JAM (2020-2021)
Mock Test No: 3
Subject: Real Gas and Intermolecular Forces

Date: 16/02/2020 **Time:** 1 hour 30 mins **Full Marks: 50**

Name: **Roll No.:**

No. of questions attempted	No. of correct answers	No. of wrong answers	Marks obtained	Total

- There is only one correct option.
- Tick (✓) to the correct option.
- There is a negative marking of 0.25 for each wrong attempt.

1. **The virial expansion for a real gas can be written in either of the following forms**

$$\frac{PV}{RT} = 1 + B_P P + C_P P + \cdots$$
$$= 1 + B_V V + C_V V + \cdots$$

If $B_V = \alpha B_P$, the value of α would be

(a) $\frac{PV}{RT}$ (b) $\frac{RT}{PV}$
(c) PV (d) RT.

2. **The compressibility factor to carbon monoxide at** 300 K **and** 800 atm **is** 1.9 **and at** 570 K **and** 200 atm **is** 1.1**. A certain mass of** CO **occupies a volume of** 1 dm^3 **at** 330 K **and** 800 atm**. Calculate the volume in litre occupied by same quantity of** CO **gas at** 570 K **and** 200 atm **(nearly).**

(a) 5 (b) 3 (c) 4 (d) 1.5.

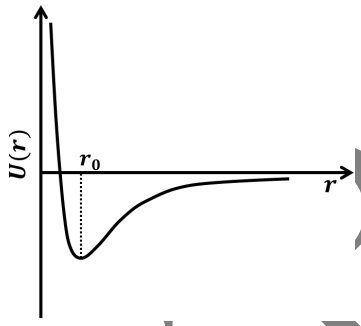
3. **The non-bonded interactions between two molecules consist of electrostatic** (EI) **and van der Waals forces** (vdW)**. Which of the following is a correct description of the distance dependence intermolecular interactions between two molecules?**

(a) At large distance, EI interactions decay faster than vdW interactions
(b) At large distances, vdW interactions decrease faster than the EI interactions
(c) Which force drops faster depends on the net charge of the molecules
(d) Both interactions have same distance dependence.

4. **The potential energy of a diatomic molecule, as a function of the internuclear separation r, is approximated as**

$$U(r) \;=\; \frac{A}{r^a} - \frac{B}{r^b}$$

where a and b are positive constants and $a > b$.



As shown in the above figure, r_0 is the equilibrium bond length. What is the energy necessary to break the bond from its equilibrium position?

(a) $\frac{A}{r_0^a} - \frac{B}{r_0^b}$ (b) $\frac{B}{r_0^b} - \frac{A}{r_0^a}$
(c) $\frac{A}{r_0^a}\left(\frac{a}{b} - 1\right)$ (d) Both (b) and (c).

5. **The concentration of a molecule in aqueous solution is $\left(\frac{C}{1000}\right)$ L^{-1}, where C is the number of molecules. Assuming the molecule is sphere of radius r_0 Angstrom, one can estimate the intermolecular (centre-to-centre) separation by,**

(a) $\frac{1}{\sqrt[3]{C}} - 2 \times r_0$ meter
(b) $\frac{1}{\sqrt[3]{C}}$ meter
(c) $\frac{1}{\sqrt[3]{C}} - 2 \times 10^{-10} \times r_0$ meter
(d) cannot be estimated based on the information above.

6. **Real gases behave differently from ideal gases because**
(i) the molecules of real gases are in constant motion.
(ii) molecules of real gases collide with the walls of the container.
(iii) molecules of real gases have volume.
(iv) molecules of real gases attract each other.

(a) (i) and (ii) (b) (iii) only
(c) (iii) and (iv) (d) all of the above

7. **The unit of the constant a in van der Waals equation of state of a real gas can be expressed as**
   (a) m^6 Pa mol^{-2} (b) m^6 J mol^{-2}
   (c) m^3 Pa mol^{-2} (d) m^3 J mol^{-2}

8. **The relationship between the van der Waals constant b of N_2 and O_2 is,**
   (a) $b(N_2) = b(O_2) = 0$ (b) $b(N_2) = b(O_2) \neq 0$
   (c) $b(N_2) > b(O_2)$ (d) $b(N_2) < b(O_2)$

9. **In the gas phase, the ratio of the excluded volume to molecular volume for a spherical molecule is _____.**

10. **In an ideal monoatomic gas, the speed of sound is given by $\sqrt{\frac{5RT}{3M}}$, if the speed of sound in argon at 25°C is 1245 km h^{-1}, the root mean square velocity in ms^{-1} is _____.**

11. **A stream of oxygen molecules at 500 K exits from a pin-hole in an oven and strikes a slit that selects the molecules traveling in a specific direction. Given that the pressure outside the oven is 2.5×10^{-7} atm, estimate the maximum distance at which the slit must be placed from the pin-hole in order to produce a collimated beam of oxygen. (Radius of $O_2 = 1.8 \times 10^{-10}$ m).**
    (a) 0.473 m (b) 0.562 m (c) 0.120 m (d) 0.320 m.

12. **For an ideal gas, the compressibility factor is**
    a) 0.5 b) 1.0 c) 1.5 d) 2.0

13. **Consider a real gas with a constant amount and a constant pressure. It has a temperature of To and a volume of V_0. If you double the temperature, what will happen to the volume?**
    (a) $2V_0$ (b) $> 2V_0$ (c) $> 2V_0$ (d) $0.5V_0$.

14. **Which of the following gases would behave the least ideally?**
    (a) O_2 (b) He (c) CO (d) HF

15. **Which of the following is relevant for real gases, but irrelevant for ideal gases? I. Volume of gas particles, II. Intermolecular forces between gas particles, III. Volume of container.**
    (a) I and II (b) I and III (c) III only (d) I only.

16. **Real gases behave differently from ideal gases because:**
(i) the molecules of real gases are in constant motion.
(ii) molecules of real gases collide with the walls of the container.
(iii) molecules of real gases have volume.
(iv) molecules of real gases attract each other.

(a) (i) and (ii) (b) (iii) only
(c) (iii) and (iv) (d) all of the above

17. **The pressure of real gases is less that that of ideal gas because of**
(a) increase in the number of collisions;
(b) finite size of particles;
(c) intermolecular attraction;
(d) increase in kinetic energy of the molecules.

18. **The temperature at which real gases obey the ideal gas laws over a wide range of pressure is called**
(a) Critical temperature (b) Boyle temperature
(c) Inversion temperature (d) Reduced temperature.

19. **An ideal gas is**
(a) an imaginary gas which obeys gas laws strictly;
(b) a real gas at high pressure and low pressure;
(c) a real gas at high temperature and low pressure;
(d) Helium gas.

20. **A real gas which obeys van der Waals equation will approach ideal behavior if**
(a) a is large, b is small (b) a is small, b is large
(c) a and b both are large (d) a, b are negligibly small.

21. **Real gases deviate from ideal behavior because, the molecules**
(a) are colorless (b) attract each other;
(c) contain covalent bonds (d) show Brownian movement.

22. **A solute is most likely to be highly soluble in a solvent if the solute is ..... and the solvent is .....**

(a) ionic or polar, non-polar, (b) ionic or polar, polar
(c) non-polar, polar (d) non-polar, ionic

23. **What type of intermolecular forces are due to the attraction between temporary dipoles and their induced temporary dipoles?**

(a) metallic bond (b) London dispersion
(c) hydrogen bond (d) ionic bond

24. **What type of interparticle forces holds liquid N_2 together?**

(a) ionic bonding (b) London forces
(c) hydrogen bonding (d) dipole-dipole interaction

25. **At room temperature,** F_2 **and** Cl_2 **are gases,** Br_2 **is a liquid, and** I_2 **is a solid. This is because:**

(a) polarity increases with molecular size.
(b) dipole-induced dipole interactions increase with molecular size. dipole-dipole interactions increase with molecular size.
(c) dispersion interactions increase with molecular size.
(d) dispersion interactions increase with molecular size and polarity increases with molecular size.

26. **Based on the following informations:** CF_4**: mol. weight 87.99, normal boiling point** $-182°C$, CCl_4**: mol. weight 153.8, normal boiling point** $-123°C$**.**
The intermolecular forces of attraction in the above substances is described by which of the following:

(a) repulsive forces (b) gravitational forces
(c) dispersion (or London) forces (d) ion-dipole forces