89/06(a)

The University of Sydney

CHEM1611 - CHEMISTRY 1 (PHARMACY)

FIRST SEMESTER EXAMINATION

CONFIDENTIAL

JUNE 2003

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
2-9	33	

INSTRUCTIONS TO CANDIDATES

- All questions are to be attempted. There are 16 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 10, 16 and 20 are for rough working only.

Short answer section

Page	Marks Max	Gained		Marker
11	10			
12	10			
13	7			
14	7			
15	8			
17	7			
18	9			
19	9			
Total	67			
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**
Excess hydrochloric acid (1 M) is added to solid sodium hydrogencarbonate.	
Lithium metal is ignited in excess oxygen.	
Solutions of mercury(I) nitrate and sodium chloride are mixed.	
Potassium dichromate solution is added to an acidified solution of iron(II) sulfate.	
Lead(II) nitrate solution is mixed with excess potassium chromate solution.	
Sodium metal is added to water.	
Excess hydrochloric acid is added to a solution of sodium tetrahydroxoaluminate.	
A solution of calcium chloride is added to a solution of sodium phosphate.	
Excess ammonia (4 M) is added to a solution of copper(II) nitrate.	
Silver sulfide is treated with excess nitric acid (5 M).	

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

Marks 3

Compound	Solubility	Compound	Solubility
$CoCl_2 \cdot 6H_2O$		$HgCl_2$	
Li_2CO_3		$Zn(CH_3CO_2)_2$	
MnO_2		$SrSO_4$	

- Complete the following table.

7

FORMULA	SYSTEMATIC NAME
$NH_4Fe(SO_4)_2 \cdot 6H_2O$	
$[Cr(OH_2)_5Cl]SO_4$	
NaH_2PO_4	
$HClO_4$	
As_2O_3	
$[Pd(NH_3)_2Cl_2]$	
SO_2	
	potassium thiocyanate
	sodium nitrite
	tetraaquadibromocobalt(III) chloride
	sodium hexacyanoferrate(III)
	lead(IV) oxide
	peroxide ion
	nickel(II) nitrate-6-water

	Marks
• A doctor recommends to a pregnant woman that she takes an iron supplement of 50 mg (as Fe^{2+}) daily. To achieve this, what mass (to the nearest mg) of iron(II) gluconate-2-water, $FeC_{12}H_{22}O_{14}\cdot 2H_2O$, would be required?	**3**
• What is the mass of each of the following at 298 K and 101 kPa pressure?	**4**
(i) argon (24.5 litre)	
(ii) water (24.5 litre)	
(iii) chlorine (12.25 litre)	
(iv) zinc (1.00 mole)	

Marks

- The time required for an unknown gas to flow through a needle of a syringe under reduced pressure is observed to be 14.4 seconds. The corresponding time for the same volume of carbon dioxide to flow through the same system is 8.7 seconds.
  (i) Calculate the molecular mass of the unknown gas. **5**

(ii) Analysis of the unknown gas gave the following percentage composition by mass:
C (9.9 %), Cl (58.6 %), F (31.5 %).
Determine the empirical formula of the compound.

(iii) From the calculations in (i) and (ii), what is the molecular formula of the gas?

- Calculate the heat input required (in J) for the conversion of 9.0 g of water from ice at 273 K to steam at 373 K. **2**

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}

	Marks
• The formulation of a pharmaceutical to be delivered by injection includes sodium chloride to make it isotonic with blood plasma. Why is this necessary?	**2**
• A solution of volume 2.00 L was prepared by mixing equal volumes of nitric acid (0.10 M) and sulfuric acid (0.10 M). To this, sodium hydroxide (10.0 g) was added. Assuming no volume change, what is the pH of the final solution?	**3**
pH =	
• Acetic acid (100 mL, 0.20 M) is mixed with solid sodium hydroxide (0.010 mol). Calculate the final pH of the solution. pK_a of acetic acid = 4.76	**3**
pH =	

Marks

- A specific variety of haemoglobin associated with heart disease was isolated from a blood sample. A sample of this haemoglobin (21.5 mg) is dissolved in water at 25 °C to make 1.50 mL of solution. The osmotic pressure of the solution was measured and found to be 3.61 mmHg. What is the molar mass of this particular type of haemoglobin?

4

Answer:

- Calcium oxalate (CaC_2O_4) is only slightly soluble in water (5.73 mg L^{-1} at 25 °C) and can be deposited in renal calculi (kidney stones). What is the molar solubility of calcium oxalate?

3

Answer:

Calculate the solubility product constant (K_{sp}) of calcium oxalate at 25 °C.

K_{sp} =

Marks

- What mass (in gram) of $Fe(OH)_2$ is produced at an iron electrode when a basic solution of NaOH undergoes electrolysis at a current of 8.00 mA for 12.0 min? **3**

Answer:

- Technetium-99 is used to monitor blood flow near the heart. It has a half life of 6.02 hours. A sample is prepared with an activity of 4.52×10^{-6} Ci. What will be its activity after 8.00 hours? **3**

Answer:

- Consider the following half-reactions and their standard reduction potentials. **3**

$$2ClO_3^- + 12H^+ + 10e^- \rightarrow Cl_2 + 6H_2O \qquad E° = 1.47 \text{ V}$$

$$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-} \qquad E° = 2.01 \text{ V}$$

Give the overall cell reaction.

Calculate $\Delta G°$ and hence the value of K_c for the cell reaction at 298 K.

$\Delta G°$ =

K_c =

- Indicate a biological function for each of the following elements.

Marks 5

Element	Biological Function
cobalt	
sodium	
iodine	
magnesium	
zinc	

- Briefly explain why a radionuclide used in diagnostic work should have a short half-life.

2

- Briefly explain why alpha emitters are not used in diagnostic work.

2

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FIRST SEMESTER EXAMINATION **JUNE 2003**

Numerical Data

Physical constants

Planck constant = $h = 6.626 \times 10^{-34}$ J s

Speed of light in vacuum = $c_o = 2.998 \times 10^{8}$ m s^{-1}

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

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

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

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

Volume of 1 mol of ideal gas at 1 atm, 0 °C = 22.4 L

Volume of 1 mol of ideal gas at 1 atm, 25 °C = 24.5 L

Density of water at 1 atm, 25 °C = 0.997 g cm^{-3}

Conversion factors

0 °C = 273 K

1 atm = 101.3 kPa = 760.0 mmHg

1 nm = 10^{-9} m

1 MHz = 10^{6} Hz = 10^{6} s^{-1}

1 L = 10^{-3} m^3

A periodic table is printed on the other side of this data sheet.
Atomic weights are included in the periodic table.

June 2003

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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]