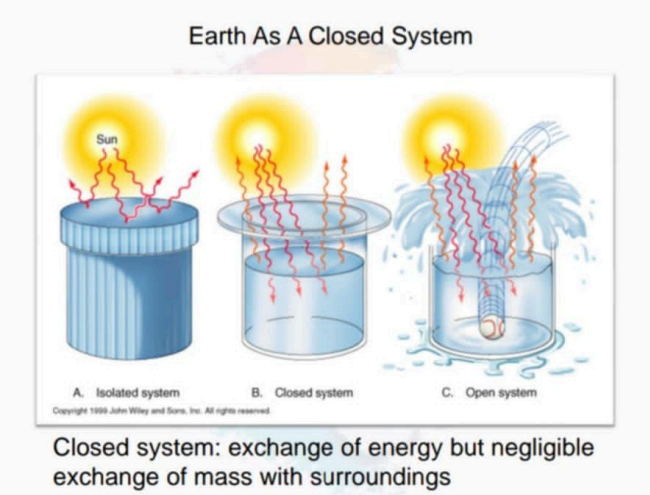
EARTH SCIENCE
2nd Quarterly Assessment

Types of Exam: Multiple choice, True/False, Identification

L1: EARTH AS A SYSTEM

Earth Systems Science - studies the flow of matter and energy in and out of the Earth's open subsystems, or Spheres
System - set of interconnected components that are interacting to form a unified whole
Subsystem - group of interconnected and interactive parts that performs an important task as a component of a larger system



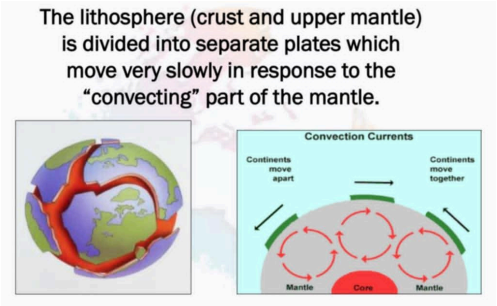
Closed system: exchange of energy but negligible exchange of mass with surroundings

Examples:
OPEN SYSTEM: Stovetop (energy and matter can pass through)
CLOSED SYSTEM: Earth (energy can pass through but mass cannot)
ISOLATED SYSTEM: Thermos (neither energy nor matter can pass)

EARTH'S SUBSYSTEMS

1. LITHOSPHERE (cont.)
- "geosphere"
- comprises the solid Earth and includes both Earth's surface and the various layers of its interior
- it is not static, but its surface (crust) is in a constant state of motion

PLATE TECTONIC THEORY - proposes that the lithosphere is divided into major plate and smaller plates resting upon the soft layer called asthenosphere



ALFRED WEGENER - proposed the concept of Pangaea; it is believed that the continent were all locked up into a huge landmass
PANGAEA - this supercontinent broke apart and gradually drifted to their present position
DYK: the plates drift sideways at the rate of 12 cm per year.

2. ATMOSPHERE - gaseous envelope that surround the Earth and constitutes the transition between its and the vacuum of space

LAYERS of the ATMOSPHERE:

1. *TROPOSPHERE* - lowest and thinnest layer; 90% of the atmosphere's mass; where weather occurs
2. STRATOSPHERE - extends from 10km to 50km above ground; less dense (less water vapor); almost no weather occurrence
3. MESOSPHERE - extends to almost 80 km high; gases are less dense; gases in this layer absorb very little UV radiation
4. THERMOSPHERE - extends to almost 600 km high; readily absorbs solar radiation; reflects radio waves
5. EXOSPHERE - atoms and molecules can escape to space

STRATOSPHERIC OZONE is GOOD ozone - protects Earth form harmful UV radiation; depletion is dtrimental to life
TROPOSPHERIC OZONE is BAD ozone - in the troposhere, ozone is a pollutant (CFCs)

3. HYDROSPHERE - includes all water on or near the Earth's surface; can be classified into two:

- **SALTWATER**
  - 97.2% of all the water on Earth is found in oceans
  - only 2.8% of the Earth's water is freshwater
  - only 0.8% is drinkable

- **FRESHWATER**
  - 2.8% is divided into:
    - Glaciers & Ice Caps = 2.15%
    - Groundwater = 0.62%
    - Surface Water = 0.03%

WATER CYCLE - water constantly moves among the oceans, the atmosphere, the solid Earth, and the biosphere

4. BIOSPHERE - "life zone" of the Earth; includes all living organisms (inc humans), and all organic matter that has not yet decomposed

BIOMES:

TERRESTRIAL BIOMES
- Tropical Rainforest
- Grassland
- Desert
- Temperate Forests
- Taiga
- Tundra

AQUATIC BIOMES
- Freshwater
  - Rivers & Streams
  - Lakes & Ponds
- Saltwater
  - Ocean & Estuaries
  - Seashores (tidal areas)

L2: EXOGENIC PROCESSES

EXOGENIC PROCESS
- external processes that occur at or near the surface of Earth
- part of the rock cycle
- responsible for transforming rocks into sediments

DEGRADATION PROCESSES

1. WEATHERING - physical breakdown and/or chemical alteration of rocks at or near the Earth's surface; does not involve movement of materials

- ***MECHANICAL WEATHERING*** - breaking up of large rocks into smaller fragments w/o changing the rock's mineral composition

☐ **FROST WEDGING** - when water gets inside the joints, alternate freezing and thawing episodes pry the rock apart.

☐ **SALT CRYSTAL GROWTH** - force exerted by salt crystal tha tformed as water evaporates from pore spaces or cracks in rocks can cause the rock to fall apart

☐ **ABRASION** - Wearing away of rocks by constant collision of loose particles

☐ **BIOLOGICAL ACTIVITY** - plants and animals as agents of mechanical weathering

- ***CHEMICAL WEATHERING*** - decomposes rocks through chemical change

- ☐ **DISSOLUTION** - dissociation of molecules into ions; dissolution of calcite and salt

- ☐ **OXIDATION** - reaction between mineral and oxygen dissolved in water

- ☐ **HYDROLYSIS** - change in the ocmpositon of mineral when they react with water

FACTORS that affect the rate of Weathering:

1. CLIMATE - areas that are cold tend to have slow rates of CW and weathering is mostly physical; CW is most active in areas w/ high temp. and rainfall

2. ROCK TYPE - minerals that constitute rocks have different susceptibles to weathering; those that are most stable to surface conditions will be th emost resistant to weathering

3. ROCK STRUCTURE - Weathering rate is influenced by joints, folds, faults, and bedding planes, with highly-jointed/fractured rocks disintegrating faster than solid rock masses of the same dimension.

4. TOPOGRAPHY - weathering occurs more quickly on a steep slope than on a gentle one

5. TIME - length of exposure to agents of weather determines the degree of weathering

2. EROSION - transporting weathered sediments by agents of erosion to diff places

AGENTS OF EROSION:

- ***WATER EROSION*** - running water is the primary source of erosion; most running water is found in rivers and streams.
- ***GLACIER EROSION***
  - ❖ PLUCKING - fractured bedrocks are incorporated into ice
  - ❖ ABRASION - when ice and its load of rock fragments slide over a bedrock
- ***WIND EROSION*** - wind carries dust, sand, & volcanic ash from one place to another; strong wind wears away soft rocks, and polishers rocks and cliffs until they are smooth.

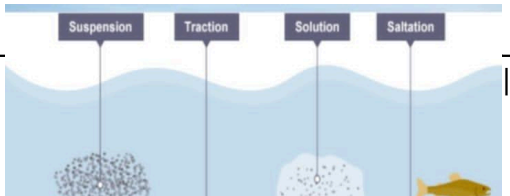
3. MASS WASTING - mass movement of rocks, soil, and regolith; driving force is gravity; step the follows weathering

TYPES:

- ***ROCK FALLS*** - a piece of rock or mass of rocks becomes dislodged and makes free-fall along a steep cliff.
- ***DEBRIS FALLS*** - involves a mixture of soil regolith, vegetation, and rocks; TALUS - accumulation of fallen materials.
- ***LANDSLIDES*** - sudden fast movement of cohesive mass of soil, rock, or regolith
  - ❖ **TRANSLATIONAL SLIDES** - movement of a mass material along a well-defined surface (bedding plane, foliation surface or joint surface)
  - ❖ **ROTATIONAL SLIDES** - descending materials move along a concave, upward curved surface
- ***FLOWS***
  - ❖ **SLURRY FLOWS** - mixture of rocks and/or regolith with 20% to 40% water; water-saturated flows.
  - ❖ **GRANULAR FLOWS** - 0% to 20% water; not saturated w/ water

4. TRANSPORTATION - materials are transported in four distinct ways:

- **SOLUTION** - materials and minerals are described in water and carried along by water
- **SUSPENSION** - suspended particles are carried by a medium (Air, Water, Ice)
- **TRACTION** - particles move by rolling, sliding, and shuffling along eroded surface; occur in all erosional agents
- **SALTATION** - particles move from the surface to the medium in quick repeated cycles



5. DEPOSITION - aggradation or accumulation of weathered sediments to create different landforms.

L3: ENDOGENIC PROCESSES

ENDOGENIC PROCESSES
- geological processes that is formed, originated and located below the surface of the earth
- inc. tectonic movement, magmatism, folding and faulting
- internal processes that takes place mainly due to HEAT and PRESSURE

THE STRUCTURE OF THE EARTH AND PLATE TECTONICS

3 MAIN LAYERS: CORE, MANTLE, CRUST

CRUST
- where we live
  - ***CONTINENTAL CRUST*** - thick (10-70km); buoyant (less dense than oceanic crust); mostly old
  - ***OCEANIC CRUST*** - thin (-7km); dense (sinks under continental crust); young

HOW DO WE KNOW WHAT THE EARTH IS MADE OF?
- Geophysical surveys: seismic, gravity, magnetics, electrical, geodesy, fieldwork, boreholes, mines.
- Acquisition: land, air, sea, satellite

HEAT IN THE INTERIOR OF THE EARTH

SOURCES OF HEAT
- Heat from when the planet formed and accreted
- Heat from decay of radioactive elements
- Frictional heating

INTERNAL TEMPERATURE OF EARTH's INTERIOR
- The mantle and asthenosphere are considerably hotter than the lithosphere, and the core is much hotter than the mantle.
  - Core - mantle boundary: 3700°C
  - Inner core - outer core boundary: 6300°C ±800°C
  - Earth's center: 6400°C ±600°C

EARTH's HEAT DISTRIBUTION
- Conduction
- Convection
- Radiation

MAGMA FORMATION
- crust and mantle are almost entirely solid, indication that magma only forms in special places where pre-existing solid rocks undergo melting.

- ***DECOMPRESSION MELTING*** - decrease in pressure affecting a hot mantle rock at a constant temperature; this process of hot mantle rock rising to shallower depths in the Earth occurs in mantle plumes, beneath rifts and beneath mid-ocean ridges.
- ***FLUX MELTING*** - result of addition of volatiles; volatiles mix w/ hot, dry rock, the volatile decreases the rock's melting point and help break the chemical bonds in the rock to allow melting.
- ***HEAT TRANSFER MELTING*** - rising magma from the mantle brings heat with it that can melt the surrounding rocks at the shallower depths.

Magma Generating Process	Example areas of occurrence
Increase in temperature	Hot spots
Decrease in pressure	Spreading margins
Addition of volatiles	Subduction zones

BOWEN's REACTION SERIES
- explain how minerals are formed under different temperature conditions, given that all the required elements for certain minerals are present.
- single "parental magma" can produce various kinds of igneous rocks through magmatic differentiation.

MAGMATIC DIFFERENTATION - process of creating one or more secondary magmas from single parent magma. (Crystal fractionation, Partial melting, Magma mixing)

CRYSTAL FRACTIONATION

- Chemical process by which the composition of a liquid (magma) changes due to crystallization.
- Common mechanism is crystal settling.
- Denser minerals crystallize first and settle down while the lighter minerals crystallize at the latter stages.

PARTIAL MELTING

- Quartz and muscovite are basically the most stable minerals at the Earth's surface, making them the ones to melt from the parent rock once exposed in higher temperature and/or pressure.

MAGMA MIXING

- May occur when 2 different magma rises up, w/ the more buoyant mass overtakes the more slowly rising body.
- Convective flow then mixes the 2 magmas, generating a single intermediate (bet. 2 parent magmas) magma.

RISE OF MAGMA

DENSITY CONTRAST

- magma is less dense than the surrounding country rock
- Magma rises faster when the density contrast bet. The magma and the country rock is greater

DEEPER LEVELS

- Magma passes through mineral grain boundaries and cracks in the surrounding rock
- When enough mass and buoyancy is attained, the overlying surrounding rock pushed aside as the magma rises
- Depending on surrounding pressure and other factors, the magma can be ejected to the Earth's surface or rise at shallower levels underneath

The rise of magma is dependent of the ff. Factors:

1. DENSITY
2. LEVELS
3. VISCOSITY

SHALLOWER LEVELS

- magma may no longer rise bcs its density is almost the same as that of the country rock
- magma starts to accumulate and slowly solidifies. When the magma solidifies at depth, it can form different types of plutonic bodies.

VISCOSITY - measure of a fluid's resistance to flow
- magmas with low viscosity flow more easily than those with high viscosity
- temperature, silica content and volatile content control the viscosity of magma

Factor	Effect to Viscosity
↑ temperature	↓ viscosity
↑ Silica content (SiO_2)	↑ viscosity
↑ dissolved water (H_2O)	↓ viscosity

TYPES OF MAGMA

1. BASALT AND BASALTIC MAGMA

- form when hot rocks in the mantle slowly rise and encounter lower pressures. This leads to ANdecompression melting.
- has low viscosity, low silica, high iron and low volatile (H2O) contents

2. RHYOLITE AND RHYOLITIC MAGMA

- formed by either:
  - Melting of mantle fluxed by water and sediments carried into the mantle in subduction zones;
  - Interaction of mantle derived basaltic magmas with continental crust
- magma is highly viscous with relatively high silica, low iron and high volatile (H2O) contents

3. ANDESITE AND ANDESITIC MAGMA

- may be formed in a variety of ways:
  - when water and sediments on the ocean floor are pushed into the mantle along subduction zones, leading to melting in the mantle.
  - When hot basaltic magma interact with continental crust on the way to the Earth's surface, which likewise leads to melting
- the silica, iron and volatile (H2O) contents and viscosity are intermediate between basalt and rhyolite