RAJARATA UNIVERSITY OF SRI LANKA

FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree

First Year - Semester I Examination - June / July 2018

CHE 1201- GENERAL CHEMISTRY

Time: Two (02) hours

Answer question No. 01 (compulsory) and any other three (03) questions.

Use of a non-programmable calculator is permitted.

Speed of light (c)	$= 3.00 \times 10^8 \text{ ms}^{-1}$
Planck's constant (h)	$= 6.63 \times 10^{-34} \text{ Js}$
Mass of electron (m_e)	$= 9.11 \times 10^{-31} \text{ kg}$
Mass of proton (m_p)	$= 1.672 \times 10^{-27} \text{ kg}$
Mass of neutron (m_n)	$= 1.675 \times 10^{-27} \text{ kg}$
Magnitude of the electron charge	$= 1.60 \times 10^{-19} \text{ C}$
Avogadro's number (N_A)	$= 6.02 \times 10^{-23} \text{ mol}^{-1}$
Rydberg constant (R)	$= 1.10 \times 10^7 \text{ m}^{-1}$

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1. A) A radio wave has a frequency of 3.6×10^{10} Hz. What is the energy (in Joule) of one photon of this radiation?

   B) Hydrogen atom has a single electron. However, the atomic emission spectrum of hydrogen is composed of multiple lines. Briefly explain.

   C) What is the wavenumber and wavelength (in Å), of the first transition in the Lyman series in the atomic spectra of hydrogen?

D) What feature of an orbital is related to each of the following quantum numbers?

    i) Principal quantum number (n)

    ii) Angular momentum quantum number (l)

   iii) Magnetic quantum number (m_l)

E) What are the possible values of spin quantum numbers (s) for an electron with $l = 1$ and
$m = 1$? Justify your answer.

F) Explain why the Rutherford's planetary model for the atom was a failure.

G) Using the de Broglie's relationship, determine the wavelength in nm, associated with an electron whose velocity is 3×10^7 m s^{-1}.
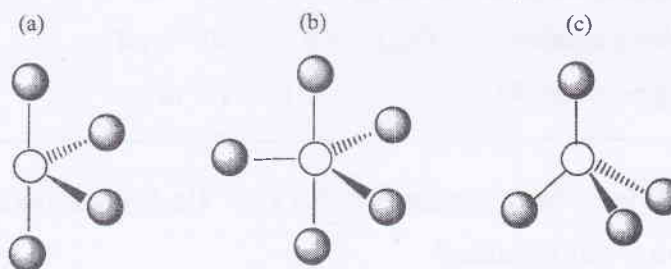
$(7 \times 15$ marks => Maximum 100 marks)

2. A) In which of these bonding patterns does X have the electrons octet?

(a)   (b)   (c)   (d)   (e)   (f)
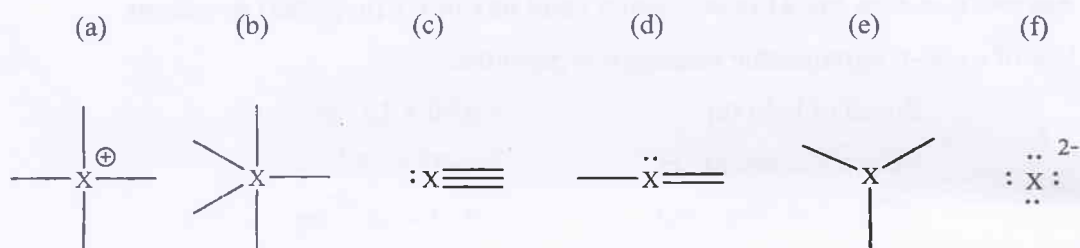
(24 marks)

B) Consider following molecular shapes to answer questions (a) to (c)

(a)   (b)   (c)

    i. Which has/have the most shared and unshared electron pairs around the central atom?

    ii. Which has the most unshared pairs around the central atom?

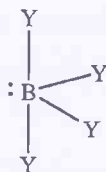   iii. Do any have only shared pairs around the central atom? $(3 \times 12$ marks)

C) State whether the sentence "A non-polar molecule may possess polar covalent bond" is correct or incorrect. Explain your answer with an example. (24 marks)
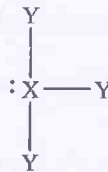
D) Give the ideal bond angle and expected deviation in the bond angle, positive or negative, for each of following compound.

(2 × 8 marks)

(a)   (b)

$$
\begin{array}{cc}
:B\overset{\displaystyle Y}{\underset{\displaystyle Y}{|}}\!\!\!-\!Y & :X\overset{\displaystyle Y}{\underset{\displaystyle Y}{|}}\!\!\!-\!Y
\end{array}
$$

3. A) Consider the following molecules.

(a) SF_4 (b) NBr_3 (c) ICl_2^-

   i. Deduce Lewis structures. Show all the steps required.
   ii. Use the Lewis structures to determine the shapes of each.   (3 × 10 marks)

B) What is the hybridization of carbon in each of the following?

(a) CO_3^{2-} (b) $C_2O_4^{2-}$ (c) $CHCl_3$

(3 × 5 marks)

C) Use molecular orbital diagrams and the bond orders to answer following questions.
   i. Is O_2^- stable?
   ii. Is O_2^- paramagnetic?
   iii. What is the outer (valence) electron configuration of O_2^-?   (35 marks)

D) Consider the molecules SCl_2, F_2, CS_2, CF_4 and $BrCl$.
   i. Which has bonds that are the most polar?
   ii. Which molecules have a dipole moment?
   Give reasons for your choice.   (4 × 5 marks)

4. A) Compare the basicity of SnO_2 in water to that of CO_2. Explain. (20 marks)

B) Complete and balance the following equations

   i. An active metal reacting with acid,

$$Al_{(s)} + HCl_{(aq)} \longrightarrow \quad ?$$

   ii. An alkali metal hydride reacting with water,

$$LiH_{4(s)} + H_2O_{(l)} \longrightarrow \quad ?$$

   iii. Reduction of a metal halide by hydrogen to form a metal,

$$PdCl_{2(aq)} + H_{2(g)} \longrightarrow \quad ?$$

(24 marks)

C) Why do the noble gases have low boiling points? (16 marks)

D) Explain the nature of bonding of the molecule B_2H_6. Include the orbital picture in your answer. (20 marks)

E) Bond length of the BF_3 molecule is shorter than the expected B-F bond length. Clarify this statement using your knowledge of backbonding. (20 marks)

5. A) Justify the formation of multiple oxidation states in transition elements. (30 marks)

B)   i. Describe the term "valance state electronegativity".

   ii. In which compound does Cr exhibit greater metallic behavior, CrF_2 or CrF_6?

(30 marks)

C) Dark green manganate salts contain the MnO_4^{2-} ion. The ion is stable in basic solution but disproportionates in acid medium to $MnO_2(s)$ and MnO_4^-.

   i. Write down the oxidation state of Mn in each of complex ion, MnO_4^{2-}, MnO_4^-, and MnO_2?

   ii. Write a balanced equation for the reaction of MnO_4^{2-} in acidic solution.

(20 marks)

D) Octahedral $[Ni(NH_3)_6]^{2+}$ is paramagnetic, whereas planar $[Pt(NH_3)_4]^{2+}$ is diamagnetic, even though both metal ions are d^8 species. Explain. (20 marks)

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