BINDURA UNIVERSITY OF SCIENCE EDUCATION
CHEMISTRY DEPARTMENT

COURSE: CH424 ENVIRONMENTAL CHEMISTRY

AUG 2023

2 HOURS

ANSWER QUESTIONS ONE AND FOUR OTHERS.TWO FROM EACH OF THE SECTIONS, A AND B. EACH QUESTION CARRIES 20 MARKS

1. (a) Define the concept of green chemistry as proposed by Anastas and Warner. [2 marks]

   (b) State the three aims of green chemistry. [3 marks]

   (c) Explain why ozone destruction via the reaction of O_3 with atomic oxygen does not occur to a significant effect in the lower stratosphere. [4 marks]

   (d) Define the term greenhouse effect. [2 marks]

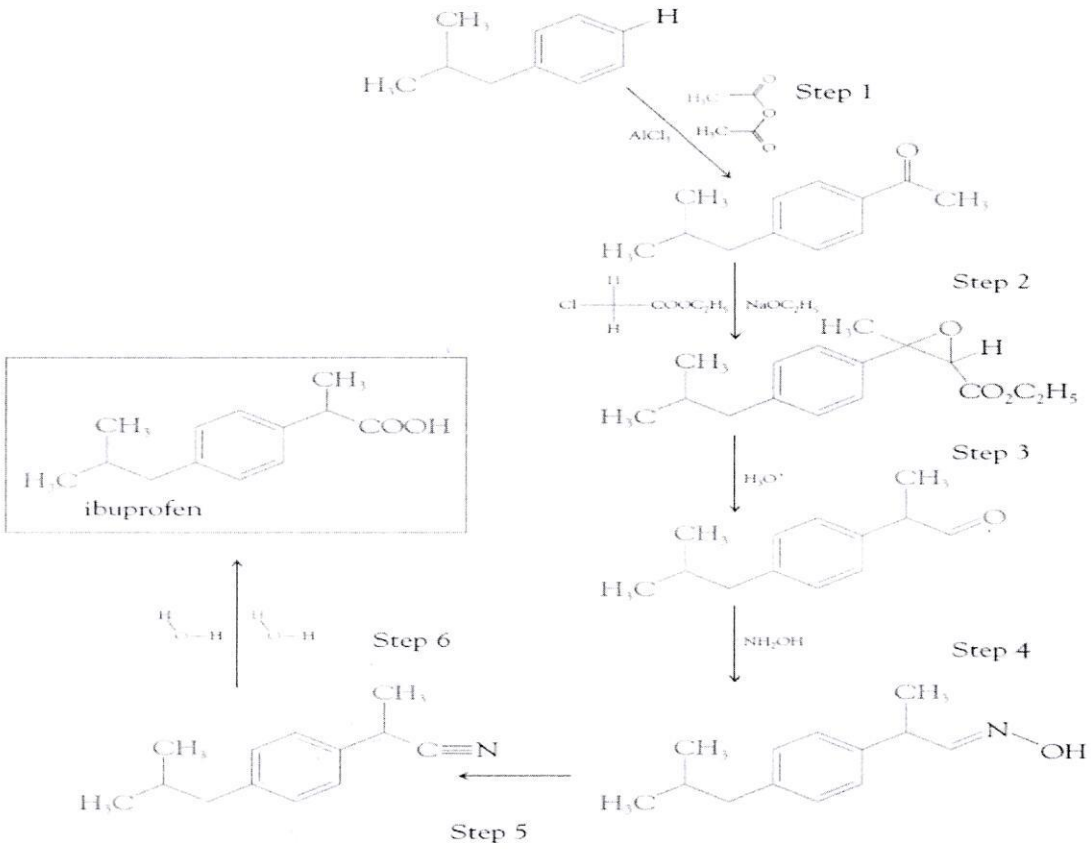
   (e) Other than the rise in temperature, list five signs of global warming caused by the greenhouse effect. [5 marks]

   (f) Define the following terms:
   (i) Biological oxygen demand [2 marks]

   (ii) Chemical oxygen demand [2 marks]

SECTION A: ANSWER TWO QUESTIONS

2. The steps below show the Boots Company synthesis of ibuprofen.



(i) Calculate the % atom economy. [10 marks]

(ii) Comment on the suitability of the method for the synthesis of ibuprofen according to the principles of Green Chemistry. [10 marks]

3. (a) Write two reactions that, aside from the catalyzed reactions, contribute most significantly to ozone destruction in the stratosphere. [4 marks]

(b) A minor route for ozone destruction in the ozone hole involves Mechanism II with bromine as X' and chlorine as X (or vice-versa). The ClO and BrO free radical molecules produced in these processes then collide with each other and rearrange their atoms to eventually yield O_2 and atomic chlorine and bromine.

(i) Write out the mechanism for this process. [6 marks]

(ii) By adding up the steps in (i), determine the overall reaction. [5 marks]

(c) Describe a mechanism by which carbon monoxide is removed from the atmosphere by its reaction with the hydroxyl radical and how the radical is regenerated. [5 marks]

4 (a) No controls on the release of CH_3Cl, CH_2Cl_2, or $CHCl_3$ have been proposed. What does that imply about their atmospheric lifetimes, compared to those for CFCs, CCl_4, and methyl chloroform? [8 marks]

(b) Show that 1 L of water saturated with oxygen at 25 °C is capable of oxidizing 8.2 mg of polymeric CH_2O. [5 marks]

(c) A 25 mL sample of river water was titrated with 0.0010 M $K_2Cr_2O_7$ and required 8.3 mL to reach the end point. What is the chemical oxygen demand, in milligrams of O_2 per liter, of the sample? [7 marks]

SECTION B: ANSWER TWO QUESTIONS

5. (a) (i) Explain the chemistry underlying the disinfection of water by chlorination. [6 marks]

(ii) Discuss the advantages and disadvantages of using chlorination to disinfect water, including the nature of the THM compounds. [6 marks]

(b) (i) What two other chemical methods, other than chlorination, are used to disinfect water? [2 marks]

(ii) What are some advantages and disadvantages to these alternatives? [6 marks]

6. (a) (i) Define the term speciation in chemistry. [2 marks]

(ii) Using mercury as an example, explain the significance of speciation in environmental problems. [6 marks]

(b) What are the main health concerns about arsenic in drinking water? [6 marks]

(c) How does the phenomenon of acid rain indirectly affect the risk to human health from mercury, lead, and cadmium? [6 marks]

7. (a) (i) Name any four pesticides on the United Nations persistent organic pollutants (POP) list. [4 marks]

(ii) Explain why DDT is no longer used in many developed countries. [2 marks]

(b) In what way are organophosphate insecticides considered superior to organochlorines as pesticides? [2 marks]

(c) Other than the chlorophenols and PCBs, what are some of the four sources of dioxins and furans in the environment? [4 marks]

(d) Name the four postulated effects of environmental hormones on human health. [4 marks]

(e) What four ways are used to recycle plastics? [4 marks]

END