89/06(a) # The University of Sydney

CHEM1611 - CHEMISTRY 1 (PHARMACY)

FIRST SEMESTER EXAMINATION

CONFIDENTIAL

JUNE 2002 **TIME ALLOWED: THREE HOURS**

GIVE THE FOLLOWING INFORMATION IN BLOCK LETTERS

FAMILY NAME		**SID NUMBER**	
OTHER NAMES		**TABLE NUMBER**	

OFFICIAL USE ONLY

Multiple choice section

	Marks	
Pages	Max	Gained
2-5	25	

INSTRUCTIONS TO CANDIDATES

- All questions are to be attempted. There are 12 pages of examinable material.
- Complete the examination paper in **INK.**
- Read each question carefully. Report the appropriate answer and show all relevant working in the space provided.
- The total score for this paper is 100. The possible score per page is shown in the adjacent tables.
- Each new short answer question begins with a •.
- Electronic calculators, including programmable calculators, may be used. Students are warned, however, that credit may not be given, even for a correct answer, where there is insufficient evidence of the working required to obtain the solution.
- A Periodic Table and numerical values required for any question may be found on a separate data sheet.
- Pages 6, 11 and 16 are for rough working only.

Short answer section

Page	Marks Max	Gained		Marker
7	10			
8	10			
9	9			
10	9			
12	6			
13	10			
14	10			
15	11			
Total	75			
Check Total				

• Write a balanced **ionic equation** for the reaction that occurs in each of the following cases. If no reaction occurs, write "no reaction". *Include only those species involved in the reaction*.	**Marks 10**
Solutions of barium chloride and sodium sulfate are mixed.	
Copper(II) oxide is treated with hydrochloric acid (6 M).	
Solutions of mercury(I) nitrate and sodium chloride are mixed.	
Dilute nitric acid is added to solid magnesium carbonate and the solution is warmed.	
A large excess of sodium hydroxide solution (4 M) is added to a solution containing aluminium ions.	
Sodium metal is added to excess water.	
Magnesium metal is ignited in excess oxygen.	
Chlorine gas is bubbled through an iron(II) sulfate solution.	
Iron(II) sulfide is treated with excess sulfuric acid (5 M).	
Cobalt(II) nitrate solution is mixed with excess sodium phosphate solution.	

- Classify each of the following as either "soluble" or "insoluble" in water at 298 K.

Marks 3

Compound	Solubility	Compound	Solubility
$K_2Cr_2O_7$		K_2SO_4	
SrC_2O_4		$Ba(OH)_2$	
CaF_2		$MgCO_3$	

- Complete the following table.

7

FORMULA	SYSTEMATIC NAME
NH_4SCN	
	cobalt(II) nitrate-6-water
$HClO_4$	
	potassium nitrite
$Bi(NO_3)_3$	
	potassium hydrogencarbonate
As	
	tetraaquadibromocobalt(III) chloride
$[Ni(OH_2)_5Cl]NO_3$	
	mercury(I) acetate
cis-$[Pt(NH_3)_2Cl_2]$	
	potassium hexacyanoferrate(II)
H_3PO_4	
	aluminium oxide

	Marks
• A gas formed by the reaction of N_2F_4 and $S_2O_6F_2$ is found to contain nitrogen (9.3%), sulfur (21.2%) and fluorine (37.7%). The remainder is assumed to be oxygen. The same gas (0.214 g) at 1.05 atm pressure and 296 K is found to occupy 33.0 mL.	**5**
What is the empirical formula of the gas?	
What is the molar mass of the gas?	
What is the molecular formula of the gas?	
• Calculate the heat input required for the conversion of 18.0 g of water from ice at 273 K to steam at 373 K. Give your answer in joules.	**2**
• Red and white blood cells have walls that are semi-permeable membranes. The concentration of solute particles in blood is approximately 0.6 M. Explain what will happen to the blood cells when placed in: (i) pure water, (ii) 1 M sodium chloride.	**2**

- Oxygen-free blood plasma (25.0 mL) is placed in a gas burette containing pure oxygen, which is maintained at a constant pressure of 101 kPa and a temperature of 37 ºC. As a result of dissolution in the plasma, the volume of oxygen decreases by 0.60 mL.

  What is the concentration of O_2 in the blood plasma expressed as molarity?

Marks 3

Answer: M

What is the concentration of O_2 in the blood plasma expressed as mg mL^{-1}?

Answer: mg mL^{-1}

- A solution was prepared by mixing hydrochloric acid (1.00 L, 0.10 M), hydrobromic acid (1.00 L, 0.20 M) and sodium hydroxide (10.0 g). What is the pH of the final solution?

3

pH =

- Ammonium chloride (100 mL, 0.20 M) is mixed with solid sodium hydroxide (0.010 mole). Calculate the final pH of the solution.

3

pH =

- When lead(II) fluoride (PbF_2) is shaken with water at 25 °C, its solubility is found to be 0.64 g L^{-1}. Calculate the value of K_{sp} for this compound at this temperature.

Marks **3**

Answer:

- For the reaction at 298 K, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

  calculate K_p and ΔS_{298} for the reaction as written.

  Data at 298 K: $\Delta H_f^\circ\ (NH_3) = -46$ kJ mol^{-1} $\Delta G_f^\circ\ (NH_3) = -16$ kJ mol^{-1}

3

K_p =

ΔS_{298} =

	Marks
• Thyroxine is a human hormone that controls metabolism. A sample weighing 0.546 g was dissolved in 15 g of benzene, and the freezing point depression was determined to be 0.240 °C. Calculate the molecular weight of thyroxine. (K_f benzene is 5.12 °C kg mol^{-1})	**4**
Answer:	
• The molar heats of vaporisation of water and nitrogen are 41 and 5.6 kJ mol^{-1} respectively. Account for this large difference.	**2**
• Phenylacetic acid ($C_6H_5CH_2COOH$) builds up in the blood of persons with phenyl-ketonuria, an inherited disorder that, if untreated, causes mental retardation or death. A study of the acid shows that a 0.12 M solution of phenylacetic acid has a pH of 2.6. What is the K_a of phenylacetic acid?	**4**
Answer:	

	Marks
• Chlorine is produced by the electrolysis of sodium chloride. Calculate the volume of $Cl_2(g)$ produced at 25 °C and 1.00 atm when a current of 10.0 A is passed through a NaCl solution for 2.00 hours.	**4**
ANSWER:	
• Technetium-99 has a half-life of 6.02 hours, and the gamma particles formed during its decay are used to monitor blood flow near the heart. If a patient is injected with 23 mg of Tc-99, what mass of Tc-99 remains in the body after 48 hours?	**3**
ANSWER:	
• The measured voltage of the cell $Cu(s) \mid Cu^{2+}(aq) \mid\mid Ag^{+}(aq) \mid Ag(s)$ is 0.35 V at 25 °C. Given $E°$ = 0.46 V and the concentration of $Ag^{+}(aq)$ is 0.010 M, calculate the concentration of $Cu^{2+}(aq)$.	**3**
ANSWER:	

- For each of the following elements, identify a biological function and indicate what feature(s) of the element make it suitable for this function.

Marks 8

Element	Biological function	Feature(s) of element
calcium		
potassium		
iron		
chlorine		

3

- Balance the following redox equation for acidic conditions.

$$Ag + Cr_2O_7^{2-} \rightarrow Cr^{3+} + Ag^{+}$$

OXIDATION half reaction
REDUCTION half reaction
OVERALL reaction

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Numerical Data

Physical constants

Avogadro constant = $N_A = 6.022 \times 10^{23}$ mol^{-1}

Faraday constant = F = 96485 C mol^{-1}

Standard atmosphere = 1 atm = 1.013×10^5 Pa = 760.0 mmHg

Ideal gas constant = R = 8.314 J K^{-1} mol^{-1}

= 0.08206 L atm K^{-1} mol^{-1}

Density of liquid water at 298 K and 1.00 atm = 0.9970 g mL^{-1}

Conversion factors

0 °C = 273 K	1 cm = 10^{-2} m
1 kJ = 10^3 J	1 nm = 10^{-9} m
1 kPa = 10^3 Pa	1 mL = 10^{-3} L
1 L = 10^{-3} m^3	1 atm = 101.3 kPa

Thermodynamic data

C_p $H_2O(l)$ = 75 J K^{-1} mol^{-1}

ΔH_{vap} $H_2O(l)$ = 41 kJ mol^{-1}

ΔH_{fus} $H_2O(s)$ = 6.0 kJ mol^{-1}

Acid ionisation constant

pK_a NH_4^+ = 9.24

Standard electrode reduction potentials

$Zn^{2+} + 2e^- \rightarrow Zn$	$E° = -0.76$ V
$Cu^{2+} + 2e^- \rightarrow Cu^{2+}$	$E° = 0.34$ V

A periodic table is printed on the other side of this data sheet.

Atomic weights are included in the periodic table.

June 2002

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89/06(b)

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 HYDROGEN **H** 1.008																	2 HELIUM **He** 4.003
3 LITHIUM **Li** 6.941	4 BERYLLIUM **Be** 9.012											5 BORON **B** 10.81	6 CARBON **C** 12.01	7 NITROGEN **N** 14.01	8 OXYGEN **O** 16.00	9 FLUORINE **F** 19.00	10 NEON **Ne** 20.18
11 SODIUM **Na** 22.99	12 MAGNESIUM **Mg** 24.31											13 ALUMINIUM **Al** 26.98	14 SILICON **Si** 28.09	15 PHOSPHORUS **P** 30.97	16 SULFUR **S** 32.07	17 CHLORINE **Cl** 35.45	18 ARGON **Ar** 39.95
19 POTASSIUM **K** 39.10	20 CALCIUM **Ca** 40.08	21 SCANDIUM **Sc** 44.96	22 TITANIUM **Ti** 47.88	23 VANADIUM **V** 50.94	24 CHROMIUM **Cr** 52.00	25 MANGANESE **Mn** 54.94	26 IRON **Fe** 55.85	27 COBALT **Co** 58.93	28 NICKEL **Ni** 58.69	29 COPPER **Cu** 63.55	30 ZINC **Zn** 65.39	31 GALLIUM **Ga** 69.72	32 GERMANIUM **Ge** 72.59	33 ARSENIC **As** 74.92	34 SELENIUM **Se** 78.96	35 BROMINE **Br** 79.90	36 KRYPTON **Kr** 83.80
37 RUBIDIUM **Rb** 85.47	38 STRONTIUM **Sr** 87.62	39 YTTRIUM **Y** 88.91	40 ZIRCONIUM **Zr** 91.22	41 NIOBIUM **Nb** 92.91	42 MOLYBDENUM **Mo** 95.94	43 TECHNETIUM **Tc** [98.91]	44 RUTHENIUM **Ru** 101.07	45 RHODIUM **Rh** 102.91	46 PALLADIUM **Pd** 106.4	47 SILVER **Ag** 107.87	48 CADMIUM **Cd** 112.40	49 INDIUM **In** 114.82	50 TIN **Sn** 118.69	51 ANTIMONY **Sb** 121.75	52 TELLURIUM **Te** 127.60	53 IODINE **I** 126.90	54 XENON **Xe** 131.30
55 CAESIUM **Cs** 132.91	56 BARIUM **Ba** 137.34	57-71	72 HAFNIUM **Hf** 178.49	73 TANTALUM **Ta** 180.95	74 TUNGSTEN **W** 183.85	75 RHENIUM **Re** 186.2	76 OSMIUM **Os** 190.2	77 IRIDIUM **Ir** 192.22	78 PLATINUM **Pt** 195.09	79 GOLD **Au** 196.97	80 MERCURY **Hg** 200.59	81 THALLIUM **Tl** 204.37	82 LEAD **Pb** 207.2	83 BISMUTH **Bi** 208.98	84 POLONIUM **Po** [210.0]	85 ASTATINE **At** [210.0]	86 RADON **Rn** [222.0]
87 FRANCIUM **Fr** [223.0]	88 RADIUM **Ra** [226.0]	89-103	104 RUTHERFORDIUM **Rf** [261]	105 DUBNIUM **Db** [262]	106 SEABORGIUM **Sg** [266]	107 BOHRIUM **Bh** [262]	108 HASSIUM **Hs** [265]	109 MEITNERIUM **Mt** [266]									

LANTHANIDES	57 LANTHANUM **La** 138.91	58 CERIUM **Ce** 140.12	59 PRASEODYMIUM **Pr** 140.91	60 NEODYMIUM **Nd** 144.24	61 PROMETHIUM **Pm** [144.9]	62 SAMARIUM **Sm** 150.4	63 EUROPIUM **Eu** 151.96	64 GADOLINIUM **Gd** 157.25	65 TERBIUM **Tb** 158.93	66 DYSPROSIUM **Dy** 162.50	67 HOLMIUM **Ho** 164.93	68 ERBIUM **Er** 167.26	69 THULIUM **Tm** 168.93	70 YTTERBIUM **Yb** 173.04	71 LUTETIUM **Lu** 174.97
ACTINIDES	89 ACTINIUM **Ac** [227.0]	90 THORIUM **Th** 232.04	91 PROTACTINIUM **Pa** [231.0]	92 URANIUM **U** 238.03	93 NEPTUNIUM **Np** [237.0]	94 PLUTONIUM **Pu** [239.1]	95 AMERICIUM **Am** [243.1]	96 CURIUM **Cm** [247.1]	97 BERKELLIUM **Bk** [247.1]	98 CALIFORNIUM **Cf** [252.1]	99 EINSTEINIUM **Es** [252.1]	100 FERMIUM **Fm** [257.1]	101 MENDELEVIUM **Md** [256.1]	102 NOBELIUM **No** [259.1]	103 LAWRENCIUM **Lr** [260.1]