

6. Considering the Sommerfeld's model of the atom perform suitable calculations to show that the energy of the electron is given by $E = -Ze^2/2a$.

[Given : $1/r = (1 + \epsilon \cos \phi) / a(1 - \epsilon^2)$; ϵ : eccentricity of the elliptical path ; a : semi-major axis of an ellipse. 3

7. Explain how Heisenberg illustrated the impossibility of violating the "Uncertainty Principle" using his imaginary microscope experiment. In the process derive the condition for the simultaneous determination of the position and momentum of an electron. 3
8. Using the wave function $\psi = A \sin(2\pi/\lambda)x$, generate the Schrödinger wave equation and explain the terms involved. 3

FIRST B. SC. EXAMINATION, 2018

(1st Semester, Old Syllabus)

CHEMISTRY (HONOURS)

PAPER - I

Time : Two hours

Full Marks : 50

Use a separate answerscript for each group.

GROUP - A

1. Answer *any two* questions : 5×2
- a) Find the units (in SI system) with reasons-
- i) 'a' & 'b' in $\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$
- ii) 'A' and 'B' in $C_{P,m} = R + \frac{A}{T} + BT^2$.
- iii) 'E_a' in $k = Ae^{-E_a/RT}$.
- b) Define 'most probable molecular speed, C_m' of a gas. Derive its expression using M-B molecular speed distribution equation.
- c) Estimate 'C_{V,m}', 'C_{P,m}' and 'γ' of carbon dioxide gas, assuming its ideal behavior, using the 'Principle of Equipartition of Energy'.

[2]

2. Answer *any two* questions : 3 $\frac{1}{2}$ × 2
- a) Draw the M-B one-dimensional velocity distribution curves at two different temperatures and explain.
 - b) Consider an ideal gas at constant pressure. What would be the effect of temperature on the value of its viscosity coefficient ? Give reasons.
 - c) Calculate the 'wall collision frequency' of oxygen gas at 300 K and 1 bar pressure.

[5]

GROUP - C

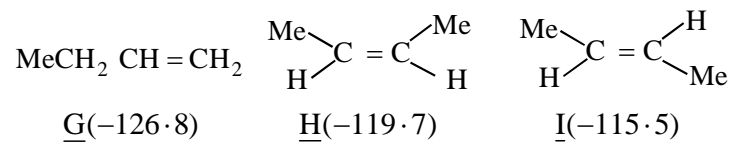
Answer question no. **4** and *any two* other questions.

- 4. a) What would be the wavelength of the 3rd line in the Balmer series in the emission spectra of H, He⁺ and Li²⁺?
[Given $R_{\infty} = 109677 \text{ cm}^{-1}$] 1 $\frac{1}{2}$
 - b) With the help of the concept of the reduced mass of a system show that
$$M_{\text{H}}/m_e = (R_{\text{H}} - 1/7R_{\text{Li}})/(R_{\text{Li}} - R_{\text{H}})$$
 [mass of Li is ~ 7 times that of H] 2
 - c) What are the pairs of properties for which there is an uncertainty in determination of their precise values simultaneously as enunciated by Heisenberg. 1 $\frac{1}{2}$
 - d) Electromagnetic radiation of wavelength 242 nm is just sufficient to ionize the sodium atom. Calculate the ionization energy of the sodium atom. 2
 - e) From the energy of the electron in the nth Bohr orbit and that of Sommerfeld and making suitable assumptions as necessary evaluate the values of the semi-major and semi-minor axes as for a Sommerfeld orbit. 3
5. With the help of suitable assumptions made by Niels Bohr create an expression for the energy of an electron in the nth orbit of the hydrogen atom 3

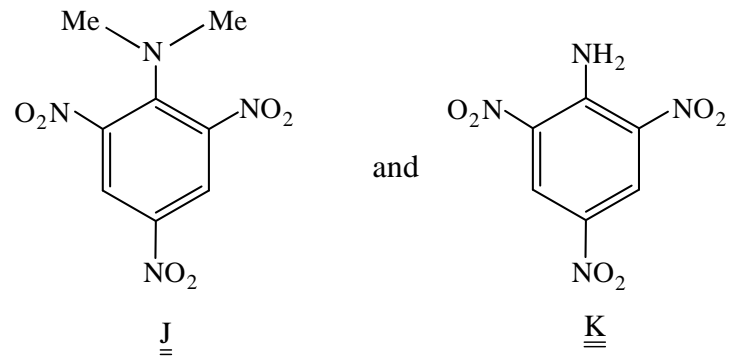
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[4]

- f) The heats of hydrogenation (in kJ mol^{-1}) of some alkenes are given below. Arrange them in the increasing order of stability. 3



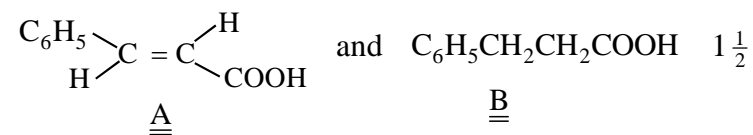
- g) Which of the following compounds is more basic and why? 3



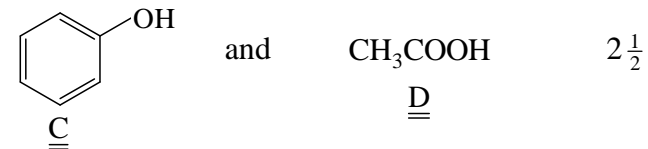
[3]

GROUP - B

3. a) Which of the following molecules will have higher melting point and why?

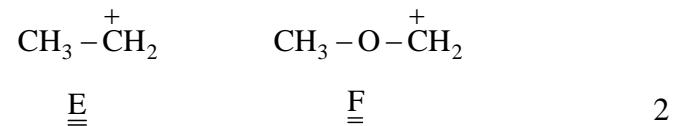


- b) Which one of the following molecules will be more acidic and why?



- c) CH_3Cl has the higher dipole moment than CH_3F – is this statement correct? Justify your answer with appropriate reason. 2

- d) Identify the more stable cation from those given below and give reasons for your answer.



- e) The pK_a^1 of maleic acid is lower than the pK_a^1 of fumaric acid but pK_a^2 of maleic acid is higher than the pK_a^2 of fumaric acid. How would you explain these result? 3

[Turn over