Subject: Chemistry Topic: States of Matter I & II (RK)
Multiple-Choice Questions

01. For a given amount of a gas the volume was increased by four times and the Kelvin temperature was increased by two times. Its pressure will be (a) increased by two times (b) increased by four times (c) decrease to its half (d) remain same.

02. For some amount of a van der Waal's gas, the volume that is unavailable for occupation by its gas molecules is: (a) the constant b (b) the constant b multiplied by the number of moles n (c) zero (d) n^2a / V^2.

03. According to Avogadro's law, at constant temperature and pressure: (a) equal no. of molecules of two gases would occupy the same volume (b) for one given gas the volume is proportional to the number of molecules (c) for one given gas the volume is proportional to the number of moles (d) none of the above.

04. At constant temperature 50 mL of O_2 gas at 2 atm pressure was mixed with 25 mL of N_2 gas at 1 atm pressure to yield a gas mixture of 75 mL volume. Assuming ideal behaviour, we find that for the gases in the mixture (a) the partial pressures are 2 atm and 1 atm respectively (b) the partial pressures are 1.33 atm and 0.33 atm respectively (c) the total pressure is 1.5 atm (d) the partial pressures are 1 atm and 0.5 atm respectively.

05. From a porous pot, 20 mL of O_2 gas diffuses in 4 min. If at the same condition of pressure and temperature, 20 mL of another gas diffuses in 8 min from the porous pot, the relative molecular mass of that gas is (a) 32 (b) 64 (c) 16 (d) 128.

06. At 127 °C, the rms (root mean square) speed of gaseous He atoms (relative atomic mass 4.00) is approximately: (a) 50 m s^{-1} (b) 1.58 km s^{-1} (c) 0.89 km s^{-1} (d) 28 m s^{-1}.

07. The vapour pressure of water (a) linearly increases with temperature and attains 1 atm pressure at 100 °C (b) non-linearly increases with temperature and attains 1.013 bar at 373 K (c) non-linearly increases with temperature and is 1 atm at 25 °C (d) decreases with temperature.

08. The surface tension of water (a) increases with its temperature (b) is the force per unit length with which the surface molecules are attracted downward towards the bulk of liquid (c) increases when a surfactant solute e.g., soap is dissolved in water (d) equals the energy required per unit area to expand the area of its surface.

09. At constant temperature, the coefficients of viscosity of ethanol, butanol and 1,1 dimethyl ethane-1-ol should be in the order (a) butanol > 1,1 dimethyl ethane-1-ol > ethanol (b) butanol > ethanol > 1,1 dimethyl ethane-1-ol (c) 1,1 dimethyl ethane-1-ol > ethanol > butanol (d) ethanol > 1,1 dimethyl ethane-1-ol > butanol.

10. Iodine (I_2) is a molecular solid. This means that (a) the bond joining the iodine atoms within an iodine molecule is van der Waal's interaction (b) the attraction binding two neighbouring iodine molecules is van der Waal's interaction (c) the bond binding two neighbouring iodine molecules is a covalent bond (d) there is no interaction binding two neighbouring iodine molecules.

11. A particular metal consists of atoms packed in hexagonal one-dimensional layers, stacked one over voids of another layer as per the pattern ABCABCABC…. The number of metal atoms per unit cell and packing fraction are respectively (a) 4 & 68% (b) 2 & 68% (c) 4 & 74% (d) 1 & 74%.

12. In an ionic solid structure made of A, B (both metal) cations and O^{2-} (oxide) anions, the oxide ions remain in a face-centred cubic (fcc) lattice. 'A' cations occupy one-eighth of the tetrahedral sites while 'B' cations occupy half of the octahedral sites of the anion lattice. The formula of the ionic solid is (a) ABO_2 (b) AB_2O_3 (c) AB_2O_4 (d) AB_4O_8.

Subject: Chemistry Topic: Stoichiometry (RK)
Multiple-Choice Questions

01. The number of molecules of dioxygen gas required for complete combustion of a million molecules of propane is: (a) one million (b) three (c) five (d) five millions

02. To decompose 10 g of pure limestone ($CaCO_3$) as per the reaction

$$CaCO_3 + 2HNO_3 = Ca(NO_3)_2 + H_2O + CO_2$$

the mass of pure nitric acid required is: (a) 10 g (b) 6.3 g (c) 12.6 g (d) 20 g

03. The mass of NH_4Cl obtainable from reaction between 2.24 L of hydrogen chloride gas at STP and 3.4 g of pure liquid ammonia is: (a) 7.05 g (b) 5.35 g (c) 5.64 g (d) 10.7 g

04. The volume of NH_3 gas obtainable by reaction of 15 L of dinitrogen gas and 15 L of dihydrogen gas, all gases at 100 ºC temperature and 100 atm pressure, assuming cent percent yield, is: (a) 10 L (b) 30 L (c) 20 L (d) can't be known from the data given

05. The volume of CO_2 gas at STP that would get absorbed in 250 mL of a 0.2 M NaOH solution is: (a) 50 mL (b) 1.12 L (c) 560 mL (d) 2.24 L

06. The volume of a 0.1 M HCl solution that would neutralise 100 mL of a 0.74% (w/v) $Ca(OH)_2$ solution is: (a) 200 mL (b) 100 mL (c) 740 mL (d) 74 mL

07. 50 mL of a 0.31% (w/v) potassium permanganate solution and excess sulphuric acid was added to 150 mL of a 0.63% (w/v) oxalic acid solution. The volume of the same $KMnO_4$ solution required to completely react with the unreacted oxalic acid solution is (a) 100 mL (b) 50 mL (c) 200 mL (d) 0 mL

08. The empirical formula of a hydrocarbon that has 14.3% hydrogen by mass is: (a) C_3H_6 (b) CH_2 (c) C_6H_6 (b) CH_4O

09. The volume of NH_3 gas at 1 atm pressure and 100 ºC temperature, that will get bound as ligand to 50 mL of a 0.2 M $CuSO_4$ solution is: (a) 1.224 L (b) 2.24 L (c) 550 mL (d) 10 mL.

10. Some amount of a hydrocarbon was burnt at 375 K in excess of air. Upon dehydration, the burnt gas volume got lowered by 300 mL, whereas upon passage through a KOH solution, the gas volume got further lowered by another 150 mL. The formula of a hydrocarbon can be: (a) CH_4 (b) C_3H_6 (c) C_2H_2 (d) None of the above.

Subject: Chemistry Topic: Electrochemistry – I & II (RK)
Multiple-Choice Questions

01. During electrolysis of aq. NaCl solution using Pt electrodes the substance liberated at the cathode is: (a) H_2 gas (b) Na metal (c) Cl_2 gas (d) Pt metal

02. During electrolysis of aq. $CuSO_4$ solution using Pt electrodes and using Cu electrodes the substances liberated at the cathode are: (a) H_2 gas and Cu metal (b) Cu metal and Cu metal (c) Cu metal and H_2 gas (d) Pt metal and Cu metal

03. During electrolysis of fused alumina solution, the substance liberated at the anode is: (a) oxygen gas (b) carbon (c) aluminium metal (d) iron

04. Which of the following is a weak electrolyte? (a) NH_4Cl (b) CH_3COONa (c) NaF (d) HF

05. Which of the following liquid is not an ionic (electrolytic) conductor of electricity? (a) aq. NaOH solution (b) aq. HCl solution (c) fused Al_2O_3 (d) mercury

06. The mass of silver liberated at the cathode when 0.5 A of current is passed for 10 minutes through an $AgNO_3$ solution and the mass of iron liberated at the cathode when 0.5 A of current is passed for 20 minutes through an $FeSO_4$ solution bears the relation (a) the masses are nearly same (b) the mass of silver is around four times that of iron (c) the mass of silver is around twice that of iron (d) the mass of silver is around eight times that of iron.

07. The mass of copper liberated at the cathode when 0.5 A of current is passed for 10 minutes through a $CuSO_4$ solution is around (a) 1 g (b) 0.2 g (c) 0.1 g (d) 20 mg

08. The number of electrons transferred during liberation of 6.35 g of Cu from a $CuSO_4$ solution is: (a) 6.022×10^{23} (b) 6.022×10^{22} (c) 3.022×10^{22} (b) 1.244×10^{23}

09. If the resistance of 0.1 M $FeSO_4$ solution was found to be 50 ohm in a cell of cell constant 1 cm^{-1}, the molar conductance of the solution is: (a) 200 S cm^2 mol^{-1} (b) 100 S cm^2 mol^{-1} (c) 50 S cm^2 mol^{-1} (d) 20 S cm^2 mol^{-1}.

10. The relation between the numerical values of the molar conductance and equivalent conductance of a given $Al_2(SO_4)_3$ solution is: (a) both are same (b) the former is twice the latter (c) the former is one-sixth of the latter (d) the former is six times the latter

11. The plot of the molar conductance vs. square root of the molarity is *not* linear for the electrolyte: (a) $Al_2(SO_4)_3$ (b) NaOH (c) HCl (d) NH_4OH

12. The standard electrode potentials of the electrodes $Ni^{2+}|Ni(s)$ and $Fe^{3+}(aq),Fe^{2+}(aq)|Pt$ are –0.23 V and 0.77V. This implies that (a) Ni^{2+} reduces Fe^{3+} to Fe^{2+} (b) Ni reduces Fe^{3+} to Fe^{2+} (c) Fe^{2+} reduces Ni^{2+} to Ni (d) In a Galvanic cell involving these two electrodes, $Ni^{2+}|Ni(s)$ will be the cathode.

13. The standard electrode potentials of the $Ni^{2+}|Ni(s)$ electrode is –0.23 V. For a 0.01 M $NiSO_4$ solution at 25 °C, the electrode potential will be (a) –0.23 V (b) –0.29 V (c) –0.20 V (d) –0.26 V

14. At the end point of a potentiometric titration between acidic $KMnO_4$ solution and a $FeSO_4$ solution, the ions that will mostly be found in the solution are (a) MnO_4^- and Fe^{2+} (b) MnO_4^- and Fe^{3+} (c) Mn^{2+} and Fe^{2+} (d) Mn^{2+} and Fe^{3+}

Subject: Chemistry Topic: Chemical Kinetics (RK)
Multiple-Choice Questions

01. The reaction $Na + H_2O \rightarrow NaOH + \frac{1}{2}H_2$ must be having the order: (a) 2, as the sum of the coefficients of the reactants in above equation is two (b) 1, as water conc. does not come into picture (c) 4, as the chemical equation must be balanced (d) can't be found from the chemical equation itself.

02. In the reaction $2NO + O_2 \rightarrow 2NO_2$, the relation between the rates $d[NO_2]/dt$ and $d[O_2]/dt$ is: (a) $d[NO_2]/dt = -d[O_2]/dt$ (b) $d[NO_2]/dt = -2d[O_2]/dt$ (c) $2d[NO_2]/dt = -d[O_2]/dt$ (d) no such relation exists.

03. The rate constant k of a chemical reaction is a constant in the sense that (a) it is independent of temperature (b) it is independent of catalyst presence (c) it is independent of reactant concentration (d) none of the above.

04. The differential rate equation expresses the dependence of the reaction rate on (a) temperature (b) catalyst concentration (c) product concentration (d) reactant concentration.

05. In the iodination reaction of acetone, $CH_3COCH_3 + I_2 \rightarrow CH_3COCH_2I + HI$, when the iodine concentration is doubled the reaction rate doesn't change but when the acetone concentration is instead doubled the reaction rate also doubles. Overall order of the reaction is (a) 2 (b) 1 (c) 0 (d) 4.

06. The acid-catalysed hydrolysis reaction of methyl acetate is called a pseudo-unimolecular reaction. The order of this reaction and molecularity of its rate-determining step is (a) 1 & 1 (b) 1 & 2 (c) 2 & 1 (d) 2 & 2.

07. For thermal decomposition of gaseous ethanal, we find that corresponding to the partial pressures 0.1 atm and 0.4 atm of ethanal gas, the rates of its decomposition are 0.0001 mol dm^{-3} min^{-1} and 0.0008 mol dm^{-3} min^{-1} respectively. The differential rate law for this reaction is:
(a) $-d[CH_3CHO]/dt = k[CH_3CHO]$ (b) $-d[CH_3CHO]/dt = k[CH_3CHO]^2$
(c) $-d[CH_3CHO]/dt = k[CH_3CHO]^3$ (d) None of the above.

08. The half-life of a chemical reaction is a constant independent of reactant concentration for: (a) zero-th order reactions (b) 3rd order reactions (c) 1st order reactions (d) 2nd order reactions.

09. For a first order reaction, the plots of reactant conc. [A] vs. time and of log[A] vs. time are: (a) both decreasing plots and the former a linear one (b) both decreasing plots and the latter a straight line (c) the former a decreasing plot and the latter an increasing one (d) both increasing plots.

10. For a first order reaction, the time required for 75% and 90% completion of the reaction are: (a) twice and five times of the half-life (b) twice and approximately thrice of half-life (c) 1.5 and 1.8 times the time for 50% completion (d) No such definite relation exists.

11. The plots of rate constant k vs. temperature T and of log k vs. 1/T are: (a) both increasing plots and the former a linear one (b) both increasing plots and the latter a straight line (c) the former a increasing plot and the latter an decreasing one (d) both decreasing plots.

12. A positive catalyst increases the reaction rate because (a) energy of activation E_a decreases and $\exp(-E_a/RT)$ decreases (b) E_a decreases and $\exp(-E_a/RT)$ increases (c) E_a decreases and rate constant k decreases (d) E_a decreases and so the reactant concentrations get increased.

Subject: Chemistry Topic: Chemical Thermodynamics (RK)
Multiple-Choice Questions with Answers

(1) During any process the energy of the universe (a) increases towards a maximum (b) remains constant (c) decreases towards a minimum (d) sometimes decreases and sometimes increases.
Ans: (b) remains constant. This is as per 1st law of thermodynamics. As per its 2nd law, however, the *entropy* of the universe increases and tends towards a maximum.

(2) The mathematical form of 1st law of thermodynamics is: (a) $q = \Delta U + w$ (b) $U = q + w$ (c) $\Delta U = q + w$ (d) $\Delta U = q$.
Ans: (c) $\Delta U = q + w$, because as per the modern convention, heat absorbed by the system q and work done on the system w together increases the internal energy U of the system, this increase being ΔU. (a) is as per the old convention, and (b) does not deal with the change in U, but with U itself.

(3) If the enthalpy of combustion of C(s) is –324 kJ mol^{-1} and the enthalpy of formation of CO(g) is –214 kJ mol^{-1}, the enthalpy of the reaction $2CO(g) + O_2(g) = 2CO_2(g)$ is: (a) –110 kJ mol^{-1} (b) –220 kJ mol^{-1} (c) –538 kJ mol^{-1} (a) –1076 kJ mol^{-1}
Ans: (b) –220 kJ mol^{-1}, as the given reaction is obtainable as the double of the difference (i.e., 1st–2nd) between the combustion reaction of C(s), i.e., $C(s) + O_2(g) = CO_2(g)$ and the formation reaction of CO(g) i.e., $C(s) + \frac{1}{2}O_2(g) = CO(g)$. So the difference (a) is wrong, also the sum (c) and the double of the sum (d).

(4) A reversible process (a) is associated with no change in the entropy of the universe (b) is a spontaneous process (c) is associated with an increase in the entropy of the universe (d) is associated with no change in the entropy S.
Ans: (a), as only in the spontaneous processes entropy of universe increases, but in reversible process it remains constant; choice (d) confuses between entropy of universe and entropy S of the system.

(5) In a spontaneous process at constant T & P (a) Gibbs free energy G of the system decreases (b) Gibbs free energy of the universe decreases (c) Gibbs free energy of the universe increases (d) G of system increases.
Ans: (a), as unlike entropy G decreases in spontaneous process, and G of the system – not of the universe.

(6) During isothermal and reversible expansion of 2 moles of an ideal gas at 300 K from volume 2 dm^3 to 3 dm^3, entropy change of the system and of the universe is: (a) 6.74 JK^{-1} & 6.74 JK^{-1} (b) 6.74 JK^{-1} & 0 JK^{-1} (c) 2.93 JK^{-1} & 2.93 JK^{-1} (d) 2.93 JK^{-1} & 0 JK^{-1}.
Ans: (b) 6.74 JK^{-1} & 0 JK^{-1}, as the relevant relation is $\Delta S = n R \ln (V_f/V_i)$ for system, whereas for the universe the entropy change is zero in a *reversible* process. (c) & (d) confuses you between $\ln (V_f/V_i)$ and $\log (V_f/V_i)$.

(7) The standard Gibbs free energy of formation of $H_2O(l)$ is –237 kJ mol^{-1}. The Equilibrium constant K_c for the reaction $2H_2(g) + O_2(g) = 2H_2O(l)$ at 298 K is given by:
(a) $\log K_c = 0.0831$ (b) $\log K_c = 83.1$ (c) $\log K_c = –83.1$ (d) $\log K_c = 41.6$.
Ans: (b). Choice (a) misses that 1 kJ = 1000 J, whereas choice (c) misses the negative sign in relation $\Delta G^o = –2.303RT \log K_c$. Choice (d) forgets that given reaction is two times the formation reaction of liquid water. (As reaction is spontaneous, K_c is very large here).

(8) A process at constant pressure and temperature is spontaneous at all temperatures if
(a) $\Delta H > 0$ and $\Delta S > 0$ (b) $\Delta H > 0$ and $\Delta S < 0$ (c) $\Delta H < 0$ and $\Delta S < 0$ (d) $\Delta H < 0$ and $\Delta S > 0$.
Ans: (d), As $\Delta G = \Delta H – T\Delta S$ with temperature T always being positive implies that ΔG will be surely negative for any T if $\Delta H < 0$ and $\Delta S > 0$.