Student Name: _____

CHEMISTRY 2024

Unit 4
Key Topic Test 3 – Laboratory analysis of organic compounds

Recommended writing time*: 45 minutes
Total number of marks available: 50 marks

QUESTION BOOK

> * The recommended writing time is a guide to the time students should take to complete this
> test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions
- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners, rulers and a scientific calculator.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 10 pages.

Instructions
- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions

Question 1

The reaction between bromine water and unknown organic chemicals is a test for which functional group?

A. carboxyl

B. hydroxyl

C. alkene

D. alkane

Question 2

A substance is likely to be very pure when:

A. the melting point range is within ±10°C.

B. the melting point range is within ±1.0°C.

C. the melting point range is within ±0.10°C.

D. the melting point range is within ±5°C.

Question 3

Distillation is a commercial separation technique used to purify

mixtures such as bioethanol based on:

A. melting point and is an exothermic process.

B. boiling point and is an exothermic process.

C. density and is an endothermic process.

D. boiling point and is an endothermic process.

Question 4

Volumetric analysis is used to determine the concentration of consumer products. When determining the concentration of iron in breakfast cereal using a standard potassium permanganate solution, which of the following statements is correct?

A. Phenolphthalein is an appropriate indicator as it has an easy to see colour-change.

B. The burette should be rinsed with distilled water prior to titration.

C. The conical flask should be rinsed with the permanganate solution prior to titration.

D. The pipette should be rinsed with the iron solution prior to titration.

Question 5

Which test would most easily distinguish samples of the two molecules shown?
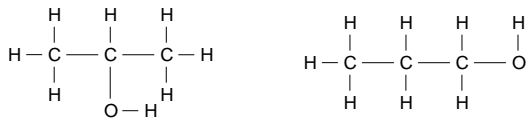
A. Reaction with propanoic acid
B. Solubility in water
C. Reaction with $Cr_2O_7^{2-}$ in acid conditions
D. Reaction with Br_2 spectrum

Question 6

Four common functional groups found in molecules in consumer products are: peptide, ester, glycosidic link and hydroxyl.

Which of these functional groups is not able to be hydrolysed with a strong base?

A. peptide

B. ester

C. glycosidic link

D. hydroxyl

Question 7

A popular painkiller is ibuprofen, which slowly degrades over time to 1-hydroxy-ibuprofen. Ibuprofen has a melting point of 75-77 °C, and 1-hydroxy-ibuprofen has a melting point of 99-107 °C.

A student tested a sample of ibuprofen from the chemistry storeroom and found that the melting point of the sample was 76-90 °C. What is the likely explanation for this observation?

A. The sample is a mixture of the two compounds: ibuprofen and 1-hydroxy-ibuprofen because the m.p. is between the two pure substance values.

B. The sample is almost all 1-hydroxy-ibuprofen because the m.p. is closer to the pure substance value for that compound.

C. The sample is not representative of the substance and more testing needs to be done.

D. The sample is a mixture of the two compounds: ibuprofen and another substance, but not definitely 1-hydroxy-ibuprofen as the value is below the 1-hydroxy-ibuprofen value and generally impurities spread the m.p. range but do not lower the m.p.

Question 8

When 2-methylpentan-2-ol is reacted with excess acidified potassium dichromate, the number of potential products that could be formed is:

A. two, as the molecule is a secondary alcohol.

B. one, as the molecule is a tertiary alcohol.

C. none, as the molecule is a tertiary alcohol.

D. one, as the molecule is a secondary alcohol.

Question 9

Which alternative gives the correct half equation for the oxidation of methanol to methanoic acid?

A. $CH_3OH(aq) + H_2O \rightarrow HCOOH(aq) + 4H^+(aq) + 4e^-$

B. $CH_3OH(aq) + 4e^- + H_2O(l) \rightarrow HCOOH(aq) + 4H^+(aq)$

C. $CH_3OH(aq) + OH^-(aq) \rightarrow HCOOH(aq) + 8H^+(aq) + 4e^-$

D. $CH_3OH(aq) \rightarrow HCOOH(aq) + 2H_2(g) + 4e^-$

Question 10

233.5g of iodine reacts exactly with 0.46 mole of a fatty acid. The fatty acid could be:

A. stearic acid

B. arachidonic acid

C. linoleic acid

D. linolenic acid

SECTION B - Short-answer questions

Instructions for Section B
Questions must be answered in the spaces provided in this book. To obtain full marks for your responses you should • Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks. • Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working. Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; $NaCl(s)$

Question 1

A student was trying to distinguish between five organic compounds (A-E). They know that the chemicals are: propanoic acid, methylpropan-2-ol, pentane, butan-2-ol and pent-3-en-1-ol but not which one is which.

Sample	Added brown Br_2 (aq)	Added acidified MnO_4^-	Added ethanol, $H_2SO_{4\,(l)}$ & heat	Added ethanoic acid, $H_2SO_{4\,(l)}$ & heat	Added Na_2CO_3 (s)
A	Bromine water was decolourised	Purple colour changed to pale pink	No apparent reaction	Fruity-smelling product formed	No apparent reaction
B	No apparent reaction	No change to purple	No apparent reaction	No apparent reaction	No apparent reaction
C	No apparent reaction	No apparent reaction	Fruity-smelling product formed	No apparent reaction	A colourless gas was produced
D	No apparent reaction	No apparent reaction	No apparent reaction	Fruity-smelling product formed	No apparent reaction
E	No apparent reaction	Purple colour changed to pale pink	No apparent reaction	Fruity-smelling product formed	No apparent reaction

They added a sample of the liquids to a series of test tubes and conducted the following tests:

a. Based on the test results, identify each unknown compound, and explain why you chose that molecule.

A

B

_____

_____

C

_____

_____

D

_____

_____

E

_____

_____

10 marks

b. Draw the structural formula for, and name of, the molecule formed in the reaction between C and ethanol.

Name:

2 marks

c. Write a balanced chemical equation for the reaction of A and bromine water using condensed formulae.

_____

_____

2 marks

d. Describe a test for the gas that was produced when C reacted with $Na_2CO_3(s)$.

_____

_____

2 marks

Total 16 marks

Question 2

A student was given the task to check the concentration of a commercial hydrogen peroxide, H_2O_2, cleaner labelled 3%.

The H_2O_2 was diluted by taking a 20mL aliquot and adding distilled water in a 250.00 mL volumetric flask to the graduated line.

25.00 mL aliquots of the diluted H_2O_2 were added to conical flasks that had been rinsed three times with distilled water. A few drops of HCl were also added to each of the flasks to acidify the solution. No indicator was added to the flasks.

The burette was rinsed with distilled water and then 10mL of 0.567 M $KMnO_4$ solution and filled with the same solution. The average titre was 22.34mL

a. Write the balanced half-equations for:

    i.   the oxidation of hydrogen peroxide.

_____

1 mark

    ii.   the reduction of permanganate to (MnO_4^-) to manganese ions (Mn^{2+}).

_____

1 mark

    iii.   the overall redox reaction.

_____

1 mark

b. Calculate the number of moles of MnO_4^- in the average titre.

_____

_____

1 mark

c. Determine the number of moles of diluted H_2O_2 present in the aliquot.

_____

_____

1 mark

d. Calculate the concentration of undiluted H_2O_2.

_____

_____

_____

_____

2 marks

e. Calculate the % mass/mass of H_2O_2 present in the original product.

_____

_____

2 marks

f. Explain why no indicator was used in this experiment.

_____

_____

2 marks

Total 12 marks

Question 3

The reaction between ethanol and dichromate ions is a redox reaction conducted in acidic conditions.

a.   **i.** Write the half equation for the reaction of ethanol to form ethanoic acid.

_____

_____

1 mark

ii. Write the balanced overall equation for the reaction and indicate any colour changes that may occur.

_____

_____

_____

3 marks

b. Police use this reaction between ethanol and acidified dichromate to determine the blood alcohol level of drivers.

If a driver is "over the limit", then their blood alcohol level is greater than 0.05%m/v. Is a driver over the limit if 10.0mL of their blood requires 12.5mL of 0.00285M $H^+/Cr_2O_7^{2-}$ to completely oxidize the ethanol it contains? Provide relevant calculations to support your answer.

_____

_____

_____

_____

_____

_____

_____

_____

5 marks

c. Determine the limiting reactant when 22.3mL of 0.0564M acidified dichromate is reacted with
    50mL of vodka that is a 40%v/v solution. The density of ethanol is 0.789g/mL.

_____

_____

_____

3 marks

Total 12 marks

END OF KEY TOPIC TEST