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Unit 3 Chemistry

Practice Exam Question and Answer Booklet

Duration: 15 minutes reading time, 90 minutes writing time

Structure of book:

Section	Number of questions	Number of questions to be answered	Number of marks
A	20	20	20
B	7	7	56
		Total	76

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, rulers and an approved scientific calculator.
- Students are not permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied:

- This question and answer booklet of 15 pages.

Instructions:

- You must complete all questions of the examination.
- Write all your answers in the spaces provided in this booklet.

Section A – Multiple-choice questions

Instructions

Answer all questions by circling your choice.
Choose the response that is correct or that best answers the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will not be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Questions

Question 1

An organic compound containing hydrogen and carbon was completely burned in oxygen to produce 8.64g of water and 21.12g of carbon dioxide. What is the empirical formula of the compound?

A. CH
B. CH_2
C. CH_4
D. C_2H_5

Question 2

When heated adequately, hydrated copper sulphate ($CuSO_4 .xH_2O$) will lose its hydration. A 1.124g sample of the hydrated copper sulphate is heated, leaving 0.719g of anhydrous copper sulphate. What is the value of x in the formula $CuSO_4 .xH_2O$?

A. 3
B. 4
C. 5
D. 6

Question 3

Which of the following reactions represents a redox reaction?

A. $Al_2(SO_4)_3$ (s) + 6$NaHCO_3$ (s) → 3Na_2SO_4 (s) + 2$Al(OH)_3$ (s) + 6CO_2 (g)
B. H_2S(g) + 2NaOH (aq) → Na_2S (aq) + 2H_2O (l)
C. Fe_2O_3 (s) + 3 H_2SO_4 (aq) → $Fe_2(SO_4)_3$ (s) + 3H_2O (l)
D. Mg (s) + H_2SO_4 (aq) → $MgSO_4$ (aq) + H_2 (g)

Question 4

Which of the following does not represent a conjugate acid-base pair?

A. HCl/Cl^-
B. H_2O/OH^-
C. H_2SO_4/SO_4^{2-}
D. $H_3PO_4/H_2PO_4^-$

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Question 5
What is the resulting pH if 25ml of 0.1M $Ba(OH)_2$ solution is added to 25ml of 0.1M HCl solution?

A. 1.30
B. 7.00
C. 11.40
D. 12.70

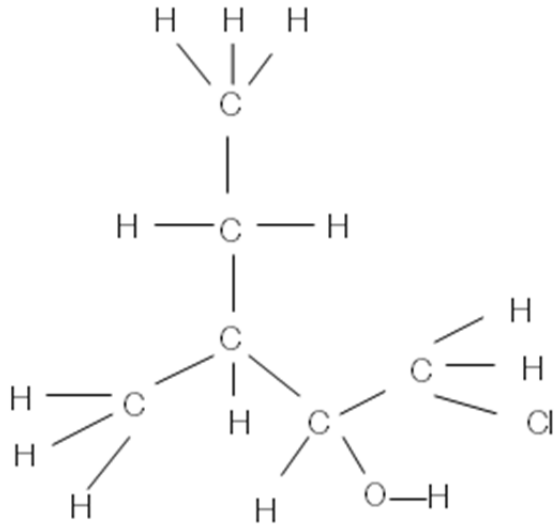
Question 6
Which of these techniques utilises the change in vibrational energy within an atom?

A. infrared spectroscopy
B. UV-visible spectroscopy
C. atomic absorption spectroscopy
D. mass spectrometry

Question 7
0.60 mol of gaseous substance X reacts completely and exactly with 5.22L of gas Y at 45°C and 101.3kPa. What is the equation for the reaction between X and Y?

A. 3X + 4Y → products
B. 4Y + 3X → products
C. 3X + B → products
D. X + 2B → products

Question 8
What is the correct name of the following molecule?



A. 2-chloro-4-ethylbutan-3-ol
B. 1-chloro-3-ethylbutan-2-ol
C. 5-chloro-3-methylpentan-4-ol
D. 1-chloro-3-methylpentan-2-ol

Question 9

Which of the following factors will increase the retention time of the compounds separated by HPLC?

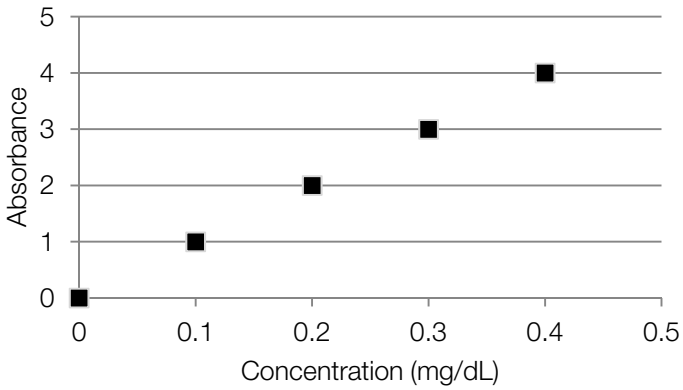
i. Increasing the temperature
ii. Increasing the length of the column
iii. Decreasing the pressure

A. ii only
B. i, ii
C. ii, iii
D. i, ii, iii

Question 10

The water in a particular dam was suspected of having a high level of lead. In order to find out the amount of lead in the water, a 20mL sample was diluted to 1L and then sprayed through the flame of an atomic absorption spectrometer. An absorbance of 1.8 was obtained.

The absorbance of different solutions of water containing known concentrations of lead was measured and graphed below. What is the concentration of lead in the water sample?



A. 1.8mg/dL
B. 9.0mg/dL
C. 90mg/dL
D. 18mg/dL

Question 11

Which of the following is the most appropriate indicator to identify the endpoint of a titration between methylamine and hydrochloric acid?

A. phenolphthalein
B. bromophenol blue
C. bromothymol blue
D. phenol red

Question 12
Which two monomers are used to produce the following polymer?

----CH_2—CHCl—CHCl—CHBr—CHCl—CH_2—CHBr—CHCl----

A. 1-bromo-2-chloroethene and 1-chloroethene
B. 1,2-dichloroethene and 1-bromoethene
C. 1-chloroethene and 1,2-dichloroethene
D. 1-bromo-2-chloroethene and 1-bromoethene

Question 13
Given that chlorine exists as a mixture of two isotopes, what is the number of molecular ion peaks a sample of 1,2,3 – trichloropropane will produce in its mass spectrum?

A. 1
B. 3
C. 4
D. 7

Question 14
What are the products of a reaction between ethanol and ammonia gas at 400°C passed over alumina?

A. ethlyamine and water vapour
B. ethylamine and carbon dioxide
C. ethylamine
D. methylamine and carbon dioxide

Question 15
Esters can be produced through

A. a dissociation reaction between a carboxylic acid and a chloroalkane
B. a substitution reaction between a carboxylic acid and an alkanol
C. a condensation reaction between a carboxylic acid and an alkanol
D. an addition reaction between a carboxylic acid and an alkanol

Question 16
An ester linkage, an amide linkage and a glycosidic linkage can be found in, respectively:

A. protein, polysaccharide, triglyceride
B. triglyceride, polysaccharide, protein
C. fatty acid, protein, polysaccharide
D. triglyceride, protein, polysaccharide

Question 17
Which of the following is reacted with methanol to produce biodiesel fuel?

A. fatty acids
B. triglycerides
C. glucose
D. ethanol

Question 18
Which of the following fatty acids cannot undergo an addition reaction with hydrogen gas?

A. linoleic acid
B. palmitic acid
C. arichidonic acid
D. oleic acid

Question 19
The sequence of bases in a particular strand of DNA is AATGCCTG. What is the sequence of bases that will pair with this strand?

A. CCGTAAGT
B. TTACGGAC
C. AATGCCTG
D. GGCATTCA

Question 20
Which of the following can cause the denaturation of biological enzymes?

i. increased temperature
ii. a change in pH
iii. the addition of various chemicals

A. i only
B. i, ii
C. ii only
D. i, ii, iii

Section B – Short-answer questions

Instructions

Answer all questions in the spaces provided.
In questions where more than one mark is available, appropriate working must be shown.
Unless otherwise indicated, the diagrams in this book are not drawn to scale.

Questions

Question 1

A chemical engineer decided to analyse a specific brand of petrol. Samples of three different compounds, X, Y and Z respectively, were extracted from the fuel. The chemical engineer then decided to run a number of tests on the samples to identify the three different compounds.

Compound X contains hydrogen, oxygen and carbon. 4.759g of X was combusted in excess oxygen, forming 5.710g of water and 10.47g of carbon dioxide.

a. Deduce the empirical formula of compound X.

4 marks

b. Given that the empirical formula of X is also its molecular formula and that X is an alkanol, draw the two possible structures of compound X.

Structure 1	Structure 2

2 marks

c. Compound X can be oxidised by acidified permanganate ions to produce a carboxylic acid. Name compound X.

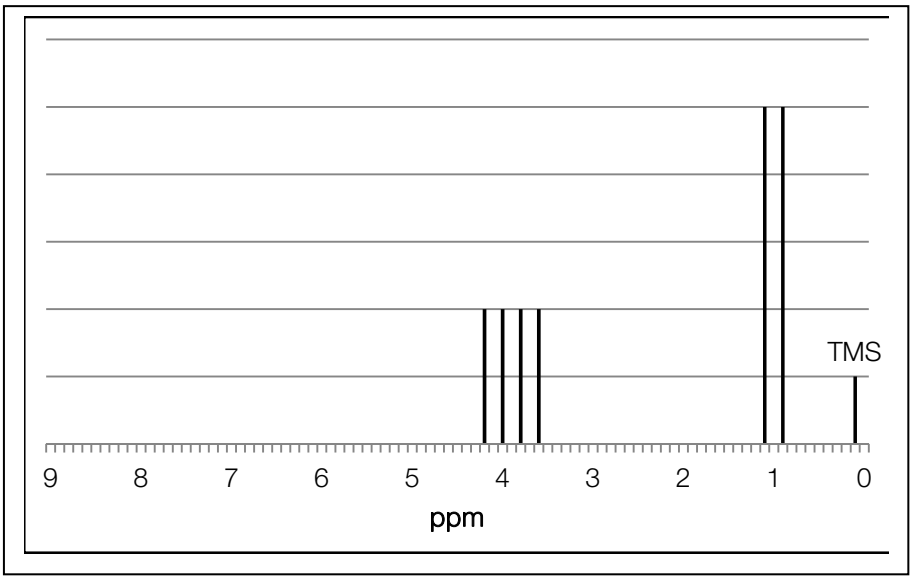
1 mark

After identifying compound X, the chemical engineer attempted to identify compound Y. Previous tests had shown that compound Y was the result of a reaction between but-2-ene with chlorine.

d. Write down the chemical reaction between but-2-ene and chlorine. States are not required. State the name given to this kind of reaction.

2 marks

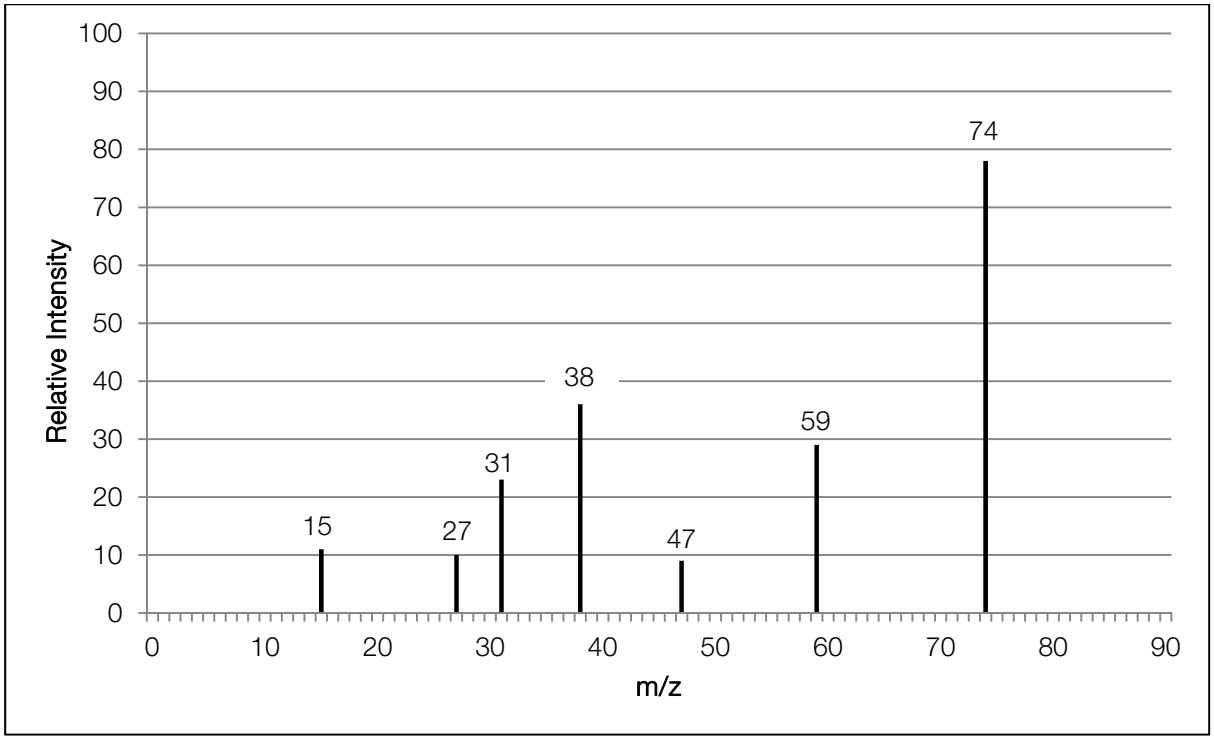
There are two possible isomers of compound Y. To identify which one compound Y is, the chemical engineer decided to use ^{1}H NMR spectroscopy. The results are shown below.



e. Draw the structure of compound Y. Write the name of compound Y on your diagram.

2 marks

Compound Z is an ester. The chemical engineer conducts mass spectrometry on compound Z. The mass spectrum obtained is illustrated below.



f. Explain the presence of the peak at

i) a m/z ratio of 59:

ii) a m/z ratio of 47:

2 marks

g. Using this information, name compound Z.

1 mark

Total 14 marks

Question 2

Elemental phosphorus is produced by treating calcium orthophosphate ($Ca_3(PO_4)_2$) with silicon dioxide and pure carbon in the form of coke. The equation for the reaction is given below.

$$2\ Ca_3(PO_4)_2\ (l) + 6SiO_2\ (l) + 10C\ (s) \rightarrow P_4\ (g) + 6CaSiO_3\ (l) + 10CO\ (g)$$

a. Name the reductant in this equation.

1 mark

b. Theoretically, for every mole of reactant, how many moles of P_4 are produced?

3 marks

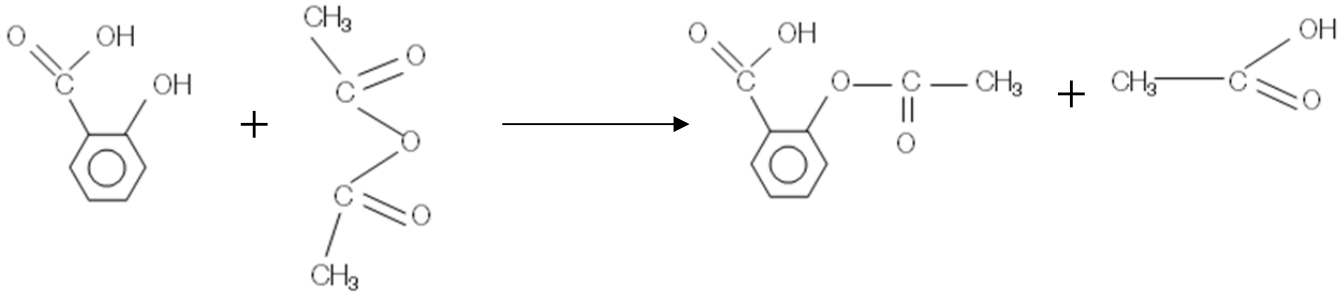
c. In reality however, the process is only 90% efficient. Calculate the mass of phosphorus gas produced if 1.000kg of calcium orthophosphate is reacted with 1.000kg of silicon dioxide and 1.000kg of coke.

4 marks

Total 8 marks

Question 3

The following equation is used to prepare aspirin:



salicylic acid ethanoic anhydride acetylsalicylic acid (aspirin) ethanoic acid

a. State the functional groups that would cause peaks in the infrared spectrum of aspirin at:

1100cm^{-1} _____

1750cm^{-1} _____

3400cm^{-1} _____

3 marks

b. Circle the ester linkage in aspirin in the given equation.

1 mark

c. 26.70g of salicylic acid ($C_7H_6O_3$) was reacted with excess ethanoic anhydride. 21.60g of acetylsalicylic acid ($C_9H_8O_4$) was then isolated. Determine the percentage yield of this particular reaction.

_____

_____

_____

_____

_____

3 marks

Total 7 marks

Question 4

In agriculture, sodium hydroxide is reacted with ammonium sulphate fertiliser to remove ammonia as a gas, with water and sodium sulphate as by-products. A 0.600g sample of fertiliser was tested for its nitrogen content. In the process, the fertiliser was transferred to a conical flask and dissolved. 25.00ml of 0.100M sodium hydroxide was added to the flask and allowed to react. Then, the excess sodium hydroxide was titrated with 0.0400M hydrochloric acid. The volume of acid at which the endpoint was achieved was 24.36mL.

a. Write the chemical equation for the reaction between sodium hydroxide and ammonium sulphate.

1 mark

b. Calculate the amount of sodium hydroxide that reacted with the ammonium sulphate fertiliser.

2 marks

c. Calculate the amount of ammonium sulphate present in the fertiliser in the conical flask. Hence, calculate percentage by mass of nitrogen in the fertiliser sample.

3 marks

d. What would be the effect on the calculated percentage of nitrogen in the fertiliser if the titration with hydrochloric acid slightly undershot completion? Explain.

2 marks

e. Name an indicator that would be appropriate to identify the endpoint of the titration of hydrochloric acid and sodium hydroxide.

_____

1 mark

f. Another simple titration with sodium hydroxide and hydrochloric acid was conducted. The sodium hydroxide was transferred to the conical flask with a pipette and then titrated with the hydrochloric acid. In the table provided, state the substance with which the equipment should have been rinsed prior to the experiment.

Conical flask _____

Burette _____

Pipette _____

3 marks

Total 12 marks

Question 5

Amino acids are essential in a healthy diet.

Two amino acids, cysteine and asparagine, can undergo a reaction forming a dipeptide.

a. Draw one possible structural formula for this dipeptide.

2 marks

b. State the name given to this type of reaction.

1 mark

c. Name the reagent that can be reacted with the dipeptide to convert it back into its separate amino acids.

1 mark

d. Upon heating, describe what happens to the primary structure of this dipeptide.

1 mark

e. Proteins are a major constituent of enzymes. Explain why the tertiary structure of an enzyme is imperative for its correct function.

2 marks

Total 7 marks

Question 6

a. Name the type of bonding that is present between a deoxyribose molecule and phosphate molecule.

1 mark

b. Using the following key, where D represents a deoxyribose molecule, P represents a phosphate molecule and A, T, G and C represent the nitrogenous bases, draw a simplistic arrangement of a double-stranded DNA helix, using all of the bases once.

2 marks

c. How many water molecules are required to separate a single strand of DNA containing 8 nitrogenous bases into its constituent nucleotides?

1 mark

Total 4 marks

Question 7

An unreactive dish containing magnesium is heated until it forms magnesium (II) oxide.

If the original mass of the magnesium and the dish is 45.0g and the final mass of the magnesium (II) oxide and the dish is 57.4g, calculate the mass of the dish.

4 marks

End of Booklet