Cambridge Pre-U

Data Booklet

Pre-U Certificate in Chemistry

For use from 2010 in all papers for the above syllabus.

CST258

UNIVERSITY of CAMBRIDGE
International Examinations

This document consists of **6** printed pages and **2** blank pages.

Important values and constants

molar gas constant	R	= 8.31 J K^{-1} mol^{-1}
the Faraday constant	F	= 9.65 × 10^4 C mol^{-1}
the Avogadro constant	L	= 6.02 × 10^{23} mol^{-1}
the Planck constant	h	= 6.63 × 10^{-34} J s
speed of light in a vacuum	c	= 3.00 × 10^8 m s^{-1}
electronic charge	e	= –1.60 × 10^{-19} C

Important equations

Specific heat capacity: $q = mc\Delta T$

where q is heat produced in joules (J); m is mass in g; c is specific thermal heat capacity in J $g^{-1}K^{-1}$; and ΔT is the temperature change in K

Gibbs energy equation: $\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$

$\Delta G^{\ominus}$ is the standard Gibbs energy change; $\Delta H^{\ominus}$ is the standard enthalpy change; T is thermodynamic temperature; $\Delta S^{\ominus}$ is the standard entropy change

Gibbs and equilibrium: $\Delta G^{\ominus} = -RT \ln K$

$\Delta G^{\ominus}$ is the standard Gibbs energy change; R is the molar gas constant; T is thermodynamic temperature; K is the equilibrium constant

Equilibrium constant: $K = \dfrac{[C]_{eq}^{c}}{[A]_{eq}^{a}[B]_{eq}^{b}}$ for the equilibrium $aA + bB \rightleftharpoons cC$

[X] is the concentration of X divided by the standard concentration

Cell free energy change: $\Delta G^{\ominus} = -nFE_{cell}^{\ominus}$

$\Delta G^{\ominus}$ is the standard Gibbs energy change; n is the number of electrons; F is the Faraday constant; $E_{cell}^{\ominus}$ is the standard cell potential

Ideal gas equation: $pV = nRT$

p is pressure; V is volume; n is amount; R is the molar gas constant; T is thermodynamic temperature

Arrhenius equation: $k = A\exp\left(\frac{-E_a}{RT}\right)$

k is the rate constant; A is the pre-exponential factor; E_a is the activation energy; R is the molar gas constant; T is thermodynamic temperature

First order kinetics: $ln\ (C_0 / C_t) = kt$

C_0 is the concentration at time $t = 0$; C_t is the concentration at time t; k is the rate constant

Electromagnetic energy: $E = hf$

E is the photon energy; h is the Planck constant; f is frequency

The Periodic Table of the Elements

Group																	
1	2											13	14	15	16	17	18
							1.0 H hydrogen 1										4.0 He helium 2
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	3	4	5	6	7	8	9	10	11	12	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	lanthanides 57-71	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	actinides 89-103	– Rf rutherfordium 104	– Db dubnium 105	– Sg seaborgium 106	– Bh bohrium 107	– Hs hassium 108	– Mt meitnerium 109	– Ds darmstadtium 110	– Rg roentgenium 111							

lanthanides	139 La lanthanum 57	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
actinides	– Ac actinium 89	– Th thorium 90	– Pa protactinium 91	– U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Qualitative Analysis Notes

[Key: ppt. = precipitate]

1 Reactions of aqueous cations

cation	*reaction with*	
	NaOH(aq)	NH_3(aq)
aluminium, Al^{3+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH_4^+(aq)	no ppt. ammonia produced on heating	–
barium, Ba^{2+}(aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca^{2+}(aq)	white ppt. with high $[Ca^{2+}(aq)]$	no ppt.
chromium (III), Cr^{3+}(aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu^{2+}(aq),	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), Fe^{2+}(aq)	green ppt., turning brown on contact with air insoluble in excess	green ppt., turning brown on contact with air insoluble in excess
iron(III), Fe^{3+}(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
lead(II), Pb^{2+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
magnesium, Mg^{2+}(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn^{2+}(aq)	off-white ppt., rapidly turning brown on contact with air insoluble in excess	off-white ppt., rapidly turning brown on contact with air insoluble in excess
zinc, Zn^{2+}(aq)	white ppt. soluble in excess	white ppt. soluble in excess

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-}(aq)	yellow solution turns orange with H^+(aq); gives yellow ppt. with Ba^{2+}(aq); gives bright yellow ppt. with Pb^{2+}(aq)
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3 (aq)); gives white ppt. with Pb^{2+}(aq)
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq)); gives yellow ppt. with Pb^{2+}(aq)
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil; NO liberated by dilute acids (colourless NO → (pale) brown NO_2 in air)
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+}(aq) (insoluble in excess dilute strong acids)
sulfite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	“pops” with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns aqueous acidified potassium dichromate(VI) (aq) from orange to green

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