

## Unit 1 What's the Temperature? / Unit 2 James Feels Hot

### The Fahrenheit Scale

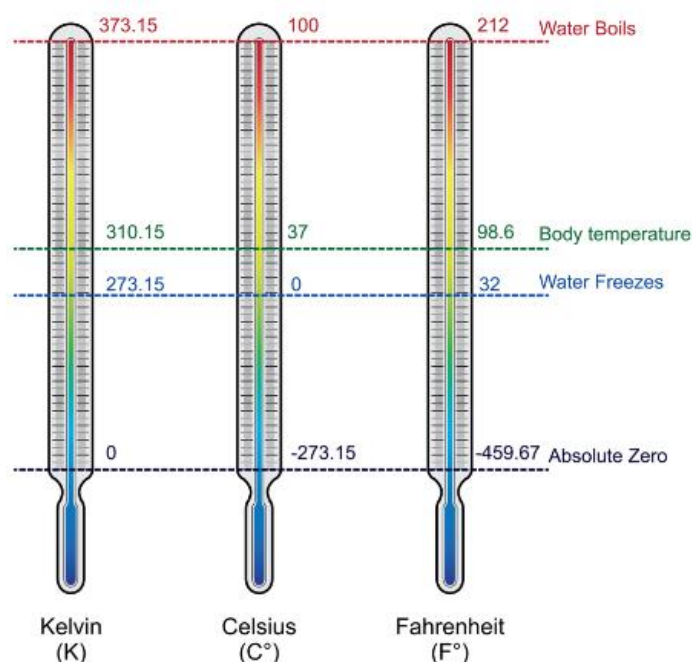
The Fahrenheit temperature scale was developed in 1717 by the German physicist Gabriel Fahrenheit.  $0^{\circ}$  was established as the freezing temperature of a solution of brine made from a mixture of water, ice, and ammonium chloride (a salt). The upper point is based on the boiling point of water, designated as  $212^{\circ}$  to maintain the original magnitude of a Fahrenheit degree, whereas the melting point of ice is designated as  $32^{\circ}$ .

### The Celsius Scale

The Celsius scale was developed in 1742 by the Swedish astronomer Anders Celsius. It is based on the melting and boiling points of water under normal atmospheric conditions. Initially, the Celsius scale used  $0^{\circ}$  in order to denote the boiling point of water and  $100^{\circ}$  in order to denote freezing point of water. These values were later inverted to  $0^{\circ}$  for the freezing point of water and  $100^{\circ}$  for the boiling point of water. Because of 100 divisions, it is also called the centigrade scale.

### The Kelvin Scale

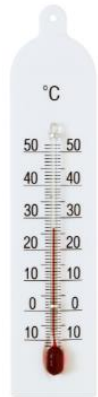
Lord Kelvin, working in Scotland, developed the Kelvin scale in 1848. His scale uses molecular energy to define the extremes of hot and cold. Absolute zero, or 0 K, corresponds to the point at which molecular energy is at a minimum. The Kelvin scale is preferred in scientific work, although the Celsius scale is also commonly used. Temperatures measured on the Kelvin scale are reported simply as K, not  $^{\circ}\text{K}$ .



## How a Thermometer Works

When you look at a regular thermometer, you'll see a thin red or silver line that grows longer when it is hotter. The line goes down in cold weather.

This liquid is sometimes colored alcohol but can also be a metallic liquid called mercury. Both mercury and alcohol grow bigger when heated and smaller when cooled. Inside the glass tube of a thermometer, the liquid has no place to go but up when the temperature is hot and down when the temperature is cold.



**Unit 3 Melting Points / Unit 4 The Case of the Disappearing Snowman****Melting and Freezing Point**

How can the melting and freezing temperatures be the same? The melting point and freezing point are the same temperature for any particular substance: 32°F (0°C) for water. This temperature is referred to as the melting point when temperatures rise above 32°F (0°C), causing ice to melt and change state from a solid to a liquid (water), as happened with the cup of crushed ice at room temperature. It is referred to as the freezing point when temperatures decrease below 32°F (0°C), causing water to change state from a liquid to a solid (ice).

**What Is The Best Weather For Building A Snowman?**

Building the perfect snowman begins with snow that packs together nicely. If the snow is too dry, it won't hold together and falls apart. If it's too wet, you have slush. How do we identify the best weather for building a snowman?

The ideal temperature for snowman construction is 30 degrees Fahrenheit (–1 degrees Celsius). At that point, the snow has only a little moisture in it but is still soft enough to shape. If it's too cold, the snow will be too powdery to form correctly. It's at this temperature that we find snowflakes called stellar dendrites. These classically branching snowflakes provide the right surface size, structure, and moisture to bind with ease.



## Unit 5 Wet and Dry / Unit 6 Hot and Humid

### Too Little Humidity

When the humidity in your home is too low, the effects can cause health issues, such as bloody noses, increased static electricity, dry skin and lips, scratchy throats and noses, lung and sinus problems, respiratory issues, and increased chance of colds. Low humidity also affects your body temperature, producing a cold feeling all over even when the thermostat is set high. Viruses and bacteria will thrive and can cause repeated health issues for you and your family.

Low humidity causes wood floors and furnishings to shrink and separate. The wallpaper on your walls may peel around the edges and loosen, and mold may grow behind the damaged wallpaper. The environment in your home becomes compromised when your humidity levels are too low.

### Too Much Humidity

High humidity levels are more likely in warm air, because it can hold more water at higher temperatures. If the air in your home is warm, it will also have the capacity to hold a lot of moisture. A home with high humidity levels will exhibit problems with excess condensation on windows, wet spots or stains on walls and ceilings, musty smells, and mold in bathrooms and other high-moisture areas. High humidity is the leading cause of mold and mildew growth in a home, causing health concerns such as increased asthma and allergy problems.

A home with too much humidity combined with high temperatures can lead to heat stroke, especially for those with heart problems. The structure of your home can become compromised by too much humidity.

## Unit 7 Heat Transfer / Unit 8 Insulating Ice

### The Three Types of Heat Transfer

**Conduction** is heat flux through solid materials.

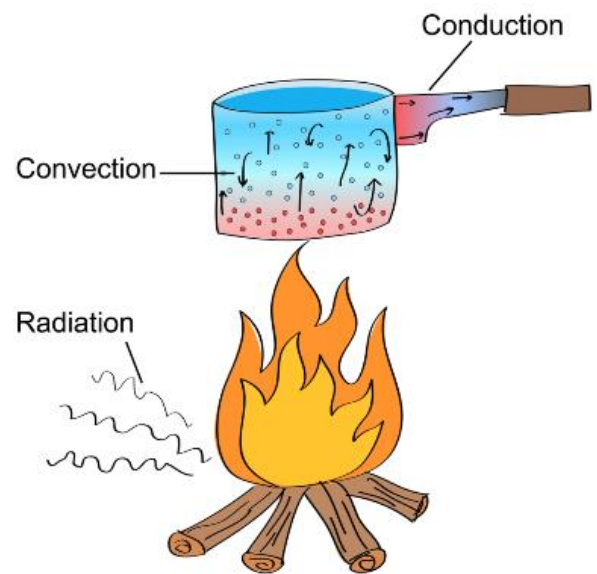
- Touching a hot cup of coffee

**Convection** is heat flux through liquids and gases.

- Feeling much colder when it is windy
- Feeling much colder in water of 25°C than in air of 25°C

**Radiation** is heat flux through electromagnetic waves.

- Feeling hot when standing close to fire
- Measurement of solar power



### How Does an Igloo Work?

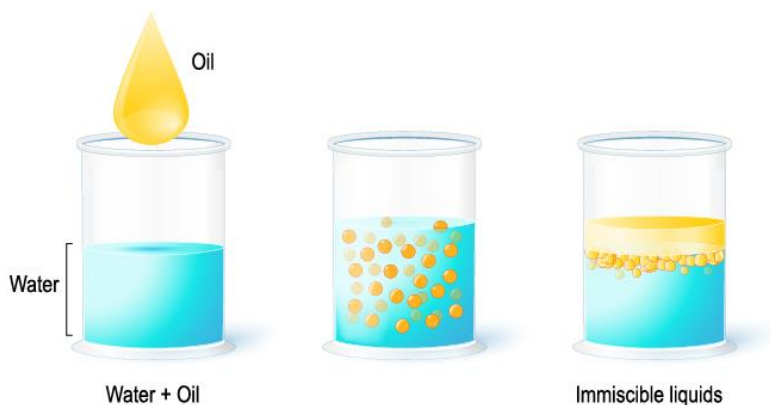
Igloos are built from compressed snow, and it has amazing insulating properties. It is a popular shelter-building material for hibernating animals as well as humans, creatures like bears and raccoons.

Also, an igloo floor is never just flat like the inside of a tent. It's cut into terraces which create an upper level for sleeping, a middle level for the fire and a lower level used as a cold sink. Heavy cold air, which naturally falls, collects on the floor – ideally near the door - and stays there. And warm air, which is lighter and naturally rises, stays in the parts of the igloo people use the most, including the area they sleep in.

## Unit 9 Dissolving Substances / Unit 10 Solvents and Solutes

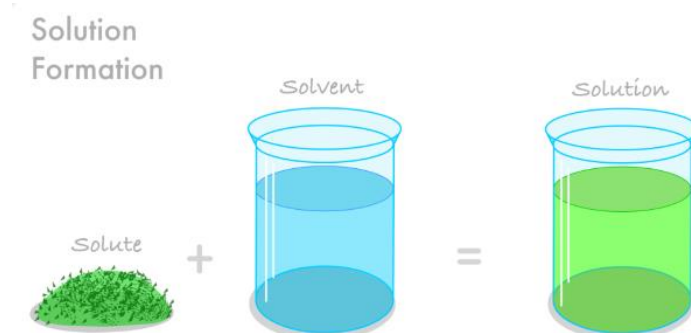
### Density and Dissolution

When two liquids combine to form a solution, they are called "miscible." If they can't be combined, they are called "immiscible." One example of this is oil and water, which is the basis of the proverb, "Oil and water don't mix." If you try to mix water and oil, the oil always floats to the top because it is less dense than water, and those oil droplets will never dissolve in water.



### Saturation and Dissolution

A solute that normally dissolves in water, like sugar or salt, won't continue to dissolve once it reaches saturation point. This is when the maximum amount of the solute has been dissolved into the water. The solution is at equilibrium, as the rate of dissolution and the rate of reforming the solid solute are equal. If you add more solute, the concentration of the solution won't change. You will simply get an accumulation of undissolved solid at the bottom of the solution.



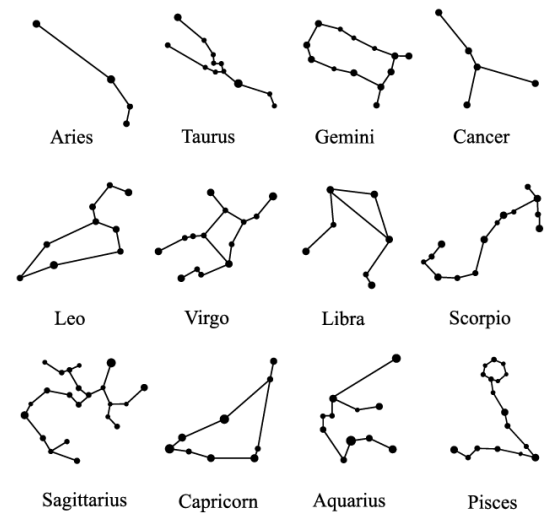
## Unit 11 All the Stars in the Sky / Unit 12 Orion and the Big Dipper

### Zodiac Constellations

Zodiac constellations are constellations that lie along the plane of the ecliptic. The ecliptic, or the apparent path of the Sun, is defined by the circular path of the Sun across the sky, as seen from Earth. In other words, the Sun appears to pass through these constellations over the course of a year.

### How many zodiac constellations are there?

There are 12 constellations in the zodiac family. They can all be seen along the ecliptic. They are: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius and Pisces.



### Constellation uses throughout history

The first use of the stars was most likely religious. People believed that their gods and goddesses lived in heaven and had created the stars. Many cultures thought that the positions of the stars were the gods' way of telling them stories. It would have seemed normal to these people to recognize the patterns, give them names and tell stories about them.

A more practical use of constellations was for agriculture. Before calendars were invented farmers relied on the stars to determine when to sow and harvest their crops. Constellations made the patterns of the stars easy to remember. Ancient farmers knew that when, for example, the constellation Orion was fully visible that winter was coming soon. Constellations allowed farmers to plan ahead.

Constellations were also used by people who were travelling long distances by ship as a navigation tool. Constellations allowed people to determine their latitude as well as which direction was north, south, east or west. This allowed ships to travel across the globe easier.

## Unit 13 Water in the Air / Unit 14 Steaming Hot Soup

**Dew** is water in the form of droplets that appears on thin, exposed objects in the morning or evening due to condensation. As the exposed surface cools by radiating its heat, atmospheric moisture condenses at a rate greater than that at which it can evaporate, resulting in the formation of water droplets. When temperatures are low enough, dew takes the form of ice; this form is called frost. Because dew is related to the temperature of surfaces, in late summer it forms most easily on surfaces that are not warmed by conducted heat from deep ground, such as grass, leaves, railings, car roofs, and bridges.

**Fog** is tiny water droplets or ice crystals suspended in the air at or near the Earth's surface. Fog can be considered as a type of low-lying cloud, usually resembling stratus, and is heavily influenced by nearby bodies of water, topography, and wind conditions. In turn, fog has affected many human activities, such as shipping, travel, and warfare.

**Steam** is generated when water is heated to boiling point, above 100° centigrade. When steam is very hot, it is invisible. If you boil some water you will notice that just above the bubbling water you can see nothing. As the steam rises it cools, condenses and becomes visible again like white smoke. The water vapor in steam is different to that in clouds because it is hot and not mixed with air. Steam will condense after contact with cooler air or cooler objects. The water molecules, which were separated because of the heat, join together again as the steam condenses to form tiny droplets of water that are visible. If water is boiled with other substances mixed in it, for example alcohol, then the steam may contain some of these other substances.



## Unit 15 Aerospace Engineers

Today we largely take international air travel for granted. Every major city in the world is little more than a hop, skip, and jump away. But what was it actually like to fly halfway around the world in the 1930s, when the very concept was still novel?

### Flying in Style

Nearly 50,000 people would fly Imperial Airways from 1930 until 1939. But these passengers paid incredibly high prices to hop around the world. The longest flights could span over 12,000 miles and cost as much as \$20,000 when adjusted for inflation.

A flight from London to Brisbane, Australia, for instance, (the longest route available in 1938) took 11 days and included over two dozen scheduled stops. Today, people can make that journey in just 22 hours, with a single layover in Hong Kong, and pay less than \$2,000 for a round trip ticket.

### London to Singapore—in Just 8 Days!

Air travel was an incredibly grueling way to get from Point A to Point B. Thanks to new planes, the expansion of air routes throughout the British Empire would happen relatively quickly in the early 1930s. By early 1932 there was service to Cape Town, South Africa. By the summer of 1933, Imperial Airways flights were reaching Calcutta, India. And by 1934 there was regular service to Australia.

The 8,458 mile trek took 8 days and according to historian Lucy Budd, included stops in Paris, Brindisi, Athens, Alexandria, Cairo, Gaza, Baghdad, Basra, Kuwait, Bahrain, Sharjah, Gwadar, Karachi, Jodhpur, Delhi, Cawnpore, Allabad, Calcutta, Akgats, Rangoon, Bangkok and Alor Star. That's exhausting enough to read, much less to experience. But it was still the fastest way to get from London to Singapore in the 1930s, even accounting for the fairly common occurrence of emergency landings.

## Unit 16 3D Printing

### 5 Materials for 3D Printing

1. **Nylon** is the most common plastic material. It is a well-known 3D printing filament because of its flexibility, durability, low friction and corrosion resistance. Nylon is also a popular material used in manufacturing of clothes and accessories.

2. **Stainless steel** is printed by fusion or laser sintering. There are two possible technologies that can be used for this material. It can be DMLS or SLM technologies. Since stainless steel is all about strength and detail, it is perfect to use for miniatures, bolts and key chains.

3. Today, it is possible to 3D print using **gold and silver**. These filaments are sturdy materials and are processed in powder form. These materials are generally used in the jewelry sector. These metals use the DMLS (Direct Metal Laser Sintering) or SLM process for printing.

4. **Titanium** is the strongest and the lightest material for 3D printing. It is used in the process called Direct Metal Laser Sintering. This metal is mainly used in high-tech fields such as space exploration, aeronautics and medical field.

5. **Ceramics** is one of the newest material that is used in 3D printing. It is more durable than metal and plastic since it can withstand extreme heat and pressure without even breaking or warping it. Moreover, this type of material is not prone to corrosion like other metals or wears away like plastics do.