Science 7/8 Unit C: Heat In The Environment

Textbook chapters: Pearson 7, Ch 10, 11, 12

Big Ideas to take away from this unit:

- Heat is a form of energy that can be transferred and transformed. These processes can be explained using the particle theory of matter.
- There are many sources of heat.
- Heat has both positive and negative effects on the environment.

Overall Expectations to compare your knowledge an understanding to as we go through the unit:

1. Assess the costs and benefits of technologies that reduce heat loss or heat-related impacts on the environment.
2. Investigate ways in which heat changes substances, and describe how heat is transferred.
3. Demonstrate an understanding of heat as a form of energy that is associated with the movement of particles and is essential to many processes within Earth's systems.

Sub-unit: Heat Causes changes in solids, liquids, and gases (changes of state and heat transfer)

Energy is the ability to make objects move. There are many forms of energy:

- Thermal energy: Total energy of the moving particles in a solid, liquid, or gas.
- Chemical energy: Energy stored in matter such as food, fuels, and clothing.
- Magnetic energy (magnetism): Energy that causes some types of metal, such as iron, to attract or repel from other metals.
- Light energy: energy that is visible to the human eye.
- Gravitational energy: stored energy an object has when it is above the Earth's surface, or another defined "zero" point. This type of energy is relative.
- Nuclear energy: stored energy at the centre of particles of matter. Nuclear power plants produce electricity from nuclear energy.
- Electrical energy (electricity): energy of electrons moving through an object (eg. A wire or device).
- Elastic energy: energy stored in objects that are stretched, compressed, bent, or twisted.
- Sound energy: energy created from oscillatory (repeated) vibrations in air particles.
- Mechanical energy: energy of objects in motion.

Class discussion: *Which of the 10 listed types of energy are kinetic? Potential? Identify the forms of energy used and produced when:*

1. *You prepare a meal using a natural gas stove.*
2. *Play the violin.*

Energy can be changed from one form to another. This is called an **energy transformation**.

Lab D6

Temperature is a measurement of the average energy of the moving particles of a solid, liquid or a gas.

Heat is the thermal energy transferred from an area of higher temperature to an area of lower temperature.

We use a **thermometer** to measure the temperature of solids, liquids, and gases.

Heat transfer can raise the temperature of a solid, liquid, or gas.

One major source of heat is the burning of **fossil fuels,** such as oil, natural gas, and coal. These fuels come from underground, and were formed millions of years ago from the remains of plants and animals. These are **non-renewable energy sources**.

Renewable energy sources is one that can be re-used or replaced, such as solar, wind, and hydro.

Not all heat is produced on purpose, and so there may be the production of **waste heat** (ex, light bulb, etc).

Lab D10

The **states of matter** are solid, liquid, and gas. Examples of **change of state** include melting, evaporation, condensation, freezing, sublimation, and deposition (Fig.10.20 pg. 295).

The **particle theory** describes how particles of solids, liquids, and gases move and explains how matter can change from one state to another. The particle theory also explains the expansion and contraction of solids, liquids, and gases. (Fig 10.21, pg 296).

Heat causes particles to move faster on average.

Lab D13

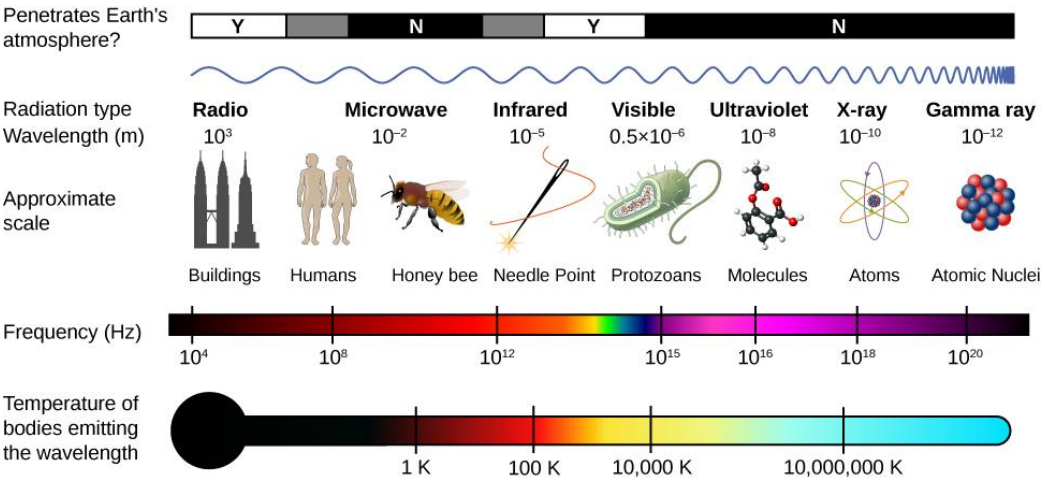
Heat is transmitted through the environment by conduction, convection, and radiation.

Conduction is the transfer of heat through a solid or between a solid and another solid, liquid, or gas that is touching. (ex?)

Convection is the transfer of heat through a fluid (liquid or gas) by moving particles. (ex? Fig 10.32 pg. 303) The circular pattern of moving particles within fluids is called a **convection current.**

Class discussion D17

Radiation is the transfer of heat in the form of waves, namely **infrared waves**, which are at the lower fringe of the visible light spectrum. Smooth, shiny, and/or light coloured surfaces reflect infrared waves while rough, matte, and/or dark coloured surfaces tend to absorb them more efficiently (ex?).



Lab D18, D19

Heat plays an important role in nature (weather and Earth's atmosphere)

The **atmosphere** is the blanket of gases surrounding Earth. The composition of the Earth's atmosphere includes: **nitrogen** (78%), **oxygen** (21%), **argon** (1%), and then trace amounts of **carbon dioxide**, neon, helium, methane, krypton, hydrogen, nitrous oxide, xenon, ozone, iodine, carbon monoxide, and ammonia. Lower altitudes also have quantities of water vapor, dirt, and dust.

The atmosphere has 5 layers:

1. Troposphere: 0-20km. Humans live in the troposphere, and almost all **weather** , or the conditions of the Earth's atmosphere at a particular time and place, occurs here. The study of weather is **meteorology.** Temperatures range from ~15degC - -51degC.
2. Stratosphere: 20-50km. The ozone layer is in the stratosphere, and deflects significant amounts of UV radiation. Temperatures range from -51degC - -3degC.
3. Mesosphere: 50-85km. Most meteors from space burn up in this atmosphere (due to…?). Temperatures range from -3degC - -90degC.
4. Thermosphere: 85-690km. Also called the upper atmosphere. The ISS orbits in this layer. The layer between the thermosphere and the mesosphere is called the mesopause, and the layer between the thermosphere and the exosphere is the thermopause. Temperatures range from -90degC – 2000degC.
5. Exosphere: 690-10,000km. Satellites orbit Earth in this layer, and fast moving particles will escape to space. The temperature in the exosphere increases from 2000degC before dropping back to the temperature of outer space at the fringes (-270degC).

Weather on Earth depends on the heat transfer from the Sun. (Fig. 11.7, pg 319)

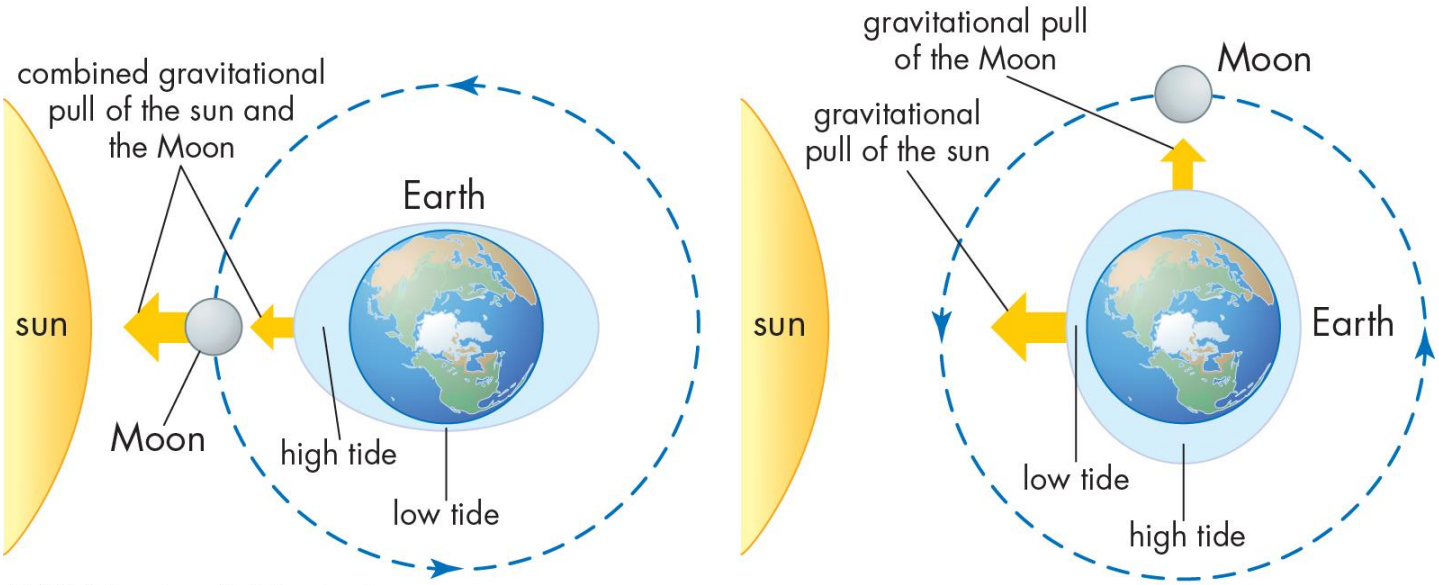
Human activities depend on the atmosphere. (why?)

Lab D26

Water is continuously moving and changing states in nature.

Heat creates the water cycle and affects weather. (Fig. 11.12, pg. 323, 11.13 pg 324). Since the Earth is a sphere, sunlight hits different latitudes at different angles and thus transfers the same amount of heat over a larger area, resulting in more heat per unit area near the equator and less at the poles. Since air travels from hot to cold (why?), there is a continuous movement of air – called **wind**. Warm air rises, and draws in cold air underneath, which begins a convection current.

Ocean currents are patterns of movement of the water in a large region of the ocean. The contribute to the movement of thermal energy from the warm regions near the equator to the cooler regions at the poles. The patterns of ocean currents contribute to the **climate,** or the long-term weather conditions over large areas of Earth. (Fig. 11.14, pg. 325). Ocean currents flow in convection patterns that depend on wind, dissolved minerals, shape of the ocean floor, heat from the Sun, lunar tides, and solar tides. (Catagories of ocean currents, Table 11.4 pg 326)



The result of air and ocean currents is wind and storms in the troposphere. String winds may produce **hurricanes**, a strong, spinning weather system over the ocean that has continuous winds exceeding 119km/h that form and grow stronger as they pick up heat from warm ocean water, or **tornadoes**, which are strong, spinning columns of air in contact with the ground and are typically unpredictable, local, and short-lived.

Earth is made of several layers. (Fig. 11.26 pg 331)

Many of Earth's features were and are formed by heat. The Earth's crust is constantly changing, and the three types of heat transfer all play a part. Conduction occurs in the solid inner core, and convection occurs due to the difference in temperature in the molten outer core and deep mantle through the molten rock beneath the surface, or **magma**. Magma then rises towards the top of the mantle and continues it's circular motion by moving sideways, and heat is transferred via conduction and radiation to the crust. (Fig. 11.27, pg.332)

The Earth's crust sits on large, thick sections called **plates**, which can move apart or together. This movement can allow magma, ash, and gas to shoot up through the crust as an eruption of a **volcano**. The sliding of the plates can also produce shaking in the crust, also known as an **earthquake**. When magma is released up through the crust, it becomes **lava**, and as it cools, forms new crust. (Fig. 11.28, pg. 333).

There are 3 types of rocks that we find on the crust of the Earth:

1. **Igneous rock** forms from lava that has cooled and hardened. They can contain large crystals (if they cool slowly) or small crystals (if they cool quickly) (ex of these scenarios?), or no crystals at all. Examples include Obsidian and pumice from lava, and granite from magma.
2. **Sedimentary rock** forms from small pieces of rock and other materials that pile up in layers. The bottom layers pack together as more and more material is pushed down, and eventually harden into sedimentary rock. Examples include sandstone, limestone, and shale.
3. **Metamorphic rock** is formed from sedimentary or igneous rocks that have been heated and changed from their original state. (Table 11.5, pg.334)

The ways minerals in rocks are arranged and the sizes of the crystals give clues as to how the rocks formed. A **mineral** is a pure, solid compound that occurs naturally. There are over 5000 recognized minerals! **Gemstones** are minerals that have exceptional beauty, colour, or rarity. Their main physical properties are colour, lustre, hardness, and how light passes through it (transparent, translucent, opaque, scattering).

Class discussion: D34

The rock cycle helps us understand how heat causes changes in Earth. The **rock cycle** is a repeating pattern in which one family of rocks changes into a different family. (Fig. 11.32, pg 335). **Weathering** is the wearing away of rock due to water, wind, chemicals, or biological systems, and **erosion** is the breakdown and movement of rocks and soil by wind, water, or ice.

Lab D35, D36

Sub-unit: Heat technologies offer benefits and require choices (How to handle heat transfer)

Lab D39

Heat is often released to the environment when energy is transformed. Any device the transforms energy from one form to another is called an **energy converter**.

Producing energy can release heat and gases into the environment, and all types of power plants have hidden costs (ex – coal, oil, hydro, nuclear, solar, wind).

Class discussion D41 + "what types of hidden costs" to #4

Additionally, there are a lot of factories in Ontario that produce a lot of heat. To cool down factories, hot air may be released and fresh air brought in with fans, an air conditioning system may be used, and/or cooling by pumping cold water in to absorb heat and then releasing the hot water back into the environment.

Heat pollution of land, water, and the atmosphere affects the environment. **Heat pollution** is the heat added to the environment from human activities, and causes negative effects on an ecosystem. Heat pollution can have unintended consequences, such as reduced oxygen in water (why?).

A **heat** island is a region that has higher air and surface temperatures than its surroundings. The temperature difference is usually greater at night than during the day, and greater in winter than in summer. Heat islands influence local weather conditions (fig. 12.13, pg 351) (why?). What are some attributes that affect how much heat islands increase temperature?

Green house gases are gases in the atmosphere that trap heat, such as water vapour, carbon dioxide, methane, and nitrogen oxides. The **natural greenhouse effect** is the natural range of temperatures that Earth experiences due to greenhouse gases. Without any of these gases, the average temperature on Earth would be about 16 degC colder – so we do need them! However, human activities release gases that contribute to global warming through the **enhanced greenhouse effect,** which is the build up of higher-than-normal greenhouse gases in the atmosphere. (Table 12.1, pg 355)

Climate changes are occurring in the environment in part due to the enhanced greenhouse effect. There is a worldwide average increase of Earth's atmosphere, land, and oceans, and this trend is called **global warming**. What are some of the consequences we've discussed that relate to high temperatures?

Class discussion: D47 + What are we doing and what needs to be done?

Lab D46

The wise use of heat and other forms of energy helps the environment. Types of energy production that don't release greenhouse gases include:

- **Wind energy**

- **Solar energy**
- **Geothermal energy**
- **Tidal energy**
- **Biofuels** ex. Ethanol an biodiesel. Ethanol is made from wheat in the prairies as well as from corn in central Canada.

Class discussion: Energy use in Canada (pg.360)

Global warming is causing major changes in the climates of various regions on Earth, also known as **climate change.** This includes changes in wind patterns, average temperature, precipitation, and the number and strength of extreme weather conditions such as floods and hurricanes. (Fig. 12.25, pg.361)

Unit project: pg. 362-364 + D51