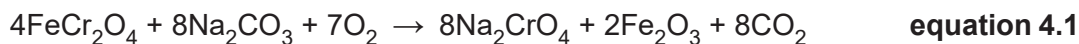


A Level Chemistry B (Salters)
H433/02 Scientific literacy in chemistry

Question Set 4

1 Chromium is a metal with many uses, one of which is the production of a shiny chromium plating on steel.

Chromium is made from its ore chromite, FeCr_2O_4 , by the following reactions. Iron has one of its common oxidation states in chromite.



- (a) (i) Complete the table below showing the oxidation states of chromium species in the equations above.

For each equation state whether chromium has been reduced, oxidised or neither.

Equation no.	Oxidation state of Cr in reactant	Oxidation state of Cr in product	Has Cr been oxidised, reduced or neither?
4.1			
4.2			
4.3			
4.4			

[4]

- (ii) Calculate the maximum mass of chromium (in kg) that could be obtained from 1000g of chromite.

mass = kg [2]

- (b) (i) Chromium plating is carried out using a solution of chromium(III) chloride with a graphite anode.

Write the electron configuration of a Cr^{3+} ion, using sub-shells and atomic orbitals. [1]

- (ii) Draw a labelled diagram of a simple apparatus to carry out chromium plating of a steel object in a student laboratory. [3]

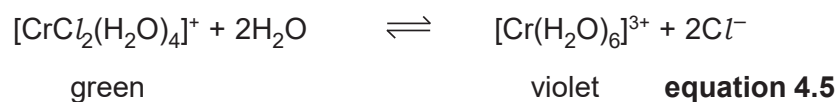
- (iii) Write a half-equation for the cathode reaction in the cell in (b)(ii). [1]

- (iv) A 'mole of electrons' is 96 500 coulombs and a coulomb is a current of 1 amp flowing for 1 second.

Calculate the time (in hours) needed to deposit 26 g of chromium at a current of 5.0 amps in the cell in (b)(ii).

time = _____ hours [3]

- (c) (i) In a solution of chromium(III) chloride an equilibrium exists, as shown in **equation 4.5**.



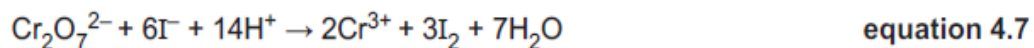
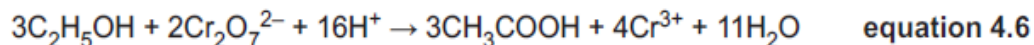
Name the ligands in the green complex. [1]

- (ii) Some students have a violet solution of chromium(III) chloride.

Use your knowledge of equilibria to suggest and explain how they might make the violet solution turn green.

Give the **name** of any reagent required. [2]

- (d) (i) The concentration of an ethanol solution can be measured using the following steps.
- add excess acidified dichromate, $\text{Cr}_2\text{O}_7^{2-}$, some of which reacts with the ethanol.
 - add excess iodide that reacts with the remaining dichromate.
 - titrate the iodine produced with sodium thiosulfate.



Some students add acid and 20.0 cm^3 of 0.200 mol dm^{-3} $\text{Cr}_2\text{O}_7^{2-}$ to 25.0 cm^3 of a 'low-alcohol' beer.

They add excess iodide ions and find that the iodine produced reacts with 27.6 cm^3 of 0.100 mol dm^{-3} $\text{Na}_2\text{S}_2\text{O}_3$.

Calculate the concentration of the ethanol in the beer (in mol dm^{-3}) and then the percentage of ethanol (in g per 100 cm^3).

concentration of ethanol mol dm^{-3}
 % ethanol = $\text{g}/100\text{ cm}^3$ **[6]**

- (ii) Suggest one assumption the students have to make when giving their result. **[1]**

Total Marks for Question Set 4: 24

Resource Materials

Question Set No: 4

The Periodic Table of the Elements

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(0)
1	2	13	14	15	16	17	18
1	2	13	14	15	16	17	18
H hydrogen 1.0	He helium 4.0	B boron 10.8	C carbon 12.0	N nitrogen 14.0	O oxygen 16.0	F fluorine 19.0	Ne neon 20.2
3	4	13	14	15	16	17	18
Li lithium 6.9	Be beryllium 9.0	Al aluminum 27.0	Si silicon 28.1	P phosphorus 31.0	S sulfur 32.1	Cl chlorine 35.5	Ar argon 39.9
11	12	13	14	15	16	17	18
Na sodium 23.0	Mg magnesium 24.3	Al aluminum 27.0	Si silicon 28.1	P phosphorus 31.0	S sulfur 32.1	Cl chlorine 35.5	Ar argon 39.9
19	20	31	32	33	34	35	36
K potassium 39.1	Ca calcium 40.1	Ga gallium 69.7	Ge germanium 72.6	As arsenic 74.9	Se selenium 79.0	Br bromine 79.9	Kr krypton 83.8
37	38	49	50	51	52	53	54
Rb rubidium 85.5	Sr strontium 87.6	In indium 114.8	Sn tin 118.7	Sb antimony 121.8	Te tellurium 127.6	I iodine 126.9	Xe xenon 131.3
55	56	81	82	83	84	85	86
Cs cesium 132.9	Ba barium 137.3	Tl thallium 204.4	Pb lead 207.2	Bi bismuth 209.0	Po polonium	At astatine	Rn radon
87	88	114	114	114	116		
Fr francium	Ra radium	Ff flerovium	Ff flerovium	Ff flerovium	Lv livermorium		
3	4	5	6	7	8	9	10
21	22	23	24	25	26	27	28
Sc scandium 45.0	Ti titanium 47.9	V vanadium 50.9	Cr chromium 52.0	Mn manganese 54.9	Fe iron 55.8	Co cobalt 58.9	Ni nickel 58.7
39	40	41	42	43	44	45	46
Y yttrium 88.9	Zr zirconium 91.2	Nb niobium 92.9	Mo molybdenum 95.9	Tc technetium	Ru ruthenium 101.1	Rh rhodium 102.9	Pd palladium 106.4
57-71 lanthanoids	72	73	74	75	76	77	78
	Hf hafnium 178.5	Ta tantalum 180.9	W tungsten 183.8	Re rhenium 186.2	Os osmium 190.2	Ir iridium 192.2	Pt platinum 195.1
89-103 actinoids	104	105	106	107	108	109	110
	Rf rutherfordium 261	Db dubnium 262	Sg seaborgium 263	Bh bohrium 264	Hs hassium 265	Mt meitnerium 266	Ds darmstadtium 267
57	58	59	60	61	62	63	64
La lanthanum 138.9	Ce cerium 140.1	Pr praseodymium 140.9	Nd neodymium 144.2	Pm promethium	Sm samarium 150.4	Eu europium 152.0	Gd gadolinium 157.2
89	90	91	92	93	94	95	96
Ac actinium 227	Th thorium 232.0	Pa protactinium 231	U uranium 238.1	Np neptunium	Pu plutonium	Am americium	Cm curium
67	68	69	70	71	72	73	74
Ho holmium 164.9	Er erbium 167.3	Tm thulium 168.9	Yb ytterbium 173.0	Lu lutetium 175.0			
97	98	99	100	101	102	103	
Bk berkelium	Cf californium	Es einsteinium	Fm fermium	Md mendelevium	No nobelium	Lr lawrencium	

Key
atomic number
Symbol
name
relative atomic mass

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