CSE CENTRE FOR STRATEGIC EDUCATION
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IARTV

CSE TEST – OCTOBER 2008

YEAR 12 - CHEMISTRY

Written test 2

SOLUTIONS BOOK

SECTION A – Multiple choice questions (20 marks)

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

Question 1 (5 marks)

a. $c_1V_1 = c_2V_2$ $= 5.00 \times 25.00 \times 10^{-3} = 500 \times 10^{-3} \times c_2$

$c_2 = 0.250$ mol L^{-1}

$[H+][OH^-] = 10^{-14}$

$[H+] = 10^{-14} / 0.250 = 4 \times 10^{-14}$

$pH = -\log[4 \times 10^{-14}] = 13.4$

2 marks

b. $K_a = \frac{[H_3O^+][In^-]}{[HIn]} = \frac{[In^-]^2}{[HIn]}$

$6 \times 10^{-5} = [In^-]^2 / 0.15$

$[In^-]^2 = 6 \times 10^{-5} \times 0.15$

$[In^-] = 0.003$ mol L^{-1}

2 marks

c. In an acidic solution the equilibrium will shift to the left side and the concentration of the yellow HIn will increase.
In an alkaline solution the equilibrium will shift to the right side and the concentration of the blue In will increase.

1 mark

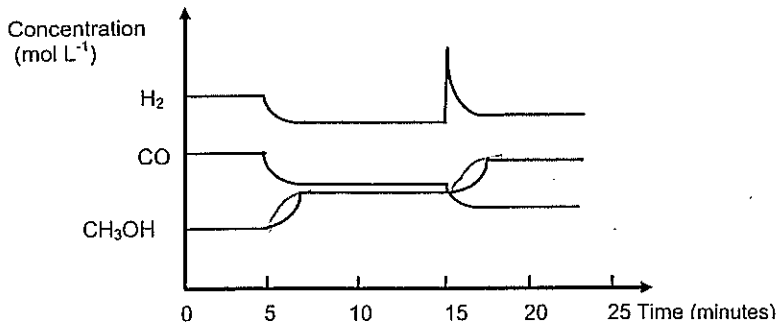
Question 2 (7marks)

a.

Change to the system	Net shift	Effect on the number of moles of O_2	Effect on the concentration of O_2
Addition of nitrogen gas at constant volume	None	None	None
Decrease in pressure	Left	Increases	~~Increases~~ Decreases
Increase in temperature	Left	Increases	Increases
Volume is halved	Right	Decreases	Increases
Steam is removed	Right	Decreases	Decreases

5 marks

b.



2 marks

Question 3 (7 marks)

	Primary cell	Secondary cell	Fuel cell
Reactants are supplied continuously			✓
Cell reactions are able to be reversed		✓	
Redox reactions are involved at the anode and cathode	✓	✓	✓
Cells contain an electrolyte	✓	✓	✓
Products of discharge remain in contact with electrode		✓	
Mass of the cell remains constant during discharge	✓	✓	✓
Direct conversion of chemical energy to electrical energy	✓	✓	✓

Question 4 (8 marks)

a. i. $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ 1 mark

ii. $C_2H_5OH(aq) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ 1 mark

b. $CH_3OH(aq) + H_2O(l) \rightarrow CO_2(g) + 6H^+(aq) + 6e^-$ 1 mark

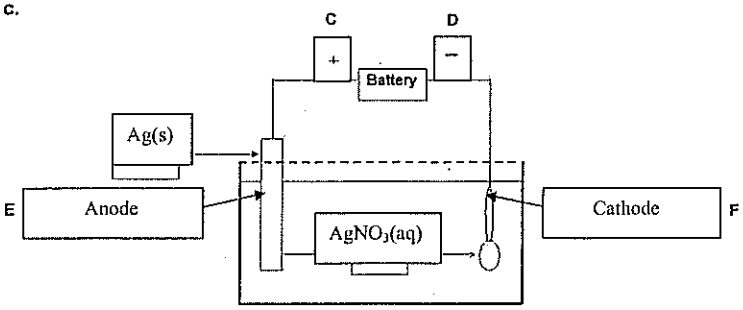
c. $n(C_2H_5OH) = 100/46.0$
$n(CO_2) = 100/46.0 \times 2$
$m(CO_2) = 2 \times 100/46 \times 44.0 = 191$ g
$n(CH_3OH) = 100/32.0$
$n(CO_2) = n(CH_3OH)$
$m(CO_2) = 100/32 \times 44.0 = 138$ g
Ethanol produces the greater mass of carbon dioxide per 100 g of fuel. 3 marks

d. i. More efficient conversion of chemical into electrical energy
Non-polluting in terms of emissions and noise 1 mark

ii. Cost of fuel, cost of cell, availability of fuel, high operating temperatures 1 mark

Question 5 (5 marks)

a. to c.



3 marks

d. $Ag^+(aq) + e^- \rightarrow Ag(s)$ 1 mark

e. Protection of metals from corrosion by galvanising, chrome plating etc 1 mark

Question 6 (10 marks)

a. A and B 1 mark

b. i. $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ 1 mark

ii. $2Fe^{3+}(aq) + Fe(s) \rightarrow 3Fe^{2+}(aq)$
1 mark

iii. One of use of non-standard conditions in terms of temperature or concentration or cell internal resistance. 1 mark

iv. Soluble and unreactive with oxidant and reductant. 1 mark

v. Platinum or Carbon(graphite) 1 mark

c. i. Decreases because hydronium ions are produced. 1 mark

ii. No change because hydronium ion concentration is unaltered. 1 mark

iii. Blue colour fades as copper ions are converted into copper metal. 1 mark

iv. It increases as copper metal is deposited. 1 mark

Question 7 (8 marks)

a. $E = 4.18 \times m \times \Delta T = 4.18 \times 100 \times 52.8 = 22\,070$ J — 2 marks

b. $n(C_4H_{10}) = 0.8/58.0$ mol

Enthalpy = $22\,070 \times 58.0/0.8$ J = 1600 kJ mol^{-1} — 2 marks

c. Theoretical value = 2874 kJ mol^{-1}

% energy = 1600/2874 x 100 = 55.7% — 2 marks

d. Yes, it would be greater because there will be no energy loss to surroundings or container and complete combustion will occur. — 2 marks

Question 8 (5 marks)

a. High temperatures — 1 mark

b. Low temperatures — 1 mark

c. Catalyst to lower activation energy and so increases the reaction rate. — 1 mark

d. i Alkanes because they have weak inter-molecular dispersion forces whereas alkanols exhibit H-bonding. — 1 mark

ii Increases because an increase in chain length increases the amount of combustion products. — 1 mark

Question 9 (9 marks)

	Haber Process	Contact Process	Ostwald Process	Cracking Process
a. Formula Industrial process	NH_3 **Haber Process**	H_2SO_4 **Contact Process**	HNO_3 **Ostwald Process**	C_2H_4 **Cracking Process**
b. Raw materials	N_2 and H_2	S and O_2 or air or SO_2	NH_3 and air and H_2O	C_2H_6 and other alkanes
c. Key Reaction	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$	$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$	$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$ or similar
d. Reaction conditions	Specific explanation of pressures, temperatures and catalyst etc used.	Specific explanation of pressures, temperatures and why catalyst etc used.	Specific explanation of pressures, temperatures and why catalyst etc used.	Specific explanation of steam cracking referring to pressures, temperatures and catalyst etc used.
e. Uses	Manufacture of fertiliser, detergents, explosives etc	Production of superphosphate and car batteries etc	Manufacture of fertiliser, explosives etc	Plastic items, industrial ethanol, pharmaceuticals
f. Waste management	Desulfurisation, Liquidfaction of CO_2, energy efficiency in terms of operating conditions. Waste heat recycled	Use of by-product waste SO_2 from smeltering instead of burning of elemental sulfur. Monitor of waste gas emission. Waste heat recycled.	Emissions source of photochemical smog. Industrial conditions such as heat exchangers, optimum reaction conditions. Catalytic decomposition of N_2O	Recycle unreacted ethane. Emitted gase can cause photochemical smog. Desulfurisation, by-products used, use o heat evolved to generate more high-pressure steam.

a. 1 mark b. 1 mark c. 1 mark d. 3 marks e. 1 mark f. 2 marks

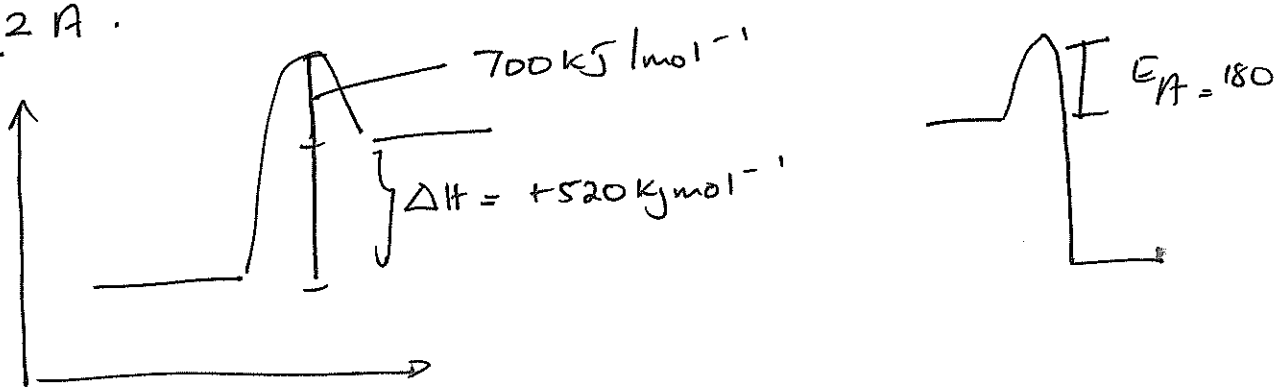
Question 1 D

A is incorrect; we usually talk about a solid catalyst with increasing surface area to increase rate of reaction. Note reactants + products are gaseous.

Both B + C will decrease rate of reaction.

Only D increases reaction rate.

Question 2 A.



ΔH for reverse reaction is $-520\ kjmol^{-1}$

$E_A = 700 - 520 = 180 kJ/mol^{-1}$

∴ ANS = A.

(Q3) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$.

4.00L vessel.

	PCl_5	PCl_3	Cl_2
initial	0.8 mol	0	0
	0.76 used	0.76 produced	0.76 produced
Eqm	0.04 mole	0.760 mol	0.760 mole.
[Eqm]	= 0.01M	0.19M	0.19M.

K_{eq}

$$K_{eq} = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{0.19 \times 0.19}{0.01}$$

$$= 3.61\ M.$$

ANS = A.

Q4) Acid + Base $\rightleftharpoons$ H_2O $\quad \Delta H = -ve$

OR $\quad H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O \quad \Delta H = \ominus$

Ionisation of water is endothermic (reverse reac^n)

$$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)} \qquad \Delta H = +$$

As temp, increases, there is a net forward reaction producing more H^+. pH decreases.

ANS = B.

Q5) D. catalyst increases rate of ~~forward~~/backward reac^n

Q6) $H_2CO_{3\,(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^-{}_{(aq)} + H_3O^+$

initial effect. increase in OH^- $\quad OH^-$ reacts with H^+, thus decreasing $[H^+]$

opposing effect: increase in $[H^+]$

net shift to right $\quad$ ANS = B

Q7) $n(OH^-) = 2 \times 5.00 \times 10^{-5}$ mole

$$c(OH^-) = \frac{2 \times 5 \times 10^{-5}}{0.01\,L} = 0.01M.$$

$[H^+][OH^-] = 10^{-14}$ $\quad$ at 25°C $\quad$ refer to d.booklet

$$[H^+] = \frac{10^{-14}}{.01} = 10^{-12}$$

$pH = 12$.

ANS = D.

Q8) $pH = 5 \therefore [H^+] = 10^{-5}$

from D. Booklet $\quad HOBr + H_2O \rightleftharpoons OBr^- + H_3O^+$

$$K_a = \frac{[OBr^-][H_3O^+]}{[HOBr]} = 2.4 \times 10^{-9}$$

$$[HOBr] = \frac{[OBr^-][H_3O^+]}{2.4 \times 10^{-9}}$$

let $[H^+] = [OBr^-] = 10^{-5}$

$$[HOBr] = \frac{(10^{-5})^2}{2.4 \times 10^{-9}}$$

$$= \frac{1 \times 10^{-10}}{2.4 \times 10^{-9}}$$

$$= 0.042\ M$$

ANS = C.

Q9) D

A + B - non-renewable.
Fuel cell H_2 must be supplied
O_2

Q10) A.

Q11) when calibrated electrically temp rises
when substance is added Temp falls.

ANS = A.

Q12) $n(H_2) = \frac{2.20}{2} = 1.10$ mole $\quad n(O_2) = \frac{16}{32} = 0.5$ mole

O_2 is Lim. Reagent.

∴ 0.5 mole of $O_2 \rightarrow \frac{-572}{2} = -286$ kJ

ANS = B.

Q13) $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

$n(H_2) = \frac{27 \times 10^3}{2} = 13500$ mole.

$n(H_2O) = 13500$ mole ∴ $m(H_2O) = n \times M$

$= 243{,}000$ g

$= 243$ kg.

ANS = C.

Q14) C

Q15) D. Booklet (A)
need a strong oxidant to oxidise Cu to Cu^{2+}
eg I_2 + Cu.

Q16) Discharging; anode is (−) oxidation occurs.

$\therefore$ $Pb + SO_4^{2-} \longrightarrow PbSO_4 + 2e^-$

Ans = A.

Q17) ↑ $Al^{3+}_{(l)} + 3e^- \longrightarrow Al_{(l)}$
$Mg^{2+}_{(l)} + 2e^- \longrightarrow Mg_{(l)}$
$Na^{+}_{(l)} + e^- \longrightarrow Na_{(l)}$ ↓

$n(Al) = \frac{n(e^-)}{3}$ $\quad \therefore n(Mg) = \frac{n(e^-)}{2}$ $\quad \therefore n(Na) = n(e^-)$

Ans = C.

Q18) $C^+ + e^- \longrightarrow C$
$B^+ + e^- \longrightarrow B$
$A^+ + e^- \longrightarrow A$

C^+ is the strongest oxidant : Ans = D.

Q19) $2Cl^- \longrightarrow Cl_2 + 2e^-$ Anode (+)
D. Booklet $2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$ Cathode (−)

Ans = D.

Q20) $Q = I \times t$
$= 278 \times 26$
$= 7228\,C$

$\frac{Q}{F} = n(e^-)$
$0.0749\ mole = n(e^-)$

D. Booklet $Ca^{2+}_{(l)} + 2e^- \longrightarrow Ca_{(l)}$ molten electrolysis!

$n(Ca) = \frac{n(e^-)}{2} = 0.03745\ mole$

$m(Ca) = 0.03745 \times 40 = 1.49\,g$ ANS = (A)