Syllabus and Sample Questions for JRF in Geology

There will be two sets of candidates applying for JRF in Geology: i) M. Sc. in Geology/Applied Geology/Earth Science or equivalent, ii) M. Sc. in Chemistry or equivalent (specialization in Physical Chemistry).

The candidates have to take two tests: Test **GM** (**Part -1:** objective and **Part -II:** short answer type/numerical problems) in the forenoon session and test **RG** (critical appreciation, short answer and objective type) in the afternoon session. For both tests Full Marks will be 100 and Time 2 Hours.

*Test code **GM Part -I** is compulsory for candidates of both streams.*

If the candidate is from "Geology/Applied Geology/Earth Science or equivalent" stream, he/she will require to answer **Part -I** and **Part II -A** of Test **GM** in the forenoon session and Test **RG Part 1-** in the afternoon session.

If the candidate is from "M. Sc. in Chemistry or equivalent (specialization in Physical Chemistry)" stream, he/she will require to answer **Part -I** and **Part -II B** of Test **GM** in the forenoon session and Test **RG Part-II** in the afternoon session.

Syllabus

FORENOON SESSION

(GM Part -1)

***Algebra**: Properties of real numbers, Geometry of complex variables, DeMoiver's theorem, Algebra of matrices, Rank & inverse of a matrix, Determinants, Solution of linear equations, Orthogonal & unitiary matrices, Eigenvalues & eigenvectors of a matrix*

***Calculus**: Sequence & series, Taylor series, Limit & continuity, Derivatives, Integration of functions of one variable, Definite integrals, Functions of several variables, Partial derivatives, Maxima & minima, Ordinary linear differential equations, Elementary linear partial differential equations, Heat conduction equations.*

***Co-ordinate Geometry**: Straight line, Conic sections, Elementary 3-D co-ordinate geometry*

(Test GM Part II -A)

Geomathematics and statistics: Paleo Vector determinations, Analysis of time-series data, Mohr's Circle of stress and strain, Geological Strain Analysis, Rheology of

materials, Heat flow within the Earth, Flow through porous media, Thermodynamic Principles, Stereographic Projection of geological data

Elementary probability theory, Measures of central tendency, Dispersion, Binomial, Poisson, Normal distributions, Student's T test, ANOVA models, Snedecor's F test, Correlation & regression.

(Test GM Part II -B)

***Thermodynamics (Principles & Applications)*:** First law of thermodynamics, relation between C_p and C_v; enthalpies of physical and chemical changes; temperature dependence of enthalpies. Second law of thermodynamics, entropy, Gibbs-Helmoltz equation, relationship between free energy change and entropy. Third law of thermodynamics and calculation of entropy, Thermochemistry and related topics.

***Chemical Equilibrium*:** Free energy and entropy of mixing, partial molar quantities, Gibbs-Duhem equation, Equilibrium constant, temperature-dependence of equilibrium constant, phase diagram of one- and two-component systems, phase rule.

***Electrochemistry*:** Conductance of solutions and related topics including ionic equilibria, solubility product, hydrolysis of salts, Electrochemical cell reactions, Nernst equation, Electrode kinetics, electrical double layer, electrode/ electrolyte interface.

***Surface Phenomena*:** Surface tension, adsorption of solids, electrical phenomena at interfaces (including electrokinetics), micelles and reverse micelles: solubilization, microemulsions, adsorption/ partition experiments.

***Reaction Kinetics*:** Rates of chemical reactions of different orders and various types of reactions, Arrhenius equation and concept of transition state, Mechanism of photochemical, chain and oscillatory reactions. Collision theory of reaction rates; steric factor, treatment of unimolecular reactions. Theory of absolute reaction rates, comparison of results with Eyring and Arrhenius equations. Ionic reactions: salt effect, Homogeneous catalysis and Michaelis-Menten kinetics; heterogeneous catalysis.

***Macromolecules*:** Number-average and weight average molecular weights; determination of molecular weights.

***Nuclear Chemistry*:** Radioactive decay and equilibrium. Nuclear reactions; types of reactions, Chemical effects of nuclear transformations; fission and fusion. Radio activity and transmutation of elements. Isotopes and their properties.

***Solutions*:** Colligative properties of solutions, Viscosity.

Elementary Principles and applications (Photochemistry) of UV-VIS, IR, NMR Spectroscopy to Simple Structural Problems.

***Data Analysis*:** Types of errors, propagation of errors, accuracy and precession, least square analysis, average standard deviation.

***Acids and Bases*:** Bronsted and Lewis acids and bases, pH and pK_a, acid-base concept in non-aqueous media; HSAB concept. Buffer solutions.

***Redox Reactions*:** Oxidation numbers. Redox potential. Electrochemical series. Redox indicators.

Sample Questions

Forenoon session

GM

Part -I

(To be answered in separate answer script, not in the Question Paper)

1. If $x_n = \sqrt{n+1} - \sqrt{n}$, then $\lim_{n\to\infty} x_n$ is equal to

(a) ∞ (b) 1 (c) 0 (d) $\sqrt{2}-1$

2. If *a* and *b* are any two positive unequal quantities and $b > a$, then which one of the following is correct

(a) $ma^{m-1}(b-a) > b^m - a^m$ (b) $ma^{m-1}(b-a) = b^m - a^m$ (c) $ma^{m-1}(b-a) < b^m - a^m$ (d) none of these.

3. The real roots of $x^3 - 5x - 5 = 0$ lies in the interval

(a) (2,3) (b) (-7, 2) (c) (3, 7) (d) (-3, -2)

4. If M and N are two matrices, given by

$M = \begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix}$, $N = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$, $i^2 = -1$, then which of the following is correct

(a) $M^2 = 1$ (b) $N^2 = 1$ (c) $MN = -NM$ (d) $MN = NM$

5. If 'O' and 'D' denote the order and degree of diffrential equation respectively, then $d^3y/dx^3 - 7\,dy/dx - 6y = e^{2x}(1 + x)$ is characterised by

(a) (O = 3, D = 3) (b) (O = 1, D = 3) (c) (O = 2, D = 3) (d) (O = 3, D = 1)

6. The maximum value of the function $f(x) = (1/x)^x$ is

(a) e (b) e^e (c) $e^{1/e}$ (d) 1/e

7. One of the radii of curvature of the curve $y^2 = \dfrac{x^2(a+x)}{a-x}$ is

(a) $\sqrt{2a}$ (b) $-\sqrt{2a}$ (c) $2\sqrt{2a}$ (d) $a\sqrt{2}$

8. The value of the integral $\int_0^\infty e^{-x^2} \cos \alpha x dx$ is

(a) $\frac{\sqrt{\pi}}{2} e^{\frac{1}{4}\alpha^2}$ (b) $\sqrt{\pi} e^{\frac{1}{2}\alpha^2}$ (c) $\frac{\sqrt{\pi}}{2} e^{\frac{-1}{4}\alpha^2}$ (d) $\frac{\pi}{2} e^{\frac{-1}{4}\alpha^2}$

9. The condition that the line $y = px + r$ is a tangent to the parabola $y^2 = 4ax$ is
(a) r = ap (b) r = 2a/p (c) r = -a/p (d) r = a/p

10. The value of Z satisfying $C^2 - Z^2C = Z^2I + I$ where $C = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ is

(a) 1, 2 (b) 1, -1 (c) 2, -2 (d) None of these

GM

Part II -A

Group A

1. Between the years 1951 and 1960, the aluminium production (in Tons) is given

1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
1.13	1.24	1.62	1.75	1.90	2.02	2.01	1.86	2.31	2.34

Assuming a linear trend in the change in production through time, find the coefficients a,

b in Y = a + bx.

2. For a rock analysis following results were obtained for 10 measurements:
SiO_2 = 56.23, 54.12, 56.10, 53.21, 50.15, 51.52, 50.19, 56.10, 49.72, 50.82

Find the instrumental precision for SiO_2.

3. Both the variables x_1 and x_2 have a large variance, but their covariance is small. Find the most appropriate inference, describing the relation between the two variables x_1 and x_2.
4. Arkoses normally contain more than 25% feldspar. Find the probability of encountering feldspar grains in a thin section of arkose.

5. Symmetric extinction angle in plagioclase is related to the solid-solution composition. Under the microscope when these are measured, what type of scale of measurement should be relevant?

Group B

1. Assuming a stoichiometrically balanced reaction A + 3B $\leftrightarrow$ 1.5 C + D and given the following standard state properties of the phases, which way will the reaction proceed at 500^{o}C , 5 Kbar?

	H (Kj/mol)	S (J/mol/K)	V (J/b)
A	-6207.34	334.16	14.98
B	-910.70	41.46	2.27
C	-3091.10	66.17	3.13
D	-3970.79	214.15	10.87

2. The cross-bedding dip directions (azimuths) measured on separate sets at a single locality, are as follows: 10, 250, 261, 265, 274, 281, 285, 290, 293, 297, 300, 301, 302, 303, 307, 311, 320, 326, 333, 352. Determine the vector mean and strength.

3. The two-dimensional state of stress at a point *P* in the x_1x_2-plane is given by:
   stress normal to x_1 = 5 kPa

   stress normal to x_2 = 3 kPa

   shear stress = 2 kPa

Write the above data as a stress tensor (or matrix). Write the deviatoric stress matrix. What are the components of stress (in the x_1- and x_2- directions) acting on a surface inclined at an angle of 60 degrees to the x_1-axis?

4. Write the Darcy's equation and derive the definition of the coefficient of permeability.

5. Under equilibrium state, the variables temperature (T), pressure (P) and specific volume (V) are interrelated. Construct a partial differential equation to relate the change in specific volume with change in T and P. β and α_v are defined as follows

   $\beta = -1/v\ (\delta v/\delta p)_T$ and $\alpha_v = 1/v\ (\delta v/\delta T)_P$

   If the material is confined, i.e. its volume does not change, then shown that changes in temperature can lead to large changes in pressure. The values of β and α_v are of the order of $10^{-11}Pa^{-1}$ and $3 \times 10^{-5}\ K^{-1}$.

GM

Part II -B

1. Show that the reaction $CO\ (g) + ½\ O_2\ (g) \rightarrow CO_2\ (g)$ at 300K is spontaneous and exothermic, when the standard entropy change is –0.094 kJ K^{-1} mol^{-1}. The standard Gibbs free energies for the formation of CO_2 and CO are –394.4 and – 137.2 kJ mol^{-1} respectively.

2. A certain buffer solution contains equal concentration of X^- and HX. Calculate the pH of the buffer. (Given, K_b for X^- is 10^{10}).

3. If there is 1% error in the value of r, the radius of the capillary, what will be the error in the viscosity coefficient calculated by using Poiseuille's equation?

4. The solubility product of CaF_2 at 27°C is 3.55×10^{-11}. Using Debye-Huckel limiting law, calculate the solubility of CaF_2 at 27°C in mol l^{-1}.

5. The conductance of aqueous NaCl, KCl, K_2SO_4 at 25°C at infinite dilution are 126.45, 149.84 abd 306.60 S cm^2 mol^{-1}. Calculate the value of $t(SO_4^{2-})$ in Na_2SO_4 at 25°C.

6. The time required for 10% completion of a first order reaction at 298K is equal to that required for its 25% completion at 308K. If the pre-exponential factor for the reaction is $3.56 \times 10^9\ s^{-1}$, then calculate its rate constant at 318K and also the energy of activation.

7. K_p for the reaction, $N_2 + 3H_2$ □ $2NH_3$ at 400°C is 1.64×10^{-4}. Find K_c. Also find ΔG^0 using K_p and K_c values and interpret the difference.

8. Blood is said to be isotonic with 0.85% NaCl solution at 40°C. Assuming complete dissociation of NaCl, calculate the total concentration of various solutes in blood. What is its approximate freezing point? [$K_f = 1.86$]

9. In a particular sample of polymer, 100 molecules have molecular weight 10^3 each, 200 molecules have molecular weight 10^4each, and 200 molecules have molecular

weight 10^5 each. Calculate the number-average and weight-average molecular weight.

10. Monochromatic light is passed through a 1 mm path length cell containing 0.005 mol dm^{-3} solution. The light intensity is reduced to 16% of its value. Calculate the molar extinction coefficient of the sample. What would be the transmittance if the cell path is 2mm?

11. When benzoic acid was shaken with mixtures of benzene and water at a constant temperature, the following results were obtained:

	I	II	III
Equilibrium concentration of benzoic acid in benzene (C_1)	0.24	0.55	0.93
Equilibrium concentration of benzoic acid in water (C_2)	0.015	0.022	0.029

Comment on these results.

12. At radioactive equilibrium, the ratio between two atoms of a radioactive element A and B are 3.1×10^9:1. If the half life period of A is 2×10^{10} year, what is the half life of B?

Syllabus

AFTERNOON SESSION

(Test RG Part -I)

1. ***Structural Geology:***Concepts of stress and strain, plastic and viscous flow; theory of brittle fracture. Folding and faulting – their classification and mechanics. Superposed folds and their recognition. Classification and genesis of foliation, lineation and joints. Outlines of the structure of the Himalayas. Isostasy and gravity anomalies.

   Plate tectonics and mobile belts' seismisity and seismic zones. Interpretation of geological maps.

2. ***Mineralogy:***General principles of mineral optics and modern methods of mineral identification.

3. ***Petrology:***Phase equilibria studies of various silicate systems with reference to petrogenesis. Concept of magma. Magma generation in the mantle, various possible processes; magmatic differentiation and assimilation.
   Petrogenetic study of important igneous or groups of igneous rocks – granites, pegmatites, alkaline rocks, andesite, basalt, ophiolites. Processes of generation of magmas in the crust and upper mantle – correlation with plate tectonics.
   Controls of metamorphism, nature of metamorphic reactions, chemical equilibrium. Facies concept : Mineral assembalges and important reactions in different metamorphic facies. Relationship between metamorphism, ultrametamorphism and granitization. Petrogenetic problems of Khondalite, Charnockite and other metamorphic rocks of India.

4. ***Geochemistry:*** Radioactivity, Radioactive decay, age and event dating, nuclear clocks. Geochemical classification and distribution of elements in the earth. Law of ionic substitution, concept of solid solution and controlling factors.

5. ***Sedimentology:*** Classification of sedimentary rocks. Transport of sediments by fluids. Environments of deposition and resulting vertical sequences of sedimentary structures and lithologies. Processes and characteristics of continental, mixed and marine sedimentation. Lithification and diagenesis of sediments. Textures and structures. Statistical analysis of grain size and shape. Palaeocurrents and basin analysis. Sedimentary facies and methods of their analysis.

6. ***Economic geology:*** Principles of classification of mineral deposits. Textures and structures of economic minerals. Processes of formation of economic mineral deposits.
   Strategic, critical and essential minerals of India.

7. ***Palaeontology***
   Evolution of life. Fossils, their nature, modes of preservation and uses. Migration, dispersal and extinction of animals and plants. Morphology, classification and evolution of important invertebrate and vertibrate fossil groups. Microfossils – techniques of their study and importance in geology. Fundamentals of palaeoecology. Brief study of the important Gondwana flora and fauna of India.

8. ***Stratigraphy:*** Principles of stratigraphy. Stratigraphic Units. Standard geological time scale. Principles of palaeogeographic reconstruction. Principles of stratigraphic correlation. Study of the important geological formations of India. Important age and correlation problem in Indian stratigraphy.

(Test RG Part -II)

1. ***Thermodynamics (Principles & Applications)*****:** First law of thermodynamics, relation between C_p and C_v; enthalpies of physical and chemical changes;

temperature dependence of enthalpies. Second law of thermodynamics, entropy, Gibbs-Helmoltz equation, relationship between free energy change and entropy. Third law of thermodynamics and calculation of entropy, Thermochemistry and related topics.

2. ***Chemical Equilibrium*****:** Free energy and entropy of mixing, partial molar quantities, Gibbs-Duhem equation, Equilibrium constant, temperature-dependence of equilibrium constant, phase diagram of one- and two-component systems, phase rule.

3. ***Electrochemistry*****:** Conductance of solutions and related topics including ionic equilibria, solubility product, hydrolysis of salts, Electrochemical cell reactions, Nernst equation, Electrode kinetics, electrical double layer, electrode/ electrolyte interface.

4. ***Surface Phenomena*****:** Surface tension, adsorption of solids, electrical phenomena at interfaces (including electrokinetics), micelles and reverse micelles: solubilization, microemulsions, adsorption/ partition experiments.

5. ***Reaction Kinetics*****:** Rates of chemical reactions of different orders and various types of reactions, Arrhenius equation and concept of transition state, Mechanism of photochemical, chain and oscillatory reactions. Collision theory of reaction rates; steric factor, treatment of unimolecular reactions. Theory of absolute reaction rates, comparison of results with Eyring and Arrhenius equations. Ionic reactions: salt effect, Homogeneous catalysis and Michaelis-Menten kinetics; heterogeneous catalysis.

6. ***Macromolecules*****:** Number-average and weight average molecular weights; determination of molecular weights.

7. ***Solids*****:** Dislocation in solids. Schottky and Frenkel defects, Electrical properties; Insulators and Semiconductors; superconductors.

8. ***Nuclear Chemistry*****:** Radioactive decay and equilibrium. Nuclear reactions; types of reactions, Chemical effects of nuclear transformations; fission and fusion. Radio activity and transmutation of elements. Isotopes and their properties.

9. ***Solutions*****:** Colligative properties of solutions, Viscosity.

10. ***Elementary Principles and applications (Photochemistry) of UV-VIS, IR, NMR Spectroscopy to Simple Structural Problems.***

11. ***Data Analysis*****:** Types of errors, propagation of errors, accuracy and precession, least square analysis, average standard deviation.

12. ***Structure and Bonding*****:** Atomic orbitals, electronic configuration of atoms (L-S coupling) and the periodic properties of elements; ionic radii, ionization potential, electron affinity, electronegativity; concept of hybridization. Molecular orbitals and electronic configuration of homonuclear and heteronuclear diatomic molecules. Shapes of polyatomic molecules; VSEPR theory. Symmetry elements and point groups for simple molecules. Bond lengths, bond angles, bond order and bond

energies. Types of Chemical Bond (weak and strong) intermolecular forces, structure of simple ionic and covalent solids, lattice energy, dipole moment, optical rotation.

13. **Acids and Bases:** Bronsted and Lewis acids and bases, pH and pK_a, acid-base concept in non-aqueous media; HSAB concept. Buffer solutions.

14. ***Redox Reactions*:** Oxidation numbers. Redox potential. Electrochemical series. Redox indicators.

15. ***Common Organic Reactions and Mechanism*:** Nucleophilic, electrophilic, radical substitution, addition and elimination reactions. Familiar name reactions: Aldol, Perkin, Hofmann, Curtius, Beckmann and Fries rearrangements, Reimer-Tiemann, Reformatsky and Grignard reactions.

16. ***Chemistry of Transition Elements*:** Coordination chemistry of transition metal ions; nomenclature in IUPAC system, structural aspects, isomerism. Stability constants of complexes and their determination; Jahn-Teller effect.

17. ***Aromatcity*:** Huckel's rule and concept of aromaticity.

Sample Questions

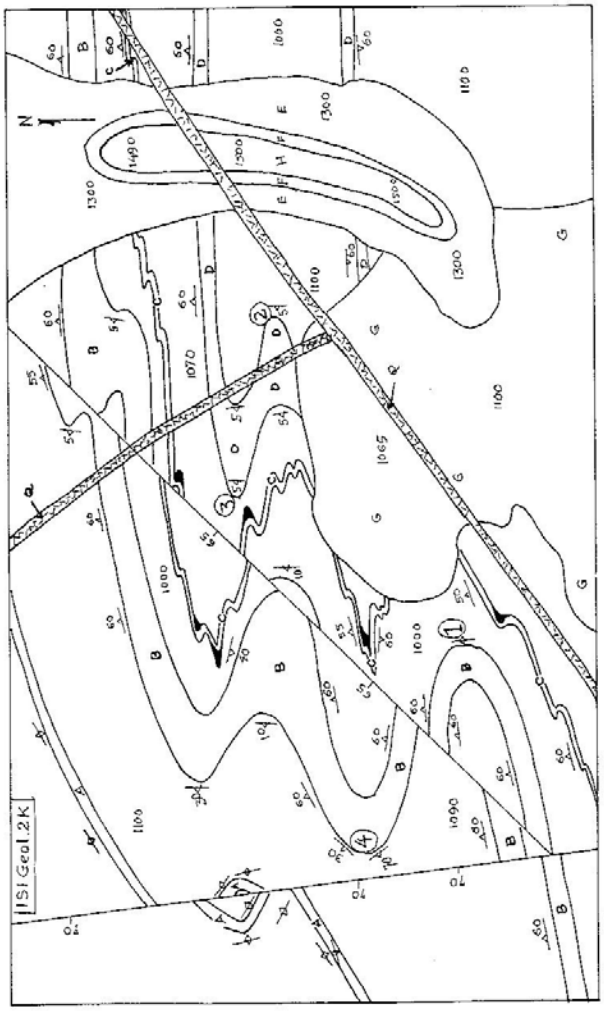
Afternoon Session

RG
PART-I

Group A

1. Work out the following from the geological map (ISI-GEOL-2K, Figure 1) given on page 1. Scale of the map is approximately 10 cm = 750m. Spot height in feet.

   (a) Describe the relation between rock sequences A-B-C-D and E-F-H.
   (b) Describe the relation between rock unit G and the other rock sequences in the area.
   (c) Which rock unit is the youngest in the area and what is its mode of occurrence? Justify your answer.
   (d) Is the NE trending fault a normal fault? Justify your answer.
   (e) Comment on the nature of displacement on the NNW trending fault.
   (f) Change in attitude of foliation shown in different parts of the mapped area indicates that the foliation is folded. Are all the folds shown on the map of comparable style? Cite orientations of fold axes and axial planes at locations 1 through 4 (circled spots) in support of your answer.



(Fig - 1)

Group B

Note : Write short answer to each of the following questions.

2. Describe briefly the history of differentiation of the earth.
3. "Granitic rocks have mineralogical compositions close to eutectics." – explain.
4. Give an account of the textural features suggestive of chemical equilibrium in metamorphic rocks.
5. Give an account of the climatic and tectonic significance of arkosic sandstones.
6. (a) Could *Archaeopteryix* fly? Justify your answer. (b) Why are fossil brachiopods mostly found with their valves closed?
7. How do you explain the origin of crustal stresses?

Group C

Questions 8-12 are multiple choice type. Select the correct answer for each and justify it.

8. The primitive crust of the earth was
   (a) granitic (b) basaltic (c) komatiitic (d) andesitic

9. The major source of heat in the primordial earth was
   (a) decay of short-lived radioactive isotopes
   (b) decay of long-lived radioactive isotopes
   (c) impact of planetesimals
   (d) all of the above

10. Bedforms with the crest trending roughly parallel to the net sediment transport direction are called

    (a) linear dune
    (b) longitudinal dune
    (c) seif dune
    (d) parabolic dune

11. Transgression is cause by
    (a) rise in eustatic sea level
    (b) rise in relative sea level
    (c) increased rate of subsidence
    (d) decreased rate of sedimentation

12. Boudins are products of
    (a) homogeneous deformation
    (b) inhomogeneous, brittle deformation
    (c) inhomogeneous, ductile deformation
    (d) none of the above.

Group D

Select the correct answer from the multiple choice. No justification is needed.

13. Temperature at the crust-mantle boundary is of the order of
    (a) 600°C
    (b) (b) 900°C
    (c) (c) 1700°C
    (d) (d) 1300°C

14. Diphyodonty does not take place in
    (a) incisors
    (b) pre-molars
    (c) molars
    (d) canines

15. Epsilon cross-stratification is common in
    (a) marine environment
    (b) fluvial environment
    (c) lacustrine environment
    (d) aeolian environment

16. S- or Z-shaped inclusion trails in garnets indicate
    (a) Syn-tectonic crystallization
    (b) Pre-tectonic crystallization
    (c) Post-tectonic crystallization
    (d) None of the above

17. Under high P-T conditions Al is favoured in a SiO_4 tetrahedra linkage in the
    (a) 4 co-ordinated position
    (b) 6 co-ordinated position
    (c) 8 co-ordinated position
    (d) 10 co-ordinated position

18. *Barapasaurus tagorie*, a Jurassic dinosaur, was recovered from
    (a) Jabalpur Formation
    (b) Ariyalur Formation
    (c) Kota Formation
    (d) Bhuj Formation

19. Paratype is formally designated when
    (a) used in the description of the species
    (b) a new specimen is used due to the destruction of the type specimen
    (c) it is not the part of the original type material
    (d) several type specimens are used

20. Foreland basins are associated with
    (a) crustal extension
    (b) strike slip faults

(c) thrust loading
(d) thermal contraction

21. Transform faults occur within
(a) continental lithosphere
(b) oceanic lithosphere
(c) both continental and oceanic lithosphere
(d) none of the above

22. An area in isostatic equilibrium would show
(a) no free air anomaly but may show Bouguer anomaly
(b) no free air and Bouguer anomaly
(c) free air anomaly but no Bouguer anomaly
(d) none of the above.

RG
PART-II

Group A

Short answer type

1. (a) What is inversion temperature?
(b) Show that the Joule-Thomson coefficient for a real gas is not zero in the limit of zero pressure.

2. (a) Write down the relation between contact angle (θ) and the surface of the drop makes with the solid surface.
(b) What is surfactant?
(c) How many types of surfactants are there? Give examples.
(d) Write down a relation between the amounts of adsorption and the surface tension of a liquid and explain the significance of this relation.

3. (a) Mention the fundamental laws of crystallography.
(b) Write a brief account on (i) Schottky defect and (ii) Frankel defect in crystals.
(c) Mention band models of solids according to electronic properties.

4. (a) What are the conditions for aromaticity?
(b) What is Huckel rule?
(c) What is order of aromaticity of the following heterocycles (with explanations): thiophene, pyrrole, furan, pyridine.

5. (a) Arrange the following compounds in order of increasing solubility in water and explain your answer.
[A] Ethanol, [B] 1,2-Ethanediol, [C] 1,2,3-propanetriol
(b) Explain what do you mean by radioactive equilibrium and state the condition under which such equilibrium is established.
(c) How is radioactive equilibrium differ from chemical equilibrium?

Group B

Select the correct answer from the multiple choice. No justification is needed.

1. The rate constant, the activation energy and the Arrhenius parameter of a chamical reaction at 25°C are 3.0×10^{-4} s^{-1}, 104.4 kJ mol^{-1} and 6.0×10^{14} s^{-1} respectively. The value of the rate constant of $T\rightarrow\infty$ is

   [A] 2.0×10^{-18} s^{-1}, [B] 6.0×10^{-14} s^{-1}, [C] ∞, [D] 3.6×10^{30} s^{-1}

2. The solubility of $BaSO_4$ in 0.1 M $BaCl_2$is:

   [A] 2.9×10^{-8}, [B] 1.5×10^{-8} ,
   [C] 2.8×10^{-9}, [D] 3.8×10^{-8}

3. Amongst the following compounds, the order of acidity is:

   Benzoic acid (I), p-hydroxy benzoic acid (II), m-hydroxy benzoic acid (III), o-hydroxy benzoic acid (IV)

   [A] I>III>IV>II [B] IV>III>I>II
   [C] II>III>IV>I [D] IV>II>III>I

4. NH_3 has a much higher boiling point than PH_3 because
   [A] NH_3 has a higher molecular weight
   [B] NH_3 undergoes umbrella inversion
   [C] NH_3 forms hydrogen bond
   [D] NH_3 contains ionic whereas PH_3 contains covalent bonds.

5. Which of the following statements is not correct:

   [A] Physical adsorption is due to van der Waals force
   [B] Chemical adsorption decreases at high temperature and low pressure
   [C] Physical adsorption is reversible
   [D] Adsorption energy for a chemical adsorption is generally greater than that of physical adsorption.

6. Which of the following spontaneous processes leads to a decrease in entropy?

   [A] Water freezes
   [B] A crystal melts
   [C] Sugar dissolves in water
   [D] A given quantity of CO_2 gas is changed into dry ice.

7. A negatively charged suspension of clay in water need for precipitation the minimum amount of

   [A] $AlCl_3$, [B] K_2SO_4,
   [C] NaOH, [D] HCl

8. When pressure is applied to the equilibrium system 'Ice-Water' which of the following phenomenon will happen?

   [A] More ice will form
   [B] Water will evaporate
   [C] More water will form
   [D] Equilibrium will not be disturbed

9. There are two capillary tubes, the cross-sectional area of one being double than that of the other. The different heights to which a liquid rises in wider and narrower capillary are in the ratio of

   [A] 0.707:1, [B] 1:1,
   [C] 1:0.707, [D] 1:2

10. Heat of transition is the heat evolved or absorbed when a substance is converted from

    [A] Solid $\rightarrow$ Liquid
    [B] Solid $\rightarrow$ Vapour
    [C] Liquid $\rightarrow$ Vapour
    [D] One allotropic form to another allotropic form.

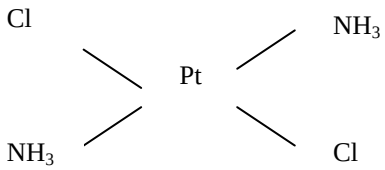
11. In the Gibbs-Helmoltz equation $[\partial(\Delta G/T)/\partial T]$ is equal to

    [A] $-\Delta H/T^2$,
    [B] $-\Delta H/T$,
    [C] $-\Delta E/T^2$,
    [D] $-\Delta E/T$

12. The conversion of $C_6H_5COCH_3 \rightarrow C_6H_5NHCOCH_3$ is accomplished by using

    [A] Hoffmann rearrangement
    [B] Beckmann rearrangement
    [C] Pinacol rearrangement
    [D] Curtius rearrangement

13. The IUPAC nomenclature for the complex given below is



[A] trans-dichlorodiamine platinum (II)
[B] trans-diaminodichloro platinum (II)
[C] trans-diaminoplatinum (II) dichloride
[D] trans-diaminoplatinate (II) chloride

14. The correct order of second ionization potential of C, N, O and F is:

[A] C>N>O>F
[B] O>N>F>C
[C] O>F>N>C
[D] F>O>N>C

15. Gelatin is mostly used in making ice-creams in order to

[A] Prevent making a colloid
[B] Stabilize the colloid and prevent crystallization
[C] Stabilize the mixture
[D] Enrich the aroma

16. One litre of a buffer solution containing 0.01 M NH_4Cl and 0.1 M NH_4OH having pK_b of 5 has pH of

[A] 9,
[B] 10,
[C] 4,
[D] 6

17. Surface tension of lyophilic sols is

[A] Lower than water
[B] More than water
[C] Equal to water
[D] None

18. The freezing point of equimolal aqueous solution will be highest for

[A] $C_6H_5NH_3^+Cl^-$ (aniline hydrochloride),
[B] $Ca(NO_3)_2$
[C] $La(NO_3)_3$,
[D] $C_6H_{12}O_6$ (glucose)

19. Vapour pressure of a solution of 5g of non-electrolyte in 100g water at a particular temperature is 2985 Nm^{-2}. The vapour pressure of pure water is 3000 Nm^{-2}, the molecular weight of the solute is

[A] 60,
[B] 120,
[C] 180,
[D] 380

20. Heat of neutralization is least when

[A] NaOH is neutralized by CH_3COOH
[B] NaOH is neutralized by HCl
[C] NH_4OH is neutralized by CH_3COOH
[D] NH_4OH is neutralized by HNO_3