RB
HO
MC

Applecross Senior High School

Organic Chemistry - Year 12

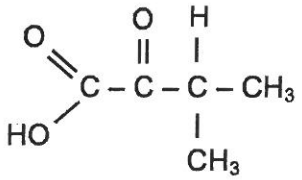
Duration: 60 minutes, Total Marks: 50

SOLUTIONS

Multiple Choice Section ____/15 , Short Answer ___/35

Multiple Choice Section

1. Consider the following molecule.



Which of the following substances could be oxidised to form the molecule above?

(a) $CH_3CHOHCH(CH_3)CH_3$
(b) $CH_3CH(CH_3)CHOHCH_2OH$
(c) $CH_2OHCH_2COH(CH_3)CH_3$
(d) $CH_3CHOHCH(CH_3)CH_2OH$

2. Which of the following best explains why heptane has a higher boiling point than 2,3-dimethylpentane?

(a) Heptane contains more hydrogen bonds than 2,3-dimethylpentane and so has stronger intermolecular forces
(b) Heptane is more polar than 2,3-dimethyl pentane and so has stronger dipole-dipole forces
(c) Heptane has less branched groups than 2,3-dimethylpentane and so has stronger dispersion forces
(d) Heptane has a higher molecular weight than 2,3-dimethylpentane and so has stronger dispersion forces

3. Which of the following equations correctly represents the substitution reaction that would occur between butane and chlorine water?

(a) $CH_3CH{=}CHCH_3 + Cl_2 \rightarrow CH_3CHClCHClCH_3$

(b) $CH_3CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CHClCH_3 + HCl$

(c) $CH_3CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CHCl_2 + CH_4$

(d) $CH_3CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CCl_2CH_3 + H_2$

4. Which of the following organic compounds would be most soluble in water?

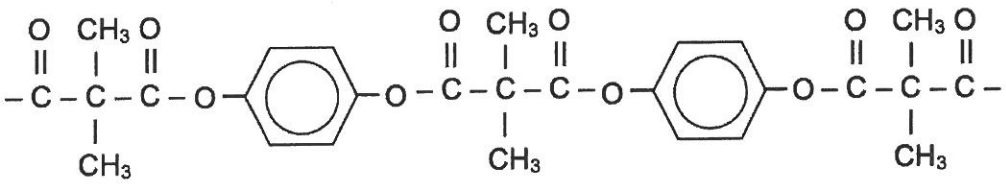
(a) $CH_3COCH_2CH_3$

(b) $CH_3CH_2CH_2COOH$

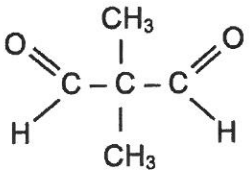
(c) $CH_3CH_2CH_2CHO$

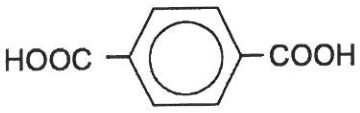
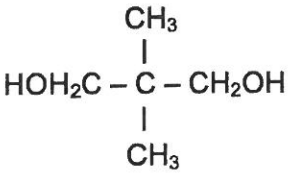
(d) $CH_3CH_2CH_2CH_2OH$

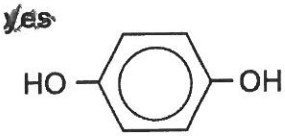
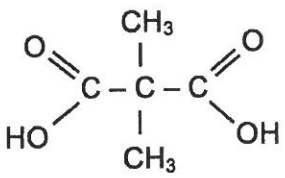
5. Consider the polymer fragment shown below.

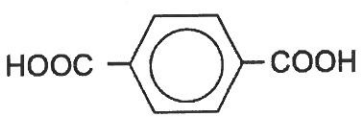
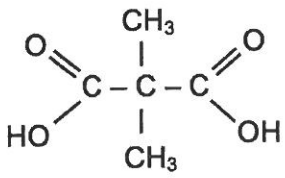


Which two monomers could have been used to produce this polymer?

(a)  and 

(b)  and 

Answer → (c) ~~Yes~~  and 

(d)  and 

6. Which of the following molecules is not an isomer of the others?

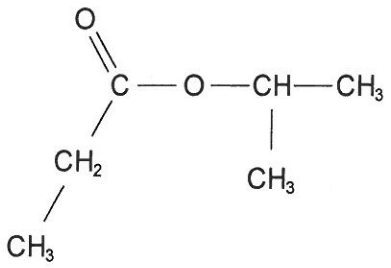
(a) 2-methyl-3-hexene

(b) 1,3-dimethylcyclopentane

(c) 2,3-dimethyl-1-pentene

(d) 3-ethylpentane

7. Which of the pairs of compounds below could be used to make the following molecule?



(a) Propanoic acid and 2-propanol

(b) Propanoic acid and 2-methylpropanol

(c) Ethanoic acid and 2-propanol

(d) Ethanoic acid and 1-propanol

8. The secondary structure of a protein refers to;

(a) the sequence of alpha amino acids along the protein chain
(b) the hydrogen bonding which occurs as the protein folds on itself
(c) the ionic bonding which occurs between zwitterions along the protein chain
(d) alpha helix and beta pleated sheet structures within the protein

9. Cyclohexane was shaken with some bromine water. Which comment below, concerning this reaction, is true.

(a) The reaction happens quickly under conditions of STP.

(b) The double bond in the cyclohexane molecule is the most reactive region of the molecule.

(c) When blue litmus paper is placed into the final mixture it turns red.

(d) Cyclohexane will not react with bromine water.

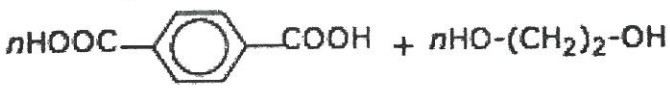
10. What holds a protein into its tertiary structure?

(a) interactions between the side chains; the "R" groups making the protein fold on itself
(b) the sequence of alpha amino acids

(c) alternating aspartic acid and lysine residues forming a large protein polymer
(d) hydrogen bonding between zwitterions

11. When combined together, the following reactants;

terephthalic acid + ethylene glycol



would be combined to form;

(a) a polyester, formed by a common addition polymerisation reaction
(b) Dacron ®, a polyester formed from a common condensation polymerisation reaction
(c) Terylene ®, a polyester formed from a common polymerisation reaction involving a diamine reactant
(d) A common ketone which can be oxidised to a secondary alcohol

12. How many primary alcohols have the molecular formula C_4H_9OH?

A. 1
B. 2
C. 3
D. 4

13. The two alcohols $(CH_3)_3COH$ and $CH_3CH(OH)CH_3$ could be distinguished by mixing each with

(a) bromine: $(CH_3)_3COH$ would decolourise the bromine, $CH_3CH(OH)CH_3$ would not.
(b) bromine: $CH_3CH(OH)CH_3$ would decolourise the bromine, $(CH_3)_3COH$ would not.
(c) acidified potassium permanganate: $(CH_3)_3COH$ would decolourise the permanganate, $CH_3CH(OH)CH_3$ would not.
(d) acidified potassium permanganate: $CH_3CH(OH)CH_3$ would decolourise the permanganate, $(CH_3)_3COH$ would not.

14. What is the IUPAC name for the organic compound with the following formula?

$$CH_3–CH_2–CH_2–C(Cl)(CH_3)–CH_2–CH=CH_2$$

A. 4-chloro-4-methyl-1-heptene
B. 2-chloro-2-propyl-4-pentene
C. 4-chloro-4-methyl-6-heptene
D. 4-chloro-4-propyl-1-pentene

15. Which of the compounds below is/are more likely to undergo substitution, rather than addition, reactions?

I. CH_3CHCH_2 II. $(CH_3)_3CH$ III. 

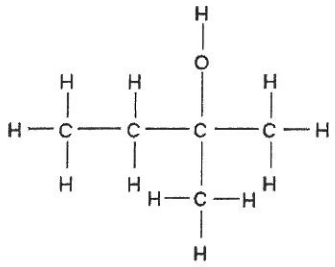
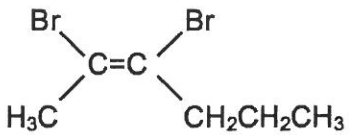
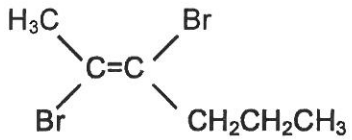
A. I only
B. II only
C. I and III only
D. II and III only

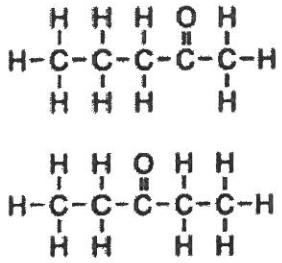
SHORT ANSWER AND CALCULATION SECTION (35 marks total)

Question 1 (3 marks)

For each of the organic molecules below;

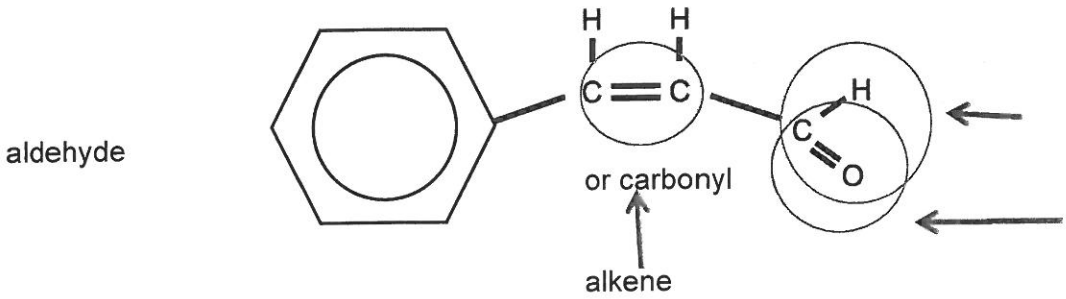
(a) Name the original substance using the IUPAC system, and (1.5 marks)
(b) Draw an isomer of the molecule that satisfies the description given. (1.5 marks)

Original organic molecule	Drawing of isomer
$CH_3CH_2CH_2CH_2CH_2OH$ Name: **pentan-1-ol**	*An isomer that is a tertiary alcohol*  (2-methylbutan-2-ol)
 Name: **cis-2,3-dibromohex-2-ene**	*A geometric (cis-trans) isomer*  (trans-2,3-dibromohex-2-ene)

$CH_3CH_2CH(CH_3)CHO$ Name: **2-methylbutanal**	*An unbranched isomer that is a ketone*  (pentan-2-one OR pentan-3-one)

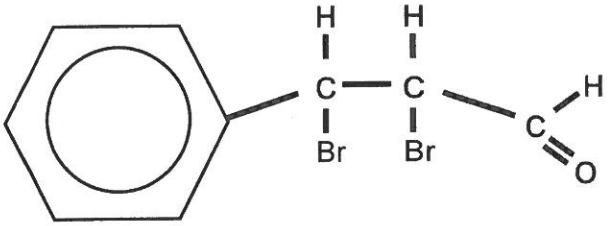
Question 2 (6 marks)

The compound shown below gives cinnamon its characteristic flavour and odour. It is a pale yellow liquid that occurs naturally in the bark of cinnamon trees.

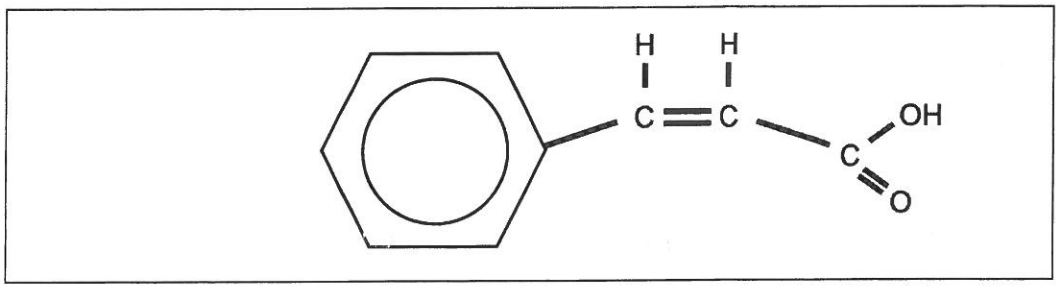


(a) On the diagram above, circle and label two functional groups present in the molecule. (2 marks)

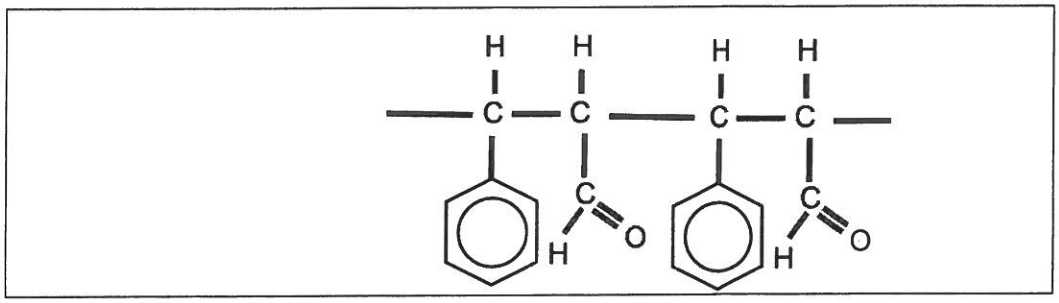
(b) Draw the structure of the product that would be formed if the **original** compound was mixed with some aqueous bromine (bromine water). (1 marks)



(c) Draw the structure of the product that would be formed if the **original** compound was mixed with an acidified solution of sodium dichromate. (1 mark)



(d) Draw the structure of the product that would be formed if the **original** compound was polymerised in the presence of an appropriate catalyst (draw two repeating units in your answer).
(2 marks)



Question 3 (15 marks)

X is a non-essential amino acid manufactured by the human body. It is also found in foods such as meat, seafood, dairy, beans and nuts. X is known to contain only the elements carbon, hydrogen, oxygen and nitrogen.

A sample of X underwent analysis to determine its molecular structure. A 0.7529 g sample was burnt in pure oxygen and this produced 1.116 g of carbon dioxide and 0.5329 g of water vapour. A separate 1.650 g sample was treated to convert all the nitrogen present to nitrogen dioxide and at 138 kPa and 82 °C, 396 mL of NO_2 was formed.

(a) Determine the empirical formula of X.
(10 marks)

OR

m(C)	**=**	**12.01 / (44.01) x 1.116**	**n(C)**	**=**	**n(CO_2)**
	=	**0.304548 g**		**=**	**m/M**
% C	**=**	**0.304548 / 0.752 x 100**		**=**	**1.116 / 44.01**
	=	**40.44999**		**=**	**0.02535787**
			m(C)	**=**	**nM**
m(H)	**=**	**2 x 1.008 / 18.016 x 0.5329**		**=**	**0.02535787 x 12.01**
				=	**0.304548 g**
	=	**0.0596318 g**			
% H	**=**	**0.0596318 / 0.752 x 100**	**n(H)**	**=**	**2 x n(H_2O)**
	=	**7.92028**		**=**	**2 x (0.5329 / 18.016)**
				=	**0.0591585**
n(N)	**=**	**n(NO_2)**	**m(H)**	**=**	**0.0591585 x 1.008**

	=	PV/RT
	=	(138 x 0.396) / (8.314 x 355)
	=	0.0185155
m(N)	=	nM
	=	0.0185155 x 14.01
	=	0.259402
% N	=	0.259402 / 1.650 x 100
	=	15.72136
% O	=	100 - 40.44999 - 7.92028 - 15.72136
	=	35.9837

	=	0.0596318 g
n(N)	=	$n(NO_2)$
	=	PV/RT
	=	(138 x 0.396) / (8.314 x 355)
	=	0.0185155
scaling n(N) to match first sample size		
n(N)	=	0.0185155 / 1.65 x 0.7529
	=	0.00844868
m(N)	=	0.00844868 x 14.01
	=	0.118366 g
m(O)	=	0.7529 - 0.304548 - 0.0596318 - 0.118366
	=	0.270354 g

	C	H	O	N
ratio	3	7	2	1

Therefore EF is $C_3H_7O_2N$

(b) Determine the molecular formula of X if the known molecular weight is 89.1 g mol^{-1}.

(2 marks)

M(EF) = 89.096 g mol^{-1}

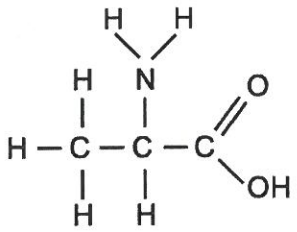
M / M(EF) = 89.1 / 89.096
= 1

Therefore MF is also $C_3H_7O_2N$

(c) Given that X is an α-amino acid, draw its structure and state the IUPAC name that would be given to alanine.

(2 marks)

Structure:



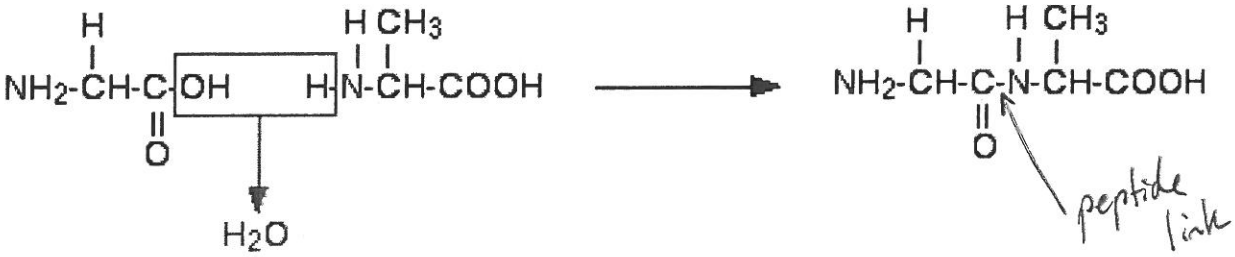
IUPAC name: **2-aminopropanoic acid**

(d) What is meant by an 'α-amino acid'? (i.e. how do α-amino acids differ from other amino acids?) (1 mark)

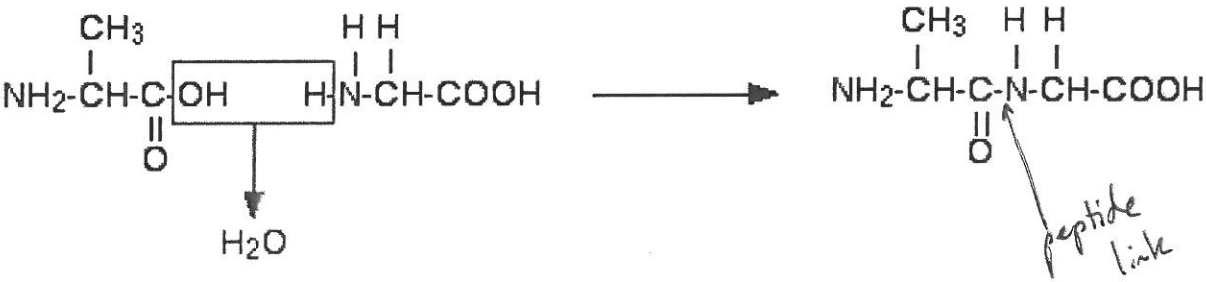
The NH_2 and COOH groups are both bonded to the same carbon

Question 4. [4 marks]

Glycine and alanine can combine together with the elimination of a molecule of water to produce a ***dipeptide***. It is possible for this to happen in one of two different ways - so you might get two different dipeptides. Write two equations to represent the formation of these dipeptides *and* identify the peptide link.
Either:

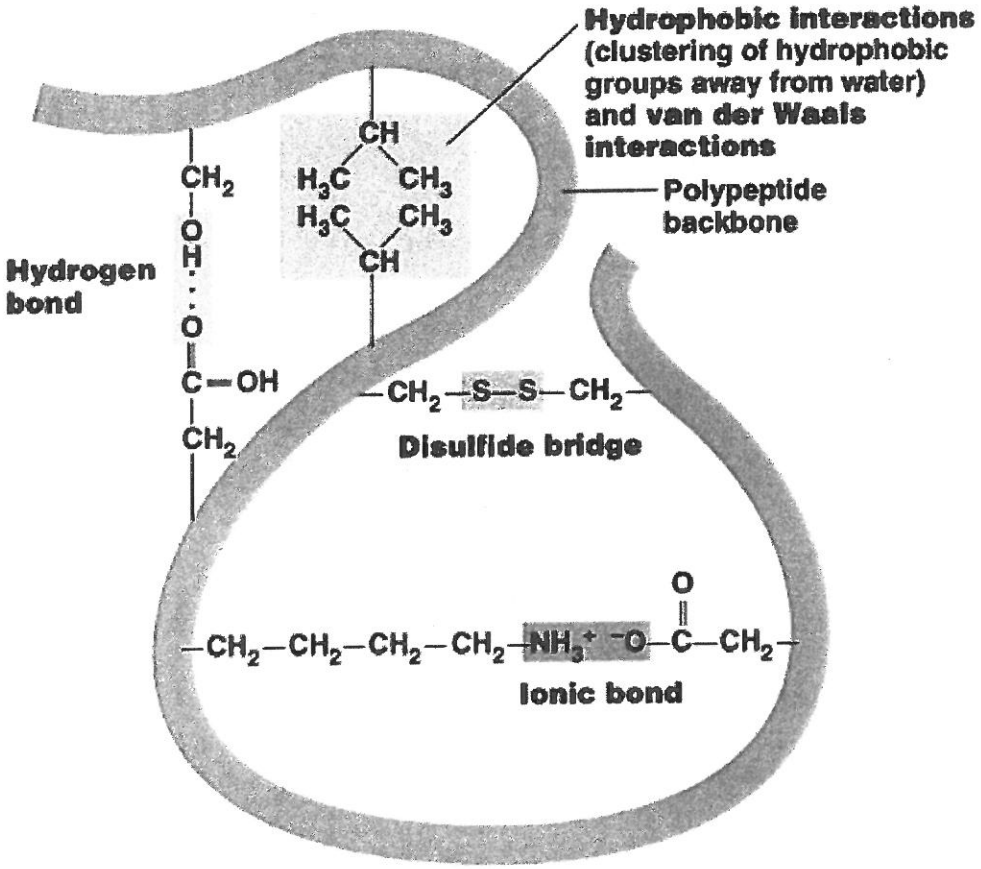


Or:



Question 5 (4 marks)

The diagram below shows a small section of a common protein, showing the types of interactions that can occur between amino acid side chains to form the overall structure of the protein. Name the type of intermolecular or intramolecular force occurring between sections of the polypeptide backbone.



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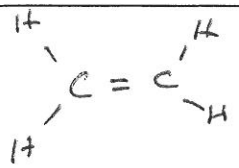
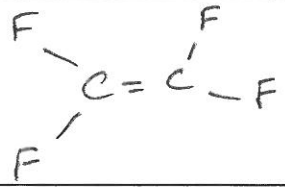
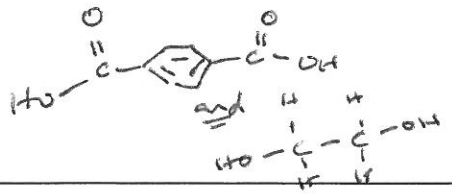
Question 7: [3 marks]

Complete the table below which relates to the properties and uses of plastics.

Plastic	**Method of polymerisation (addition or condensation; write "A" or "C")**	**Monomer(s) used to produce polymer**
High density polyethene	A	
Polytetrafluoroethene (Teflon)	A	
Polyethylene terephthalate (PET)	C	

END OF TEST

$n(CO_2) = \frac{1.116}{44}$

$= 0.025364$ mol. ✓

$n(H_2O) = \frac{0.5329}{18}$

$= 0.02961$ mol. ✓

$m(C) = 0.30436$ g

$\%(C) = \frac{0.304}{0.7529} \times 100$ ✓

$= 40.43\%$

$m(H) = 0.05921$ g

$\%H = \frac{0.05921}{0.7529} \times 100$ ✓

$= 7.864\%$.

$n(NO_2) = \frac{PV}{RT} = \frac{188 \times 0.396}{8.314 \quad 355}$

$= 0.01852$ mol ✓

$m(N) = 0.2592$ g ✓

$\%(N) = 15.71\%$

$\%(O) = 100 -$

$= 35.996\%$. ✓

C	H	O	N.
$\frac{40.43}{12}$	$\frac{7.864}{1}$	$\frac{35.996}{16}$	$\frac{15.71}{14}$ ✓
3.37	7.86	2.25	1.12
3	7	2	1 ✓

$C_3H_7NO_2$ $(M = 89$ g/mol$)$ ✓

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b) ∴ also Molecular formula.

c)

2-aminopropanoic acid.

d)

Friday - Period 1

Applecross Senior High School
Science Department
RELIEF TEACHER INFORMATION 12

Teacher absent: R. BOELEN — Date: ~~11~~ 08/16
Relief teacher: _____ — Room: S206
Class: Yr 12 Chem — Period: ~~5~~ 1
Class list attached? ☐ Please indicate student absences on class list.

Please lock laboratory at completion of lesson (key in science staff office).

Work to be covered. If there are any problems please see the Head of Department.

1. Mark Roll

2. Students to work on questions
   Set 18 # 9, 10 p139
   Set 21 # 10 p171
   } Lucarelli

   and

   Review Ex 24-1 p525
   24-2 p527
   Q's & P's #1-5 p537
   } Foundations of Chemistry - in book shelf, top shelf.

Thanks,
Ric

NB: Students have been made aware of the work they need to do.

Relief teacher's comments. Please indicate how much work was covered, any discipline problems, anything for the regular teacher to follow up etc.

Please leave this sheet in the pigeon hole (main staff room) of the teacher for whom you were relieving.