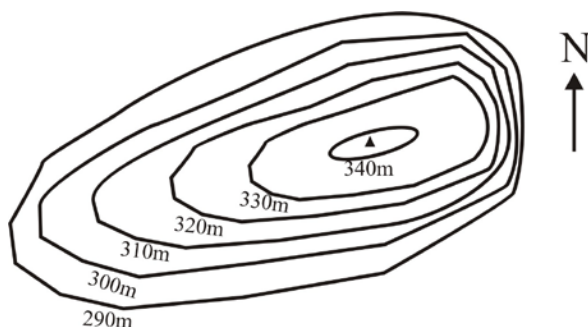


## SECTION – A

### MULTIPLE CHOICE QUESTIONS (MCQ)

**Q. 1 – Q.10 carry one mark each.**

- Q.1 The most abundant metal (by weight %) in the Earth's crust is  
 (A) Al (B) Fe (C) Na (D) Mg
- Q.2 The correct order of increasing stability of minerals during chemical weathering is  
 (A) olivine, pyroxene, biotite, quartz (B) olivine, biotite, pyroxene, quartz  
 (C) quartz, biotite, pyroxene, olivine (D) pyroxene, olivine, biotite, quartz
- Q.3 In the topographic map the steepest slope is



- (A) northerly (B) southerly (C) easterly (D) westerly
- Q.4 Gabbro contains much more alumina than peridotite because it is richer in  
 (A) orthopyroxene (B) orthoamphibole  
 (C) olivine (D) plagioclase
- Q.5 Coking coal in India is found in  
 (A) Neyvelli, Tamil Nadu (B) Jharia, Jharkhand  
 (C) Palana, Rajasthan (D) Garampani, Meghalaya
- Q.6 The amplitude of ground motion during an earthquake of magnitude 7 in Richter scale is how many times more than that of a magnitude 5?  
 (A) 10 (B) 100 (C) 1000 (D) 10,000
- Q.7 The failed arm of a continental rift is called  
 (A) hot spot (B) horst (C) decollement (D) aulacogen
- Q.8 The hardest mineral (with the exception of diamond) in the Moh's scale of hardness is  
 (A) an oxide (B) a silicate  
 (C) a phosphate (D) a carbonate

Q.9 Which one of the following is capable of transporting sediments against the slope?

- (A) river current (B) turbidity current  
(C) tidal current (D) rip current

Q.10 Which is the most abundant ion in the normal seawater?

- (A)  $\text{Cl}^-$  (B)  $\text{SO}_4^{2-}$  (C)  $\text{Na}^+$  (D)  $\text{K}^+$

**Q. 11 – Q. 30 carry two marks each.**

Q.11 Match minerals in Group I with the corresponding silicate structure in Group II.

**Group I**

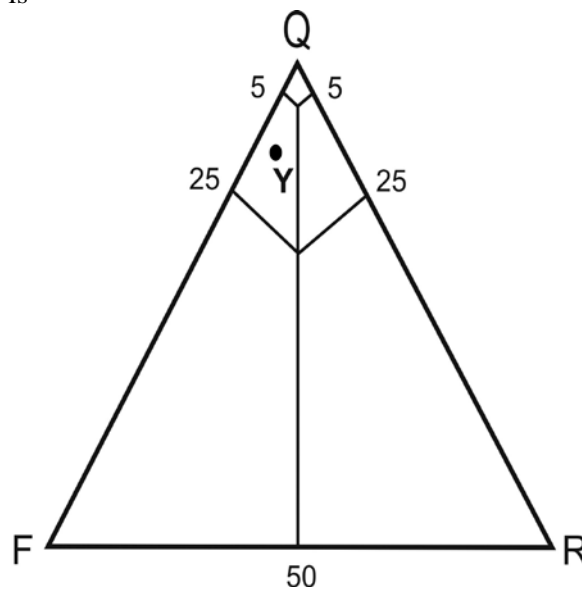
- i) Anthophyllite  
ii) Hedenbergite  
iii) Cordierite  
iv) Zeolite

**Group II**

- P) Cyclosilicate  
Q) Tectosilicate  
R) Double chain silicate  
S) Single chain silicate

- (A) i – R; ii – S; iii – Q; iv – P  
(B) i – S; ii – R; iii – Q; iv – P  
(C) i – R; ii – S; iii – P; iv – Q  
(D) i – P; ii – Q; iii – R; iv – S

Q.12 The correct name for the well sorted sandstone, whose framework composition plots at Y in the following QFR diagram, is

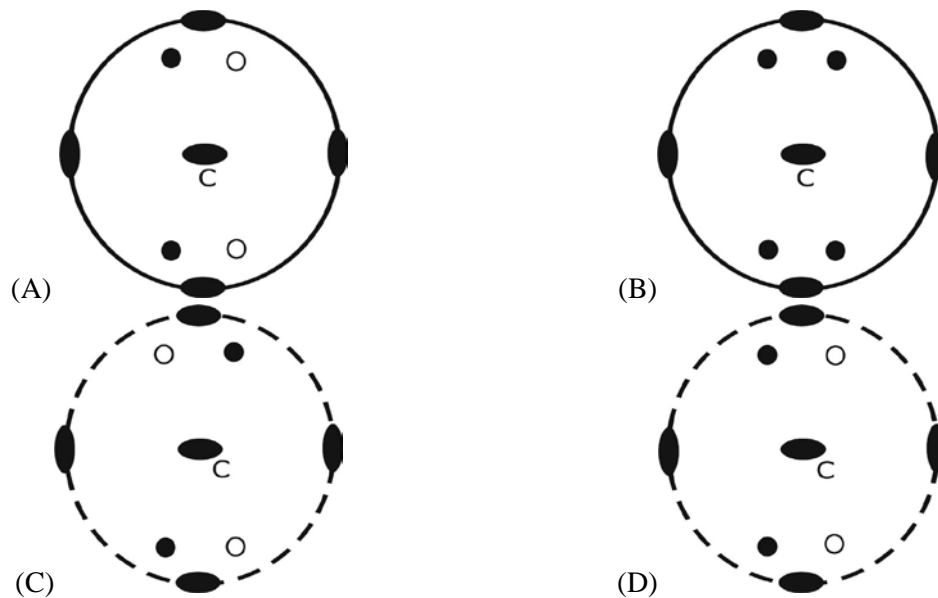


- (A) arkose (B) subarkose  
(C) lithic arkose (D) quartz arenite

Q.13 Which one of the following optical properties of minerals is NOT observed under crossed nicols?

- (A) Extinction (B) Interference colour  
(C) Interference figure (D) Pleochroism

- Q.14 Choose the correct stereographic projection among the following that represents 222 crystal symmetry.



- Q.15 Match the folds listed in Group I with corresponding geometric characteristics in Group II.

**Group I**

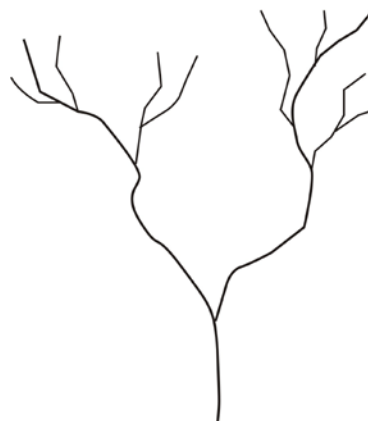
- i) Parallel
- ii) Chevron
- iii) Similar
- iv) Mushroom

**Group II**

- P) Angular hinge
- Q) Minimum thickness parallel to the axial surface is at the hinge
- R) Negative inter-limb angle
- S) Constant thickness parallel to the axial surface

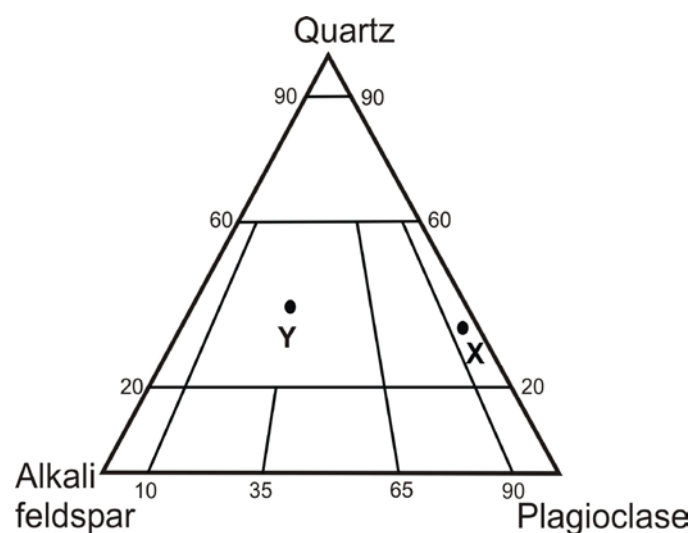
- (A) i – Q; ii – R; iii – S; iv – P
- (B) i – S; ii – P; iii – Q; iv – R
- (C) i – Q; ii – P; iii – S; iv – R
- (D) i – S; ii – R; iii – Q; iv – P

- Q.16 The number of 4<sup>th</sup> order stream(s) present in the drainage network shown below, as per hierarchical classification, is



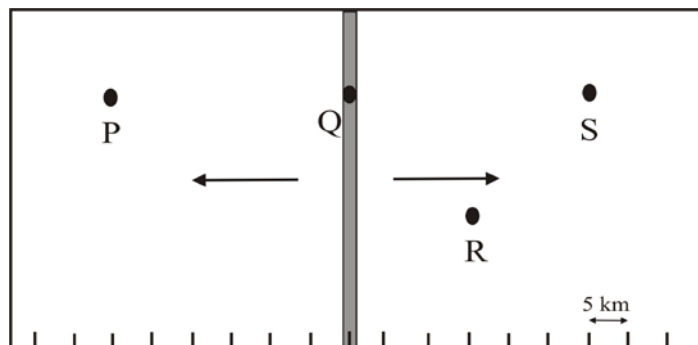
- (A) one
- (B) two
- (C) three
- (D) four

- Q.17 During metamorphism, temperature can increase at constant pressure in the case of  
 (A) exhumation by erosion (B) burial by subduction  
 (C) burial by underthrusting (D) intrusion of batholith
- Q.18 Choose the correct chronological order from oldest to youngest for the following stratigraphic units  
 P - Chitradurga Group; Q - Sargur Group; R - Ajabgarh Group; S - Udaipur Group
- (A) Q, P, S, R (B) P, Q, S, R  
 (C) Q, R, P, S (D) Q, R, S, P
- Q.19 Identify the rock types at X and Y in the following QAP diagram of IUGS.



- (A) X is granodiorite and Y is granite  
 (B) X is granodiorite and Y is alkali feldspar granite  
 (C) X is tonalite and Y is granite  
 (D) X is tonalite and Y is alkali feldspar granite

- Q.20 A schematic diagram of a divergent plate boundary, with arrows indicating directions of plate movement, is given below. Which one of the following statements is NOT true for points P, Q, R and S, if the spreading rate for both the plates is uniform and same through time and space?



- (A) The rocks at P and S have the same age  
 (B) The rocks at S are twice as old as those at R  
 (C) The age of rocks at Q is 0 Ma  
 (D) The age of the rocks decreases progressively from P to S
- Q.21 Mississippian and Pennsylvanian belong to which period?  
 (A) Permian (B) Devonian  
 (C) Carboniferous (D) Silurian
- Q.22 A gravity dam with E–W axis is to be constructed in a narrow river valley between two N–S trending parallel ridges. The river is flowing from south to north. The lithology of the area is represented by 2 to 5 m thick metasedimentary rocks – quartzite, phyllite and schist. Which of the following geological conditions will be most suitable?  
 (A) Beds in both the ridges strike N–S but dip towards each other  
 (B) Beds in both the ridges strike N–S but dip in opposite direction to each other  
 (C) Beds in both the ridges strike E–W and dip towards N (downstream)  
 (D) Beds in both the ridges strike E–W and dip towards S (upstream)
- Q.23 Match the ore deposits in Group I with the localities in Group II
- | Group I        | Group II                     |
|----------------|------------------------------|
| i) Copper      | P) Balaghat, M.P.            |
| ii) Lead-Zinc  | Q) Panchpatmali, Odisha      |
| iii) Manganese | R) Rampura-Agucha, Rajasthan |
| iv) Bauxite    | S) Khetri, Rajasthan         |
- (A) i - S, ii - R, iii - Q, iv - P  
 (B) i - S, ii - R, iii - P, iv - Q  
 (C) i - P, ii - R, iii - Q, iv - S  
 (D) i - S, ii - Q, iii - R, iv - P

Q.24 Match the following stratigraphic units (Group-I) with their ages (Group-II)

**Group I**

- i) Cumbum Formation
- ii) Baisakhi Formation
- iii) Kopili Formation
- iv) Barakar Formation

**Group II**

- P) Cenozoic
- Q) Mesozoic
- R) Palaeozoic
- S) Proterozoic

- (A) i - R, ii - P, iii - Q, iv - S  
(C) i - S, ii - R, iii - P, iv - Q

- (B) i - S, ii - Q, iii - P, iv - R  
(D) i - S, ii - Q, iii - R, iv - P

Q.25 Which one of the following sedimentary structures is related to gravitational instability?

- (A) groove cast                      (B) load cast                      (C) gutter cast                      (D) flute cast

Q.26 Match features mentioned in Group-I with the fossil types in Group-II.

**Group I**

- i) Escutcheon
- ii) Plastron
- iii) Delthyrium
- iv) Siphuncle

**Group II**

- P) Brachiopoda
- Q) Nautiloidea
- R) Echinoidea
- S) Bivalvia

- (A) i - S, ii - R, iii - Q, iv - P  
(C) i - S, ii - P, iii - Q, iv - R

- (B) i - S, ii - R, iii - P, iv - Q  
(D) i - R, ii - Q, iii - P, iv - S

Q.27 Which one of the following is an upper Gondwana flora?

- (A) *Ptillophyllum*                      (B) *Phyllothea*  
(C) *Glossopteris*                      (D) *Schizoneura*

Q.28 Choose the correct match of items in Group I with the items in Group II.

**Group I**

- i) Eutectic crystallisation
- ii) Fractional crystallisation
- iii) Exsolution
- iv) Submarine eruption

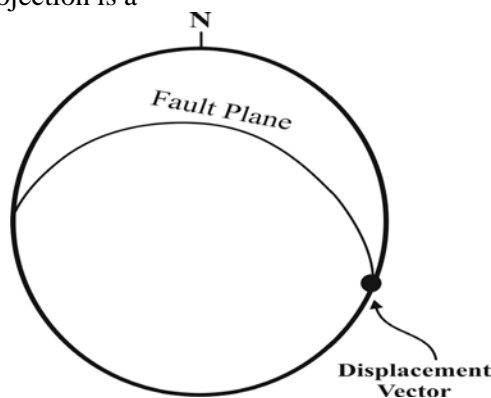
**Group II**

- P) Perthitic texture
- Q) Graphic texture
- R) Pillow structure
- S) Crystal zoning

- (A) i - Q, ii - S, iii - R, iv - P  
(C) i - S, ii - Q, iii - P, iv - R

- (B) i - Q, ii - S, iii - P, iv - R  
(D) i - S, ii - Q, iii - R, iv - P

- Q.29 The fault for which the orientation and displacement vector are given in the following lower hemisphere stereographic projection is a



- (A) vertical fault      (B) thrust fault      (C) normal fault      (D) strike-slip fault
- Q.30 The change in coordination number of silicon (Si) when  $\alpha$ -quartz transforms to stishovite, which has octahedral coordination, is
- (A) 2      (B) 4  
(C) 6      (D) 8

## SECTION - B

### MULTIPLE SELECT QUESTIONS (MSQ)

**Q. 31 – Q. 40 carry two marks each.**

- Q.31 Which of the following is/are found only in the brittle shear zones?
- (A) Cataclasite      (B) Mylonite  
(C) Psuedotachylite      (D) Gouge
- Q.32 Which among the following statements related to headward erosion by river is/are correct?
- (A) Length of tributaries increases  
(B) Length of the main channel increases  
(C) Streams get captured  
(D) Channel gradient increases upstream
- Q.33 In a thin section of 30  $\mu\text{m}$  thickness, the R.I. of a mineral are:  $\epsilon = 1.565$  and  $\omega = 1.468$ . Choose the correct statement(s) about its optical properties.
- (A) Uniaxial +ve      (B) Uniaxial -ve  
(C) 1<sup>st</sup> order interference colour      (D) low to moderate relief

- Q.34 Which of the following statements is/are NOT true for equilibrium crystallization of plagioclase from a melt in the binary system  $\text{NaAlSi}_3\text{O}_8$ – $\text{CaAlSi}_2\text{O}_8$  at constant pressure?
- (A) Composition of the first-formed solid depends on the initial composition of the melt.  
(B) Solid composition is always more anorthitic than the coexisting melt.  
(C) Composition of the final solid is the same as the initial composition of the melt.  
(D) Equilibrium crystallization leads to the formation of zoned crystals.
- Q.35 The value of gravity at the Earth's surface is dependent on
- (A) latitude (B) altitude  
(C) composition of underlying material (D) relative position of Sun–Earth
- Q.36 Choose the burrowing form(s) of bivalve.
- (A) *Mya* (B) *Teredo* (C) *Pecten* (D) *Venus*
- Q.37 Which of the following environments is/are characterized by predominant deposit of mud?
- (A) Barrier bar (B) Lagoon  
(C) Fluvial flood plain (D) Fluvial channel
- Q.38 Which of the following stratigraphic units belong(s) to Cretaceous?
- (A) Bhuj Formation (B) Ariyalur Group  
(C) Patcham Formation (D) Katrol Formation
- Q.39 Which of the following ore deposit(s) is/are formed only by hydrothermal process?
- (A) 'Sn-W' ore associated with greissenised rock  
(B) Layered type chromite ore associated with dunite-peridotite-pyroxenite  
(C) Vein type gold ore associated with greenstone belt  
(D) Ni-Cu sulphide ore associated with gabbroic rocks.
- Q.40 Migmatite is a rock
- (A) in which mafic-rich parts are intermixed with pods or layers of granitic composition  
(B) with melanosome and leucosome  
(C) with a solid residue and partial melt  
(D) which forms at high grade metamorphic conditions

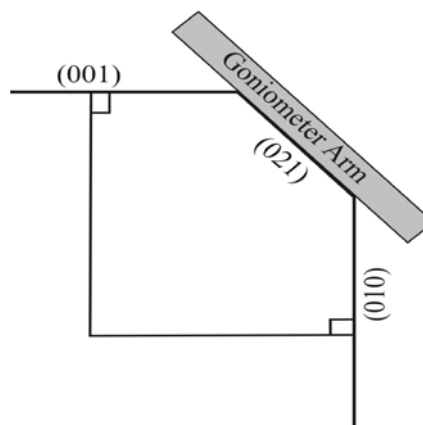


## SECTION – C

### NUMERICAL ANSWER TYPE (NAT)

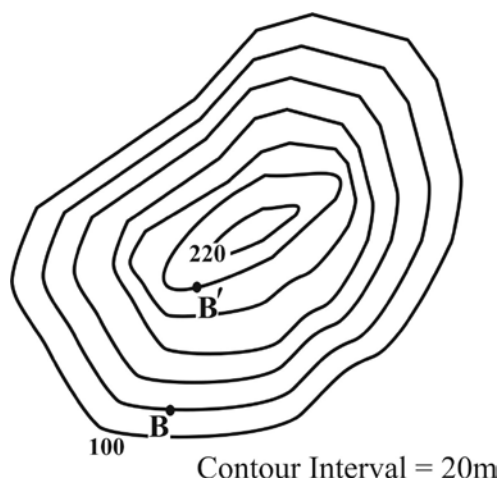
**Q. 41 – Q. 50 carry one mark each.**

- Q.41 Based on the ideal end member formula of diopside, the mole proportion (%) of CaO for plotting the mineral on a CaO-MgO-SiO<sub>2</sub> triangular diagram is \_\_\_\_\_.
- Q.42 The phi ( $\phi$ ) value of a sediment particle having 4 mm diameter is \_\_\_\_\_.
- Q.43 Calcite, quartz, wollastonite and CO<sub>2</sub> fluid were present in equilibrium during the formation of a calc-silicate rock. In the chemical system CaO-SiO<sub>2</sub>-CO<sub>2</sub>, the degree of freedom of this assemblage is \_\_\_\_\_.
- Q.44 Weight of a 10 cm<sup>3</sup> medium grained sandstone block with 20% (v/v) porosity, in dry state is 26g. The density of the block when fully saturated with water is \_\_\_\_\_ g/cm<sup>3</sup>.
- Q.45 In the following figure, the exterior angle measured between (001)  $\wedge$  (021) with a goniometer in a crystal is 40°. The interior angle between (010)  $\wedge$  (021) in degrees is \_\_\_\_\_.



- Q.46 If the elevation of a wave cut platform is 55 m above the sea level and the age of the erosional surface is 120 kilo years, the rate of rock uplift at this coastal location is \_\_\_\_\_ m/kilo years (give answer in two decimal places).
- Q.47 A foliation plane has strike 025° and 60° easterly dip. A mineral lineation on this foliation plane has a rake/pitch of 90°. The plunge direction of the mineral lineation in whole circle bearing is \_\_\_\_\_ degrees.
- Q.48 Two outcrops on a 1 : 25000 map are 12 cm apart. The ground distance between the two outcrops is \_\_\_\_\_ km.

- Q.49 Fine muds are deposited at a rate of 1 cm per 1000 y. Assuming constant sedimentation rate and absence of compaction, a 1 km thick sequence would be deposited in \_\_\_\_\_million years.
- Q.50 B and B' are two points on the topographic map shown below. The distance between B and B' along the linear traverse BB' is 220m. The angle of the slope along this traverse is \_\_\_\_\_ degree (give answer in two decimal places).



**Q. 51 – Q. 60 carry two marks each.**

- Q.51 The half life of a radionuclide A is double that of a radionuclide B. The fraction of A remaining when B is reduced to  $1/64$  is \_\_\_\_\_. Give answer in three decimal places.
- Q.52 The total metal content of a mineable  $40\text{m} \times 40\text{m} \times 3\text{m}$  ore block having bulk density  $2.75 \text{ g/cm}^3$  and assay value 1.5 wt % Cu is \_\_\_\_\_metric tonnes.
- Q.53 The temperature at the Earth's surface is  $25^\circ\text{C}$ . The temperature at the base of the Earth's crust (30 km thick), if the geothermal gradients are  $25^\circ\text{C/km}$  up to 15km depth and  $15^\circ\text{C/km}$  further down, is \_\_\_\_\_ $^\circ\text{C}$ .
- Q.54 A melt in the binary system  $\text{MgO-SiO}_2$  contains 89.92 wt%  $\text{SiO}_2$ . If all the magnesium is consumed to form enstatite ( $\text{MgSiO}_3$ ), how many moles of this mineral will crystallize from 100 grams of the melt? Give answer in two decimal places.

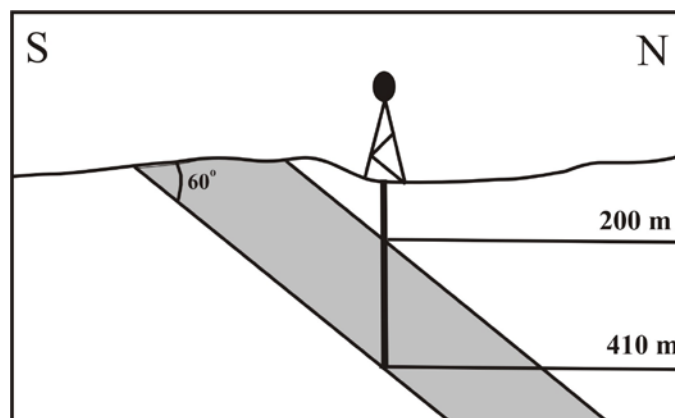
*Molecular weight* :  $\text{MgO} = 40.3$ ,  $\text{SiO}_2 = 60.1$

- Q.55 A lherzolite xenolith from the mantle contains 50 volume % olivine, the rest being equal proportions of orthopyroxene and clinopyroxene. If the densities of the minerals are (in g/cc) olivine = 3.42, orthopyroxene = 3.28 and clinopyroxene = 3.46, the bulk density of the xenoliths in g/cc is \_\_\_\_\_ (give answer in two decimal places).

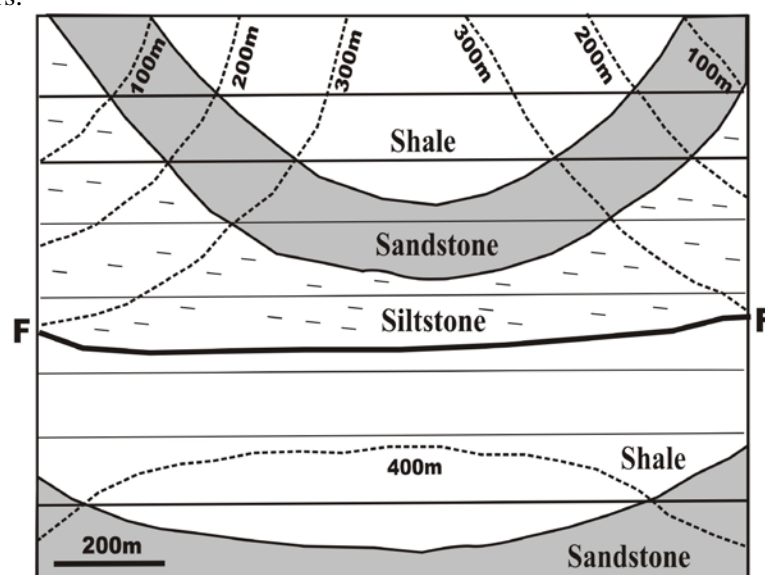
Q.56 The  $\text{SiO}_2$  value, recalculated on volatile free basis, of the rock whose major oxide (wt%) composition given below is \_\_\_\_\_. Give answer in two decimal places.

$\text{SiO}_2$	45.58
$\text{Al}_2\text{O}_3$	12.49
$\text{FeO (T)}$	12.44
$\text{MgO}$	11.36
$\text{CaO}$	09.93
$\text{Na}_2\text{O}$	02.25
$\text{K}_2\text{O}$	01.67
<b>Total</b>	<b>95.72</b>

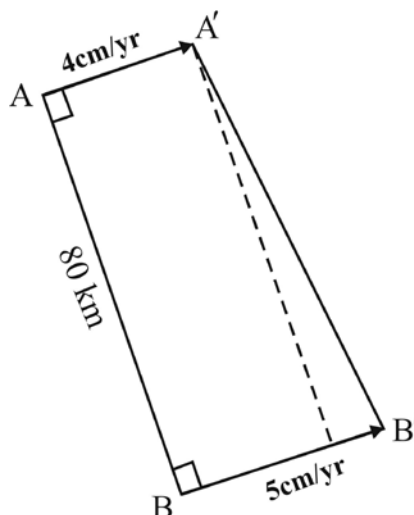
Q.57 As shown in the following figure, a vertical well intersects the top and bottom of an inclined bed at 200 m and 410 m depths, respectively. If the true dip of the bed is  $60^\circ$  to the north, the true thickness of the bed is \_\_\_\_\_ metres.



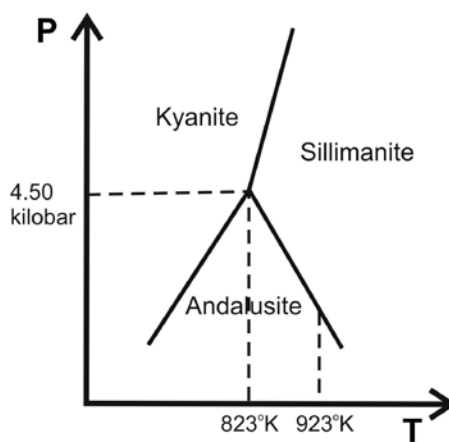
Q.58 In the given geologic map, the horizontal lines are stratum contours. The throw on the fault (F-F) is \_\_\_\_\_ meters.



- Q.59 Two localities A and B on a continental plate as shown in the figure below, are separated by a distance of 80 km. The plate velocities measured at A and B are 4 cm/yr and 5 cm/yr, respectively. Assuming no faulting in the area, the new distance between A and B will be \_\_\_\_\_ km in one million years. Give answer in two decimal places.



- Q.60 In the following schematic diagram, the aluminosilicate triple point is located at the pressure of 4.50 kbar and temperature of 823°K. If the reaction andalusite = sillimanite has negative slope with a value of  $-18.22 \text{ bar/}^\circ\text{K}$ , the pressure of the reaction at 923°K is \_\_\_\_\_ kbar (give answer in two decimal places).



(Figure not to scale)

**END OF THE QUESTION PAPER**