

UNIVERSITY OF SWAZILAND
Faculty of Health Sciences

BSC IN ENVIRONMENTAL HEALTH SCIENCE

SECOND SEMESTER FINAL EXAMINATION 2013

TITLE OF PAPER : ENVIRONMENTAL CHEMISTRY

COURSE CODE : EHM104

DURATION : TWO HOURS

MARKS : 100

INSTRUCTIONS :

- : ANSWER ONLY FOUR QUESTIONS
- : EACH QUESTION CARRIES 25 MARKS
- : QUESTIONS ONE, TWO AND THREE ARE COMPULSORY
- : NO QUESTION PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM
- : BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR

QUESTION ONE

1. Evidence for the evolution (origin) of life comes from all of the following except
 - a. Chemical experiments
 - b. Fossils
 - c. Chemical analysis of ancient rocks and samples
 - d. Study of water chemistry
2. The solar system originated about
 - a. 2.6 billion years ago
 - b. 4.6 billion years ago
 - c. 3.6 billion years ago
 - d. 5.6 billion years ago
3. In the earliest period of the earth's life, the solid materials present in its core consisted of
 - a. Fe and alloys of Fe
 - b. Fe and Ca
 - c. Fe and S
 - d. Fe and Mg
4. The mantle and crust was made of
 - a. Oxides and carbonates
 - b. Oxides and sulfates
 - c. Oxides and silicates of metals.
 - d. Silicates and nitrates
5. Very early in the earth's history, water was formed most likely by reactions
 - a. $4\text{H}_2 + \text{CO}_2 \rightarrow 2\text{H}_2\text{O} + \text{CH}_4$
 - b. $\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - c. $2\text{HCl} + \text{ZnO} \rightarrow \text{ZnCl}_2 + \text{H}_2\text{O}$
 - d. $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
6. Which of the following best describe biologists' current hypothesis about the production of the earth's atmospheric oxygen?
 - a. Photosynthesis by terrestrial plants produced atmospheric oxygen
 - b. The breakdown of iron ore deposits produced atmospheric oxygen
 - c. The photosynthesis by cyanobacteria produced atmospheric oxygen
 - d. Chemosynthesis by terrestrial plants produced atmospheric oxygen
7. The gas that is least likely to have formed earth's primitive atmosphere is
 - a. Methane
 - b. Ammonia
 - c. Oxygen
 - d. Water vapor

8. The source of energy that probably contributed least to the synthesis of biological chemicals on primitive earth is
- Ultraviolet light
 - Hydropower
 - Radioactivity
 - Lightning
9. Which of the following explain(s) the origin of organic molecules on earth?
- Formation of organic molecules from gaseous inorganic molecules and an energy source
 - Formation of organic molecules around hydrothermal vents in ocean floor
 - Formation of dust particles in outer space
 - All of these answers
10. Ozone which contributes to the formation of smog is found in the
- troposphere
 - mesosphere
 - thermosphere
 - stratosphere
11. Human health problems closely associated with ozone depletion include all of the following except
- Skin cancer
 - Eye cataracts
 - Increased incidence of heart disease
 - Suppression of the immune response
12. All of the following are volatile organic compounds (VOCs) except
- methane
 - chlorofluorocarbon
 - carbon monoxide
 - benzene
13. All of the following describe soils that are vulnerable to acid deposition except
- thin
 - low in buffering ions
 - acidic
 - high in hydroxyl (OH⁻) ions
14. Asbestos has been used for the following except
- fire proofing
 - insulation of refrigerators
 - insulation of heaters and pipes
 - wall and ceiling decoration

15. Increased greenhouse gases originate from
- Burning fossil fuels
 - Use of CFCs
 - Deforestation
 - All of these answers.
16. The threat to global warming can be addressed by
- Using energy more efficiently
 - Halting deforestation
 - Slowing population growth
 - All of the above
17. Which of the following compounds undergo resonance?
- Benzene
 - Naphthalene
 - Xylenes
 - TNT
18. Which chlorinated biphenyl has an effect of reducing the size of the penis in men and enlarging the size of the vagina in females?
- PCBs
 - PBBs
 - Methyl Phenol
 - DDT
19. Water is a
- Diatomic molecule
 - Triatomic molecule
 - Monatomic molecule
 - Tetratomic molecule
20. The water molecule has a V shape structure with a bond angle of
- 103°
 - 102°
 - 104°
 - 105°
21. Below a temperature of --- degrees, the density of water starts to decrease.
- 0°C
 - 4°C
 - 100°C
 - 3°C

22. Polar molecules attract one another – leading to a
- Dipolar interaction between the +ve region of one molecule and the –ve region of another
 - Tri-polar interaction between the +ve region of one molecule and the –ve region of another
 - Mono-polar interaction between the +ve region of one molecule and the –ve region of another
 - Tetra-polar interaction between the +ve region of one molecule and the –ve region of another
23. Ice that form at 0⁰C, has about --- greater volume and a lower density than water.
- 40%
 - 30%
 - 20%
 - 10%
24. Soil structure controls the size and amount of ---- associated with the aggregates.
- Pores
 - Clay minerals
 - Soil moisture
 - Organic matter
25. Which of the following statements is false?
- CFCs are relatively unreactive compounds
 - CFCs are heavy molecules that will sink in the atmosphere
 - Ultraviolet radiation will cause CFCs to break down and release chlorine
 - One chlorine molecule may convert 100,000 molecules of ozone to molecular oxygen

TOTAL 25 MARKS

QUESTION TWO

For this question, copy the letter of the question on your answer book, and write the correct answer next to the letter.

- Soil is the final product of ----- (1 mark)
- Mention five ecological roles of soil (5 marks)
- When you look at the fine structure of the soil it shows you that soil consists of (i)-----
----- (ii)----- (iii)-----, and (iv)----- (4 marks)
- Typically, between bedrock and soil lies a layer called ----- consisting of ----- (2 marks)
- In as far as plant life and growth is concerned, the most important layer of soil is the -----
----- which consists of (i)----- (ii)-----
----- and (iii)----- (4 marks)

- f. The most common indicator of soil formation from parent rocks consists of -----
- (1 mark)
- g. The reaction $\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Mn}^{2+} + 2\text{H}_2\text{O}$, indicates that the soil is ----- (1
mark)
- h. The two most abundant elements in soil inorganic matter are (i) ----- and (ii)
----- (2 marks)
- i. Organic matter in soil performs the following functions (i) -----, (ii) ----
-----, and (iii) ----- (3 marks).
- j. Two complexing agents produced by fungi in soil are (i) ----- and (ii)
----- (2 marks)

TOTAL 25 MARKS

QUESTION THREE

- a. The most important unique properties of water that largely determine its environmental
chemical behaviour are (i) -----, (ii) -----, (iii) -----
-----, (iv) -----, (v) -----, (vi) -----,
(vii) -----, (viii) ----- (8 marks)
- b. The thermal stratification of water bodies results from water's ----- (1
mark)
- c. The ability of solutes in water to neutralize added strong acids is called ----- and
water hardness is due mostly to the presence of ----- while for water near
neutral pH, the major contributor to alkalinity is ----- (3 marks)
- d. A major pollutant contributor to acidity in water is free mineral acid, manifested by the
presence of ----- (1 mark)
- e. The chemical formula H_3O^+ stands for ----- and can be abbreviated simply as
----- (2 marks)
- f. A bare metal ion cannot exist as separate entity in water, but is present instead as -----
----- (1 mark)
- g. Calcium is present in water as a consequence of ----- (1 mark)
- h. The reaction $2\text{C}_{17}\text{H}_{35}\text{COONa} + \text{Ca}^{2+} \rightarrow \text{Ca}(\text{C}_{17}\text{H}_{33}\text{CO}_2)_{2(s)} + 2\text{Na}$ is a manifestation of ---
----- (1 mark)
- i. Oxidation-reduction reactions in water involve the transfer of ----- and in natural
water, wastewater, and soil are carried out by ----- (2 mark)
- j. The parameter pE is defined as ----- and in a pE-pH diagram for iron
in water, the species that predominates at low pE and low pH is ----- whereas at high
pE and higher pH, it is ----- (3 marks)
- k. A ligand in water bodies bonds to a metal ion to form a ----- (1 mark)
- l. Most of the important chemical phenomena associated with water do not occur in
solution, but rather through ----- (1 mark)

TOTAL 25 MARKS

QUESTION FOUR

- a. The bottom layer of the atmosphere is the -----, extending over an altitude of -----, and the next layer up is the -----, with an altitude range of approximately ----- (4 marks)
- b. The most significant feature of atmospheric chemistry is the occurrence of ----- resulting from the absorption by molecules of -----, designated ----- (3 marks)
- c. Two vital protective functions of the atmosphere are ----- and -----, and it also serves as a source of ----- for plants and ----- for animals and other organisms. (4 marks)
- d. In descending order, the five most abundant gases in the atmosphere are -----, -----, -----, -----, and ----- (5 marks)
- e. Why is it that at very high altitudes, normally reactive species such as atomic oxygen, O, persist for long periods of time? ----- (1 mark).
- f. The fact that hydrogen has not been lost to outer space from Earth's atmosphere is due to the existence of ----- (1 mark)
- g. The existence of the ionosphere is due to the action of ----- under conditions of ----- (2 marks)
- h. Air masses move from regions of ----- to regions of ----- (2 marks)
- i. An atmospheric condition that is particularly important for air pollution and sometimes affected by topography is that of ----- (1 mark)
- j. The values of the dry adiabatic lapse rate and of moist adiabatic lapse rate are ----- and ----- respectively (2 marks)

TOTAL 25 MARKS

QUESTION FIVE

1. Discuss the sources, chemical reactions and environmental effects of the following substances in the atmosphere. Propose one way of controlling each of them.
 - b. Nitrogen oxides (7 marks)
 - c. Sulfur oxides (6 marks)
2. Draw the triatomic molecule of water and explain the origin on water's surface tension. How is this surface tension useful to the human life and other organisms living in water? (12 marks).

TOTAL 25 MARKS