CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2016

FINAL EXAMINATION	**DURATION**
SCH101 – Chemical Concepts	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

Section A must be answered on the multiple choice answer sheet provided and must be handed in with your answer booklet.

Section B to be answered must be answered in the answer booklet provided.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
No additional printed material is permitted	1 x 16 Page Book 1 x Scrap Paper 1 x Faculty/School Multiple Choice Answer Sheet Formula Sheet and Periodic table

COMMONWEALTH OF AUSTRALIA

Copyright Regulations 1969

Warning

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

Section A
Multiple Choice Questions

This section should be answered on the **multiple choice answer sheet** provided. Please ensure that your name and student number is written on the **answer sheet** and placed in the completed answer Booklet.

1 mark for each question. **Total Marks for this section: 50**

Suggested Time allocation for Section A: **75 minutes**

Section B
Short Answer Questions
Answer all 5 questions.

Total No of Marks for this section: 50 marks

This section should be answered in the Answer Booklet provided.
Show <u>all</u> formulas and working.
Marks for each question are indicated. Suggested Time allocation for Section B: **105 minutes**

Question 1

(a) What are the two ways that real gases differ from ideal gases?

[2 marks]

(a) At what conditions do real gases behave like ideal gases?

[2 marks]

(b) Nitroglycerin is a shock-sensitive liquid that detonates by the reaction:

$4C_3H_5(NO_3)_3$ (l) → $6N_2$ (g) + $10H_2O$ (l) + $12CO_2$ (g) + O_2 (g)

Calculate the total volume of product gases at 150 kPa and 100^oC from the detonation of 1.0g of nitroglycerin.

[3 marks]

(c) Iodine has a triple point at 113.5 °C and 0.1191 atm, normal melting point at 113.7 °C, and normal boiling point at 184.3 °C. It's critical point is at 581 °C and115.5 atm. Draw a phase diagram for iodine and clearly label all the transition temperatures. What is its state at 5 atm and 170 °C? [Hint: the graph does not have to be to scale]

[3 marks]

Question 2

(a) Define 'specific heat capacity' of a substance.

[1 marks]

(b) Calculate ΔH_r for the reaction:

$$MnO_2\ (s) + 2C\ (graphite) \rightarrow Mn\ (s) + 2CO\ (g)$$

from the following information:

$$Mn\ (s) + O_2\ (g) \rightarrow MnO_2\ (s)\ ; \qquad \Delta H_r = -520.03\ kJ$$

$$2C\ (graphite) + O_2\ (g) \rightarrow 2CO\ (g) \qquad \Delta H_r = -221.04\ kJ$$

[3 marks]

(c) The energy required to break C-C bonds in a molecule is 348 kJ/mol. Will ultraviolet light of wavelength 420 nm be able to break the bond?

[3 marks]

(d) Give a set of four quantum numbers { n, l, m_l, m_s} for a 4d orbital.

[2 marks]

(e) What is the maximum number of electrons that can fill a 4d orbital?

[1 marks]

Question 3

(a) Give the orbital box diagram for V and Zn and predict whether they are paramagnetic or diamagnetic.

[3 marks]

(b) Use VSEPR theory to predict the geometrical shapes and bond angle of $CClO_3^-$ ion.

[2 marks]

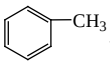
(c) Briefly explain what kind of attractive forces must be overcome for each of the following:

(i) melt ice

(ii) boil molecular bromine

(iii) change liquid hydrogen chloride to the gaseous state

[3 marks]

(d) Explain why toluene () is easily soluble in naphthalene () than in water.

[2 marks]

Question 4

(a) What is the freezing point of 0.525 *m* (molal) aqueous solution of glucose ($C_6H_{12}O_6$)?

[Data: K_f = -1.86 $^oC/m$ for water]

[2 marks]

(b) The osmotic pressure of blood is 775 kPa at 37°C. What mass of glucose ($C_6H_{12}O_6$,) is needed to prepare 2.25 L of solution for intravenous injection? The osmotic pressure of the glucose solution must equal the osmotic pressure of blood.(R = 8.314 L kPa K^{-1} mol^{-1})

[3 marks]

(c) Given the initial rate data for the reaction A + B → C, determine the rate law, rate constant and the final rate expression for the reaction.

[A], M	[B], M	$\Delta[C]/\Delta t$ (initial) M/s
0.0500	0.160	2.24×10^{-3}
0.0750	0.160	3.36×10^{-3}
0.0 750	0.272	9.72×10^{-3}

[3 marks]

(d) The half-life of vanadium-48 is 16.0 days. If a tank contains 3.32 x 10^{28} molecules of vanadium-48 per litre, how much vanadium-48 will be left after 365 days?

[2 marks]

Question 5

(a) For the equilibrium: $2CH_4\,(g) \rightleftharpoons C_2H_2\,(g) + 3H_2\,(g)$

the equilibrium partial pressures are 0.0238 atm for CH_4, 0.146 atm for C_2H_2 and 0.386 for H_2:

(i) Calculate the value of K_p.

(ii) What is the value of K_c at 250°C?

[3 marks]

(b) Give the name and formula of a polyprotic and a monoprotic acid.

[1 marks]

(c) What is the pH of 0.18 M aqueous formate ion? (K_b of HCO_2^- = 5.6 x 10^{-11})

[2 marks]

(d) A buffer is prepared consisting of 0.75 mol of sodium dihydrogenphosphate, NaH_2PO_4, and 0.60 mol of sodium hydrogenphosphate, Na_2HPO_4, dissolved in water to make a 600.0 mL solution. The K_a for the dihydrogenphosphate ion is 6.2 x 10^{-8} at 25°C. What is the pH of the buffer?

[2 marks]

(e) Antimony sulfide, Sb_2S_3 (K_{sp}= 1.7 x 10^{-93}) is dissolved in water. What is the concentration of sulfide ions in a saturated solution of Sb_2S_3?

[2 marks]

End of Examination paper

FORMULA SHEET:

Some physical constants that might be useful:

Avogadro's number, $N_A = 6.022 \times 10^{23}$
Universal gas constant, R = 0.08206 L.atm/mol.K = 8.314 J/K.mol = 8.314 L.kPa/K.mol
1 cal = 4.184 J
1 atm= 760 mm Hg = 760 torr =1.013 bar = 101.3 kPa
STP: T = 273.15 K, P = 1.00 atm, V = 22.4 L for 1.00 mol
Rydberg constant, $R = 2.179 \times 10^{-18}$
Speed of light, $c = 2.998 \times 10^{8}$ m/s
Plank's constant, $h = 6.63 \times 10^{-34}$ Js;

Some equations that might be useful

$$\left(p + \frac{n^2 a}{V^2}\right)(V - nb) = nRT \qquad \sqrt{u^2} = \sqrt{\frac{3RT}{M_r}}$$

$Q = m \times s \times \Delta T$ $\qquad \ln P_1 - \ln P_2 = -\frac{\Delta_{vap}H^\circ}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$c = \lambda\gamma$ $\qquad E = h\gamma = \frac{hc}{\lambda}$ $\qquad \lambda = \frac{h}{mv}$

$E = -2.179 \times 10^{-18}\left(\frac{Z^2}{n^2}\right)$ $\qquad \Delta x . \Delta v \geq \frac{h}{4\pi m}$

$s = k_H \times p$ $\qquad \Delta T_b = i \times K_b \times m$ $\qquad \Pi = i \times cRT$

Rate = $k[A]^m[B]^n$ $\qquad k = Ae^{-E_a/RT}$ $\qquad \ln k = -\frac{E_a}{R}\left(\frac{1}{T}\right) + \ln A$ $\qquad t_{1/2} = \frac{0.693}{k}$

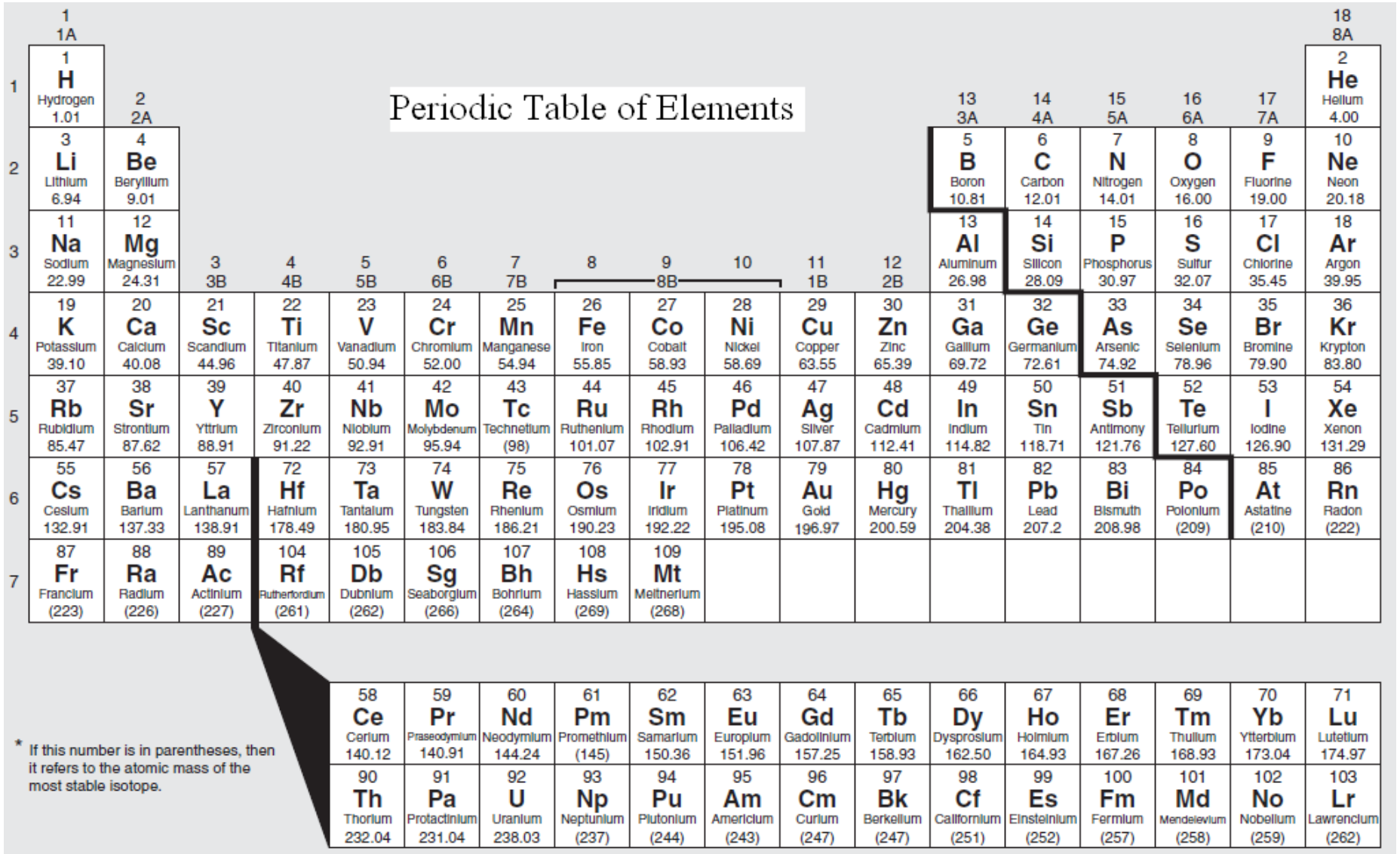
Order	Rate	Integrated Rate Law
0	$r = k[A]^0 = k$	$[A]_t = -kt + [A]_o$
1	$r = k[A]$	$\ln [A]_t = -kt + \ln [A]_o$
2	$r = k[A]^2$	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o}$

$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$ $\qquad K_p = K_c (RT)^{\Delta ng}$

$pH = -log[H_3O^+]$ $\qquad K_a = \frac{[H_3O^+][A^-]}{[HA]}$ $\qquad K_b = \frac{[BH^+][OH^-]}{[B]}$

$pK_a = -\log_{10} K_a$
$pK_b = -\log_{10} K_b$

$\mathrm{pH} = \mathrm{p}K_a + \log\left(\frac{[\text{conjugate base}]}{[\text{acid}]}\right)$



FINAL EXAMINATION
SCH101 – Chemical Concepts

Semester 1, 2016