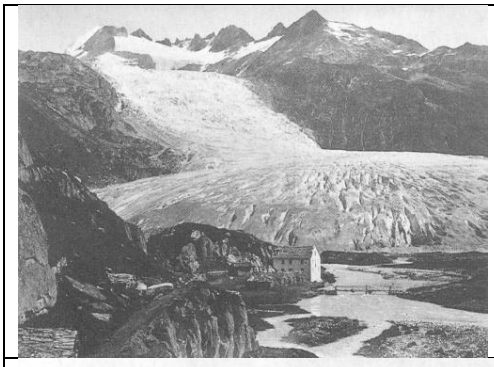
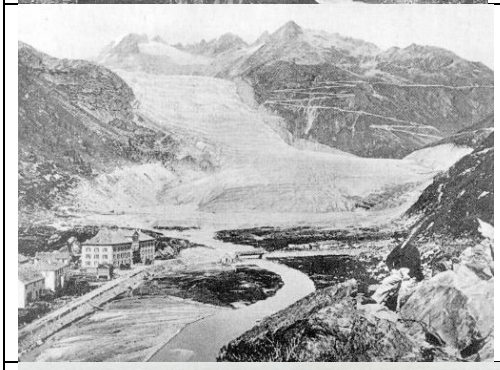
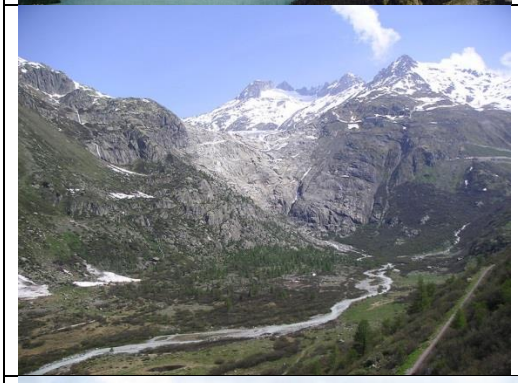
For this section you need to know a named case study, or as the exams sometimes call them – an example. Where a question says "using an example…." It means just that – use an example – otherwise you can't ever get more than a level one answer (1 – 2 marks).

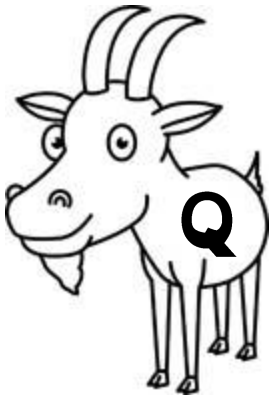
Our example is the Rhone Glacier in Switzerland, it's in the south of the country and is one of a number of glaciers in Switzerland. It is also a good example of one that is retreating quickly, and the potential impact of this on the surrounding area.

Since 1860 the thickness of the Rhone glacier has reduced by 34m, and even though the length of the glacier changes over the course of the year (with it retreating in the summer, and advancing in the winter) shown by the red line, the overall length of the glacier (shown by the green line) shows a significant reduction, around 1.2km has been lost, with the fastest reduction being from 1950 onwards (shown by the steeper, declining green line).



Other evidence for retreat of the Rhone Glacier comes in the form of photographs taken over time.

	**1865 – The glacier fully extends to the valley floor, widening out as it hits the floor. It is a short distance away from the singular house on the flat valley floor; with the amount of melted ice creating a small glacial river.**
	**1870 – The glacier continues to extend to the valley floor, and widens out but there is significantly less than five years previously where there was a visible mound of ice at the snout of the glacier. It is further away from the house on the valley floor (which has been joined by other buildings) and the river is greater in size.**
	**1900 – The glacier just about extends to the valley floor but no longer widens out at the snout. There is significantly more building on the valley floor, with a wider river producing plenty of water; likely for a popular tourism trade.**
	**2005 – The glacier no longer extends to the valley floor, the snout is about a quarter of the way up the valley, the flat valley floor is very green, and almost all of the buildings have gone. This could be because of increased chances of flooding, or a decrease in tourism to the area. The river is long, but not particularly wide.**
	**2008 – The glacier has retreated higher now, it is about halfway up the valley itself, and the flat valley floor is now totally green, with farming buildings having been built, showing that the valley is no longer in danger of ice, instead it is a fertile area for crops. Rock, previously eroded by abrasion (see later) has been uncovered as the glacier has retreated backwards.**



11) Using the photographs and information on the previous page write a series of postcards describing how the landscape has changed over time.

12) What has caused the glacier to melt? Use the information below to explain why the Rhone glacier has retreated.

Glacial retreat is particularly important in Switzerland, for starters if it continues there is the potential in the short term for catastrophic flooding, while long term the tourist industry could suffer a significant drop.

The glacier is also hugely important for Switzerland's water and electricity supply, as during the summer much of the melted ice is either treated and used for drinking water, or used to produce around half of Switzerland's energy.

Scientists have suggested that glacial retreat has been causes by the warming up of the earth, with an increase in temperature of 0.74°C since 1900, which in part may be linked to the increased use of fossil fuels (like oil and coal) or the increased emissions (releasing of) carbon dioxide in the atmosphere, which has caused a greenhouse effect, and raised temperatures in the world.

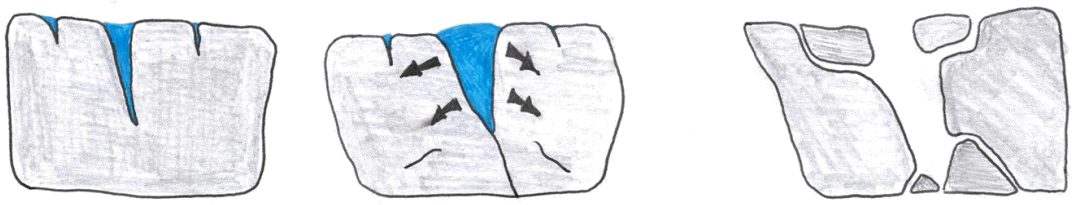
As a result it is too warm for snow to fall, instead falling as rain, meaning a lack of glacial ice being created, and the chance for flooding increased.

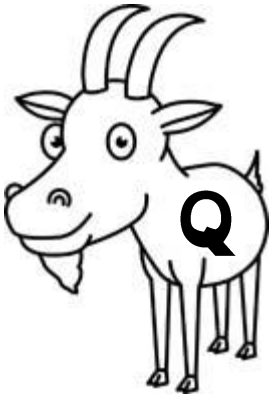
What is Freeze Thaw Weathering?

Freeze thaw weathering is a process that breaks down rock, causing it to be eroded away through abrasion and plucking (see next section). It is also the main cause of jagged, angular rocks outside of glaciers (called nunataks).

The diagram on the next page shows you an idea as to how it happens, it beginsns when water gets into a crack in the rock and gets trapped, as temperatures drop the water freezes and expands (as ice has a greater volume than water) causing increased pressure on the surrounding rock.

Importantly, this process continues and repeats a number of times with the ice melting (thawing), crack in the rock and more pressure being applied to the surrounding rock. Eventually the join in the rock becomes so weak the rock breaks off leaving behind jagged rock, and the weathered rock is transported away.





13) Using the diagrams above and the information on the previous page explain what freeze thaw weathering is and the impact that it has.

14) What impact would global warming have on the amount of freeze thaw weathering?

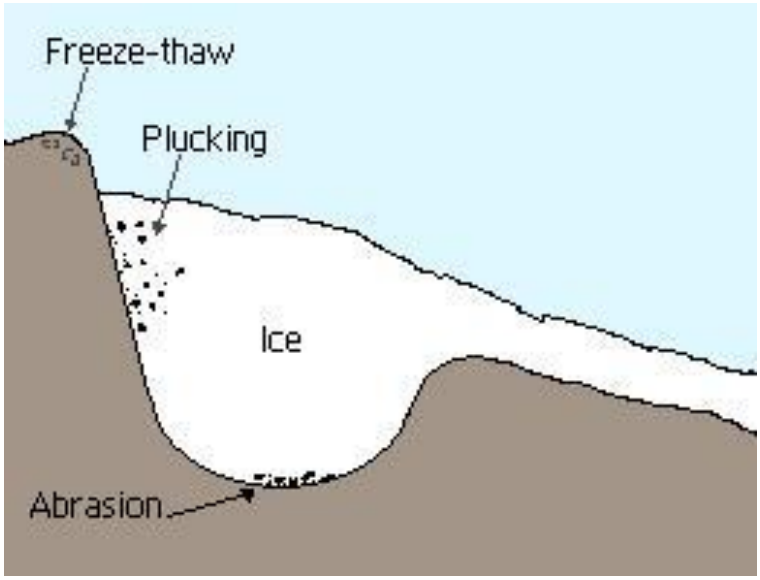
15) Explain what abrasion and plucking are, how they occur and the impact that they have.

What is Abrasion and Plucking?

Abrasion and plucking are forms of erosion, this means that they wear away **and** remove the rock from the place it has eroded.

Abrasion takes place underneath the glacier (see diagram) where the glacier rubs against the valley and normally leaves behind a smooth valley floor because of it. More accurately it is the process where rock fragments in the ice grind against the rock over which the ice is moving (like rough sandpaper) wearing away the land.

Plucking is where melt water at the base of the glacier freezes on the rock surface, causing the glacier to stick to the rock. As the glacier moves downhill it tears out pieces from the rock surface leaving behind a steep wall of rock.



If you don't believe that ice can become sticky remember why when you were young you were always taught to never lick anything metal when it was cold.

What landforms are created by erosion?

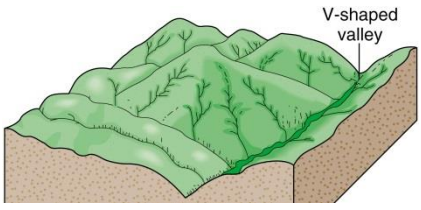
This is potentially a big section on your exam, it could be a big 8 marker question, where you're expected to explain how a number of landforms are created, or it could be a 6 mark question where you're asked to draw a diagram to explain what is going on. It could be a one (or even a four mark) question where you are given one (or a number of) photograph(s) of landforms and asked to name them. We're going to take each one in turn in the next couple of pages….

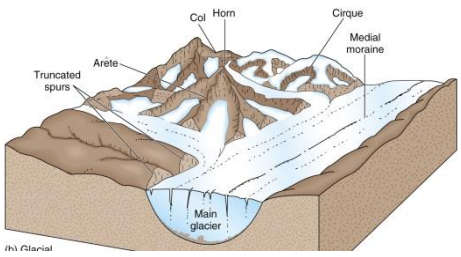
U Shaped Valley / Glacial Trough

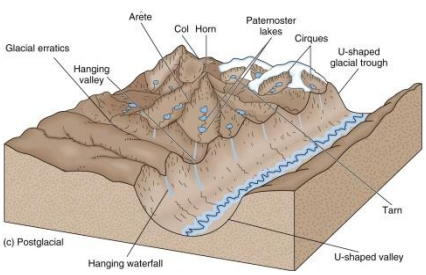
A U shaped valley is also called a glacial trough; it is probably the easiest of the landforms to explain caused by erosion over thousands of years. Examples are found in Wales and the Lake District and are easily spotted by their steep sides, flat bottom and often a misfit stream (a small river found in a huge valley that it could not have created) at the bottom.

U shaped valleys are formed when glacial ice fills a V shaped valley (which was created by a river eroding down to sea level and the sides of the valley collapsing down to make a V shape) during an ice age.

As the V shaped valley is now filled by glacial ice as the glacier moves downhill it erodes away at the sides (through plucking) and the bottom (through abrasion). Following the end of the ice age as the glacial ice melts away the U shaped valley is left behind. The diagrams below show a good idea as to how the valley shape changes over time.







Before **During the Ice Age** **After the Ice Age**

Corrie (sometimes called a cirque)

Corries are armchair shaped hollows found at the tops of mountains, where glaciers begin.

At the top of mountains are small hollows where snow can accumulate (gather), as we already know the snow compacts into ice and this accumulates over many years to compact and grow into a glacier.

Even though the ice is trapped in a hollow and unable to move downhill, gravity will still encourage it to move, when this is movement is more curved it is called rotational slip. Glacial ice moves downhill because of gravity and the weight of the ice.

The ice freezes to the back wall of the mountain and as it moved downhill it plucks rock out steepening the back wall. Erosion and weathering by abrasion, plucking and freeze-thaw action will gradually make the hollow bigger.

These processes create a characteristic rounded, armchair shaped hollow with a steep back wall. When ice in a corrie melts, a circular lake is often formed at the bottom of the hollow.

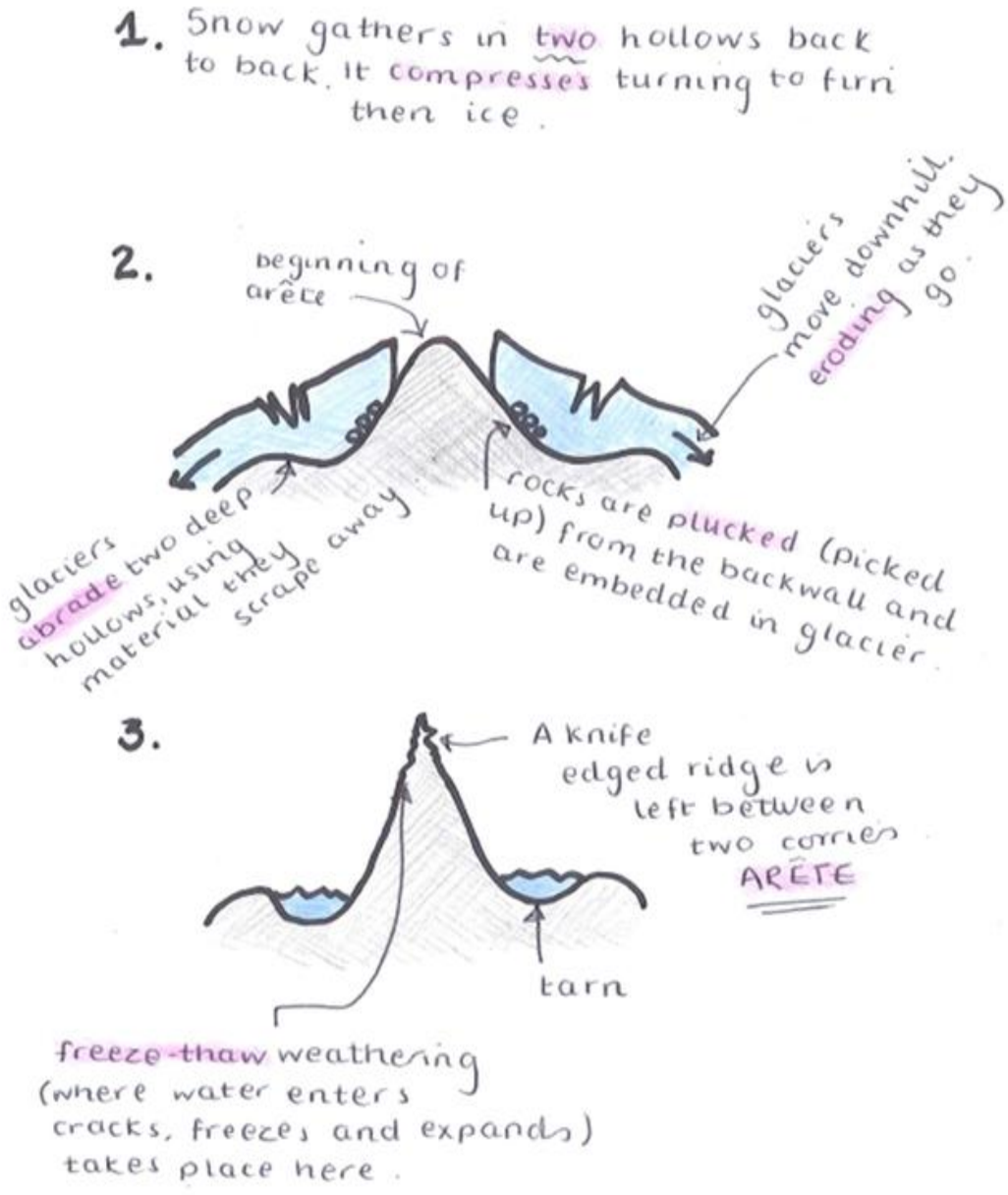
This is known as a tarn or cwm.

The diagram to the left should help explain this more.

Arête

Arêtes are knife edge like ridges found between two corries. It is key that you understand how corries are formed in order to fully explain how an arête is formed.

As each glacier erodes a corrie either side of the ridge, the back wall of the corries become steeper and the ridge becomes narrower and higher. A good example is Crib Goch in Snowdonia, where around 7 people a year die by stepping / falling off the side of it every year.



Pyramidal Peaks

Pyramidal Peaks are where three or more arêtes meet, and therefore there are three or more corries too. It is key therefore that you know how corries and arêtes are formed to be able to fully explain how a pyramidal peak is formed.

The glaciers have carved away at the top of a mountain, creating a sharply pointed summit; good examples are Mont Blanc, and Mount Everest.

1. Snow gathers in three or more hollows back to back. It compresses, turning to firn then ice.

2.

3.

Hanging Valleys and Truncated Spurs

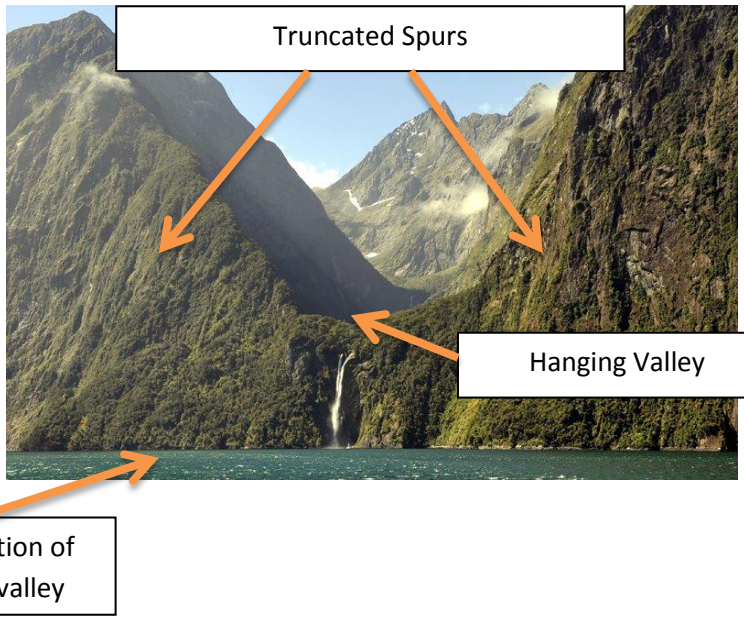
These link in very nicely with the U shaped valley information from earlier, so once again if you don't understand that you're going to struggle with this.

Within all glacial valleys there are main glaciers and smaller tributary glaciers (just like with rivers) that feed into the main glacial valley. The main glacier can erode its valley to a much greater extent because they are wider, deeper; have more weight and more material during erosion.

The tributary valley glaciers are smaller, have less weight and material therefore erode their valley less. This means that the main valley is made deeper, wider and steeper.

This becomes really obvious after the glacial ice melts, when the tributary glacier is left hanging high above the main valley. When rivers return, they often form waterfalls in these hanging valleys.

Truncated spurs are a bit trickier to get your head around, they are areas of harder rock that the river previously would wind around (called interlocking spurs, if you remember!) that have been cut off by the main glacier as it extends downstream.



Ribbon Lakes

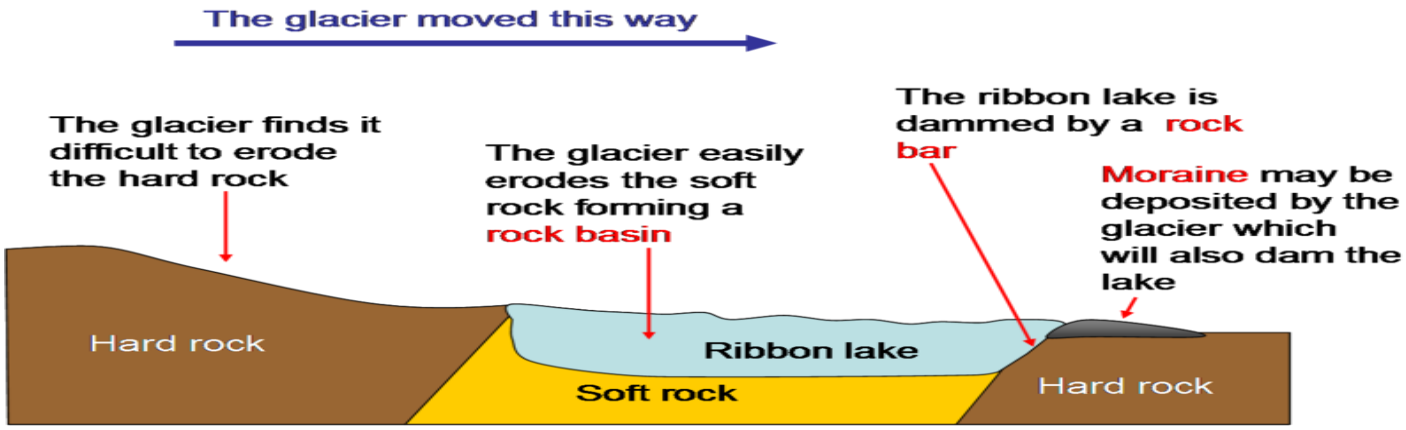
Ribbon lakes are long, thin lakes found on the floor of U shaped valleys – they can sometimes fill the bottom of a U shaped valley, but are always easy to spot on an OS map because they are on flat land surrounded by steep sides.

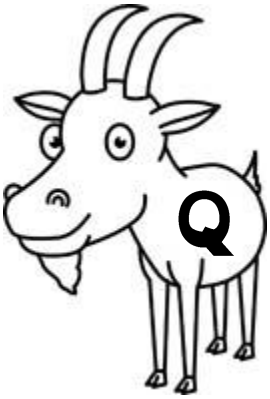
Ribbon lakes are created as a glacier flows over the land, it flows over hard rock and softer rock.

Softer rock is less resistant (or less tough – and so is easier to erode), and as the glacier moves downhill the material at the bottom of the glacier (known as ground moraine – see later sections) can carve a deep trough.

When the glacier has retreated, (melted) water will collect in the deeper area and create a long, thin lake called a ribbon lake.

Many of the lakes in the English Lake District are ribbon lakes, like Lake Windermere for example.





16) Using the information above draw out a step by step flow diagram of how each landform is created. Test yourself by then covering over one step of the diagram and see if you can remember it.

17) Draw out each of the diagrams for the landforms shown above without the annotations / explanation around it and then without the use of the revision guide – add in your own annotations. In a different colour add in all the bits you've missed.

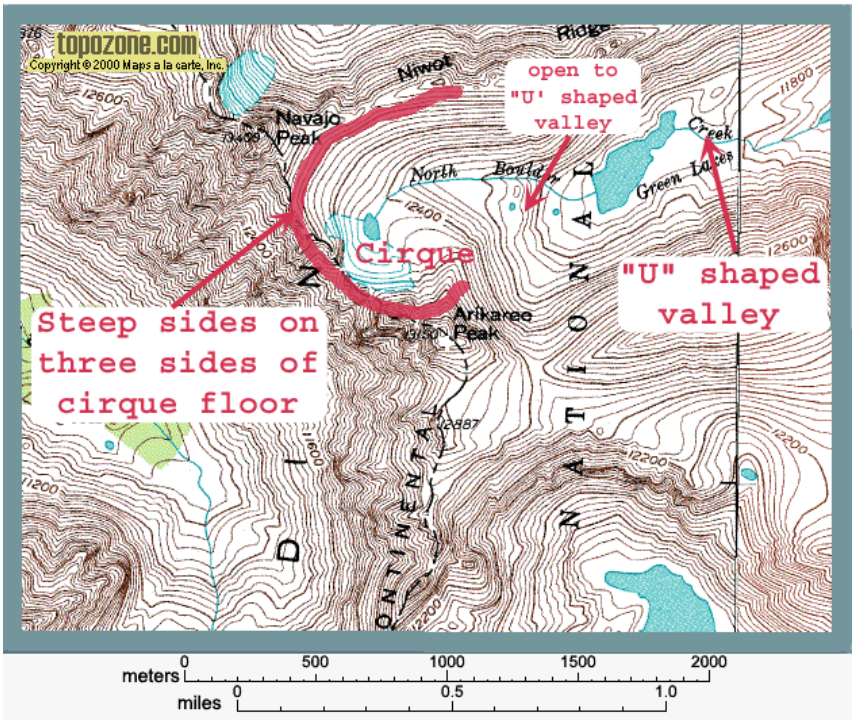
18) Draw pictures of each landform, write the characteristics of each landform around the picture then get someone to show you just the picture and see how many of the characteristics you can name / remember.

19) Find someone, anyone, who isn't a geographer and bore them rigid talking about all the crazy landforms you need to learn about. Keep talking about them, keep learning about them, keep drawing them – it's the only way you'll learn about them.

Finding Landforms on an OS map

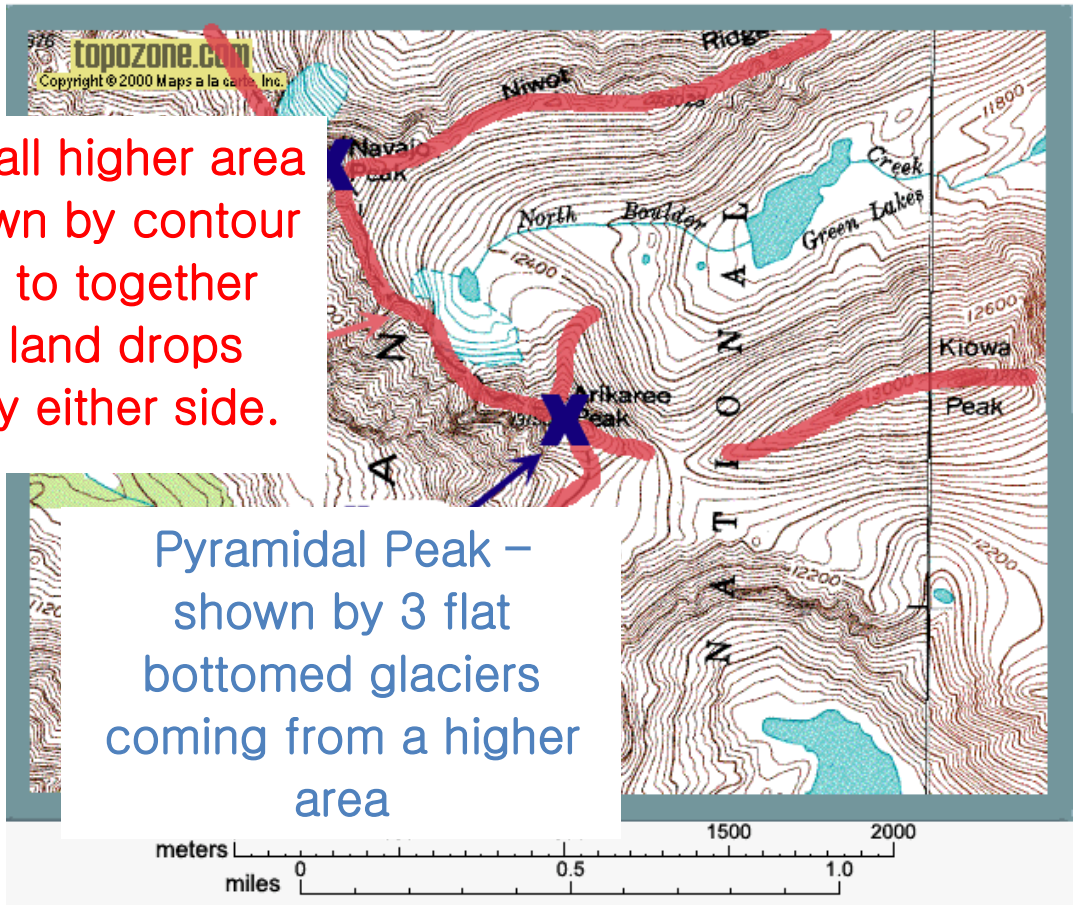
In every GCSE geography exam there is the potential for a skills question, it could be a graph to complete or read from, a photograph to label or annotate, or an Ordnance Survey (called an OS map).

We'll do lots of work on OS maps in class, but for this section you need to be able to spot certain glacial landforms on a map. The characteristics of each landform on the previous few pages will really help – but so the next few pages.



For example the image on the right shows you how a corrie (sometimes called a cirque) can be spotted, along with a U shaped valley (steep sides – shown by the contour lines being very close together, and the flat valley floor shown by the contour lines being much wider apart).

Arête – a small higher area of land, shown by contour lines close to together where the land drops away quickly either side.



Pyramidal Peak – shown by 3 flat bottomed glaciers coming from a higher area

U-shaped valley and Ribbon lake on an O.S.Map

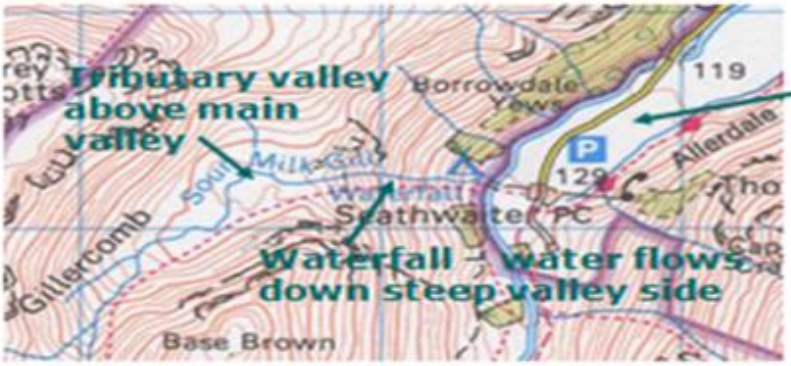
Whiteness on map due to flat valley floor

Ribbon Lake

Steep Valley sides close contours

Identifying a Hanging Valley on an O.S. map

- A hanging valley is the most difficult feature to identify on an O.S. map.
- Look for a glacial trough first, then try to look for a small valley 'hanging' above the main valley floor.



Transportation and Deposition: Process

Transportation is a key word to do with the movement of material carried within the glacier.

Material carried within the glacier is called moraine and there are four landforms created by the deposition of it – this is covered in a later section.

Rotational slip is one way in which material is moved around by the glacier (see earlier section) – another is bulldozing where material is pushed forward by the snout (end) of the glacier – a little bit like a bulldozer or a broom. This creates a landform called terminal moraine, but can also leave behind landforms called drumlins when material is deposited.

Deposition is the name given to when material is dropped from the glacier this tends to happen when the ice melts, at which point moraine changes its name to glacial till.

Transportation and Deposition: Landforms

As glaciers move material as they travel downhill the moraine (material) carried within them produces some very different landforms.

Lateral Moraine

Lateral moraine is found at the sides of the glacier, it is mostly rock that has fallen off the sides of the glacier because of freeze thaw. When the glacier melts it creates a slight ridge on the valley side.

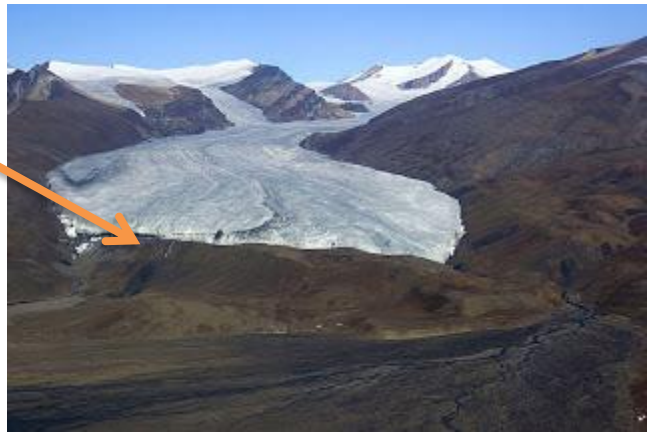
Medial Moraine

Medial moraine is found when a smaller glacier joins the main, bigger glacier. Two lateral moraines merge to produce a single line of moraine that runs down the centre of the main glacier. When the glacier melts a ridge in the centre of the valley is left behind.

Ground Moraine

Ground moraine is material dragged underneath the glacier because of abrasion. When the glacier melts uneven, rough ground is left behind and so a photograph is incredibly difficult to find for you….sorry!

Terminal Moraine



Terminal moraine is material that collects at the snout of the glacier (often because of bulldozing) to form a high ridge. It can be tens of metres high and stretch right across the valley. It represents the furthest distance that the glacier advanced to.

Drumlins

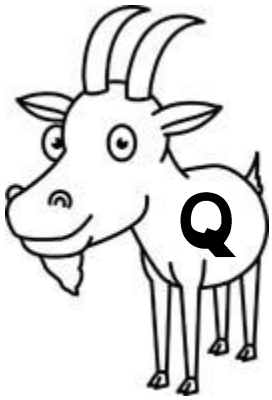
Drumlins are smooth, egg shaped hills about 10m in height and up to a couple of hundred metres in length.

They are made of moraine and are caused when moraine collects in front of an immovable object before spilling over the top and down behind the immovable object.

The glacier shapes and moulds the drumlin with a blunt end facing up valley and a pointed tail end facing down the valley, in the direction that the ice travelled. When the glacier melts a drumlin is left behind.

Erratics

An erratic is a boulder that is different to the bedrock upon which it is sitting. They have been transported and d eposited by a glacier from an area of one rock type to another. Therefore erratics are useful indicators of patterns of former ice flow.



20) Explain what the different types of moraine are and how they are formed.

21) Draw a diagram with annotations to explain how drumlins are formed.

22) Explain in less than 40 words what an erratic is and why they are useful to geographers.

A Hazard in Mountain Areas: Avalanche

An avalanche is when a large amount of snow and ice falls down a mountain at massive speeds (up to 185 miles per hour), and can be fatal particularly when it covers people in snow and ice.

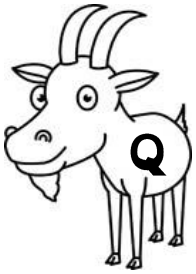
There are two types of avalanche – a powder avalanche - this is when a layer of snow with slides over another layer of snow and down the mountain side, and a slab avalanche when a massive amount of snow slides over the ground remaining as one large block (or slab).

Powder avalanche

Slab avalanche

Avalanches are caused by six main reasons:

- **Heavy snowfall – this adds to the weight of previous snowfalls, and can make slab avalanches much more likely particularly as with each layer of snow a separate frozen layer of ice is created**
- **Steep slopes – avalanches are much more likely to occur on steep slopes between 30° - 45° where snow can settle, but the slope is steep enough for it to be moved easily, and quickly.**
- **Removing trees – for skiing resorts mean that the avalanche can move downhill quicker and without any obstacle in its way.**
- **Temperature rise – can cause sudden melting which can often lead to avalanches, as melted ice can act a bit like a banana skin!**
- **Heavy rainfall – can make the slope slippery and trigger an avalanche**
- **Human factors – are a big cause of avalanches – off-piste skiers and snow mobiles are heavy enough to trigger a fast movement of snow and ice downhill. Some explosions set by humans for clearing snow or areas for development can cause the ground to shake and trigger an avalanche.**



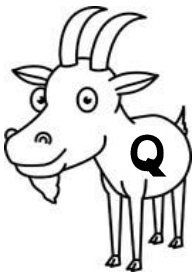
23) Design a leaflet warning tourists in mountain areas of the causes and risks of an avalanche.

Tourism in Mountain Areas: Chamonix

Chamonix is a massive tourist resort located in the north-west of the Alps, close to the Swiss (15kms) and Italian (15kms) borders making it popular with a large number of tourists from all across Europe.

Chamonix and its valley are famous for the views of Mont Blanc, Europe's highest mountain (4,808m)

Chamonix has been a popular tourist destination for over 250 years. It has a population of 10,000, and over 100,000 tourists a day in summer and 60,000 tourists a day in winter. Many people who live in the area work in the tourism industry and the town his now well served by fast motorway roads, and a nearby airport will only increase the number of tourists who visit.



24) Sort the information in the table on the next page to show:

- ☐ **Winter attractions**
- ☐ **Summer attractions**
- ☐ **Positive impacts**
- ☐ **Negative impacts**
- ☐ **Ways of managing tourism**

25) Explain why so many tourists go to Chamonix and the impacts that this has on the area.

26) How is tourism being managed in Chamonix? Why are they doing this?

27) What are the environmental impacts of tourism in Chamonix? Are these more positive or negative?

Options for skiers and snowboarders of all abilities	Roads into Chamonix are small and easily congested at peak times.	In summer, the Montenvers railway takes visitors to the Mer de Glace.	350km marked hiking trails, 40km of mountain bike tracks and Snowshoe trails for hikers
In summer the town comes to life with live music, colourful flowers and cafes.	Mass tourism can be noisy and damaging to the environment, conflicting with tourists interested in more peaceful activities.	Escape Mont-Blanc – A cooperation addressing issues on transport, nature conservation, forests and water resources.	Job opportunities are available in hotels, restaurants, sports facilities and as guides/instructors.
The money from tourism supports local services, e.g. shops.	The local transport and health care systems are maintained.	Hiking and mountain biking has eroded mountain paths.	At peak tourist time the town is noisy and crowded.
Museums, shops and historical buildings provide attractions away from the slopes.	Easy access to peaks from cable cars and cog railways	Shops, restaurants, etc. are tourist orientated making prices higher for locals.	The money from tourism allows Chamonix to be maintained as an attractive town.
Activities include; rock climbing, mountaineering, paragliding, rafting, canyoning and pony trekking.	Tourists can conflict with locals, e.g. Farm animals can be affected by tourists who leave gates open or leave litter.	Tomorrow's Valley initiative works with locals and tourists to plan sustainable management.	The local authority provides environmentally friendly transport system with clean energy buses and free transport.
A range of hotels, restaurants, heated swimming pools and spas.	Chamonix are promoting responsible tourism, and working to protect the environment.	At the Mer de Glace visitors can get up close to the glacier and even go in an ice cave.	Two new cross country ski courses

Management Scheme: Tomorrow's Valley

Tomorrow's Valley is a management scheme used in Chamonix to be able to continue to encourage the continued growth of tourism while protecting the natural and cultural environment, in other words – through sustainable development.

For example it has developed more service networks, like electricity lines, and are burying these underground to protect the look of the area. Historic buildings/monuments are being preserved or renovated to protect the history of the area, and to encourage tourists to learn about it.

Natural wetlands and peak bogs have been preserved and the planting of trees and the use of local building materials minimises the visual impacts of skiing on the landscape.

In popular tourist areas the scheme has spent money on maintaining and way-marking footpaths and cleaning rivers to help preserve the environment and provide seasonal employment for locals while also supporting traditional local employment sectors like farming so that not everyone who lives in the town relies on tourism.

This is particularly important should the impacts of climate change effect places like Chamonix – as they have done in other mountainous areas.

The Impact of Climate Change on Mountain Tourist Areas

Glacial areas are fragile environments, easily affected by human activities like tourism.

Abondance is a typical ski resort in the Haute-Savoie region in the east of France on the border with Switzerland.

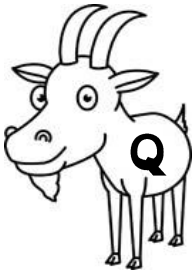
It is heavily dependent on tourism due to the income it brings to the area, particularly during the winter but with climate change and its impacts the amount of snow had decreased, resulting in tourists being transported further up the mountain in the search for snow and ice and in some years snow has been artificially created in order to create snow for their ski slopes.

In 2007 the ski resort closed due to 15 years of unreliable snowfall.

The local council have 2 options in attempt to secure the future of the area for the people that live there.

1. **Develop other winter sports, including ski touring, snowshoeing and snow-mobiling. These activities are less dependent on snow than traditional skiing.**
2. **Develop a summer programme of activities, including hiking, water sports and mountain biking. This would enable the town to become more of an all-year round resort, giving a more steady income.**

There is the concern that the council could encourage development of tourist opportunities in areas that still receive snow, higher up in the mountain, but this would involve more roads, more ski lifts being developed and trees would need to be cut down; potentially causing more avalanches and environmental damage – but surely locals need their jobs and livelihoods protecting?



28) Using the information above what issues does Abondance face? Why?

29) What would you do in the future if you were the decision maker in the local council? Why?