Exam 1 Preview

EXAM CODES: **CHM1011 – Mock Exam # 1**

TITLE OF PAPER: **CHEMISTRY I**

EXAM DURATION: 2 hours writing time

READING TIME: 10 minutes

THIS PAPER IS FOR STUDENTS STUDYING AT: (tick where applicable)

☐ Berwick	X Clayton	☐ Malaysia	☐ Off Campus Learning	☐ Open Learning
☐ Caulfield	☐ Gippsland	☐ Peninsula	X Monash Extension	☐ Sth Africa
☐ Parkville	☐ Other (specify)			

During an exam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, mobile phone, smart watch/device, calculator, pencil case, or writing on any part of your body. Any authorised items are listed below. Items/materials on your desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession.

No examination materials are to be removed from the room. This includes retaining, copying, memorising or noting down content of exam material for personal use or to share with any other person by any means following your exam.
Failure to comply with the above instructions, or attempting to cheat or cheating in an exam is a discipline offence under Part 7 of the Monash University (Council) Regulations.

<u>AUTHORISED MATERIALS</u>

OPEN BOOK	**☐ YES**	**X NO**
CALCULATORS	**X YES**	**☐ NO**

*** Calculators with School of Chemistry/Faculty of Science authorization label only**

SPECIFICALLY PERMITTED ITEMS	**X YES**	**☐ NO**

if yes, items permitted are:
***Molecular Modelling Kits**

Candidates must complete this section if required to write answers within this paper

STUDENT ID: __ __ __ __ __ __ __ __ DESK NUMBER: __ __ __ __ __

Data Page

Useful equations

Wave equation: $c = \nu\lambda$

Einstein equation: $E = h\nu$

Rydberg equation: $\frac{1}{\lambda} = R(\frac{1}{n_a^2} - \frac{1}{n_b^2})$

Balmer equation: $\nu = 3.29\times10^{15}(\frac{1}{n_a^2} - \frac{1}{n_b^2})$

Bond order = $\frac{1}{2}$*(# bonding electrons - # anti-bonding electrons)*

Gases

Ideal Gas Equation: $pV = nRT$

Total Pressure = Σ Partial Pressures of Component Gases

Thermodynamics

$\Delta U = q + w$

$w = -p\Delta V$

$q = mc\Delta T$

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G° = -RT\ln K$

$\Delta G = \Delta G° + RT \ln Q$

Equilibria

Henderson-Hasselbach: $\text{pH} = \text{pK}_a + \log\frac{[\text{base}]}{[\text{acid}]}$

Activity: $a_i = \frac{\gamma_i m_i}{m_i^0}$

Kinetics

Zero-order reaction: $[A]_t = [A]_o - kt$

First-order reaction: $[A]_t = [A]_o\exp(-kt)$

Second-order reaction (only one reactant A): $\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$

Half-life: $t_{1/2} = 0.693/k$

Arrhenius equation: $k = \text{A}e^{-\text{Ea}/RT}$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Physical constants

$c = 2.998 \times 10^8$ ms^{-1}

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

$R = 1.097 \times 10^7$ m^{-1}

$N_A = 6.022 \times 10^{23}$

$R = 8.314$ J/K/mol
$= 0.08206$ atm·L/mol·K

1 atm = 1.013×10^5 Pa

1 bar = 1.0×10^5 Pa

K_w at 25 °C = 1.0×10^{-14}

0 °C = 273.15 K

Question 1 (2 + 3 = 5 marks)

(a) An electronic transition in a hydrogen atom from the ground state occurs through absorption of 1.937 × 10^{-18} J of energy as electromagnetic radiation. Determine the frequency of the photon that was absorbed by the hydrogen atom.

$E = h\nu$

Rearrange $\nu = E/h = \frac{1.937 \times 10^{-18}\ J}{6.626 \times 10^{-34}\ J\,s}$

$\nu = 2.923 \times 10^{15}$ Hz (or s^{-1})

(- ½ mark if not to 4 sig. figs)

(b) If n_i indicates the initial energy level, and n_f the final energy level, determine the value of n_i and n_f.

As the transition is from the ground state, $n_i = 1$

Most convenient to use the Balmer Equation

$$\nu = (3.29 \times 10^{15})\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

Rearrange

$$n_f^2 = \sqrt{\frac{1}{\left(1/n_i^2 - \frac{\nu}{3.29 \times 10^{15}}\right)}}$$

$$= \sqrt{\frac{1}{\left(1/1^2 - \frac{2.923 \times 10^{15}}{3.29 \times 10^{15}}\right)}}$$

$= 3$

Exam 2 Preview

EXAM CODES:	**CHM1011 – Mock Exam # 2**
TITLE OF PAPER:	**CHEMISTRY I**
EXAM DURATION:	2 hours writing time
READING TIME:	10 minutes

THIS PAPER IS FOR STUDENTS STUDYING AT: (tick where applicable)

☐ Berwick	**X** Clayton	☐ Malaysia	☐ Off Campus Learning	☐ Open Learning
☐ Caulfield	☐ Gippsland	☐ Peninsula	**X** Monash Extension	☐ Sth Africa
☐ Parkville	☐ Other (specify)			

During an exam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, mobile phone, smart watch/device, calculator, pencil case, or writing on any part of your body. Any authorised items are listed below. Items/materials on your desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession.

No examination materials are to be removed from the room. This includes retaining, copying, memorising or noting down content of exam material for personal use or to share with any other person by any means following your exam.
Failure to comply with the above instructions, or attempting to cheat or cheating in an exam is a discipline offence under Part 7 of the Monash University (Council) Regulations.

<u>AUTHORISED MATERIALS</u>

OPEN BOOK	☐ **YES**	**X NO**
CALCULATORS	**X YES**	☐ **NO**

*** Calculators with School of Chemistry/Faculty of Science authorization label only**

SPECIFICALLY PERMITTED ITEMS	**X YES**	☐ **NO**

if yes, items permitted are:
***Molecular Modelling Kits**

Candidates must complete this section if required to write answers within this paper

STUDENT ID: _ _ _ _ _ _ _ _   DESK NUMBER: _ _ _ _ _

Data Page

Useful equations

Wave equation: $c = \nu\lambda$

Einstein equation: $E = h\nu$

Rydberg equation: $\frac{1}{\lambda} = R(\frac{1}{n_a^2} - \frac{1}{n_b^2})$

Balmer equation: $\nu = 3.29\times10^{15}(\frac{1}{n_a^2} - \frac{1}{n_b^2})$

Bond order = $\frac{1}{2}$*(# bonding electrons - # anti-bonding electrons)*

Gases

Ideal Gas Equation: $pV = nRT$

Total Pressure = Σ Partial Pressures of Component Gases

Thermodynamics

$\Delta U \quad q + w$

$w = -p\Delta V$

$q = mc\Delta T$

$\Delta G^\circ = \Delta H^\circ \quad T\Delta S^\circ$

$\Delta G^\circ = -RT\ln K$

$\Delta G = \Delta G^\circ + RT\ln Q$

Equilibria

Henderson-Hasselbach: $\mathrm{pH} = \mathrm{pK_a} + \log\frac{[\mathrm{base}]}{[\mathrm{acid}]}$

Activity: $a_i = \frac{\gamma_i m_i}{m_i^0}$

Kinetics

Zero-order reaction: $[A]_t = [A]_o - kt$

First-order reaction: $[A]_t = [A]_o\exp(-kt)$

Second-order reaction (only one reactant A): $\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$

Half-life: $t_{1/2} = 0.693/k$

Arrhenius equation: $k = \mathrm{A}e^{-\mathrm{Ea}/RT}$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Physical constants

$c = 2.998 \times 10^8\ \mathrm{ms^{-1}}$

$h = 6.626 \times 10^{-34}\ \mathrm{J.s}$

$R = 1.097 \times 10^7\ \mathrm{m^{-1}}$

$N_A = 6.022 \times 10^{23}$

$R = 8.314$ J/K/mol
$= 0.08206$ atm·L/mol·K

1 atm = 1.013×10^5 Pa

1 bar = 1.0×10^5 Pa

K_w at 25 °C = 1.0×10^{-14}

0 °C = 273.15 K

Question 1 (4 + 2 + 2 + 1 = 9 marks)

(a) The Rydberg equation may be used to calculate the energy difference between any pair of orbitals in a single electron atom or ion. Calculate the wavelength (in nanometers) of the transition from the n=1 to n=4 levels in atomic hydrogen. Express your answer to four significant figures.

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$= (1.097 \times 10^{7})\left(\left(\frac{1}{1}\right)^2 - \frac{1}{4^2}\right)$$

$$= 1.028 \times 10^{7}\ M^{-1}$$

$$\therefore \lambda = 9.723 \times 10^{-8}\ M$$

Convert to nanometers $(\times 10^{9})$

$$\lambda = 97.23\ nm$$

(b) Convert the wavelength you determined in part (a) into frequency.

$$\nu = c/\lambda = \frac{2.998 \times 10^{8}}{9.723 \times 10^{-8}}$$

$$= 3.083 \times 10^{15}\ Hz$$

(c) Convert the frequency you determined in part (b) into energy.

$$E = h\nu = (6.626 \times 10^{-34})(3.083 \times 10^{15})$$

$$= 2.043 \times 10^{-18}\ J$$

(d) Does this transition correspond to an emission or an absorption event?

Absorption