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CHEMISTRY
Unit 3
Trial Examination

SOLUTIONS BOOK

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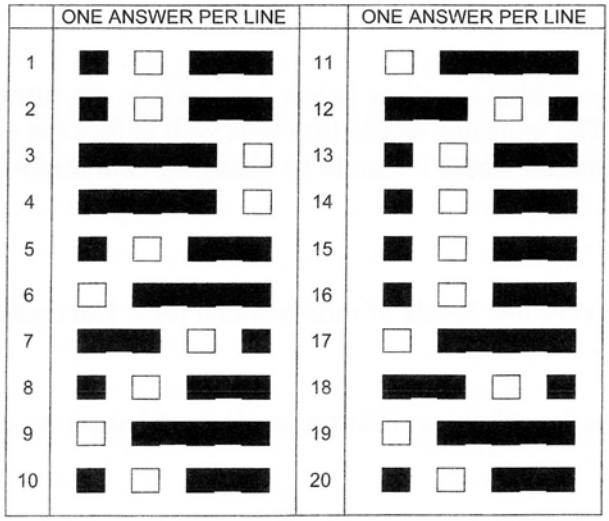
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



SECTION A (Total 20 marks)

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

Comments for Section A answers

Question 1
16 g of O_2 = ½ a mole of molecules
1 g of H_2 = ½ mol of H_2 but then have 1 mol of H atoms. Each H atom has one electron i.e. 6.0×10^{23} ions
24 g C is 2.0 mol of C
1 mol of NaCl has 2 mol of ions. **Correct Answer: B**

Question 2
A primary standard can contain water but its formula must be known. For example, a basic primary standard is $Na_2B_4O_7.10H_2O$ and an acidic primary standard is potassium hydrogen phthalate, $KH(C_8H_4O_4)$. Both are not anhydrous. **Correct Answer: B**

Question 3
Pipettes are highly accurate pieces of equipment and deliver 20.00 ± 0.01 mL providing they have been used appropriately. This gives an accuracy of 0.05%. The 20 mL which is written on the bulb of the pipette does not indicate its accuracy. **Correct Answer: D**

Question 4
From the data table, bromophenol blue is yellow below 3.0 and is in the form HIn and only blue above 4.6, in the form of In^-. The indicator would turn blue well before the equivalence point of a strong acid/strong base combination where it should be changing colour close to pH 7.0.
Correct Answer: D

Question 5
Atomic absorption is used for very low levels of mostly metal ions. **Correct answer: B**

Question 6
The reaction is an addition reaction where an HBr molecule is added across each of two C/C double bonds. **Correct Answer: A**

Question 7
The H atom and Br atom can add across each double bond in two different ways. However there are only three isomers because of molecular symmetry. **Correct Answer: C**

Question 8
Band A has the smaller R_f value as R_f = distance of A from origin / distance of solvent from origin. This means that B is adsorbed less strongly onto the stationary phase than A. **Correct Answer: B**

Question 9
R_f = distance of A from origin / distance of solvent from origin = 4/9 = 0.44 **Correct Answer: A**

Question 10
Low resolution will not pick up any splitting. Because of the symmetry of the molecule, only two singlets would be seen under low resolution. **Correct Answer: B**

Question 11
Octanoic acid has the formula $CH_3(CH_2)_6COOH$ or $C_8H_{16}O_2$. Putting on two OH groups would require removing two hydrogen atoms so that there will be no change in the number of H atoms which would still be 16. **Correct Answer: A**

Question 12
Alkanols have three points for hydrogen bonding with water. The alkanol with the shortest C chain would be the most soluble i.e. CH_3CH_2OH. **Correct Answer: C**

Question 13
The balanced reduction half-equation is: $ClO_3^- + 2H^+ + e^- \rightarrow ClO_2 + H_2O$
For **1 mole** ClO_2 produced, **1 mole** of electrons is required: **Correct Answer: B**

Question 14
The molecule must be named from the right. The Cl atom is on C3 and there are 6 C atoms so 3-chlorohexane. **Correct Answer: B**

Question 15
Each ethene molecule has a relative mass of 28.
This means the chain contains $2.0 \times 10^4 \div 28 = 714$ molecules and therefore $714 \times 2 = 1428$ atoms. **Correct Answer: B**

Question 16
Not all atoms are shown. Careful counting gives $C_{13}H_{18}O_2$. **Correct Answer: B**

Question 17
Step A represents photosynthesis and Step B represents fermentation. **Correct Answer: A**

Question 18
$M(CH_2OHCH_2COOH) = 90.0\ gmol^{-1}$. Since an H_2O molecule is released when the monomers are joined by a condensation reaction, the mass of the polymer will be $500 \times 90 - 499 \times 18 = 36\,018$.
Correct Answer: C

Question 19
The glycerine triplamitate will need to be hydrolysed to release palmitic acid which can then be esterified with methanol to give methyl palmitate, $CH_3(CH_2)_{14}COOCH_3$ or $C_{17}H_{34}O_2$.
Correct Answer: A

Question 20
Since both are liquids with a substantial difference in boiling point, they could easily be separated by fractional distillation. **Correct Answer: B.**

SECTION B – Short answer questions (Total 68 marks)

Question 1 (4 marks)

a. Linolenic acid has the formula $C_{17}H_{29}COOH$ (see data book). A saturated fatty acid has the formula $C_nH_{2n+1}COOH$ eg stearic acid, $C_{17}H_{35}COOH$. Since linolenic acid has six H atoms less for the same number of C atoms it must have three C=C. One or more C=C make linolenic acid unsaturated. **(1 mark)**

b. Each linolenic acid molecule will require 3 molecules of I_2 **(1 mark)**

$n(C_{17}H_{29}COOH) = m/M = 1.00 / 278$ mol **(1 mark)**
$n(I_2) = 3 \times 1.00 / 278$ mol $= 0.0108$
$m(I_2) = n \times M = 0.0108 \times 253.8 = 2.74$ g **(1 mark)**

Question 2 (3 marks)

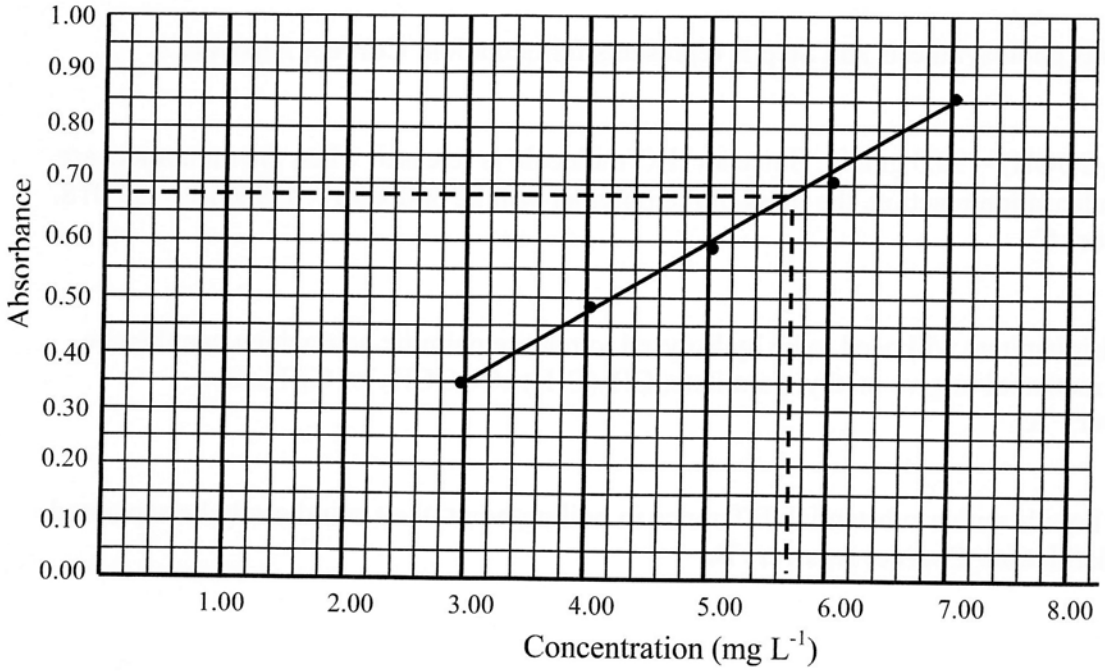
Intermolecular is between molecule bonding
CH_3Cl is polar and therefore will have dipole-dipole attractions **(1 mark)**
CH_4 is non-polar and therefore will have dispersion forces only **(1 mark)**
CH_3OH is polar and will have hydrogen bonding **(1 mark)** (dipole-dipole attractions is not enough)

Question 3 (9 marks)

a. There may be another species present in the product which could also absorb at 240 nm and would therefore give an inaccurate reading.

(1 mark)

b.



Accurate plotting of points (and drawing of line of best fit) **(1 mark)**
Label axes showing 'Absorbance' and 'Concentration (mg L^{-1})' **(1 mark)**
Appropriate scaling so that most of the area of the grid provided is used **(1 mark)**

c. Concentration in sample is 5.7 mg L^{-1} (allow ± 0.2 mg L^{-1}) **(1 mark)**

d. **i.** mass of fluorescent brightener 101 in 500 mL is 5.7 / 2 = 2.85 = 2.9 mg **(1 mark)**

ii. Molar mass = 16 x 12.0 + 12 x 1.0 + 3 x 16.0 = 252 g mol^{-1} **(1 mark)**

$n_{\text{fluorescent brightener 101}}$ = mass/M = $2.9 \times 10^{-3} \div 252 = 1.15 \times 10^{-5}$ mol **(1 mark)**

number of molecules = n x N_A = $1.15 \times 10^{-5} \times 6.02 \times 10^{23}$

number of molecules = 6.9×10^{18} (*accept* 6.8×10^{18}) **(1 mark)**

Question 4 (8 marks)

a. **i.** Each nucleotide consists of a phosphate, deoxyribose and one of four base units **(2 marks)**. **For any omission subtract 1 mark.**

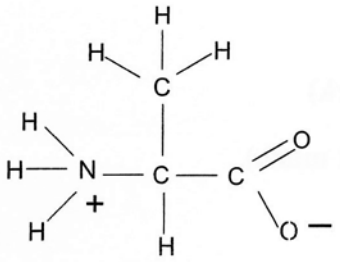
ii. The phosphate and deoxyribose units **(1 mark)** condense to form the covalent linkages in the backbone of the DNA with the deoxyribose and base condensing **(1 mark)**.

b. The base labelled A (Adenine) on one strand can form two hydrogen bonds with T (Thymine) on the other strand and vice-versa **(1 mark)**. The base labelled G (Guanine) on one strand can form three hydrogen bonds with C (Cytosine) on the other strand and vice-versa **(1 mark)**.

c. The DNA strands have a residual negative charge from the phosphate groups in the backbone and can be attracted to a positive electrode **(1 mark)**. The heavier DNA strands move more slowly and so the different sized strands can separate **(1 mark)**.

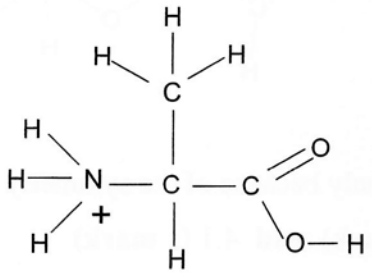
Question 5 (5 marks)

a. In water **(1 mark)**



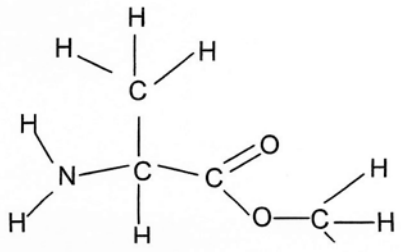
both charges must be shown

In acid **(1 mark)**



positive charge should be close to the N atom

Methyl ester **(1 mark)**



(also accept protonated amino group)

b. Enzymes can have their tertiary structure affected by changes in pH and so an active site might be completely changed **(1 mark)**. This markedly changes their ability to bond with the substrate in order to lower the activation energy for the reaction involving the substrate **(1 mark)**.

Question 6 (7 marks)

a. $n(HCl) = c \times V = 0.150 \times 20.80 \times 10^{-3} = 3.12 \times 10^{-3}$ mol **(1 mark)**

$n(CO_3^{2-}) = n(HCl) = 3.12 \times 10^{-3}$ mol

$[Na_2CO_3] = n / V = 3.12 \times 10^{-3} / 0.025 = 0.125$ M **(1 mark)**

b. The CO_3^{2-} ions produce more HCO_3^- **(1 mark)**

c. $n(HCl) = c \times V = 0.150 \times 33.25 \times 10^{-3} = 4.99 \times 10^{-3}$ mol **(1 mark)**

$n(HCO_3^-)$ from $CO_3^{2-} = 3.12 \times 10^{-3}$ mol **(1 mark)**

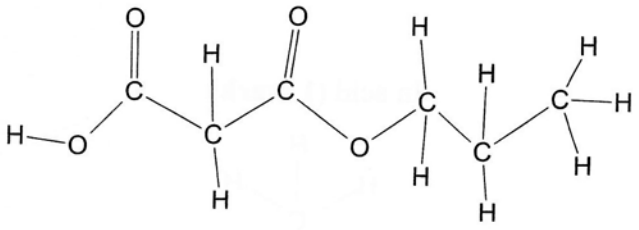
$n(HCO_3^-)_{originally} = 4.99 \times 10^{-3} - 3.12 \times 10^{-3} = 1.87 \times 10^{-3}$ mol **(1 mark)**

$[HCO_3^-]_{originally} = n / V = 1.87 \times 10^{-3} / 25.0 \times 10^{-3} = 7.48 \times 10^{-2}$ M **(1 mark)**

(Also accept 7.47×10^{-2} M)

Question 7 (8 marks)

a.



(1 mark)

b. **i.** 2 peaks only because of the symmetry of the molecule **(1 mark)**

ii. 2.0 **(1 mark) and** 4.1 **(1 mark)**

c. **i.** c is a doublet **(1 mark)** (split by the lone H atom on the adjacent C atom)

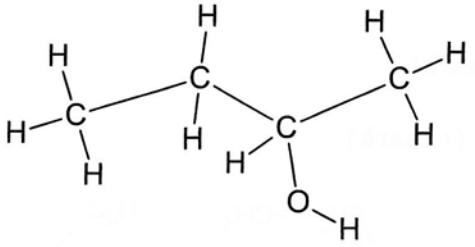
ii. d is a doublet **(1 mark)** (split by the lone H atom on the adjacent C atom)

d. **i.** $-OCH_2CH_3^+$ **(1 mark)**

ii. $-CH_2CH_3^+$ **(1 mark)**

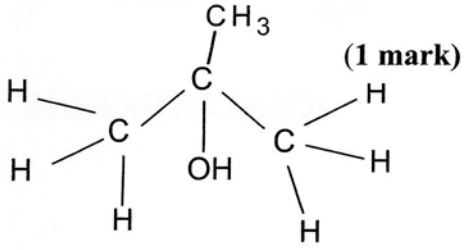
Question 8 (14 marks)

a.



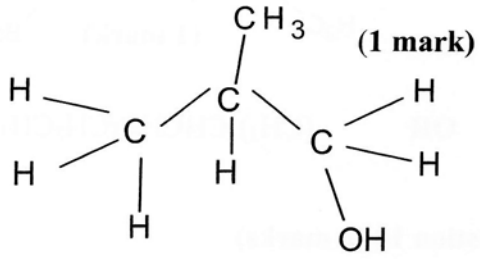
(1 mark)

2-butanol **(1 mark)**



(1 mark)

methylpropan-2-ol **(1 mark)**



(1 mark)

methylpropan-1-ol **(1 mark)**

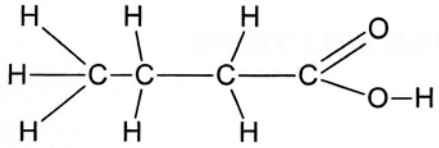
b. $CH_3CH_2CH_2CH_2OH(l) + CH_3COOH(aq) \rightarrow CH_3COOCH_2CH_2CH_2CH_3(l) + H_2O(l)$

(1 mark)

c. Butylethanoate **(1 mark)**

d. $CH_3CH_2CH_2CH_2OH(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$ **(1 mark)**

e. **i.**



(1 mark)

ii. Butanoic acid **(1 mark)**

iii. Gas bubbles – as carbon dioxide produced **(1 mark)**

$2CH_3CH_2CH_2COOH(l) + Na_2CO_3(s) \rightarrow 2CH_3CH_2CH_2COONa(aq) + CO_2(g) + H_2O(l)$

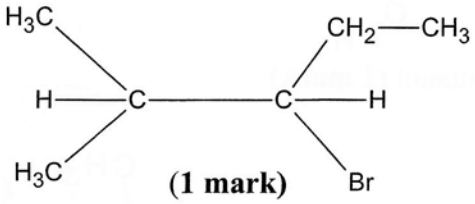
Balance correct **(1 mark)** States correct **(1 mark)**

Question 9 (4 marks)

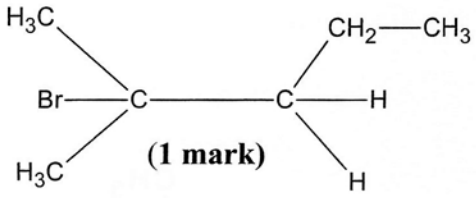
a. 2-methylpent-2-ene **(1 mark)**

b. **i.** An addition reaction **(1 mark)**

ii.



(1 mark)



(1 mark)

OR $(CH_3)_2CHCHBrCH_2CH_3$ $(CH_3)_2CBrCH_2CH_2CH_3$

Question 10 (6 marks)

n $Ba_3(PO_4)_2$ in 20.00 mL sample = m/M = 1.5 / 601.9 = 2.49×10^{-3} mol **(1 mark)**

n $Ba_3(PO_4)_2$ in 250.0 mL sample = $2.49 \times 10^{-3} \times 250.0 / 20.00 = 3.11 \times 10^{-2}$ mol **(1 mark)**

n($BaCl_2$) / n $Ba_3(PO_4)_2$ = 3 / 1

n($BaCl_2$) = $3 / 1 \times 3.11 \times 10^{-2} = 0.0934$ mol **(1 mark)**

m($BaCl_2$) = 0.0934 x 208.3 = 19.4 g **(1 mark)**

if 85% pure, need 19.4 x 100 / 85 = 22.8 g **(1 mark)** = 23 g to two sig. figures **(1 mark)**

END OF SUGGESTED SOLUTIONS