ON-LINE EXAMINATION INSTRUCTIONS

SLE133 Chemistry in our World

TRIMESTER 2 2023

READ INSTRUCTIONS BEFORE COMMENCING

- Plagiarism, Collusion and Contract Cheating, constitute cheating and are considered extremely serious breaches of Academic Integrity. Students identified to have engaged in any of these breaches will receive severe penalties.

- By submitting this assessment, you certify that the work is entirely your own except where work quoted or paraphrased is acknowledged in the text. You agree that Deakin College may make and retain copies of this work for the purposes of marking, review and checks of academic integrity.

Important Note:

- This is an open book exam
- You may use a calculator
- You may use an (non-electronic or electronic) dictionary

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1. You have **2 hours and 15 minutes** (within a 3hr time limit) to complete this exam. If you commence the exam late, you are still required to submit this document by the exam cut-off time. Any submissions made after the exam cut-off time will incur significant late penalties.

2. All late submissions will be subject to penalties without an approved Special Consideration application. The penalties for late submissions are:
   - 1 – 15 minutes late: a 25% mark reduction
   - 16 – 30 minutes late: a 50% mark reduction
   - Beyond 30 minutes late: a mark of zero (0) for the exam

3. This is a submission based (Turnitin or Assignment) exam which requires you to upload and submit your completed work into Moodle, in order for it to be accepted. Please manage your time carefully and ensure that you complete the questions required and submit the document onto Moodle within the given time. Submissions made outside of Moodle (email, Facebook and other) are not accepted.

4. This examination consists of **2 parts** and is marked out of **60 total marks.** It represents **40%** of the total assessment in this unit.
   The exam sections are as follows:
   - **Part 1:** Short Answer = **20 marks**
   - **Part 2:** Extended Response = **40 marks**

5. Attempt all questions. **To be eligible for full marks for questions involving calculations, your response must provide full working.** Submission is to be to the TurnItIn Dropbox under the final exam tab in Moodle. You may submit in any of the following ways:
   1. **Print, complete on the printed paper then upload the scanned pages** to Moodle as a single file (.pdf or .doc/.docx).
   2. If you do not have a printer, **use some blank pieces of paper for this exam**.
      Write the number and name of the question followed by your answer. Do this for all questions and answers. Once you have completed the exam, **write the page number on each page**. Upload all pages as a **single** .pdf or .doc/.docx scanned file.

   If you do not have a scanner, you may use Office Lens, CamScanner or an equivalent app to scan your exam into a single file.

6. A formula sheet and periodic table is provided in a file titled “Formula Sheet and Periodic Table” provided just below this exam. You may print this off or leave it open whilst you complete your exam.

Question		Possible Marks	Awarded Marks
Part 1: Short Answer			
S1	Electron configuration	2	
S2	Isotopes	2	
S3	Ionic Formula	2	
S4	Avogadro's number	2	
S5	Line structure	2	
S6	Empirical Formula	2	
S7	Atomic Mass Calculation	2	
S8	Ideal Gas Law	2	
S9	pH	2	
S10	Titration Calculation	2	
Part 2: Extended Response Questions			
E1	Stoichiometric Calculations		
	a)	1	
	b)	2	
	c)	2	
	d)	2	
	e)	3	
	f)	2	
	g)	1	
E2	Thermodynamics and States of Matter		
	a)	3	
	b)	3	
	c)	2	
	d)	3	
	e)	2	
	f)	2	
E3	Molecular Structure and Bonding		
	a)	2	
	b)	2	
	c)	2	
	d)	1	
	e)	2	
	f)	3	
Exam Total		60	

Part 1 – Short Answer [2 Marks Each – 20 Marks]

1. An element has an atomic number of 34. Write the electron configuration, including shells and subshells, of the element with this atomic number. Also provide the **electron configuration** of the ion formed by this element. **HINT:** This element is a **main group** element. **2 Marks**

Element: Ion formed:

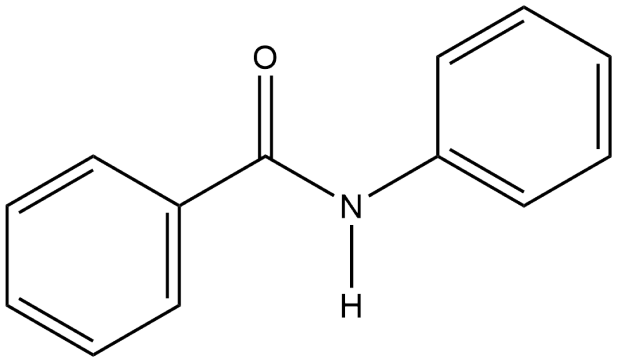
2. Calculate the number of protons, neutrons and electrons in the ion presented below. An example is provided for the ion . **2 Marks**

	Protons:	**Neutrons:**	**Electrons:**
$^{19}F^-$	9	10	10
$^{65}Cu^{2+}$			

3. Write the chemical formula of a compound that would have the chemical formula X_3Y_2, where X is any applicable metal cation and Y is a polyatomic anion that fits this chemical formula. **2 Marks**

4. Calculate the amount in mole of carbon dioxide, CO_2, in a sample of carbon dioxide gas containing 7.35×10^{21} carbon dioxide gas molecules. **2 Marks**

5. Provide the molecular formula and empirical formula of the compound presented in the below line structure. Remember to follow the correct order of elements as covered in SLE133. **2 Marks**



Molecular Formula:	**Empirical Formula:**

6. Determine the empirical formula of a compound that, upon being decomposed into its component elements, is found to be 26.58% K, 35.35% Cr and 38.07% O. Show full working. **2 Mark**

7. An imaginary element, Bz, has 2 naturally occurring isotopes. Bz-115 atoms have a mass of 114.9885u and abundance of 33.71%. The second isotope, Bz-118 has a mass of 117.7998u and abundance of 66.29%. Calculate the atomic mass of this imaginary element. **2 Marks**

8. Calculate the **mass** of carbon dioxide gas, CO_2, contained in a 1.000L gas cylinder with a pressure of 325.05kPa at 25.0°C. Show full working. **2 Marks**

9. Calculate the pH of a solution with a hydroxide ion concentration, OH^- of $[OH^-] = 4.28 \times 10^{-10}$ M. Remember to show units and full working. **2 Marks**

10. A solution of sulfuric acid, H_2SO_4, is missing its label. It is titrated against sodium hydroxide, NaOH, to find its concentration. A 20.00mL aliquot of sulfuric acid is titrated against 11.75 mL of 0.210M NaOH, after which the acid-base indicator changes colour. Use this information to calculate the concentration of sulfuric acid. **2 Marks**

Part 2 – Extended Response

Question 1: Stoichiometry [1+2+2+2+3+2+1 = 13 Marks]

Solid aluminium hydroxide $Al(OH)_3$ is used in several brands of antacid tablets. This reacts with stomach acid, which we will treat as a hydrochloric acid solution for this question, forming aluminium chloride $AlCl_3$ solution and liquid water.

a) Calculate the molar mass of the compound Aluminium hydroxide, $Al(OH)_3$. Show full working.
1 Mark

b) To test the effects of a quantity of antacid on the stomach, a 0.160 M solution of HCl is produced to a volume of 80.0 mL. Calculate the mass of HCl that would be in this solution. **2 Marks**

c) Write a balanced chemical equation for the reaction between aluminium hydroxide, $Al(OH)_3$, and hydrochloric acid, HCl. Remember to include states. **2 Marks**

d) If the amount of HCl in b) is reacted with 0.450 g of aluminium hydroxide, identify the limiting reagent in this reaction. Explain your answer. **2 Marks**

e) Calculate the theoretical yield, in grams, of aluminium chloride formed in this reaction. **3 Marks**

f) Calculate the number of ions of aluminium, Al^{3+}, and chloride, Cl^-, will be found in the aluminium chloride solution formed in this reaction. **2 Marks**

g) If 489mg of $AlCl_3$ is recovered, calculate the percentage yield of aluminium chloride. **1 Mark**

Question 2: Thermodynamics [3+3+2+3+2+2 = 15 Marks]

For the following chemical reaction, the values for the change in enthalpy and entropy are provided:

$$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$$

$$\Delta S_r = -146.5\ J\ mol^{-1}\ K^{-1},\ \Delta H_r = -114.1\ kJ\ mol^{-1}$$

a) Calculate the Gibbs free energy change, ΔG_r for this reaction at 25.0°C. State clearly if this reaction is spontaneous at this temperature. **3 Marks**

b) Based on your answer in a), at which temperature would the reaction either become or cease to be spontaneous? Explain your answer. **3 Marks**

c) Explain why the value for ΔS is negative in this reaction with respect to the trends in entropy change covered in SLE133. List 2 cases where the entropy change would be positive. **2 Marks**

d) Using the following chemical reactions and Hess' Law:

N_2O_4 (g) → 2 NO_2 (g) $\Delta H_r = +57.93$ kJ mol^{-1}

2 NO (g) + O_2 (g) → 2 NO_2 (g) $\Delta H_r = -114.1$ kJ mol^{-1}

Find ΔH_r for the following reaction:

2 NO (g) + O_2 (g) → N_2O_4 (g)

3 Marks

e) A gas mixture of total pressure 141 kPa is composed of 2 parts Nitrogen monoxide, NO, to 3 parts oxygen gas, O_2. Calculate the partial pressure of both gases in this gas mixture. **2 Marks**

f) Calculate the amount of work done by a piston when it expands from a volume of 2.05L to a volume of 7.81L under constant atmospheric pressure (1.013×10^5 Pa)? **2 Marks**

Question 3: Bonding and Intermolecular Forces [2+2+2+1+2+3=12 Marks]

Propan-2-ol, also called Isopropyl Alcohol, has the chemical formula $CH_3CHOHCH_3$.

a) Show the full electron configuration of the element C. Clearly mark the core and valence electrons on your electron configuration. **2 Marks**

b) Isopropyl alcohol has a density of 0.786 g mL^{-1}. Calculate the amount, in mole, of acetone in a 300mL sample of acetone. **2 Marks**

c) Isopropyl alcohol combusts according to the following reaction:

$$CH_3CHOHCH_3\ (l) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (g)$$

Balance the above chemical equation and calculate the amount of carbon dioxide formed, in moles, from the combustion of 30.0mL of isopropyl alcohol. **2 Marks**

d) Identify the predominant intermolecular forces in isopropyl alcohol. Briefly explain your answer. **1 Mark**

e) Isopropyl alcohol contains C-C bonds, a C-O bond, C-H bonds and an O-H bond. Arrange these bonds in order of **decreasing** bond polarity. **2 Marks**

f) Using the information from c), calculate the pressure of carbon dioxide collected when this reaction occurs in a 15.0L container. The container is in a room with a temperature of 28.5°C

3 Marks

End of Exam

Numerical Data

atomic mass unit	u	= 1.660 54 × 10^{-27} kg
Avogadro constant	N_A	= 6.0221 × 10^{23} mol^{-1}
electron mass	m_e	= 9.1094 × 10^{-31} kg
proton mass	m_p	= 1.6726 × 10^{-27} kg
neutron mass	m_n	= 1.6749 × 10^{-27} kg
gas constant	R	= 8.3145 J K^{-1} mol^{-1}
Planck constant	h	= 6.6261 × 10^{-34} J s
Rydberg constant for hydrogen	R_H	= 2.1811 × 10^{-18} J
	R_H / h	= 3.2916 × 10^{15} Hz
elementary charge	e	= 1.6022 × 10^{-19} C
speed of light in vacuum	c	= 2.9979 × 10^{8} m s^{-1}
Faraday constant	F	= 96 485 C mol^{-1}
Boltzmann constant	k	= 1.380 66 × 10^{-23} J K^{-1}
Ionic product of water at 25 °C	K_w	= 1.0 × 10^{-14}

Some Useful Formulae

$\Delta E = h\nu$

$S = k \ln W$

$$\Delta E = R_H\left(\frac{1}{n_{lower}^2} - \frac{1}{n_{higher}^2}\right)$$

$$E_{\text{cell}} = E^o_{\text{cell}} - \frac{RT}{nF}\ln\frac{[\text{products}]}{[\text{reactants}]}$$

$c = \lambda\nu$

$\Delta G = -nFE$

$\lambda = \frac{h}{m\nu}$; in this equation, v is the letter "vee"

$Q = It$

$\mu = Qr$

$q = m\,c\,\Delta T$

$\Delta G = \Delta H - T\Delta S$

$$k = Ae^{-E_a/RT}$$

$$\ln P = \frac{-\Delta H_{\text{vap}}}{RT} + \text{constant}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

$$\ln\frac{P_2}{P_1} = \frac{-\Delta H_{\text{vap}}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o}$$

$$\ln K = \frac{-\Delta G}{RT} = \frac{-\Delta H}{RT} + \frac{\Delta S}{R}$$

$$V = \frac{k_2[E]_0[S]}{K_M + [S]}$$

$$\Delta S = \frac{q_{\text{rev}}}{T}$$

Periodic Table of the Elements

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.29
55 Cs 132.905	56 Ba 137.327	57-71	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

Lanthanoid series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.26	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.9	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinoid series	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)