

ENTRANCE EXAMINATION FOR ADMISSION, MAY 2010

Ph.D. (EARTH SCIENCES)

COURSE CODE : 110



Register Number :

Signature of the Invigilator  
(with date)

COURSE CODE : 110

Time : 2 Hours

Max : 400 Marks

*Instructions to Candidates :*

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you -1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

1. Crystallographic axes of a crystal coincide with the three edges of a guide cube. If there exists a 3-fold axis of symmetry coinciding with the body diagonal of the guide cube then this crystal belongs to
  - (A) Isometric system
  - (B) Tetragonal system
  - (C) Orthorhombic system
  - (D) Trigonal system
  
2. Pyramid form in crystal consists of
  - (A) at least three non-parallel faces that are capable of intersecting in one point
  - (B) at least two non-parallel faces intersecting in a line
  - (C) at least three non-parallel, non-intersecting faces
  - (D) at least three parallel faces
  
3. There are 5 ways in which building blocks of crystal can be arranged in 2-dimensions giving rise to 5-plane lattices. In how many ways could these be arranged in 3-dimensions?
  - (A) 14
  - (B) 7
  - (C) 32
  - (D) 232
  
4. Two atoms are likely to make an ionic bond if
  - (A) there is large difference in their electronegativity values
  - (B) they are of equal size
  - (C) there is not much difference in their electronegativity values
  - (D) if both of them are non-metals
  
5. Coordination number of a cation surrounded by anions in a crystal generally depends on the ratio of the radius of cation to anion. The coordination number
  - (A) will be small if radius ratio is large
  - (B) will be large if bond length is small
  - (C) will be half of the total bond length
  - (D) will be large if radius ratio is large
  
6. A crystal that has only a center of symmetry belongs to point group
  - (A) 1
  - (B) 1 bar
  - (C) m
  - (D) no point group
  
7. What causes magmatism above subduction zones?
  - (A) Plume
  - (B) Fluids released from subducting plate
  - (C) Melting of subducting plate
  - (D) Mantle convection

8. Carbonatite complexes are associated with  
 (A) Ophiolites (B) Layered igneous complexes  
 (C) Flood basalts (D) Alkaline rocks
9. The sulphide mineral found in some stony-iron meteorites but not found on earth is  
 (A) Chalcocite (B) Pentlandite (C) Troilite (D) Covellite
10. The northern margin of Indian plate is marked by  
 (A) Himalaya (B) Indus suture zone  
 (C) Tibet Plateau (D) Shivaliks
11. Suture Zone present in an orogenic belt is characterized by  
 (A) Oceanic crustal rocks and arc-trench sediments  
 (B) Molasse sediments  
 (C) Normal faults  
 (D) Horst and graben structures
12. Aulacogen type of sedimentary basins form due to  
 (A) Failing of one of the rifts of triple-rift junction  
 (B) Thrusting in a collision related mountain building process  
 (C) Strike slip faulting along the margin of continent  
 (D) Subsidence due to normal faulting
13. What is the symbol for a point group having three mutually perpendicular axes of two fold symmetry and a centre of symmetry?  
 (A) 2 (B) 2 m (C) 2 mm (D) 2/m 2/m 2/m
14. Divalent Ca and monovalent Na substitute for each other in plagioclase to give rise to different members of plagioclase series. The charge balance is achieved by  
 (A) incorporation of another monovalent cation like H in the structure  
 (B) keeping one cation site vacant  
 (C) simultaneous substitution of Al and Si  
 (D) creating or breaking one bond with one of the non-bridging oxygen

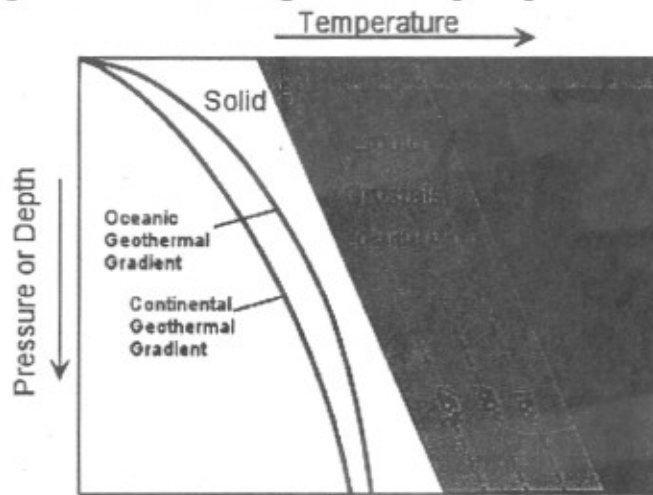
15. The difference between tholeiitic and calc-alkaline basalts is mainly in
- (A) iron and alumina content                      (B) alkali content  
(C) quartz content                                      (D) calcium content
16. The composition of the bulk earth is similar to:
- (A) Moon    (B) Fe-Ni meteorites  
(C) Mercury     (D) Carbonaceous chondrites
17. The sub-solvus granites are made up of Na-rich and K-rich alkali feldspars, both show exsolution textures. Under what conditions these granites crystallize?
- (A) At Pressure = 0.5 GPa, H<sub>2</sub>O absent  
(B) At Pressure = 0.1 GPa, H<sub>2</sub>O absent  
(C) At Pressure = 0.5 GPa, H<sub>2</sub>O saturated  
(D) At Pressure = 0.1 GPa, H<sub>2</sub>O undersaturated
18. Which one of the following statement is correct regarding the relative values of entropy at 600 °C among the minerals microcline, orthoclase and sanidine?
- (A) Microcline has the highest entropy value  
(B) Orthoclase has the highest entropy value  
(C) Sanidine has the highest entropy value  
(D) All the minerals have equal entropy value
19. Tonalites extensively occur in Archean terrains. These rocks essentially consist of:
- (A) Quartz = 30%, Plagioclase = 30%, Alkali feldspar = 30% and hornblende = 10%  
(B) Quartz = 30%, Plagioclase < 10%, Alkali feldspar > 50% and hornblende = 10%  
(C) Quartz = 30%, Plagioclase > 50%, Alkali feldspar < 10% and hornblende = 10%  
(D) Quartz = 30%, Plagioclase = 30%, Alkali feldspar = 30% and hypersthene = 10%
20. If the average density of the continental crust with a thickness of 40 km is 2700 kg/m<sup>3</sup> and acceleration due to gravity is 9.8 m/s<sup>-2</sup> then what will be the pressure expected at its base?
- (A) 0.56 GPa                      (B) 1.06 GPa                      (C) 0.78 GPa                      (D) 2.16 GPa

Answer the following three questions after studying the table given below :

Material	Basalt magma	Andesite magma	Olivine	Pyroxene	Plagioclase	Chromite
Density kg/m <sup>3</sup> at 1100°C	2750	2690	3200	3150	2650	5000

21. The basalt magma remaining at a temperature of 1100°C crystallizes olivine as the liquidus phase. What type of differentiation the magma will undergo?
- (A) Thermal differentiation                      (B) Flow differentiation  
(C) Gravitational settling of olivine              (D) Buoyant rise of olivine
22. The andesite magma crystallizes plagioclase and pyroxene at a temperature of 1100°C. What type of magma differentiation is expected?
- (A) Gravitational settling of both the minerals  
(B) Settling down of pyroxene and floating of plagioclase  
(C) Buoyant rise of both the minerals  
(D) Settling down of plagioclase and floating of pyroxene
23. Assuming that all the minerals in the above table had similar size and shape when they crystallized from the basalt magma, which one of the above minerals will experience faster rate of differentiation?
- (A) Olivine              (B) Pyroxene              (C) Plagioclase              (D) Chromite
24. Calculate the concentration of Sr in residual magma formed on 10% fractional crystallization of plagioclase from a dacite magma having 1000 ppm Sr. Assume the  $k_d^{\text{plagioclase/melt}} = 4$
- (A) 250 ppm              (B) 625 ppm              (C) 729 ppm              (D) 812 ppm

Answer the following four questions after studying the figure given below which show the geothermal gradient and melting relationship for peridotite mantle.



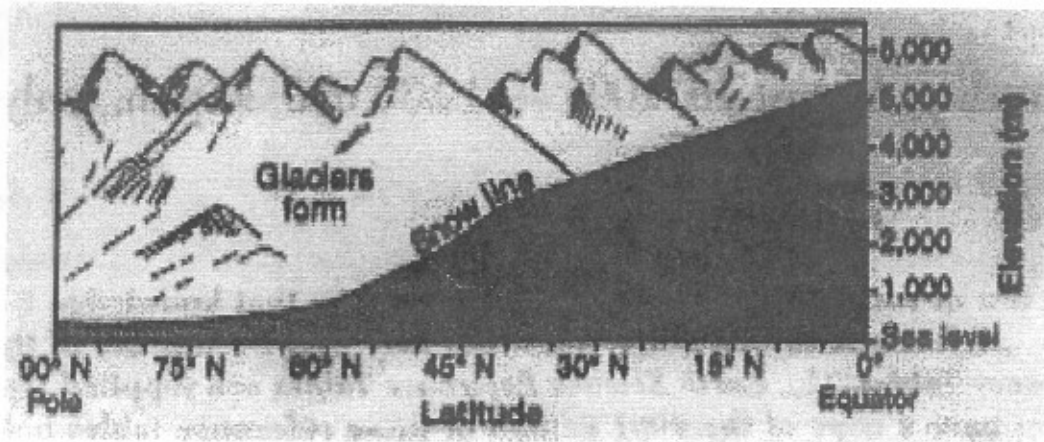
25. If temperature is measured at a constant depth in the continental crust and oceanic crust what will be the expected result?
- (A) Higher temperature below the oceanic crust
  - (B) Higher temperature below the continental crust
  - (C) Similar temperature below the oceanic and continental crusts
  - (D) Temperature will not be stable
26. Which one of the following statements regarding melting of the peridotite with the thermal gradients given in the figure is correct?
- (A) Partial melting of peridotite will occur below the continental crust
  - (B) Partial melting of peridotite will occur below the oceanic crust
  - (C) Partial melting of peridotite will occur below both the oceanic and continental crusts
  - (D) No melting of peridotite will occur below both the oceanic and continental crusts
27. What will be the effect of addition of water to the upper mantle on the melting relation of the peridotite?
- (A) The solidus will be lowered to intersect the oceanic geothermal gradient
  - (B) The liquidus will be lowered to intersect the oceanic geothermal gradient
  - (C) The solidus will be elevated
  - (D) This will not affect the solidus and liquidus

28. Why is the rate of change of temperature vs. pressure ( $dT/dP$ ) much less and tends to be constant at greater depths in the mantle?
- (A) The rocks are highly compressed      (B) The viscosity increases with depth  
(C) Convective transport of heat      (D) Conductive transport of heat
29. Elements that partition strongly into the early crystallizing minerals are said to be
- (A) Compatible      (B) Incompatible  
(C) Large Ion Lithophiles      (D) Rare Earth elements
30. Which of the following is NOT true for Komatiites
- (A) these are ultramafic lavas  
(B) are associated with greenstone belts  
(C) are of Archean age  
(D) characterized by ophitic texture.
31. In pelitic rocks chloritoid is favoured over chlorite in rocks having
- (A) High-Al and high Fe/Mg ratio      (B) Low-Al and high Fe/Mg ratio  
(C) High-Al and high Mg/Fe      (D) High-K and high Al ratio.
32. At an invariant point  $\phi$  (number of phase) is equal to \_\_\_\_\_ where C is the number of component.
- (A) C      (B) C+1      (C) C+2      (D) C+3
33. Snowball garnet is characteristic of \_\_\_\_\_ crystal growth.
- (A) pre-kinematic      (B) syn-kinematic  
(C) post-kinematic      (D) poly-kinematic
34. The reaction 'Albite + Quartz = Jadeite' is characteristic of transition from
- (A) blueschist to eclogite facies      (B) greenschist to amphibolite facies  
(C) amphibolite to granulite facies      (D) blueschist to greenschist facies.
35. In case of prolate strain ellipsoid, there will be equal shortening in all direction on/along
- (A)  $\lambda_1\lambda_2$  plane      (B)  $\lambda_1\lambda_3$  plane      (C)  $\lambda_2\lambda_3$  plane      (D)  $\lambda_3$  axis

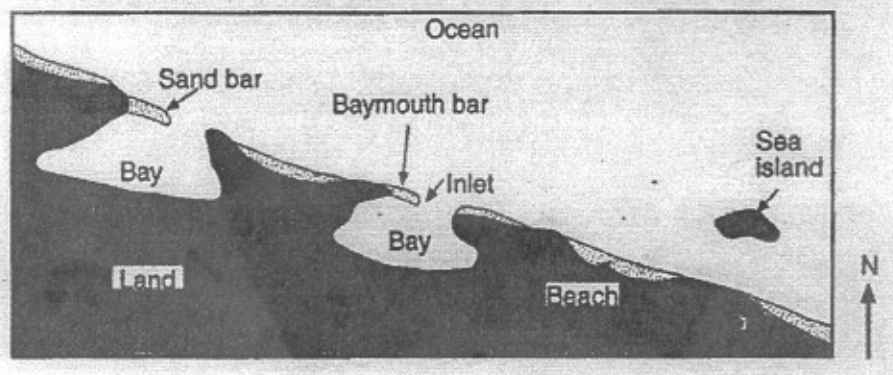
36. In case of non-coaxial (simple shear) deformation, line of no longitudinal strain is \_\_\_\_\_ to the shear direction.  
 (A) parallel (B) perpendicular (C) at  $45^\circ$  (D) at  $25^\circ$
37. One of the following defines the condition for strike fault, where A and B are respectively pitch of the bedding trace and net slip on the fault plane.  
 (A)  $A = B$  (B)  $A = 0$   
 (C)  $B = 0$  (D)  $A = 0, B = 45^\circ$
38. One of the following defines the condition for Type-II fold interference, where  $AP_1$  and  $f_1$  are respectively the axial plane and fold axis of the early fold, and  $a_2$  and  $b_2$  are respectively displacement vector and fold axis of the later fold.  
 (A)  $AP_1 \wedge a_2 = 0, f_1 \wedge b_2 \neq 0$  (B)  $AP_1 \wedge a_2 \neq 0, f_1 \wedge b_2 \neq 0$   
 (C)  $AP_1 \wedge a_2 \neq 0, f_1 \wedge b_2 = 0$  (D)  $AP_1 \wedge a_2 = 0, f_1 \wedge b_2 = 45^\circ$
39. If the pitch of a linear structure is  $90^\circ$  on a bed whose strike is  $N30^\circ E$  and dip  $50^\circ$  towards SE, then the plunge of the linear structure will be  
 (A)  $30^\circ$  (B)  $45^\circ$  (C)  $50^\circ$  (D)  $60^\circ$
40. In the normal limb of a fold, the dip of the cleavage is \_\_\_\_\_ than/to the bedding dip.  
 (A) greater (B) smaller (C) similar (D) half
41. In the triangular ACF diagrams used to designate the mineralogical and chemical composition of metamorphic facies, the 'A' apex represents  
 (A)  $Al_2O_3$  (B)  $Al_2O_3 + Fe_2O_3 - Na_2O - K_2O$   
 (C)  $Al_2O_3 + Fe_2O_3 - K_2O$  (D)  $Al_2O_3 + Na_2O + K_2O$
42. Paired metamorphic belt is a characteristic feature of  
 (A) Continental collision zone (B) Subduction zone  
 (C) Sea floor spreading zone (D) Continental rift zone
43. Which of the following sedimentary environments would you expect the sand deposits to be poorly sorted?  
 (A) alluvial (B) beach (C) desert (D) glacial



44. Graph below shows the snow line (the elevation above which glaciers form at different latitudes in the Northern Hemisphere). At which location would a glacier most likely form?



- (A) 0° at an elevation of 6,000 m  
 (B) 15° N latitude at an elevation of 4,000 m  
 (C) 30° N latitude at an elevation of 3,000 m  
 (D) 45° N latitude at an elevation of 1,000 m
45. Coarse clastic material can be transported into a deep marine environment by
- (A) rivers (B) wind  
 (C) turbidity currents (D) all of these
46. The map below shows some features along an ocean shoreline. In which general direction is the sand being moved along this shoreline by ocean (long shore) currents?



- (A) northeast (B) northwest (C) southeast (D) southwest

47. Marine sediments deposited in water depths greater than about 12,000 feet usually lack
- (A) carbonate shells
  - (B) silica-rich shells
  - (C) fine grained material transported by the wind
  - (D) all of these
48. In which of the following environments would you expect to find oscillation ripples?
- (A) alluvial
  - (B) beach
  - (C) deep-sea
  - (D) desert
49. Which of the following rocks is deposited only by non-biological, chemical precipitation?
- (A) halite
  - (B) limestone
  - (C) chert arenite
  - (D) coal
50. Which of the following processes does not occur during diagenesis?
- (A) compaction
  - (B) cementation
  - (C) lithification
  - (D) metamorphism
51. Which of the following sedimentary environments is dominated by waves and tidal currents?
- (A) glacial
  - (B) alluvial fans
  - (C) deltaic
  - (D) deep marine
52. Siliceous environments, named for the silica-rich shells deposited in them, occur
- (A) in an evaporite environment
  - (B) in a swamp environment
  - (C) in a reef environment
  - (D) in a deep-sea environment
53. Which one of the following would indicate the former presence of a glacial lake?
- (A) varved clay
  - (B) out wash sands
  - (C) till
  - (D) loess

54. What is the porosity of newly deposited mud?
- (A) less than 5% (B) between 5% and 25%  
 (C) between 25% and 50% (D) 50%
55. Which of the following sandstone types is most likely to form by the mechanical and intense chemical weathering of a granite?
- (A) quartz arenite (B) litharenite  
 (C) arkose (D) shale
56. The lowering effect on the water table about the base of the well stem is called a(n):
- (A) aquiclude (B) artesian surface  
 (C) cone of depression (D) speleothem
57. Which of the following statements about the water table is false :
- (A) the water table changes when discharge is not balanced by recharge  
 (B) the water table is generally flat  
 (C) the water table is above the land surface in lakes  
 (D) the water table is depressed near high volume pumping wells
58. This kind of drainage suggests strong variations in erosional resistance of the bedrock :
- (A) dendritic (B) meandering  
 (C) trellis (D) deranged
59. Which rock type makes a good cap rock for oil and gas reservoirs?
- (A) limestone (B) conglomerate  
 (C) sandstone (D) shale
60. Placing geologic events in sequential order as determined by their position in the rock record is called
- (A) absolute dating (B) correlation  
 (C) historical dating (D) relative dating
61. Glacial striations on an outcrop trend NW-SE. The direction of ice movement was
- (A) NE to SW (B) NW to SE  
 (C) SW to NE (D) Either NW or SE

62. Deccan volcanic flow started at the end of  
 (A) Permian period (B) Triassic  
 (C) Jurassic (D) Cretaceous
63. Trellis drainage is most likely to develop on  
 (A) natural levees (B) tilted sedimentary rock layers  
 (C) granite (D) horizontal layers of volcanic rocks
64. Which one of the following is a landform created by wave erosion?  
 (A) spit (B) sea arch  
 (C) breakwater (D) estuary
65. What type of sediments are produced by marine micro-organisms?  
 (A) iron and magnesium (B) siliceous and calcareous  
 (C) clay and silt (D) evaporates
66. Why don't calcareous sediments form in the deep oceans?  
 (A) it is too cold  
 (B) there is no sunlight  
 (C) calcium carbonate dissolves at great depth  
 (D) there is no oxygen
67. The 3 domains involved in all the ore forming processes are  
 (A) Melting-migration-crystallisation  
 (B) Dissolution-transportation-precipitation  
 (C) Source-migration path-ore trap  
 (D) Partial melting-transportation-deposition
68. PGE refers to a group of six precious metals including  
 (A) Pt-Pd-Rh-Ru-Ir-Os (B) Pt-Pd-Re-Os-Rh-Ru  
 (C) Pt-Pd-Re-Os-Au-Ag (D) Pt-Pd-Rh-Ru-Re-Os
69. One of the following group represents the rare metals.  
 (A) Sn-W-Mo (B) Li-Be-Nb (C) Cu-Pb-Zn (D) Ce-Nd-Sm
70. Rare metal deposits are commonly associated with  
 (A) carbonatite (B) syenite  
 (C) granite pegmatite (D) gabbro

71. One of the following pairs does not form exsolution intergrowth in ore mineral assemblages.
- (A) chalcopyrite-sphalerite (B) magnetite-ilmenite  
(C) pyrite-pyrrhotite (D) chalcopyrite-cubanite
72. One of the following ore minerals is commonly not idioblastic
- (A) pyrite (B) galena (C) magnetite (D) sphalerite
73. Refer to the four options of previous question and give answer to the following two questions. What is common to all these four minerals?
- (A) Opaque (B) Cubic system  
(C) Metallic luster (D) Perfect cleavage
74. The following statements describe how one of these four minerals is different from the others. Identify the wrong statement.
- (A) Magnetite is the only oxide mineral  
(B) Galena is the only mineral which does not contain iron in wt% level  
(C) Galena has distinctly high specific gravity among these minerals  
(D) Magnetite has the highest reflectance among these minerals
75. One of the following is a magmatic sulphide deposit
- (A) Cyprus-type copper-zinc (B) Kuroko-type lead-zinc  
(C) Epithermal silver-lead (D) Sudbury copper-nickel
76. This question is about the correct answer of the previous question. The host rock of the magmatic sulphide deposit is
- (A) Gabbro (B) Pyroxenite (C) Dunite (D) Carbonatite
77. Hydrothermal deposits are recognised by
- (A) wallrock alteration (B) occurrence in veins  
(C) crustification texture (D) all the above
78. The ore metal of one of the following deposits is derived from silicate magma of intermediate composition, transported by and deposited from magmatic-hydrothermal fluid, and forms very large deposits of low grade ore.
- (A) Skarn tungsten (B) Greisen tungsten  
(C) Porphyry copper (D) Hydrothermal uranium

79. The ore metals of one of the following deposits are derived from basic volcanic rock, transported by and deposited from sea water-hydrothermal fluid, and forms massive sulphide deposits.
- (A) Cyprus-type copper-zinc                      (B) Kuroko-type lead-zinc  
(C) Sudbury-type nickel-copper                      (D) Epithermal silver-lead
80. The ore metal of one of the following deposits is derived from rocks of continental crust, transported by meteoric water and deposited in organic carbon-rich zones of Phanerozoic arenaceous sediment.
- (A) Redbed-type copper  
(B) Sandstone-type uranium  
(C) Unconformity-type uranium  
(D) Quartz-pebble-conglomerate type uranium
81. A basic assumption in the interpretation of fluid inclusions is that these are
- (A) isochoric              (B) isobaric              (C) isothermal              (D) isochemical
82. Degree of fill of a fluid inclusion refers to the relative proportion of
- (A) liquid phase to the total volume of fluid inclusion  
(B) vapour phase to the total volume of fluid inclusion  
(C) daughter crystal to the total volume of fluid inclusion  
(D) liquid + vapour phases to the total volume of fluid inclusion
83. Boiling of fluid, mixing of fluids and fluid-rock interaction are the important processes responsible for
- (A) leaching of metal from source rock  
(B) transport of metal by a fluid phase  
(C) deposition of ore from a hydrothermal fluid  
(D) dispersion of metal in a rock
84. Uranium deposit types are correctly arranged in decreasing order of age (that is old to young) in one of the following.
- (A) QPC – Unconformity – Sandstone              (B) Unconformity – QPC – Sandstone  
(C) Sandstone – Unconformity – QPC              (D) Unconformity – Sandstone – QPC
85. One of the following ore minerals is not common in beach placer deposits.
- (A) ilmenite              (B) rutile              (C) magnetite              (D) hematite

86. Typical profile of a lateritic bauxite deposit consists of (from top to bottom)
- (A) laterite-bauxite-lithomarge-partially weathered bed rock-bed rock
  - (B) bauxite-laterite-lithomarge-partially weathered bed rock-bed rock
  - (C) lithomarge-laterite-bauxite-partially weathered bed rock-bed rock
  - (D) lithomarge-bauxite-laterite-partially weathered bed rock-bed rock
87. Metals in one of the following options are recovered from their ores by acid leaching.
- (A) silver and uranium
  - (B) silver and molybdenum
  - (C) gold and uranium
  - (D) gold and molybdenum
88. One of the following metals does not form any mineral in which it is a constituent element.
- (A) Niobium
  - (B) Cerium
  - (C) Platinum
  - (D) Rhenium
89. Apart from lode gold deposits, gold is produced in India from
- (A) copper concentrate
  - (B) lead concentrate
  - (C) uranium ore
  - (D) chromite
90. Asbestos deposits in Pulivendla area of Cuddapah basin occur
- (A) within dolostone
  - (B) within limestone
  - (C) at the contact zone between dolostone and basic dyke
  - (D) at the contact zone between limestone and basic dyke
91. The asbestos mined from Pulivendla area of Cuddapah basin is a
- (A) chrysotile
  - (B) chrysolite
  - (C) cristobalite
  - (D) chiastolite
92. A world class barite deposit occurs in Cuddapah basin at
- (A) Vemula
  - (B) Vempalli
  - (C) Mangampet
  - (D) Kodur
93. "Green marble" mined from Rishabdev area of Aravalli fold belt is
- (A) actinolite-bearing dolomitic marble
  - (B) diopside-bearing dolomitic marble
  - (C) epidote-bearing dolomitic marble
  - (D) serpentinised peridotite

94. A world class wollastonite deposit occurs in southern part of Delhi fold belt at  
 (A) Basantgarh and Pipela (B) Deri and Ambamata  
 (C) Belka Pahar and Khera Tarla (D) Balda and Dewa-ka-bera
95. In the process of froth flotation for concentrating sulphide ores, pine oil and oleic acid are used as  
 (A) frother (B) collector  
 (C) frother and collector respectively (D) modifier
96. In ore processing, size reduction of ore by crushing and grinding results in  
 (A) optimal liberation of ore minerals from gangue minerals  
 (B) concentration of ore minerals  
 (C) separation of gangue minerals  
 (D) all the above
97. Jigging is a process in which minerals are separated according to their  
 (A) magnetic susceptibility  
 (B) density  
 (C) water-adhering or air-adhering character  
 (D) size
98. One of the following is not a hydrothermal deposit.  
 (A) Hutti gold deposit (B) Malanjkhand copper deposit  
 (C) Degana tungsten deposit (D) Bastar-Koraput tin deposit
99. One of the following is the characteristic mineral assemblage of greisen.  
 (A) Quartz-microcline-sodic plagioclase  
 (B) Quartz-orthoclase- sodic plagioclase  
 (C) Quartz-muscovite-topaz-fluorite  
 (D) Quartz-microcline-sodic plagioclase-fluorite
100. One of the following mineral deposits does not occur in skarn.  
 (A) Cu-Pb-Zn (B) Fe-Sn-W (C) Wollastonite (D) Cr-Ni-Ti