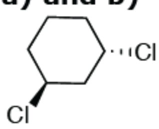
2008 National Qualifying Exam – Chemistry
Solutions

Section A (Multiple Choice)

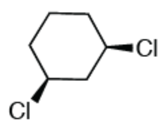
Question #	Answer	Question #	Answer	Question #	Answer
Q1	C	Q6	E	Q11	A
Q2	D	Q7	B	Q12	A
Q3	C	Q8	D	Q13	A
Q4	D	Q9	B	Q14	A
Q5	E	Q10	C	Q15	E

Question 16

a) and b)



trans

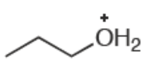


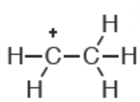
cis

c)

(i) O = nucleophilic
(ii) N = nucleophilic
(iii) C = neither
(iv) C = electrophilic, I = nucleophilic

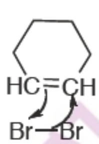
d) **(i)** Br^+ Br^-

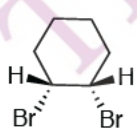
(ii)  NH_3

(iii) 

e)

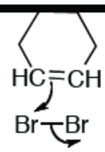
(i) bottom
(ii) bottom
(iii) both equal

f) **(i)** 

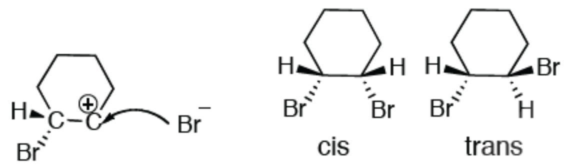
(ii) 

cis

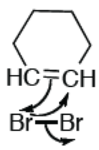
g) **(i)**



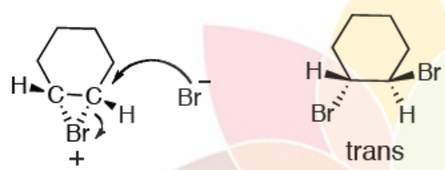
(ii)



h) **(i)**



(ii)



i) mechanism 3

Question 17

Chemistry NQE 2008 Q17

a)
i) Manganese, +VII, MnO_4^-
ii) Carbon, -III, **C**H_3COOH,

b)
C_2H_6O + H_2O → $C_2H_4O_2$ + 4 H^+ + 4 e^- [oxidation]
MnO_4^- + 8 H^+ + 5 e^- → Mn^{2+} + 4 H_2O

c)
5 C_2H_6O + 4 MnO_4^- + 12 H^+ → 5 $C_2H_4O_2$ + 4 Mn^{2+} + 11 H_2O

d)
n(MnO_4^-) = 0.05 x 0.0144 = 7.20 x 10^{-4} M
n(CH_3CH_2OH) = 5/4 x 7.20 x 10^{-4} = 9.00 x 10^{-4} M
[CH_3CH_2OH] in diluted white wine = 9.00 x 10^{-4} M/0.02 = 4.50 x 10^{-2} M

e)
$[CH_3CH_2OH]$ in white wine = 4.50 x 10^{-2} M x 500/10 = 2.25 M
1 L of wine has 2.25 x M_w (CH_3CH_2OH) = 2.25 x 46.07 = 103.7 g
v(CH_3CH_2OH) = 103.7/.79 = 131.2 mL
% v/v = 13.1 %

f)
If 1.2g of acetic acid in 1L $[CH_3COOH]$ = 1.2/60.05 = 1.998 x 10^{-2} M
20.00 mL diluted to 100.00 mL $[CH_3COOH]$ = 3.997 x 10^{-3} M
n(CH_3COOH) in 10.00 mL = 3.997 x 10^{-5} M
If approx. 20.00 mL titre of NaOH, [NaOH] = 3.997 x 10^{-5}/0.02 = 1.998 x 10^{-3} M
Most appropriate solution is 2.00 x 10^{-3} M

g)
All ethanol in wine now converted to acetic acid
$[CH_3COOH]$ in distillate = (2.25+1.998 x 10^{-2})/5 = 0.45299 M
A higher concentration of acetic acid requires a higher concentration of NaOH.
Use strongest NaOH available.

h)
No, even if the interference of the additional acetic acid produced from the reaction with MnO_4^- was taken into account, the proportion of the original acetic acid is very small and with this method its determination would be inaccurate.

Question 18

(a) From Figure 2, $\varepsilon_{Try} = 5.6 \times 10^3\ M^{-1}\ cm^{-1}$ and $\varepsilon_{Tyr} = 1.4 \times 10^3\ M^{-1}\ cm^{-1}$

(b) $\varepsilon_{glucagon} = (2 \times 1.4 \times 10^3 + 1 \times 5.6 \times 10^3) = \mathbf{8.4 \times 10^3\ M^{-1}\ cm^{-1}}$

(c) $c = \dfrac{A}{c \times \ell} = \dfrac{0.95}{8.4 \times 10^3 \times 1} = 1.13 \times 10^4\ mol\ L^{-1}$ (**1.1×10^4 mol L^{-1}** to 2 SF)

(d) $1.13 \times 10^4\ mol\ L^{-1} \times 3485\ g\ mol^{-1} = \mathbf{0.39\ g\ L^{-1}}$

(e)

(i) $1.0\ g\ L^{-1}$ glucagon $= \dfrac{1.0}{3485} = 2.87 \times 10^{-4}\ mol\ L^{-1}$

$A = \varepsilon \times c \times \ell = 8.4 \times 10^3\ M^{-1}\ cm^{-1} \times 2.87 \times 10^{-4}\ M \times 1.0\ cm = 2.41$ (**2.4** to 2 SF)

(ii)

Amino acid frequency in glucagon is: $\dfrac{2}{29} \times 100 = 6.90\%$ tyrosine and $\dfrac{1}{29} \times 100 = 3.45\%$ tryptophan.

ε(100 amino acids in glucagon) $= (6.90 \times 1.4 \times 10^3 + 3.45 \times 5.6 \times 10^3) = 2.9 \times 10^4\ M^{-1}\ cm^{-1}$

ε(100 amino acids in **average** polypeptide) $= (3.4 \times 1.4 \times 10^3 + 1.3 \times 5.6 \times 10^3) =$
$1.2 \times 10^4\ M^{-1}\ cm^{-1}$

A(1.0 g L^{-1} **average** polypeptide) =
A(1.0 g L^{-1} glucagon) $\times \dfrac{\varepsilon(\text{100 amino acids in average polypeptide})}{\varepsilon(\text{100 amino acids in glucagon})} =$

$2.41 \times \dfrac{1.24 \times 10^4}{2.90 \times 10^4} = \mathbf{1.0}$

(f) ε(unknown protein) $= (3 \times 1.4 \times 10^3 + 6 \times 5.6 \times 10^3) = 3.78 \times 10^4\ M^{-1}\ cm^{-1}$

A(0.24 g L^{-1} glucagon) $= 0.24 \times 2.41 = 0.578$

A(unknown protein) $= 1.85 - 0.578 = 1.27$

c(unknown protein) $= \dfrac{1.27}{3.78 \times 10^4 \times 1} = \mathbf{3.4 \times 10^{-5}\ mol\ L^{-1}}$

Question 19

a) *(1 mark)*

Non-metal

b) *(2 marks)*

n(NaOH) = cV
= 1.00 M × 0.018L
= 0.018mol

M_w = $^m/_n$
= $^{0.29}/_{0.018}$
= 16.1 (× 2 = 32.2 → S)
= Sulfur

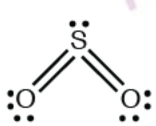
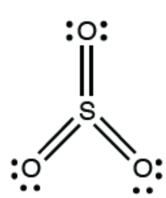
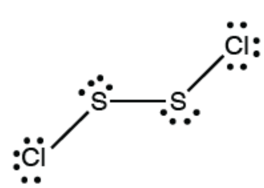
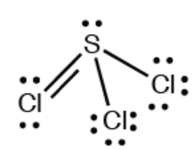
c)

A *(2 marks)*		
	S <u>or</u> S_8	
B *(2 marks)*		
	SO_2	$S + O_2 \rightarrow SO_2$
C *(2 marks)*		
	SO_3	$2 – SO_2 \rightarrow 2SO_2$
D *(2 marks)*		
	H_2SO_3	$SO_2 + H_2O \rightarrow H_2SO_3$
E *(2 marks)*		
	H_2SO_4	$SO_3 + H_2O \rightarrow H_2SO_4$
F *(3 marks)*		
	S_2Cl_2	$2S + Cl_2 \rightarrow S_2Cl_2$ $S_2Cl_2 + Cl_2 \rightarrow 2SCl_2$

d)

H *(3 marks)*
$SCl_2 + SO_3 \rightarrow SOCl_2 + SO_2$ H
I *(3 marks)*
$SOCl_2 + 2H_2O \rightarrow H_2SO_3 + 2HCl$

e) *(2 marks each)*

B	**C**	**F**	**F**
			
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