THE OPEN UNIVERSITY OF TANZANIA

FACULTY OF SCIENCE, TECHNOLOGY AND ENVIRONMENTAL STUDIES

DEPARTMENT OF PHYSICAL SCIENCES

OPH 411: APPLIED EARTH PHYSICS

INSTRUCTIONS:

- Answers all questions, showing clearly your arguments on how you arrive at an answer. Information not supplied in this assignment or in the study material can be obtained from other sources.
- Remember to write your **Names**, **Registration number** and **Full address.**
- **Assignment one** should reach the Faculty by **12th December 2008** and **Assignment two** by **27th March 2009**

ASSIGNEMENT I- 2008/2009

Question 1

(a) By using well illustrated examples, present an argument to support the claim that properties of materials are dictated by the structure of those materials.

(b) Give a full account of the filling scheme of the electrons in the atoms of the first 10 elements. Show clearly the relevant quantum numbers, and show that the result is consistent with the placing of these elements in the Periodic Table of the elements.

(c) AuCu3 has a FCC lattice structure. The radius of a copper atom is 0.128 nm, and the radius of a gold atom is 0.144nm. Copper and gold have atomic weights of 63.55 amu and 196.97 amu respectively. Find (i) the lattice parameter of the unit cell, (ii) the atomic mass of the unit cell in grams, and (iii) the density of the compound.

(d) (i) What is the difference between a ductile and a brittle material? Give one example for each.

(ii) Explain in terms of structure and molecular forces why the coefficient of viscosity is different for different liquids under the same temperature conditions. Give appropriate examples to illustrate your answer.

Question 2

(a) Water rises to a height of 10 cm in a certain capillary tube. The level of mercury in the same tube is depressed by 3.42 cm. Compare the surface tensions of water and mercury. Density of mercury is 13.8 g/cm^3 and angle of contact for water and mercury are zero and 135º respectively.

(b) Consider a simplified model of the singly-ionized atom, He +: two protons plus two neutrons in the nucleus, "orbited" by one electron at a constant distance of 2.65×10^{-11} m.

(i) What is the strength/magnitude of the attractive electric force between the nucleus and the electrons?

(ii) What is the strength/magnitude of the attractive gravitational force between the same particles?

(iii) For this nucleus and orbiting electrons, how many times stronger is the electrostatic force in part (i) than the gravitational force in part (ii)? When Chemists deals with the interaction forces between atoms, is it valid for them to consider only electrostatic forces (ionic bonds, dipole interactions Van der Waals forces, etc.) while ignoring gravitational forces?

Question 3

(a) State the four radiation laws and show that Wien's displacement law follows from Planck's law. Explain clearly all the symbols used.

(b) List the factors that influence radiation reaching the earth's surface.

(c) White short notes (*a maximum of 2 pages*) about the hydrological cycle and define what the term "*precipitable water"* mean in this context.

Question 4

The "surfaces" of stars are not sharp boundaries like the surface of the Earth. Most of the radiation that a star emits is in thermal equilibrium with the hot gases that make up the star's outer layers. Without too much error, then, we can treat starlight as cavity radiation. Here are the wavelengths at which the spectral radiances of three stars have their maximum values:

Star	λmax	Appearance
Sirius	240 nm	Blue-white
Sun	500 nm	Yellow
Betelgeuse	850 nm	Red

(i) What are the surface temperatures of these stars?

(ii) What are the radiant intensities of these three stars?

(iii) The radius *r* of the sun is 7.0×10^{8} m and that of Betelgeuse is over 500 times larger (that is 4.0×10^{11} m). What is the total radiated power output of these stars?

Question 5

(a) The density of material increase towards the centre of the earth and at the s,e time the velocity of seismic waved increases towards the centre. Account for the paradox.

(b) Given the elastic constants and density of the following rock types, calculate the seismic velocities and fill the table.

Material	Bulk Modulus (k), 10^9 N/m^2	Shear Modulus (μ), 10^9 N/m^2	Density (ρ), kgm^{-3}	Compression Waves (V_p)	Shear Wave (V_s)
Water	2.2	0.0	1000		
Shale	8.8	17.0	2400		
Limestone	38.0	22.0	2700		

Quartz	33.0	39.0	2700		
Granite	88.0	22.0	2600		
Peridotite	139.0	58.0	3300		

Question 6

(a) Write short notes on first earthquake detection instrument.

(b) If a seismograph station has 3 pendulums, at what orientation are they placed for maximum sensitivity? What four measurements can scientists estimate from this setup?

(c) What are the differences and similarities between tidal waves and tsunamis?

ASSIGNEMENT II- 2008/2009

Question 1

(a) Distinguish between the critical point and the triple point of a substance. By using information available in your study material unit or otherwise, determine the critical constants of the following gases: oxygen, carbon dioxide and helium.

(b) Derive equation 4.31 in your study material (page 123).

(c) Conduction process in real gases can be explained through the kinetic interchange during molecular collision. Why this explanation does not hold for an ideal gas?

(d) A family enters a winter vacation cabin that has been unheated for such a long time that the interior temperature is the same as the outside temperature (0º C). The cabin consists of a single room of floor area 6 m by 4 m and height 3 m. The room contains one 2–kW electrical heater. Assuming that the room is perfect airtight and that all the heat from the electrical heater is absorbed by the air, none escaping through the walls or being absorbed by the furnishings, how long after the heater is turned on will the air temperature reach the comfort level of 21º C?

Question 2

(a) Distinguish between electronic conductivity and ionic conductivity. Discuss the possibility of having ionic conductivity in solids, assuming that the availability of energy is not a limitation.

(b) Show that magnetic behaviors of materials can be explained in terms of the structure of the materials. Illustrate your answer by appropriate examples.

(c) Superconductors are classified as either *Type I* or *Type II*. Write short notes on each type (NB: Do not copy from your provided study material). What are the main differences between the two?

(d) The Behaviour of *Type I* superconductors can be explained by the *BCS Theory*. Summarize the essential components of this theory.

Question 3

(a) Define the terms: (i) renewable energy sources (ii) non-renewable energy sources. Give at least three examples of each. Mention at least two demerits of each type.

(b) Energy released from nuclear reactions is very much larger than that obtained from the process of burning fossil fuel. Briefly explain the reason for these differences from nuclear and atomic points of view.

(c) Explain what a displacement height is and distinguish it from roughness length.

Question 4

(a) By using appropriate boundary conditions derive an equation for the flow of heat in soils. Define clearly all the terms used.

(b) What factors affect the flow of water in soils. Does the temperature of the soil in any way affect the flow of water in the soil?

(c) The temperature at the soil surface is 20°C and at 5 cm depth is 25°C. If the thermal conductivity of the soil is 1.67 W/m K, calculate the amount of heat per unit area that will flow from the surface to the 5 cm depth in 12 hours assuming that the temperature are maintained constant throughout the day. State the direction of the flow.

Question 5

(a) Sketch the zones of the atmosphere to show the position of the ionosphere.

(b) What forces contribute to the ionization?

(c) What is the importance of the ionosphere in radio communication and which layer in the ionosphere is responsible for the reflections of radio waves?

(d) Given the following data for a gravity station:

Latitude: 10º82´S and Longitude33º43´

Elevation: 1521.0 m. Calculate

(i) Theoretical gravity (ii) free air correction (iii) Bouguer correction (iv) Free air correction (v) Free air gravity anomaly and (vi) Bouguer gravity anomaly. Use the average density crustal density.

Question 6

(a) Discuss the importance of the local magnetic field in the study of crustal structure and earth's history.

(b) Explain the concept of isostasy in geophysics and discuss why isostatic equilibrium is likely to be maintained during the erosion of a mountain range but not during the melting of an ice sheet at the end of a recent Ice Age.

(c) Explain hoe the radius of the earth and centripetal forces due to the earth's rotation affect the gravitational acceleration on the surface of the earth.

(d) Magnetic measurements are made on samples A and B of ocean floor basalt obtained from two locations: A - 90°E 41.0°S, B - 90°E 43.5°S. These points are thought to lie north and south respectively of an oceanic spreading ridge. Samples A and B both show a magnetic inclination of 61° but sample A shows normal polarity while B shows reversed polarity. Explain what it meant by magnetic inclination, magnetic polarity reversal and calculate the latitude of the spreading ridge.

&& END &&