Section A: Q.1 – Q.10 Carry ONE mark each.

Q.1 The plate tectonic setting of Benioff-Wadati zone is

(A) continental rift

(B) subduction zone

(C) passive margin

(D) mid-oceanic ridge

Q.2 Neutron-rich unstable nuclides undergo

(A) β^- (negatron) decay

(B) β^+ (positron) decay

(C) α-decay

(D) electron capture

Q.3 Which one of the following textures is found in alkali olivine basalt?

(A) Rapakivi

(B) Graphic

(C) Blastoporphyritic

(D) Intergranular

Q.4 The mineral assemblage found in a granulite facies metabasalt is

(A) glaucophane + lawsonite + chlorite

(B) orthopyroxene + garnet + plagioclase + clinopyroxene + quartz

(C) actinolite + albite + chlorite + epidote

(D) omphacite + garnet + quartz

Q.5 *Glossopteris* is found in which of the following formations?

(A) Raniganj

(B) Bagra

(C) Lameta

(D) Nimar Sandstone

Q.6 In a sequence of undeformed sedimentary rocks, younger rocks overlie older rocks. This conforms to the principle of

(A) superposition

(B) uniformitarianism

(C) faunal succession

(D) original horizontality

Q.7 Dropstones are found in

(A) Barakar Formation

(B) Talchir Formation

(C) Raniganj Formation

(D) Bijori Formation

Q.8 The sedimentary structure formed by unidirectional current is

(A) trough cross-bedding

(B) oscillation ripple

(C) concretion

(D) hummocky cross-stratification

Q.9 Which of the following is the precursor of petroleum?

(A) Sporinite

(B) Clarain

(C) Kerogen

(D) Vitrain

Q.10 Which of the following is an amorphous variety of SiO_2?

(A) Quartz

(B) Citrine

(C) Agate

(D) Opal

Section A: Q.11 – Q.30 Carry TWO marks each.

Q.11 The name of an igneous rock having a modal composition of 55% olivine, 40% orthopyroxene and 5% plagioclase, as per the IUGS classification scheme, is

(A) gabbro

(B) troctolite

(C) lherzolite

(D) harzburgite

Q.12 Which of the following is the correct decreasing order of abundance of elements in our solar system?

(A) O > H > Fe > He

(B) O > Fe > H > He

(C) H > O > Fe > He

(D) H > He > O > Fe

Q.13 The suture of a cephalopod having smooth saddles and crenulated lobes is called

(A) orthoceratitic

(B) goniatitic

(C) ceratitic

(D) ammonitic

Q.14 Which of the following is a body fossil?

(A) Coprolite

(B) Footprint

(C) Cast

(D) Stromatolite

Q.15 Match the morphological features in Group I with the corresponding taxa in Group II.

	Group I		Group II
P.	Dissepiment	1.	Echinodermata
Q.	Delthyrium	2.	Trilobita
R.	Pygidium	3.	Brachiopoda
S.	Ambulacrum	4.	Anthozoa

(A) P – 4, Q – 3, R – 2, S – 1

(B) P – 4, Q – 3, R – 1, S – 2

(C) P – 2, Q – 3, R – 4, S – 1

(D) P – 3, Q – 4, R – 2, S – 1

Q.16 Match the sedimentary features/structures in Group I with the corresponding processes in Group II.

Group I	Group II
P. Stylolite	1. Liquefaction
Q. Pseudonodule	2. Diagenesis
R. Current crescent	3. Organo-sedimentary binding
S. Stromatolite	4. Scouring

(A) P – 2, Q – 1, R – 4, S – 3

(B) P – 2, Q – 3, R – 4, S – 1

(C) P – 3, Q – 1, R – 4, S – 2

(D) P – 4, Q – 1, R – 2, S – 3

Q.17 Match the geomorphic features in Group I with the corresponding environments in Group II.

Group I	**Group II**
P. Dreikanter	1. Glacial
Q. Cirque	2. Beach
R. Natural levee	3. Eolian
S. Berm	4. Fluvial

(A) P – 3, Q – 1, R – 4, S – 2

(B) P – 2, Q – 1, R – 4, S – 3

(C) P – 3, Q – 4, R – 1, S – 2

(D) P – 4, Q – 2, R – 3, S – 1

Q.18 The correct hierarchy of the given stratigraphic units is

(A) Group > Member > Formation > Bed

(B) Eon > Era > Epoch > Period

(C) Group > Formation > Member > Bed

(D) Eon > Era > Series > Systems

Q.19 Match the minerals in Group I with their highest order of interference color in Group II (for 0.03 mm mineral thickness).

Group I	Group II
P. Sillimanite	1. First order
Q. Quartz	2. Second order
R. Muscovite	3. Greater than third order
S. Calcite	4. Third order variegated

(A) P – 2, Q – 4, R – 1, S – 3

(B) P – 3, Q – 1, R – 2, S – 4

(C) P – 2, Q – 1, R – 4, S – 3

(D) P – 4, Q – 2, R – 3, S – 1

Q.20 The saturated thickness of an unconfined aquifer is defined by the distance between

(A) the ground surface and the water table

(B) the water table and the underlying confining layer

(C) the water table and the mean sea level

(D) the ground surface and the underlying confining layer

Q.21 Darcy's law quantifies the volume of groundwater flow

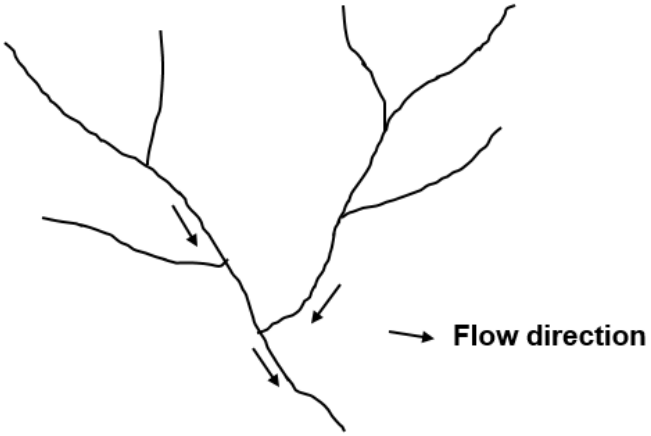
(A) per unit surface area of the aquifer

(B) per unit time

(C) per unit cross-sectional area of the aquifer

(D) per unit cross-sectional area of the aquifer per unit time

Q.22 According to Strahler's stream ordering system, what is the highest order of stream in the given diagram?



(A) 4

(B) 3

(C) 2

(D) 1

Q.23 A tunnel with vertical walls and arched crown is constructed through a set of sedimentary beds. The thickness of individual beds is significantly less than the wall-height of the tunnel. For which of the following conditions, one of the tunnel walls becomes unstable?

(A) The tunnel axis is horizontal and the beds are horizontal

(B) The tunnel axis is parallel to the strike of beds and the beds dip $45^{o} – 60^{o}$

(C) The tunnel axis is parallel to the strike of beds and the beds are vertical

(D) The tunnel axis is perpendicular to the strike of beds and the beds are vertical

Q.24 A plunging fold will NOT show a V-shaped outcrop pattern on a planar ground surface if the plunge of the fold axis is

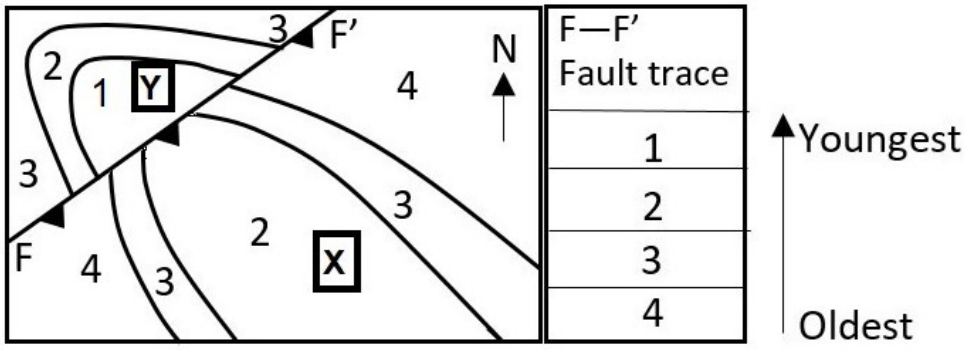
(A) equal to the dip of the ground surface in the same direction

(B) steeper than the dip of the ground surface in the same direction

(C) equal to the dip of the ground surface in the opposite direction

(D) steeper than the dip of the ground surface in the opposite direction

Q.25 The given map shows the outcrop patterns of beds (1 – 4) across a fault plane, F – F', on a flat ground. X and Y refer to the two blocks across F – F'. Which one of the following options is the correct interpretation of the structure depicted on the map?



(A) A south-easterly plunging synform that was subsequently faulted with block X upthrown

(B) A north-westerly plunging antiform that was subsequently faulted with block Y upthrown

(C) A south-easterly plunging antiform that was subsequently faulted with block X downthrown

(D) A north-westerly plunging synform that was subsequently faulted with block Y downthrown

Q.26 The crystal form ‘dome’ contains

(A) two parallel faces related by a 2-fold axis of symmetry

(B) two non-parallel faces related by a 2-fold axis of symmetry

(C) two parallel faces related by a mirror plane

(D) two non-parallel faces related by a mirror plane

Q.27 The symbols [100], {100} and (100) in a crystal represent the sequence

(A) form, line and face

(B) form, face and line

(C) line, face and form

(D) line, form and face

Q.28 Match the stratigraphic units in Group I with the corresponding Archean cratons in Group II.

Group I	Group II
P. Bababudan Group	1. Eastern Dharwar
Q. Banded Gneissic Complex-I	2. Western Dharwar
R. Bonai Granite	3. Aravalli
S. Kolar Group	4. Singhbhum

(A) P – 2, Q – 3, R – 4, S – 1

(B) P – 3, Q – 2, R – 1, S – 4

(C) P – 2, Q – 1, R – 4, S – 3

(D) P – 4, Q – 3, R – 2, S – 1

Q.29 Which one of the metamorphic facies sequence in order of increasing metamorphic grade defines thermal metamorphism ?

(A) Sanidinite → pyroxene hornfels → hornblende hornfels → albite-epidote hornfels

(B) Albite-epidote hornfels → hornblende hornfels → sanidinite → pyroxene hornfels

(C) Hornblende hornfels → albite-epidote hornfels → pyroxene hornfels → sanidinite

(D) Albite-epidote hornfels → hornblende hornfels → pyroxene hornfels → sanidinite

Q.30 Nickel ores are NOT associated with

(A) ultramafic igneous rocks

(B) laterites

(C) sea-floor polymetallic nodules

(D) skarns

Section B: Q.31 – Q.40 Carry TWO marks each.

Q.31 Which of the following statements on mantle partial melting are correct?

(A) Shallow melting produces tholeiitic basalts.

(B) Low-degree melting produces alkaline basalts.

(C) Presence of CO_2-rich volatiles favors the formation of tholeiitic basalts.

(D) Presence of H_2O-rich volatiles favors the formation of alkaline basalts.

Q.32 Which of the following fossil groups are from the Siwalik Group?

(A) Proboscidea

(B) Giraffidae

(C) Dinosauria

(D) Equidae

Q.33 The correct stratigraphic successions arranged from the oldest to the youngest are

(A) Uttatur → Trichinopoly → Ariyalur → Niniyur

(B) Chari → Patcham → Umia → Katrol

(C) Chinji → Nagri → Dhok Pathan → Tatrot

(D) Semri → Rewa → Kaimur → Bhander

Q.34 Which of the following combinations are correctly matched?

(A) Photic zone – biogenic carbonate rocks

(B) Delta – progradational coarsening-up succession

(C) Sabkha – shelf storm deposit

(D) Shelf break – submarine fans

Q.35 High drainage density is representative of a terrain with

(A) high relief

(B) arid climate

(C) impermeable surface layer

(D) permeable surface layer

Q.36 Mass-wasting processes are

(A) landslides

(B) lahars

(C) avalanches

(D) sand storms

Q.37 Which ones of the following correspond to the Pyroxene group?

(A) $CaMgSi_2O_6$

(B) $CaAl_2SiO_6$

(C) $Ca_2Si_2O_6$

(D) $NaFeSi_2O_6$

Q.38 Which of the following processes are correctly matched with corresponding deformation structures?

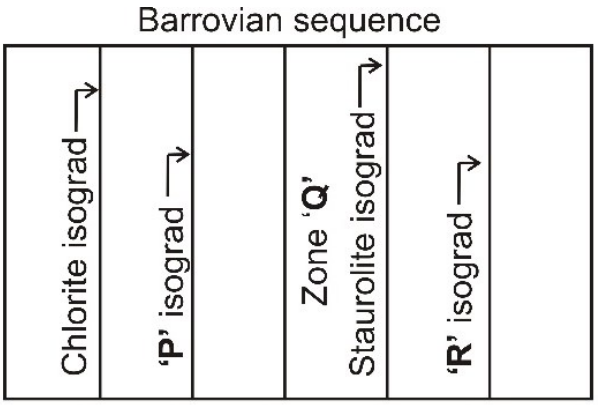
(A) Pressure solution – rock cleavage

(B) Jointing – plumose markings

(C) Layer parallel compression – buckle folds

(D) Cohesion loss – slickensides

Q.39 For the given Barrovian metamorphic sequence, which of the following statements are correct?



A) Grade of metamorphism increases from left to right.

(B) 'P' isograd is the Garnet isograd.

(C) Zone 'Q' is the Garnet zone.

(D) 'R' isograd is the Kyanite isograd.

Q.40 Which ones of the following are formed by brittle deformation?

(A) Cataclasite

(B) Breccia

(C) Mylonite

(D) Gouge

Section C: Q.41 – Q.50 Carry ONE mark each.

Q.41 The value of φ (*phi*) of a sediment grain having a diameter of 0.125 mm is _____. (*In integer*)

Q.42 The vertical separation of a displaced horizontal stratum along a dip-slip reverse fault is 10 m when measured on a section perpendicular to the fault-strike. If the dip of the fault is 30º, the net slip of the fault will be _____ m. (*In integer*)

Q.43 The dips of the normal and overturned limbs of a horizontal-overturned antiform are 30º and 70º, respectively. The interlimb angle of this fold is _____ degrees. (*In integer*)

Q.44 In a mineral with formula $KAl_3Si_3O_{10}(F_{0.5}OH_x)$, the value of 'x' is _____. (*Round off to one decimal place*)

Q.45 The atom percent of Fe in pyrrhotite of composition $Fe_{0.77}S$ is _____. (*Round off to two decimal places*)

Q.46 Consider the univariant metamorphic reaction Albite = Jadeite + Quartz. The minimum number of chemical components required to describe the composition of all the phases is _____. (*In integer*)

Q.47 The mean flow velocity of water in an open channel having an average depth of 0.2 m, and with Froude Number 4, is _____m/s. (*Round off to one decimal place*) (Use g = 9.8 ms^{-2})

Q.48 An aquifer has a cross-sectional area of 10 m^2 and a hydraulic conductivity of 0.25 cm/s. The volume of water that will flow per second through the aquifer for a hydraulic gradient of 0.04 is _____ cm^3. (*Round off to three decimal places*)

Q.49 The geothermal gradient in the continental crust is 0.02 ºC/m. If the surface temperature is 25 ºC, the temperature at a depth of 18 km from the surface is _____ ºC. (*In integer*)

Q.50 The area of a triangular block of a massive orebody is 1500 m^2. If the thickness of the orebody is 5 m, 6 m and 7 m at the three corners of the triangular block, and the ore density is 2.5 tons/m^3, the estimated ore reserve of the block is _____ tons. (*In integer*)

Section C: Q.51 – Q.60 Carry TWO marks each.

Q.51 Clinopyroxene crystallizing from a basaltic magma has Sm concentration of 24 ppm. If the clinopyroxene-melt partition coefficient for Sm is 1.2, the concentration of Sm in the basaltic magma will be _____ ppm. (*In integer*)

Q.52 The lithostatic pressure at a depth of 36.5 km in the continental crust having an average density of 2800 kg/m^3, is _____GPa. (*Round off to the nearest integer*) (Use g = 9.8 m/s^2)

Q.53 The fraction of $^{24}_{11}Na$ atoms remaining after a decay interval of 5.0 hours will be _____. (*Round off to three decimal places*) (Use $t_{1/2}$ = 15.0 hours)

Q.54 The thickness of a dipping coal bed measured along a vertical drill hole is 15 m. If the dip of the coal bed is 30º, the orthogonal thickness of the coal bed is _____ m. (*Round off to the nearest integer*)

Q.55 The mole fraction of forsterite in olivine with MgO = 29.17 weight %, FeO = 34.65 weight % and SiO_2 = 36.18 weight % is _____. (*Round off to two decimal places*) (Use molecular weight, in g/mol, of MgO = 40.31, FeO = 71.85 and SiO_2 = 60.00)

Q.56 A partially saturated soil sample has a volume of 1200 cc. The volume of water present in the sample is 300 cc. The mass of solid in the sample is 1908 g and the particle density is 2.65 g/cc. The porosity (n) of the soil sample is _____ %. (*In integer*)

Q.57 A rock element during deformation, experienced a pressure change of 5×10^4 N/m^2, due to which its volume changed from 4 cm^3 to 3.9 cm^3. The bulk modulus of the rock is _____ $\times10^6$ N/m^2. (*In integer*)

Q.58 For an anisotropic crystal of thickness 0.04 mm and refractive indices of 1.636 and 1.486 along the slow and fast directions, respectively, the retardation produced is _____ nm. (*In integer*)

Q.59 An orebody contains pyrite and chalcopyrite in the same molar proportions. The percentage concentration of Cu in the ore will be _____. (*Round off to the nearest integer*)

(Use atomic weight, in g/mol, of Cu = 63.55, Fe = 55.85, S = 32.06)

Q.60 In the given isobaric binary temperature-composition (T-X) phase diagram involving solids A and B, the fraction of melt remaining at point Q for a magma having initial composition P will be _____. (*Round off to one decimal place*)