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Family Name					
Given Name/s					
Student Number					
Teaching Period	Semester 1, 2019				

SCH101 – Chemical Concepts	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes
INSTRUCTIONS TO CANDIDATES		
<p>Section A must be answered on the multiple choice answer sheet provided and must be handed in with your answer booklet. [Total marks= 50] Section B to be answered must be answered in the answer booklet provided. [Total marks= 50] Formula sheet and periodic table can be found at the end of the exam paper</p>		
EXAM CONDITIONS		
<p><u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.</p>		
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 College Multiple Choice Answer Sheet Formula Sheet/s	

**THIS EXAMINATION IS PRINTED
DOUBLE-SIDED.**

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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 **MCQ 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 all formulas and working.

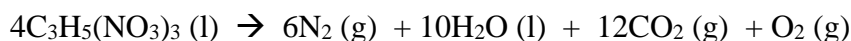
Marks for each question are indicated. Suggested Time allocation for Section B: 105 minutes

Question 1

- a) State Avogadro's law of gases and give the mathematical expression of the law.

[2 marks]

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



Calculate the total volume of product gases at 150 kPa and 100°C from the detonation of 1.0g of nitroglycerin

[3 marks]

- c) Water in a glass tube has lower meniscus while mercury has a higher meniscus. Explain the reasons behind this phenomenon in terms of adhesive and cohesive forces.

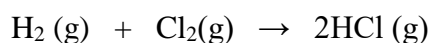
[2 marks]

- d) The phase diagram of CO₂ has a triple point at -56.6 °C and 5.19 atm, and a critical point at 31.0 °C and 73 atm. The solid and gas phases are in equilibrium at -78.7 °C and 1.00 atm. Sketch a Phase Diagram for CO₂ labelling the above conditions of temperature and pressure. What is its state at 5 atm and 170 °C? [Hint: The graph does not have to be to scale]

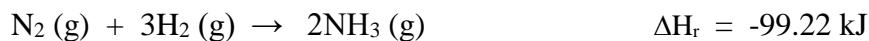
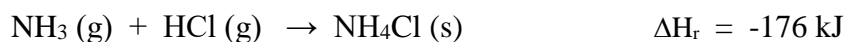
[3 marks]

Question 2

- a) Calculate the enthalpy of reaction for the synthesis of hydrogen chloride gas:



from the following data:



[3 marks]

- b) When heated in a flame, sodium atoms emit light with a frequency of $5.09 \times 10^{14} \text{ s}^{-1}$. What is the wavelength of this radiation in nm?

[2 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? Justify your answer by energy calculations.

[2 marks]

- d) Mt Kosciuszko in the Snowy mountains range is the highest elevation in Australia. It raises to a height of 2228 m above sea level. At this height, the atmospheric pressure is 77.20 kPa. At what temperature does water boil at the highest point of Mt Kosciuszko? The vapor pressure of water at 373.15 K is 101.3 kPa. ($\Delta_{\text{vap}}H^\circ$ for $\text{H}_2\text{O} = 40.7 \text{ kJ/mole}$ and $R = 8.314 \text{ J/K}\cdot\text{mol}$)

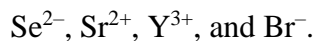
[3 marks]

Question 3

- a) With the help of the electronic configuration of Mn, classify Mn as paramagnetic or diamagnetic.

[2 mark]

- b) Arrange the following ions in order from smallest to largest ionic radii:



[2 marks]

- c) Draw Lewis structures and then use VSEPR theory to predict the geometrical shapes and bond angle of the following species. **Classify** as polar or nonpolar compounds.



[4 marks]

- d) KI has a higher melting point than I_2 . Briefly explain why in terms of intermolecular forces.

[2 marks]

Question 4

- a) The Henry's law constant for N_2 , O_2 and CO_2 in water at $25\text{ }^\circ\text{C}$ is $6.25 \times 10^{-4}\text{ M/atm}$, $1.28 \times 10^{-3}\text{ M/atm}$ and $3.45 \times 10^{-2}\text{ M/atm}$ and their partial pressures are 0.78 atm , 0.21 atm and 0.041 atm respectively. What is the equilibrium concentration of these gases in water when the gas pressure over the water is 1.00 atm ? Which of these gases will have the highest concentration in water at the same temperature and pressure?
- [3 marks]
- b) What is the boiling point of a solution containing 0.80 g caffeine, $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$, dissolved in 13.20 g benzene? The boiling point of pure benzene is $80.1\text{ }^\circ\text{C}$ and the boiling point elevation constant, K_{bp} , is $2.53\text{ }^\circ\text{C}/m$.
- [2.5 marks]
- c) The osmotic pressure of blood is 775 kPa at $37.0\text{ }^\circ\text{C}$. What mass of NaCl is needed to prepare 2.00 L of saline solution for intravenous injection? [Hint: The osmotic pressure of the saline solution must equal the osmotic pressure of blood.]
- [2.5 marks]
- d) The half-life of vanadium-48 is 16.0 days . If a tank contains 3.32×10^{28} molecules of vanadium-48 per litre, how much vanadium-48 will be left after 365 days ?
- [2 marks]

Question 5

- a) Following experimental data were collected for the reaction



Experiment No.	$[\text{Na}_2\text{SO}_3]$, in mol L^{-1}	$[\text{NaClO}_2]$, in mol L^{-1}	Rate, in mol $\text{L}^{-1} \text{ s}^{-1}$
1	0.050	0.010	1.2×10^{-5}
2	0.10	0.010	2.3×10^{-5}
3	0.20	0.020	9.5×10^{-5}

Determine the full rate equation, including the value of the rate constant, k and its units.

[3 marks]

- b) For the equilibrium: $2\text{COF}_2(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{CF}_4(\text{g})$ [$K_{\text{eq}} = 2.00$, at 750°C]

In an equilibrium mixture, the concentration of COF_2 is 0.285 M and concentration of CF_4 is 0.123 M .

- (i) What is the equilibrium concentration of CO_2 ?
(ii) What is the value of K_p at 750°C

[3 marks]

- c) What is the pH of 0.18 M aqueous formate ion? (K_b of $\text{HCO}_2^- = 5.6 \times 10^{-11}$)

[2 marks]

- d) Aluminium hydroxide is only slightly soluble in water, having $K_{\text{sp}} = 1.8 \times 10^{-5}$ at 25°C . Calculate the solubility of Aluminium hydroxide in water at 25°C in mol/L.

[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, $R = 0.08206 \text{ L.atm/mol.K} = 8.314 \text{ J/K.mol} = 8.314 \text{ L.kPa/K.mol}$

$1 \text{ cal} = 4.184 \text{ J}$

$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 1.013 \text{ bar} = 101.3 \text{ kPa}$

STP: $T = 273.15 \text{ K}$, $P = 1.00 \text{ atm}$, $V = 22.4 \text{ L}$ for 1.00 mol

Rydberg constant, $R = 2.179 \times 10^{-18}$

Speed of light, $c = 2.998 \times 10^8 \text{ m/s}$

Plank's constant, $h = 6.63 \times 10^{-34} \text{ Js}$;

Some equations that might be useful

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

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

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

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

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

$$\text{Rate} = k[A]^m[B]^n \quad k = A e^{-E_a/RT} \quad \ln k = -\frac{E_a}{R} \left(\frac{1}{T}\right) + \ln A$$

$$t_{1/2} = \frac{0.693}{k}$$

Order	Rate	Integrated Rate Law
0	$r = k[A]^0 = k$	$[A]_t = -kt + [A]_0$
1	$r = k[A]$	$\ln [A]_t = -kt + \ln [A]_0$
2	$r = k[A]^2$	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$$K_p = K_c (RT)^{\Delta n_g}$$

$$pH = -\log[H_3O^+]$$

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

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

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

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

