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CHEMISTRY
Unit 3
Trial Examination

SOLUTIONS BOOK

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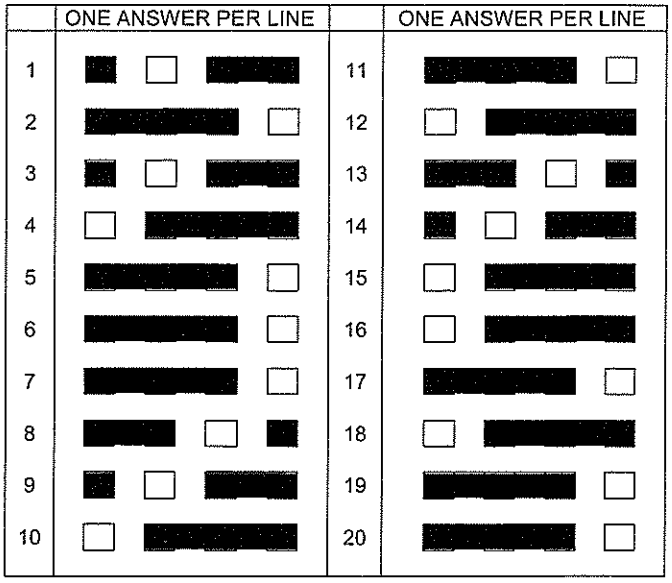
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



SECTION A (Total 20 marks)

1.	B	**2.**	D	**3.**	B	**4.**	A	**5.**	D
6.	D	**7.**	D	**8.**	C	**9.**	B	**10.**	A
11.	D	**12.**	A	**13.**	C	**14.**	B	**15.**	A
16.	A	**17.**	D	**18.**	A	**19.**	D	**20.**	D

Comments for Section A answers

Question 1

A. $n(C) = 0.10 \times 6 = 0.60$ mol

B. $n(C_2H_4) = m/M = 20/28 = 0.714$ mol $\quad n(C) = 2 \times n(C_2H_4) = 1.43$ mol

C. $n(CO_2) = V/V_m = 20/22.4 \quad n(C) = n(CO_2) = 0.893$ mol

D. $n(CH_4) = N/N_A = 1.0 \times 10^{23} / 6.02 \times 10^{23} = 0.17$ mol $\quad n(C) = n(CH_4) = 0.17$ mol

Correct answer is B.

Question 2

The sequence of nitrogen bases form the basis of the genetic code. Genes are particular sequences of the bases. **Correct answer is D.**

Question 3

The isomers are

$CH_3CH_2CH_2CH_2CH_2CH_3$

$CH_3CH(CH_3)CH_2CH_2CH_3 \quad CH_3CH_2\,CH(CH_3)CH_2CH_3$

$CH_3CH(CH_3)CH(CH_3)CH_3 \quad CH_3C(CH_3)_2CH_2CH_3$ **Correct answer is B.**

Question 4

Only A has a structure which permits oxidation at the carbon which is on the right side of the molecule. This carbon is referred to as a primary carbon atom. **Correct answer is A.**

Question 5

In CH_3CH_2Br, there are two sets of non-equivalent protons. The 3 equivalent hydrogens of the CH_3 group will split the CH_2 signal into a quartet and the 2 equivalent hydrogens in the CH_2 will split the CH_3 into a triplet. Hence 7 peaks will be seen in the high resolution ^1H NMR. **Correct answer is D.**

Question 6

A is an addition reaction, B is ionisation, C is combustion or oxidation, D is substitution. In D, a second hydrogen atom has been replaced with a chlorine atom. **Correct answer is D.**

Question 7

A. Would require more diluted fruit juice so the discrepant titre would be higher.
B. This dilutes the fruit juice further, so the titre would be bigger.
C. This is correct technique and would not lead to a discrepancy.
D. This dilutes the sodium hydroxide so less fruit juice is required. **Correct answer is D.**

Question 8

$C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2H_2O$ $n(O_2) / n(C_2H_4) = 3/1$ $n(O_2) = 3 \times 0.5 = 1.5$ **Correct answer is C.**

Question 9

The formation of a peptide link involves a condensation reaction to release a water molecule.
Correct answer is B.

Question 10

Infrared Spectroscopy could identify the presence of the C = O, carboxyl group. **Correct answer is A.**

Question 11

$C_{16}H_{32}O_2$ if saturated formula would be $CH_3(CH_2)_{14}COOH$ - atom match

$C_{18}H_{36}O_2$ if saturated formula would be $CH_3(CH_2)_{16}COOH$ - atom match

$C_{20}H_{38}O_2$ if saturated formula would be $CH_3(CH_2)_{18}COOH$ - two less H atoms, so mono-unsaturated

$C_{24}H_{44}O_2$ if saturated formula would be $CH_3(CH_2)_{22}COOH$ - four less H atoms so 2 C/C double bonds

Correct answer is D.

Question 12

499 ester links are created. Therefore 499 water molecules are lost

Mass would be 500 x 90 – 499 x 18 = 45 000 – 8982 = 36 018 **Correct answer is A.**

Question 13

Because of the 'symmetry' of the molecule, there are only 3 different carbon environments and 3 different hydrogen environments. **Correct answer is C.**

Question 14

Sodium hydroxide absorbs CO_2 from the atmosphere. The older sample would contain less mole of NaOH and therefore a lower titre would be required. **Correct answer is B.**

Question 15

GLC would be used to determine the ethanol content. **Correct answer is A.**

Question 16

NaH has H in -1 state H_2SO_4 has H in +1 state $NaHSO_4$ has H in + 1 state H_2O_2 has H in +1 state
Correct answer is A.

Question 17
H_2O_2 as an oxidant is the only suitable chemical which is higher than the reductant I^- in the electrochemical series. **Correct answer is D.**

Question 18
At equivalence point, ammonim ion is formed and this is weakly acidic. Therefore the solution has a pH of less than 7 at equivalence point. **Correct answer is A.**

Question 19
GC or CG pairs have 3 H-bonds between them; AT/TA pairs have 2 H-bonds between them.
So this sequence has 3 + 2 + 2 + 3 + 3 = 13 H-bonds. **Correct answer is D.**

Question 20
Stearic acid is $C_{17}H_{35}COOH$ and methanol is CH_3OH.
The biofuel is an ester and has the formula $C_{17}H_{35}COOCH_3$. **Correct answer is D.**

SECTION B – Short answer questions

Question 1 (4 marks)

Let T = titre volume in mL $n(AgNO_3) = c \times V = 0.4998 \times T \times 10^{-3}$ **1 mark**

$n(Ag^+) = n(Cl^-) = n(AgNO_3)$ $n(Cl^-) = n(NaCl)$ **1 mark**

$m(NaCl) = n \times M = 0.4998 \times T \times 10^{-3} \times 58.5$

% NaCl (m/m) = 100 x m(NaCl) / m(sample) $1.58 = 100 \times 0.4998 \times T \times 10^3 \times 58.5 / 50.0$ **1 mark**

$T = 50.0 \times 1.58 / 100 \times 0.4998 \times 10^{-3} \times 58.5 = 27.0$ mL **1 mark (check sig fig)**

Question 2 (8 marks)

a. $n(HCl) = 0.513 \times 32.2 \times 10^{-3}$ mol = 0.0165 mol **1 mark**

$n(NaOH)_{left\ over} = n(HCl)$

$n(NaOH)_{initially} = c \times V = 1.00 \times 20.00 \times 10^{-3} = 0.0200$ mol **1 mark**

n(NaOH) reacting with ester = 0.0200 – 0.0165 = 0.0035 mol **1 mark**

n(ester) = n(NaOH) = 0.0035 (1:1 reaction)

$n = m/M \rightarrow M = m/n = 0.308 / 0.0035 = 88.0\ g\ mol^{-1}$ **1 mark**

b. the ester must have a formula $RCOOR^1$

COO has a mass of 44 so the residue hydrocarbon mass must be 44. **1 mark**

$CH_3CH_2CH_3$ is 44 **1 mark**

c. **i.** Possible semi-structures for the ester are

$CH_3COOCH_2CH_3$ or $HCOOCH_2CH_2CH_3$ or $CH_3CH_2COOCH_3$ **1 mark**

ii. Given that it has a multiplet in the ^1H NMR, its structure must be $HCOOCH_2\mathbf{CH_2}CH_3$ **1 mark**. The highlighted CH_2 will actually be split into 12 peaks.

Question 3 (11 marks)

a. The nitrogen in the amino group is bonded to one carbon **1 mark**

b. This nitrogen has 3 bonds and a lone pair. **1 mark** (This results in a triangular pyramidal shape.)

c. The COOH group becomes $COO^- Na^+$ **1 mark** **(The charges must be shown to get the mark.)**

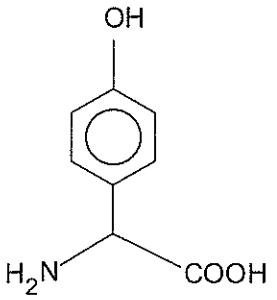
d. The penicillin salt is much more soluble. **1 mark**

e. **i.** $n(NaOH) = c \times V = 0.00500 \times 1.00 = 0.00500$ mol **1 mark**

$m(NaOH) = n \times M = 0.00500 \times 40.0 = 0.200$ g **1 mark**

ii. $pOH = -\log_{10}[OH^-] = -\log_{10} 0.00500 = 2.3$, $pH = 11.7$ **1 mark**

iii.



2 marks

iv. The bromine solution would decolourise. **1 mark**
It undergoes an addition reaction **1 mark** with the C/C double bond.

Question 4 (3 marks)

a. **i.** $CH_3CH_2CH(CH_3)\,COOH$ **1 mark**

ii. $CH_3CH(OH)CHClCHClCH_3$ **1 mark**

b. 5-chloro-4-methyl-hex-2-ene **1 mark** (accept 4-methyl-5-chloro)

Question 5 (4 marks) ½ mark for each correct answer

Compound	Number of low resolution ^1H signals	Number of ^{13}C signals
A	2	1
B	1	1
C	4	4
D	3	3

Question 6 (6 marks)

1 mark for correct formulae in equation, **1 mark** for reagents and both reagents must be given for the mark.

a. $CH_3CH_2Cl \xrightarrow{NH_3 \text{ followed by NaOH}} CH_3CH_2NH_2$

b. $C_2H_4 \xrightarrow{H^+ / H_2O} CH_3CH_2OH$

c. $CH_3CH_2OH \xrightarrow{CH_3COOH / \text{conc } H^+} CH_3COOCH_2CH_3$

Question 7 (8 marks)

a. $Na_2SO_4\,(aq) + Pb(NO_3)_2(aq) \longrightarrow PbSO_4\,(s) + 2NaNO_3(aq)$

1 mark for correct identification of precipitate, **1 mark** for balanced equation

b. $n(Na_2SO_4) = c \times V = 0.0900 \times 10.0 \times 10^{-3} = 0.900 \times 10^{-3}$ mol
$n(Pb(NO_3)_2) = c \times V = 0.0800 \times 15.0 \times 10^{-3} = 1.20 \times 10^{-3}$ mol **1 mark**
Since the reaction is 1:1 $Pb(NO_3)_2$ is in excess by 0.300×10^{-3} mol **1 mark**

c. $n(PbSO_4) = n(Na_2SO_4)$ **1 mark** $m(PbSO_4) = n \times M = 0.900 \times 10^{-3} \times 303.3 = 0.273$ g **1 mark**

d. % yield $= 100 \times 0.273 / 0.268 = 102\%$ **1 mark**

e. The precipitate was not washed thoroughly with de-ionised water before it was dried to remove soluble impurities. **1 mark**

Question 8 (7 marks)

a. $m(C) = 12.0 \times 3.60 / 44.0 = 0.982$ g $n(C) = 0.982 / 12.0 = 0.0818$ mol **1 mark**

$m(H) = 2.0 \times 1.472 / 18.0 = 0.164$ g $n(H) = 0.164 / 1.0 = 0.164$ mol **1 mark**

$m(O) = 1.80 - m(C) - m(H) = 1.80 - 0.982 - 0.164 = 0.654$ g

$n(O) = 0.654 / 16.0 = 0.0409$ mol **1 mark**

$n(C) : n(H) : n(O) = 0.0818 : 0.164 : 0.0409 = 2.00 : 4.00 : 1.00$ EF is C_2H_4O **1 mark**

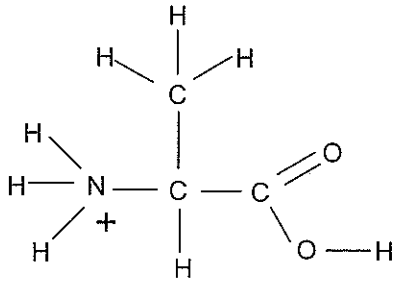
b. $PV = nRT = mRT/M$ $M = mRT / PV = 2.279 \times 8.31 \times 373 / 80.3 \times 1.00 = 88.0$ **1 mark**

The mass of the EF unit is 44.0 so the MF must be $C_4H_8O_2$ **1 mark**

c. Sodium hydroxide or potassium hydroxide – or any other soluble hydroxide. **1 mark**

Question 9 (12 marks)

a.



1 mark for showing all bonds correctly, **1 mark** for the cationic species correctly shown

b. Ala – Phe **$H_2NCH(CH_3)CO$**NHCH($CH_2C_6H_5$) COOH (Ala residue highlighted) **1 mark**

Phe – Ala $H_2NCH(CH_2C_6H_5)CO$**NHCH(CH_3)COOH** (Ala residue highlighted) **1 mark**

c. Water (accept H_2O) **1 mark**

d. **i.** From the left

ion-ion bonds **1 mark**

hydrogen bonds **1 mark**

di-sulfide bonds **1 mark**

dispersion forces **1 mark**

ii. the disulfide link will be – S – S – **1 mark**

iii. hydrogen bonds are broken in the secondary structure **1 mark**

the covalent bonds in the primary structure are not affected **1 mark**

END OF SUGGESTED SOLUTIONS