

# PHYS 203 - Exam 1 Notes - Earth in Space

## Week 1 – Introduction to Earth Science (Ch.1)

### Earth Science & Earth System

- Four main spheres:
  - Atmosphere – air, weather
  - Hydrosphere – water, ice
  - Biosphere – plants, animals
  - Geosphere – land, rocks
- Interaction with the exosphere (sun, space).
- Example: 2004 Sumatra earthquake & tsunami demonstrated interactions:
  - Geosphere (earthquake) → Hydrosphere (tsunami waves) → Biosphere (destruction of life) → Atmosphere (air displacement, weather changes).

### What is Science?

- Science is:
  - A process of discovery (not memorization of facts).
  - Driven by curiosity and creativity.
- Case Study: Hutchinson Gas Explosions (2001)
  - Hypothesis: gas migrated underground through fractures.
  - Geologists used prior knowledge to predict gas migration routes.

### Doing Science

- Hypothesis – testable, falsifiable explanation.
- Observations – measurable facts and data.

- Prediction – statement of expected outcome.
- Reasoning:
  - Inductive – general conclusion from specific data.
  - Deductive – specific conclusion from general principle.
- Example:
  - Hurricanes 2005 → Inductive reasoning (low pressure → severe damage).
  - All hurricanes are low pressure → Deductive reasoning.

## Scientific Method Rules

- Hypotheses are tentative, testable, empirical, and must explain natural causes.
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## Week 2 – Earth in Space (Ch.2 & Ch.7.1)

### Old vs. New Views

- Geocentric model – Earth-centered (ancient).
- Heliocentric model – Sun-centered, proposed by Copernicus, confirmed by Galileo's Venus observations.

### Origin of Universe & Solar System

- Earth is a small, rocky planet orbiting the Sun.
- Sun = 99.8% of solar system's mass.
- Solar activity:
  - Differential rotation → sunspots and flares.
  - Solar wind → deflected by Earth's magnetic field.
  - Causes auroras, can disrupt satellites and power grids.

### Planets

- Terrestrial planets – Mercury, Venus, Earth, Mars (rocky, layered).
- Jovian planets – Jupiter, Saturn, Uranus, Neptune (gas giants, rings, moons).

- Pluto reclassified as dwarf planet.

## **Earth, Sun, and Seasons**

- Tilt of Earth's axis ( $23.5^\circ$ ) causes seasons, not distance from Sun.
- Seasonal differences explained by sun angle and daylight duration.

## **Minerals (Intro to Ch.7)**

- Rocks are made of ~20 common minerals.
  - Example: granite contains feldspar, quartz, mica, amphibole.
  - Minerals are naturally occurring, inorganic, with orderly internal structures.
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## **Week 3 – Rocks & Minerals (Ch.7.2 & Ch.7.3)**

### **Mineral Basics**

- Minerals composed of elements (8 main elements = 98% of crust).
- Bond types:
  - Ionic – weak (e.g., NaCl).
  - Covalent – strong (e.g.,  $\text{SiO}_2$ ).
- Silicate tetrahedron ( $\text{SiO}_4^{4-}$ ) is the most common structure.

### **Mineral Identification**

- Properties: cleavage, hardness, color, luster.
- Examples:
  - Mica → 1 cleavage plane.
  - Feldspar → 2 cleavage planes at  $90^\circ$ .
  - Amphibole → 2 cleavage planes not at  $90^\circ$ .

### **The Rock Cycle**

1. Igneous (cooled magma/lava).

2. Weathering → sediment.
3. Lithification → sedimentary.
4. Heat/pressure → metamorphic.
5. Melting → magma → restart cycle.

## **Sedimentary Rocks**

- Clastic – rock fragments (sandstone, shale, conglomerate).
- Chemical – precipitated from solutions (evaporites like salt, gypsum).
- Biochemical – formed by organisms or remains (limestone, coal, chalk).

## **Metamorphic Rocks**

- Contact metamorphism – from magma heat (limestone → marble).
  - Regional metamorphism – mountain building processes (heat and pressure create foliation).
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# **Week 4 – Plate Tectonics & Mountains (Ch.4 & Ch.6)**

## **Plate Tectonics**

- Replaced older models: contracting Earth → continental drift → plate tectonics.
- Wegener's evidence for drift:
  - Fossils, mountain alignment, continental fit, paleoclimate data.
- Seafloor evidence:
  - Symmetrical rock ages, magnetic stripes, ridges, trenches.

## **Mountains**

- Form at convergent boundaries (crust thickening).
- Himalayas: 70 km thick crust.
- Principle of Isostasy:
  - Mountains "float" like wood on mantle.

- Higher = thicker, less dense crust.
  - Roots beneath mountains balance surface elevation.
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## **Week 5 – Earthquakes (Ch.5)**

### **Faults & Plate Tectonics**

- Fault = fracture where movement occurs.
- Types:
  - Normal → hanging wall moves down.
  - Reverse → hanging wall moves up.
  - Strike-slip → lateral movement (e.g., San Andreas).

### **Earthquake Mechanics**

- Focus = origin point; Epicenter = surface point above.
- Stress builds in rocks, elastic deformation → sudden release = earthquake.
- Recurrence interval: large quakes take hundreds of years, smaller ones less time.

### **Seismic Waves**

- Body waves:
  - P (primary) – compressional, fastest.
  - S (secondary) – shear, slower, cannot move through liquids.
- Surface waves:
  - Rayleigh – vertical ground movement.
  - Love – horizontal, side-to-side motion.
- Surface waves cause most destruction.

### **Measurement**

- Seismograph records → seismograms.

- Magnitude = energy released.
- Intensity = observed damage.

## **Global Distribution**

- Shallow quakes: mid-ocean ridges.
  - Deep quakes: subduction zones (Wadati–Benioff zones).
  - Largest quakes: convergent boundaries (Chile, Japan, Alaska).
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