

# **GATE – Mining Engineering**

**(Topic Wise Questions 2007-2017)**

**Topic: Geomechanics/Rock**

**Mechanics and Ground**

**Control/Strata Control**

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## **GATE SYLLABUS:**

Geo-technical properties of rocks; Rock mass classification; Ground control, instrumentation and stress measurement techniques; Theories of rock failure; Ground vibrations; Stress distribution around mine openings; Subsidence; Design of supports in roadways and workings; Rock bursts and coal bumps; Slope stability.

2007

Q.3 Bulk modulus of rock is defined as

(A)  $\frac{\text{shear stress}}{\text{volumetric strain}}$

(B)  $\frac{\text{hydrostatic pressure}}{\text{shear strain}}$

(C)  $\frac{\text{hydrostatic pressure}}{\text{volumetric strain}}$

(D)  $\frac{\text{shear stress}}{\text{shear strain}}$

Q.5 Radial stress on the excavation boundary of a circular tunnel is

(A) always zero

(B) always positive

(C) always negative

(D) positive in some area and negative in some area

Q.7 Which one of the following supports does NOT require a power pack for its operation

(A) chock shield support

(B) open circuit hydraulic prop

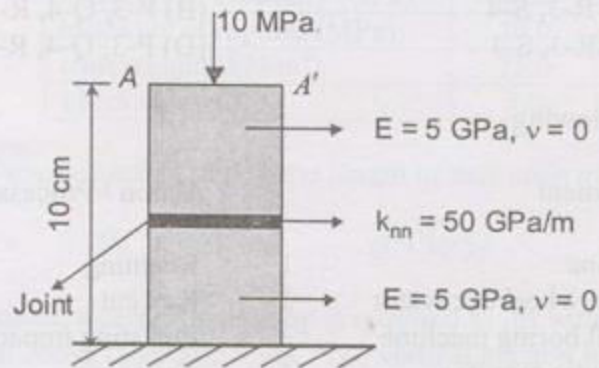
(C) close circuit hydraulic prop

(D) Alpine breaker line support

Q.26 A point P (10, 3) MPa on the Mohr's circle represents normal and shear stresses. If the centre of the Mohr's circle is C (6, 0) MPa, the normal and shear stresses in MPa on the point diametrically opposite to P are

- (A) 2, -3                      (B) 4, -3                      (C) 2, 3                      (D) 4, 3

Q.27 A rock sample with a horizontal joint is subjected to 10 MPa of normal pressure as shown in the figure. The elastic modulus and Poisson's ratio of the rock are 5.0 GPa and 0 respectively. If the normal stiffness ( $k_{nn}$ ) of the joint is 50 GPa/m, normal displacement at the top of the sample (AA' line) in mm is



- (A) 0.2                      (B) 0.4                      (C) 0.6                      (D) 0.8

Q.28 The state of stress ( $\sigma_{xx}, \sigma_{yy}, \tau_{xy}$ ) at a point below ground is found to be (5, 15, -3) MPa. The angle measured in the counter clockwise direction between the x-axis and the major principal axis in degree is

- (A) 9.52                      (B) 15.48                      (C) 150.48                      (D) 164.52

Q.29 The unconfined compressive strength of a cylindrical rock sample is 90 MPa. The angle of internal friction of the rock is  $30^\circ$ . If a confining pressure of 5 MPa is applied radially to the rock sample, the confined compressive strength in MPa is

- (A) 92.88 (B) 95.00 (C) 105.00 (D) 110.0

Q.30 A circular opening of radius  $a$  is made underground in hydrostatic stress condition. The radial distance from the centre of the opening, where the tangential stress is twice the radial stress, is

- (A)  $a$  (B)  $\sqrt{2}a$  (C)  $\sqrt{3}a$  (D)  $2\sqrt{3}a$

Q.31 Coal pillar strength is represented by  $S = S_1 h^\alpha w^\beta$ , where  $S_1$  = insitu strength of the pillar,  $h$  = mining height, and  $w$  = pillar width. Two bord and pillar panels are developed in the similar geological conditions at depths  $D_1$  and  $D_2$  with mining heights  $h_1$  and  $h_2$  respectively. If the gallery width and the pillar width in both the panels remain the same, the ratio of pillar safety factors,  $SF_1/SF_2$  is

- (A)  $\left(\frac{h_2}{h_1}\right)^\alpha \frac{D_1}{D_2}$  (B)  $\left(\frac{h_2}{h_1}\right)^\alpha \frac{D_2}{D_1}$  (C)  $\left(\frac{h_1}{h_2}\right)^\alpha \frac{D_1}{D_2}$  (D)  $\left(\frac{h_1}{h_2}\right)^\alpha \frac{D_2}{D_1}$

Q.37 In an underground opening, the immediate roof strata consists of two rock layers with the following properties:

Property	Layer-1	Layer-2
Modulus of elasticity (GPa)	60.0	40.0
Modulus of rupture (MPa)	20.0	10.0
Unit weight ( $\text{kN/m}^3$ )	25.0	20.0
Thickness (m)	5.0	2.5

Considering a factor of safety of 4.0, the length of safe span in m is

- (A) 27.82 (B) 34.06 (C) 36.54 (D) 39.34

Q.39 Match the following

	Support system		Support principle
P	Shotcrete	1	reinforces rock mass by binding them together
Q	Backfill	2	acts as link between two layers of rock to transfer load between them
R	Bolt	3	imposes kinematic constraints on key pieces in a stope boundary
S	Prop	4	prevents spatially progressive disintegration of near field rock mass

(A) P-3, Q-4, R-2, S-1

(C) P-4, Q-3, R-1, S-2

(B) P-2, Q-1, R-4, S-2

(D) P-3, Q-4, R-1, S-2

Q.40 Match the following

	Stope		Drill machine		Method of drilling
P	Shrinkage	I	Drill jumbo	1	Fan drilling
Q	Room-and-pillar	J	Down-the-hole hammer	2	Overhand drilling
R	Sublevel	K	Hand held stopper	3	Parallel drilling
S	Sublevel caving	L	Mechanised fan drill	4	Frontal /vertical/downward benching

Q.46 Four benches are being worked by the opencast mining system. Height, width and face angle for each bench are 15 m, 50 m and  $70^\circ$  respectively. The overall slope angle of the benches in degrees is

(A) 15.45

(B) 19.25

(C) 32.65

(D) 36.25



Q.47 Match the following

	Rock mass condition		Shaft sinking method		Limiting depth (m)
P	Water bearing strata of loose sand or gravel	I	Freezing	1	40
Q	Competent rock with fissures and cracks filled with water	J	Depression of ground water level	2	150
R	Highly permeable coarse solid or gravel with heavy water flow	K	Cement grouting	3	1000
S	All types of water bearing rocks	L	Caissan	4	> 600

- (A) P-L-4, Q-K-1, R-J-2, S-I-3  
(C) P-L-2, Q-K-4, R-J-3, S-I-1

- (B) P-L-1, Q-K-4, R-J-2, S-I-3  
(D) P-L-4, Q-K-3, R-J-2, S-I-1

**Linked Answer Questions: Q.76 to Q.85 carry two marks each.**

**Statement for Linked Answer Questions 76 & 77:** Porosity of a coarse grain sandstone sample is 15%. The specific gravity of sandstone is 2.8.

Q.76 What is the void ratio in the sandstone sample?

- (A) 0.150 (B) 0.176 (C) 0.850 (D) 1.176

Q.77 If the sandstone sample is fully saturated in water, the saturated density of the sample in  $\text{kg/m}^3$  is

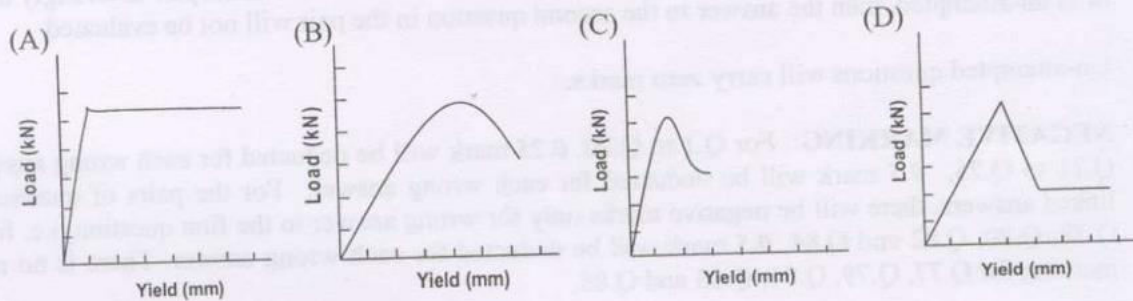
- (A) 1590 (B) 2234 (C) 2438 (D) 2531

**2008**

Q.3 The tool used to correct borehole deviation is

- (A) String shot (B) Kelly (C) Whipstock (D) Ratchet

Q.5 The load-yield characteristic of a hydraulic prop is represented by the curve



Q.6 In longwall caving, the thickness of immediate roof is calculated from

- (A) Bulking factor and width of longwall face
- (B) Seam thickness and width of longwall face
- (C) Seam thickness and bulking factor
- (D) Bulking factor and length of the panel

Q.9 If swell factor of ore in a shrinkage stope is 1.4, the output from the stope in percent of broken ore is

- (A) 0
- (B) 29
- (C) 40
- (D) 100

Q.10 The velocity of the wave type that determines the 'rippability' of rockmass is

- (A) P wave
- (B) S wave
- (C) Raleigh wave
- (D) Love wave

Q.11 In the order of the chronological development, the longwall support systems are arranged as

- P Powered support
- Q Link bar and friction support
- R Frame support
- S Hydraulic support

- (A) P>Q>R>S
- (B) R>S>Q>P
- (C) S>R>P>Q
- (D) Q>S>R>P

Q.14 Under identical water head and roadway conditions for water dam construction, if P, Q, and R represent the thickness of flat dam, cylindrical dam and spherical dam respectively, the thickness would follow the order

- (A) R>P>Q
- (B) P>R>Q
- (C) P>Q>R
- (D) Q>P>R

Q.15 The grain size distribution of soil is known as

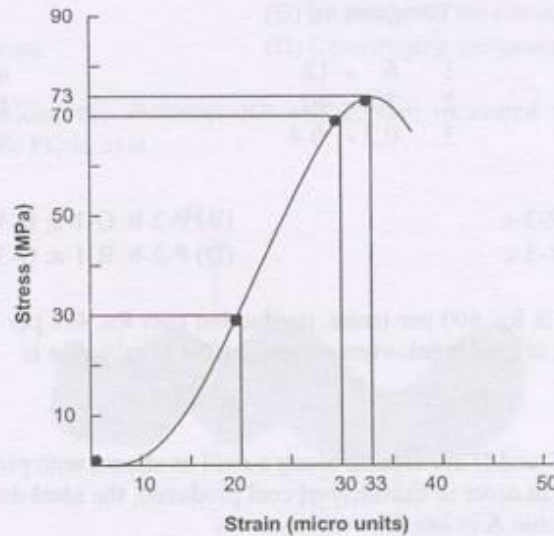
- (A) Permeability
- (B) Structure
- (C) Porosity
- (D) Texture



Q.20 In a bi-axial stress field the vertical stress is 10 MPa and the Poisson ratio for the rock mass is 0.2. The horizontal stress in MPa is,

- (A) 1.5 (B) 2.5 (C) 2.0 (D) 5.0

Q.27 From the stress-strain diagram shown below, the tangent and the secant moduli of elasticity in GPa are



- (A) 4.0, 2.2 (B) 3.3, 2.3  
(C) 3.3, 1.5 (D) 4.0, 1.5

Q.28 A bord and pillar operation is planned at a depth of 300 m in a strata of average unit weight  $24.5 \text{ kN/m}^3$  and compressive strength 15.50 MPa. If the width of the opening is 6 m considering a factor of safety of 1, the maximum possible extraction ratio in percentage is

- (A) 28 (B) 34 (C) 45 (D) 53

Q.34 A confined aquifer of 75 m thickness has 2 monitoring wells spaced 2500 m apart along the direction of water flow. The hydraulic conductivity of the aquifer is 40m per day. The water head difference between the wells is 1.5 m. Applying the Darcy's law, the rate of flow per meter of distance perpendicular to the direction of flow in  $\text{m}^3/\text{day}$  is

- (A) 2.1 (B) 1.8 (C) 1.45 (D) 1.21

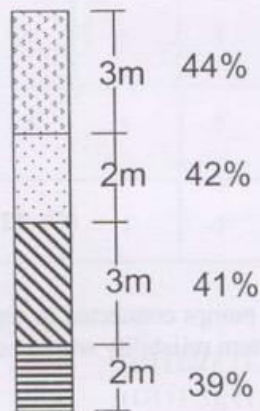
Q.39 The wt % of solids in a sand-water stowing pipe is 60. If the solids density is  $3000 \text{ kg/m}^3$ , the pulp density of the slurry in  $\text{kg/m}^3$  is

- (A) 1380 (B) 1420 (C) 1560 (D) 1670

Q.69 Match the following:

Failure criteria	Relationship
P. Drucker- Prager	1. $\sigma_1 = \sigma_3 + \sqrt{m\sigma_3 + s^2}$
Q. Hoek – Brown	2. $\tau = c + \sigma_n \tan \phi$
R. Mohr – Coulomb	3. $\sqrt{\frac{2}{3}} \left[ \left( \frac{\sigma_1 - \sigma_2}{2} \right)^2 + \left( \frac{\sigma_2 - \sigma_3}{2} \right)^2 + \left( \frac{\sigma_3 - \sigma_1}{2} \right)^2 \right]^{\frac{1}{2}}$ $= A(\sigma_1 + \sigma_2 + \sigma_3) + B$
(A) P-1, Q-3, R-2	(B) P-3, Q-1, R-2
(C) P-3, Q-2, R-1	(D) P-1, Q-2, R-3

Q.70 An assay value of alumina in a borehole from a bauxite deposit is as shown below. If the cut-off grade is 40%, the composite value of ore in the borehole in percent is



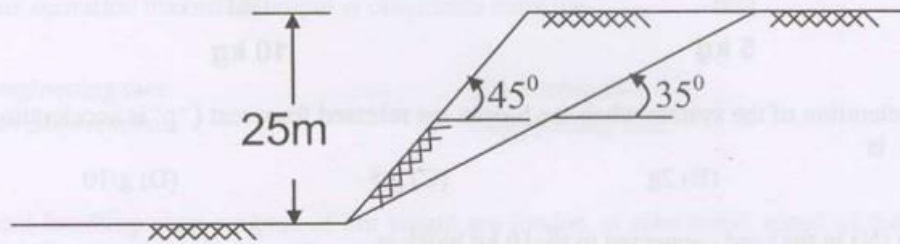
(A) 31.6

(B) 33.9

(C) 41.7

(D) 42.2

**Statement for Linked Answer Questions 76 and 77:** An open pit mine bench has a potential failure plane as indicated below. The unit weight, cohesion, and angle of internal friction of the rock mass are  $24.5 \text{ kN/m}^3$ ,  $0.02 \text{ MPa}$  and  $30^\circ$  respectively.

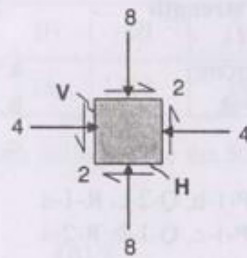


- Q.76 The driving force for failure, on the potential failure plane is
- (A) 187 N (B) 1.87 kN (C) 18.7 kN (D) 1.87 MN
- Q.77 The 'factor of safety' of slope under given conditions is
- (A) 0.7 (B) 0.9 (C) 1.1 (D) 1.3

**2009**

- Q.6 The rock mass classification system that considers "active stress" factor is
- (A) Q-system (B) RMR (C) RQD (D) GSI
- Q.7 In a triaxial compression test if  $\sigma_1$  is axial stress and  $\sigma_2$  and  $\sigma_3$  are confining stresses, then
- (A)  $\sigma_3 > \sigma_2 = \sigma_1$  (B)  $\sigma_1 > \sigma_2 = \sigma_3$  (C)  $\sigma_1 = \sigma_2 > \sigma_3$  (D)  $\sigma_3 = \sigma_2 > \sigma_1$
- Q.8 In a longwall mining subsidence phenomenon, the "angle of break" is the angle between
- (A) the vertical line at the panel edge and line connecting the panel edge and zero subsidence on the surface
- (B) the vertical line at the panel edge and line connecting the panel edge and point of critical deformation on the surface
- (C) the vertical line at the panel edge and line connecting the panel edge and the point of the maximum tensile strain on the surface
- (D) the horizontal line and the line connecting the panel edge and zero subsidence on the surface

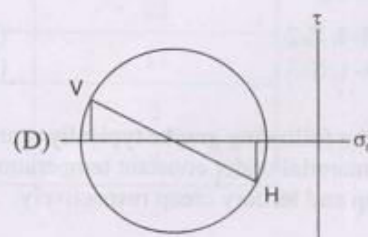
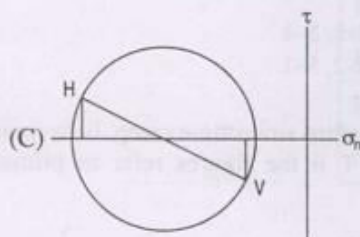
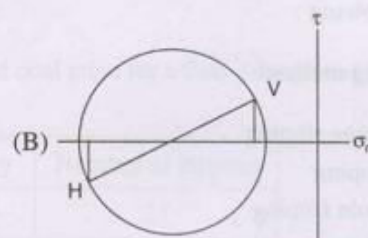
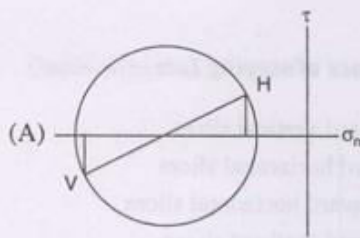
- Q.27 The grain density and bulk density of a dry coarse grained sandstone rock sample are 3.0 gm/cc and 2.7 gm/cc respectively. The void ratio of the sample in percentage is
- (A) 8.4 (B) 10.0 (C) 11.1 (D) 30.5
- Q.28 The ratio of uniaxial compressive strength to uniaxial tensile strength of a sandstone specimen is 8:1. The theoretical value of angle of internal friction of the specimen in degree is
- (A) 51 (B) 41 (C) 32 (D) 7
- Q.29 A circular tunnel is made underground where far field vertical and horizontal stresses are  $P_0$  and  $KP_0$  respectively. The tangential stress ( $\sigma_{\theta\theta}$ ) at the boundary of the tunnel for  $\theta = 45^\circ$  from the horizontal plane is  $3P_0$ . The value of K is
- (A) 0 (B) 1 (C) 2 (D) 3
- Q.34 The planes H and V represent the horizontal and vertical planes respectively as shown in the figure. Which one of the following Mohr circles represents the stress conditions applied in planes H and V ?



All stresses are in MPa

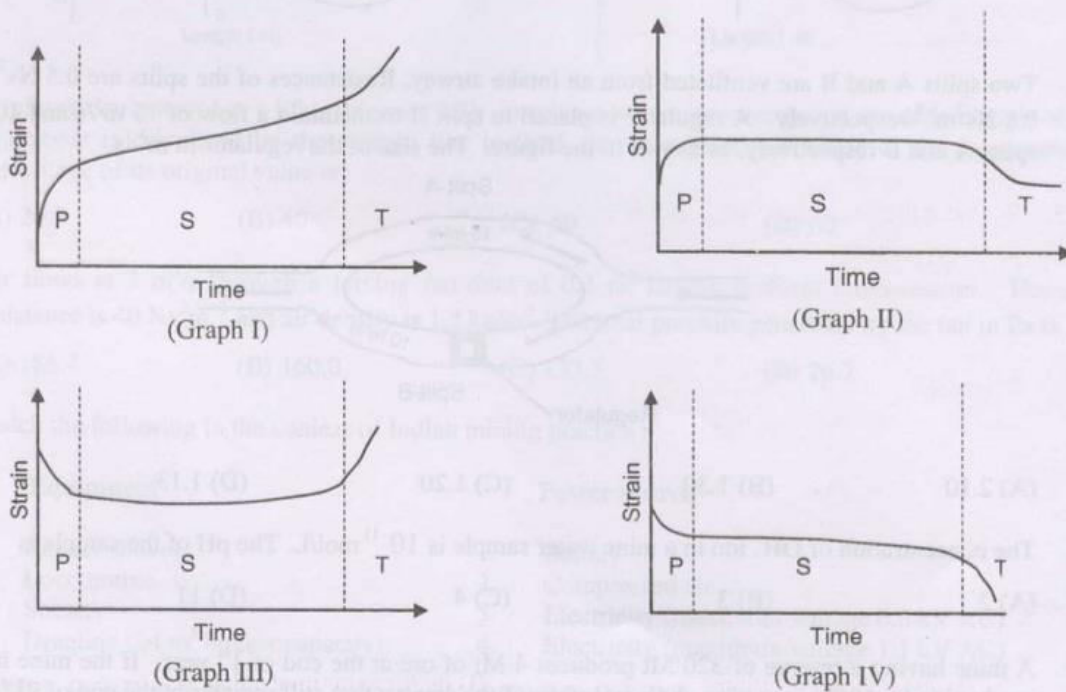
$\tau$  and  $\sigma_n$  refer shear stress and normal stress respectively

Note: shear stress is positive if it tries to rotate the element in clockwise direction





Q.40 Which one of the following graphs typically represents the standard strain-time creep behaviour of an isotropic rock material under constant temperature ? P, S and T in the figures refer to primary creep, secondary creep and tertiary creep respectively.



- (A) Graph I      (B) Graph II      (C) Graph III      (D) Graph IV

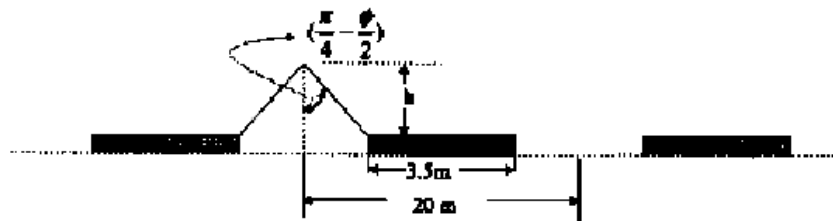
**2010**

Q.6 In an underground coal mine, a freshly exposed roof can be supported by a temporary support in the form of

- (A) triangular chocks
- (B) screw props
- (C) safari supports
- (D) hydraulic props



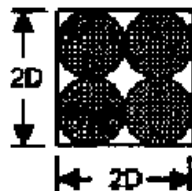
- Q.13 In Mohr-Coulomb failure criterion, the ratio of the uniaxial compressive strength to the tensile strength is
- (A)  $\frac{1+\sin \phi}{1-\sin \phi}$  (B)  $\frac{1-\sin \phi}{1+\sin \phi}$   
 (C)  $\frac{C(1+\sin \phi)}{(1-\sin \phi)}$  (D)  $\frac{2C(1+\sin \phi)}{(1-\sin \phi)}$
- Q.14 The average Young's modulus and Poisson's ratio values of a limestone sample are  $60 \times 10^3$  MPa and 0.3 respectively. The shear modulus in MPa is
- (A) 23.07 (B) 230.7 (C) 2307.0 (D) 23070.0
- Q.15 The angle of draw in a trough subsidence helps in determining the
- (A) maximum subsidence  
 (B) extent of surface subsidence  
 (C) plane of fracture  
 (D) critical width of the opening
- Q.45 In block caving operation the draw points are placed at 20 m center to center, with the pillar width 3.5 m as shown in the figure below. The muck is assumed to have zero cohesion and  $35^\circ$  friction angle. The height of draw cone (h) in m is



- (A) 12.5 (B) 14.6 (C) 15.8 (D) 16.5

**Common Data for Questions 48 and 49:**

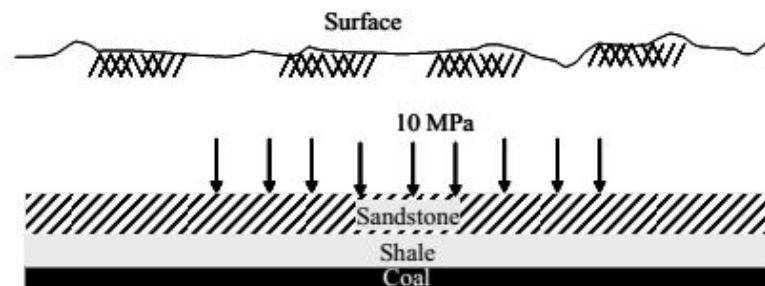
The granular media in an ore bin is assumed to be of regular spherical shape represented by the geometry as shown in the figure. The unit weight of solids is  $25 \text{ kN/m}^3$ .



- Q.48 The void ratio is
- (A) 0.91 (B) 0.84 (C) 0.78 (D) 0.69
- Q.49 The dry density in  $\text{kN/m}^3$  is
- (A) 13.09 (B) 12.50 (C) 11.74 (D) 10.87

# 2011

- Q.8 Stress concentration at a point on the wall of a vertical shaft results in a compressive stress of 59.66 MPa. The wall rock mass has an unconfined compressive strength of 89.49 MPa. The safety factor of the shaft wall at the point is
- (A) 0.67 (B) 0.86 (C) 1.23 (D) 1.50
- Q.9 A core sample of 54 mm diameter having Young's modulus of 68.97 GPa fails in uniaxial compression at 0.1% axial strain. The axial load at failure in kN is
- (A) 158.00 (B) 68.97 (C) 58.00 (D) 15.80
- Q.35 A typical case of gravity loading under complete lateral restraint in flat strata is shown in the figure below. The physico-mechanical parameters of the strata are given in the table. The *in situ* stresses ( $\sigma_z, \sigma_H$ ) on the top of the coal seam in MPa are



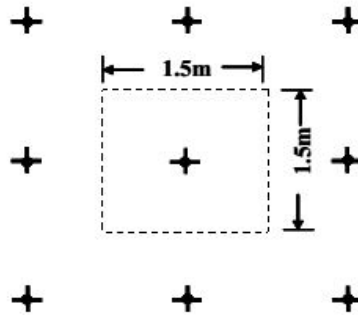
Cross-section of the strata

Strata	Thickness (m)	Specific Gravity	Young's Modulus (GPa)	Shear Modulus (GPa)
Sandstone	50	2.35	26.40	12.5
Shale	25	2.15	20.50	8.25
Coal	20	1.52	2.41	0.95

- (A) (10.17, 2.54) (B) (10.17, 3.69) (C) (11.68, 3.69) (D) (11.68, 2.54)

**Statement for Linked Answer Questions 54 and 55:**

The bolts are spaced at 1.5 m centre-to-centre in a square pattern as shown in the figure below. The tensile stress in 22 mm diameter bolt rod is 193.35 MPa. The unit weight of the roof layer is 25 kN/m<sup>3</sup>.



Plan view of rock bolting pattern

Q.54 The axial load in the bolt rod in kN is

- (A) 294.0                      (B) 173.5                      (C) 147.0                      (D) 73.5

Q.55 At equilibrium, the thickness of the roof layer supported by the bolt in m is

- (A) 1.31                      (B) 2.4                      (C) 2.62                      (D) 3.08

## 2012

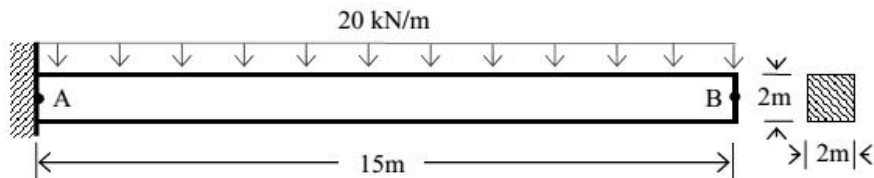
Q.5 If Poisson's ratio of a rock sample is 0.25, then the relationship among the modulus of elasticity (E), modulus of rigidity (G) and bulk modulus (K) is

- (A)  $E = K = G$                       (B)  $E > G > K$                       (C)  $E = G > K$                       (D)  $E > K > G$

Q.7 A cylindrical rock specimen is uniaxially loaded under compression and fails at 50 MPa. The fracture plane is inclined at an angle of 45° with the axial direction. The normal and shear stresses respectively on the failure plane in MPa are

- (A) 50, 50                      (B) 0, 50                      (C) 50, 0                      (D) 25, 25

Q.8 A uniformly distributed load of 20 kN/m is acting on a 15 m long cantilever beam AB of area of cross section 2 m x 2 m, as shown in the figure. The beam is fixed at point A. The modulus of elasticity of the material is 1.0 GPa.



The maximum vertical displacement of the beam in m is

- (A) 0.004                      (B) 0.020                      (C) 0.071                      (D) 0.190

Q.12 The roof bolt that follows the principle of point anchorage is

- (A) expansion shell bolt (B) full column grouted bolt  
(C) split set bolt (D) swellex bolt

Q.39 A series of triaxial tests of sandstone samples reveal the cohesion and the angle of internal friction as 21.65 MPa and  $30^\circ$  respectively. Based on the assumption that the sandstone samples follow the Mohr-Coulomb's failure criteria, the tensile strength in MPa is

- (A) 12.50 (B) 18.75 (C) 21.65 (D) 25.00

Q.44 Match the following:

**Mining system**

**Face supports**

- |   |                               |
|---|-------------------------------|
| P Mechanized longwall in flat seam          | 1 Cable bolting               |
| Q Blasting gallery method                   | 2 Shield support              |
| R Mechanized longwall in steep seam         | 3 Alpine breaker line support |
| S Wangawilli method for 3 m thick coal seam | 4 Troika shield support       |

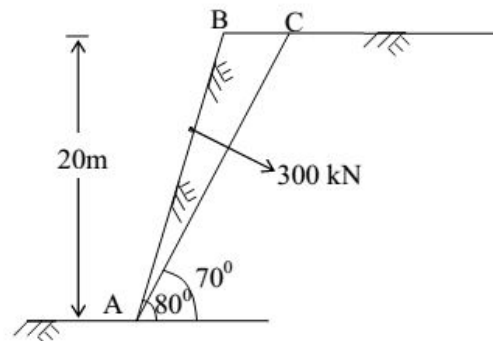
(A) P-2, Q-1, R- 4, S-3

(B) P-4, Q-1, R-3, S-2

(C) P-4, Q-2, R-3, S-1

(D) P-2, Q-3, R- 4, S-1

Q.45 An opencast mine bench has a potential failure plane AC as indicated in figure. Bolts are installed to stabilize the failure plane providing a resultant bolting force of 300 kN. The area of sliding block ABC is  $37.45 \text{ m}^2$ . The unit weight, cohesion and angle of internal friction of rock are  $25 \text{ kN/m}^3$ , 20 kPa and  $40^\circ$  respectively.



The factor of safety of slope when bolts are installed perpendicular to the failure plane is

- (A) 0.79 (B) 1.08 (C) 1.78 (D) 3.46

Q.47 A circular tunnel of 1.85 m radius is driven in rock in a hydrostatic stress field of 20 MPa. The tunnel lining is provided before occurrence of any rock deformation. The shear modulus of rock is 2 GPa and the modulus of elasticity of lining material is 3 GPa. Assuming both rock and lining behave elastically, the radial pressure on the rock and lining interface in MPa is

- (A) 8.19 (B) 9.91 (C) 11.62 (D) 13.33

Common Data for Questions 48 and 49:

A 2.5 m thick coal seam lying at an average depth of 100 m has been developed by bord and pillar method. The width of the square pillars is 30 m (centre to centre) and the gallery width is 4 m. The average density of the overlying strata is  $26 \text{ kN/m}^3$  and the pillar strength is  $4500 \text{ kN/m}^2$ .

- Q.48 Extraction ratio during the development of the pillar is  
 (A) 0.129 (B) 0.148 (C) 0.218 (D) 0.249
- Q.49 The safety factor of the pillar is  
 (A) 1.1 (B) 1.3 (C) 1.5 (D) 1.7

## 2013

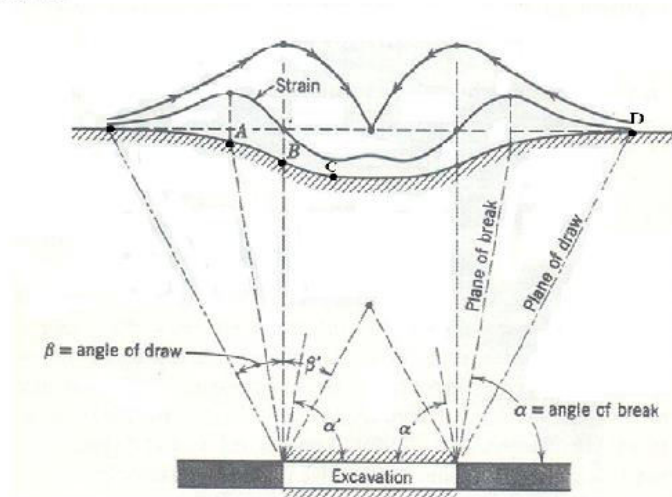
Q.3 In the Moh's scale of hardness, the minerals in increasing sequence of hardness are

- (A) calcite, gypsum, topaz, diamond  
 (B) topaz, gypsum, calcite, diamond  
 (C) calcite, gypsum, diamond, topaz  
 (D) gypsum, calcite, topaz, diamond

Q.28 A cylindrical rock specimen of diameter 54 mm has Young's modulus of 68.97 GPa and Poisson's ratio of 0.35. The rock specimen fails in uniaxial compression at a lateral strain of 0.01%. The axial load at failure in kN is \_\_\_\_\_

Q.32 A core sample of a rock, having diameter 54 mm and length 108 mm, is subjected to axial loading. If the axial strain and Poisson's ratio are  $2000 \times 10^{-6}$  and 0.28 respectively, the value of volumetric strain, represented in micro-strain is \_\_\_\_\_

Q.45 A sub-critical subsidence profile is shown in the figure below. The points A, B, C, and D represent respectively the points of



- (A) zero vertical displacement, maximum tension, inflexion, maximum compression  
 (B) inflexion, maximum tension, maximum compression, zero vertical displacement  
 (C) maximum tension, inflexion, maximum compression, zero vertical displacement  
 (D) maximum compression, maximum tension, inflexion, zero vertical displacement



- Q.46 The uniaxial compressive strength of a limestone sample is 80 MPa. The sample is confined at a pressure of 20 MPa in a triaxial compressive strength test. Based on Hoek-Brown failure criteria the maximum principal stress at failure in MPa is (consider rock constants as  $m = 7.88$ ,  $s = 1.0$  and  $a = 0.5$ )
- (A) 117.9 (B) 132.3 (C) 137.9 (D) 157.9

Statement for Linked Answer Questions 54 and 55:

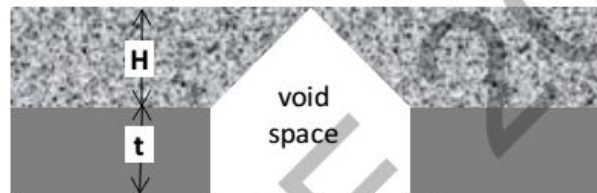
A 4.6 m wide vein dipping at  $80^\circ$  is mined by horizontal cut-and-fill stoping method. The fill is to be placed in the stope along the length of 46 m and to a height of 3.0 m. If the specific weight of the fill material is  $15.86 \text{ kN/m}^3$  and the porosity is 35%, under fully saturated conditions

- Q.54 the volume of water in the fill in  $\text{m}^3$  is
- (A) 222.18 (B) 332.40 (C) 336.44 (D) 634.80
- Q.55 the mass of solids in saturated fill in tonnes is
- (A) 820.00 (B) 804.10 (C) 799.30 (D) 788.80

## 2014

- Q.3 If  $\sigma_s$  is the induced stress and  $\sigma_i$  is the insitu stress at a point below ground, the 'stress concentration' at that point is
- (A)  $\sqrt{\frac{\sigma_s}{\sigma_i}}$  (B)  $\sqrt{\frac{\sigma_i}{\sigma_s}}$  (C)  $\frac{\sigma_i}{\sigma_s}$  (D)  $\frac{\sigma_s}{\sigma_i}$
- Q.4 The components of state of stress at a point in  $x$ - $y$  plane are given as  $\sigma_{xx} = 5 \text{ MPa}$ ,  $\sigma_{yy} = 10 \text{ MPa}$  and  $\tau_{xy} = -2 \text{ MPa}$ . The sum of the principal stresses acting on the  $x$ - $y$  plane in MPa is \_\_\_\_\_
- Q.10 Given  $S$  is the setting load and  $Y$  is the yield load of a hydraulic prop, the correct relationship is
- (A)  $S < Y$  (B)  $S > Y$  (C)  $S = Y$  (D)  $S = Y^2$
- Q.13 Which one of the following is the most likely mode of slope failure for waste dump
- (A) Circular (B) Wedge  
(C) Plane (D) Toppling

- Q.21 A flat coal seam of thickness (t) 3 m is excavated and broken roof rock has completely filled the space created due to extraction as shown in the figure. If the bulking factor of roof rock is 1.2, the caving height (H) in m is \_\_\_\_\_



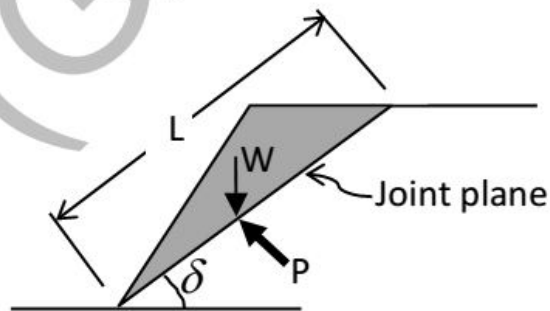
- Q.22 A piece of coal sample weighs 10 kg in air and 2 kg when immersed in water. The specific gravity of the coal sample is \_\_\_\_\_
- Q.23 In a borehole log of 1.2 m in length, recovery of rock cores in cm is given below  
20, 8, 15, 8, 8, 4, 3, 9, 10, 1, 5, 10

The RQD in percentage is

- (A) 29.2 (B) 31.8 (C) 45.8 (D) 50.0

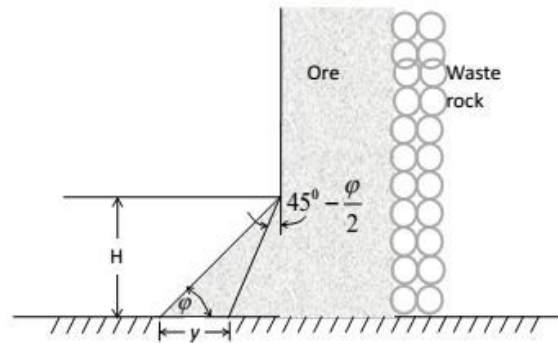
- Q.28 A dry rock sample of diameter 50 mm and length 100 mm weighs 300 g. After saturating in brine solution of specific gravity 1.05, its weight increased to 330 g. The porosity of the rock sample in percentage is \_\_\_\_\_

- Q.29 A joint plane of length  $L$  and dip  $\delta$  intersects the toe of a slope as shown in the figure. The weight of the shaded block is  $W$ . Uniform water pressure  $P$  acts normal to the joint plane. If the cohesion and angle of internal friction of the joint surface are  $c$  and  $\phi$  respectively, then the expression for 'safety factor' of the shaded block is



- (A)  $\frac{Lc + (W \sin \delta - LP) \tan \phi}{W \cos \delta}$  (B)  $\frac{Lc + (W \cos \delta + LP) \tan \phi}{W \sin \delta}$
- (C)  $\frac{Lc + (W \cos \delta - LP) \tan \phi}{W \sin \delta}$  (D)  $\frac{Lc + (W \sin \delta + LP) \tan \phi}{W \cos \delta}$

- Q.35 The height  $H$  of a drawpoint in a sublevel caving stope is 3.0 m. If the angle of repose ( $\phi$ ) of broken ore is  $35^\circ$ , the digging depth  $y$  of the loader as shown in the figure in m is \_\_\_\_\_



- Q.52 A series of tri-axial compression tests conducted on sandstone samples reveal the following relationship between major and minor principal stresses

$$\sigma_1 = 50 + 3\sigma_3 \quad [\text{stresses are in MPa}]$$

The cohesion in MPa and angle of internal friction in degrees of sandstone respectively are

- (A) 14.43, 30.0      (B) 14.43, 60.0      (C) 0.21, 73.9      (D) 0.21, 16.1

## 2015

Question Number : 11 Question Type : MCQ

Out of the support categories given for an underground coal mine, identify the 'active support'.

- (A) wire mesh      (B) shotcrete  
(C) fully grouted roof bolt      (D) hydraulic prop

Options :

1. ✖ A
2. ✖ B
3. ✖ C
4. ✔ D

Question Number : 12 Question Type : MCQ

---

Massive sandstone in immediate roof delays the local fall in goaf of a coal mine. Under this condition, crushing of the pillars at outbye side is called

- (A) coal bump (B) overriding of pillars  
(C) stiffening of pillars (D) spalling of pillars

Options :

1. ✖ A  
2. ✔ B  
3. ✖ C  
4. ✖ D

Question Number : 17 Question Type : MCQ

The excess pore pressure in backfill material in a cut-and-fill stope leads to

- (A) reduction in strength of the wall rock  
(B) enhancement of bearing strength of fill  
(C) loss of shear resistance of fill  
(D) prevention of progressive failure of crown pillar

Options :

1. ✖ A  
2. ✖ B  
3. ✔ C  
4. ✖ D

Question Number : 25 Question Type : MCQ

Dilatancy of rock is associated with

- (A) increase in surface area after fragmentation  
(B) decrease in volume due to compression of rock  
(C) increase in shear strain due to cracking of rock  
(D) increase in volume due to cracking of rock

Options :

1. ✖ A  
2. ✖ B  
3. ✖ C  
4. ✔ D

Question Number : 40 Question Type : MCQ

Match the following locations with support types in coal mines.

Location	Support type
P. Roadway junctions	1. Powered support
Q. Between adjacent panels	2. Chock and bolt
R. Longwall face	3. Back fill
S. Goaf	4. Barrier pillar

(A) P-2,Q-3,R-1,S-4 (B) P-4,Q-3,R-1,S-2 (C) P-2,Q-4,R-1,S-3 (D) P-2,Q-3,R-4,S-1

Options :

1. ✖ A
2. ✖ B
3. ✔ C
4. ✖ D

Question Number : 46 Question Type : NAT

Subsidence profile function,  $s(x)$ , along the lateral cross-section over a flat longwall panel is given as

$$s(x) = 0.8 \left[ 0.996 - \tanh\left(\frac{8.3x}{D}\right) \right], \text{ m}$$

where  $x$  = distance (m) from the inflection point and  $D$  = depth (m) of the seam. Considering that the inflection point lies vertically above the edge of the panel, the angle of draw in degrees for a depth of 250 m is \_\_\_\_\_

Correct Answer :

20 to 21



Question Number : 47 Question Type : NAT

A goaf void of  $250 \text{ m}^3$  is filled in 3 hours by hydraulic sand stowing method. Density of the sand is  $2.6 \text{ tonne/m}^3$ . If the filling factor of goaf void is 0.9 and sand to water ratio in the stowing mixture is 1.0 tonne to  $1.1 \text{ m}^3$ , the stowing rate in  $\text{m}^3/\text{h}$  is \_\_\_\_\_

Correct Answer :

286 to 293

Question Number : 49 Question Type : MCQ

Match the method of mining with strength of orebody, type of support and orebody geometry.

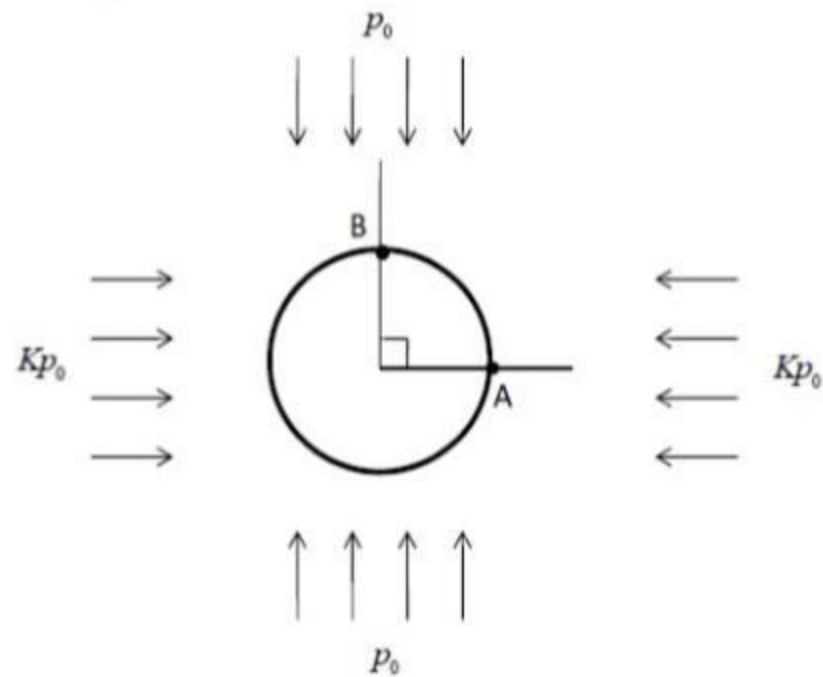
Strength	Support	Geometry	Method
P. Strong	L. Unsupported	X. Tabular and steep	1. Cut-and-fill
Q. Moderate	M. Artificially supported	Y. Tabular and flat	2. Block caving
R. Weak	N. Self-supporting	Z. Massive and steep	3. Room and Pillar

- (A) P-M-X-3, Q-N-Z-2, R-L-Y-1  
(B) P-L-X-1, Q-N-Z-3, R-M-Y-2  
(C) P-N-Y-3, Q-M-X-1, R-L-Z-2  
(D) P-L-Z-1, Q-N-Y-3, R-M-X-2

Options :

- 
1.  A  
2.  B  
3.  C  
4.  D

A circular tunnel is constructed in a biaxial far field stress (vertical stress  $p_0$  and horizontal stress  $Kp_0$ ) as shown in the figure.



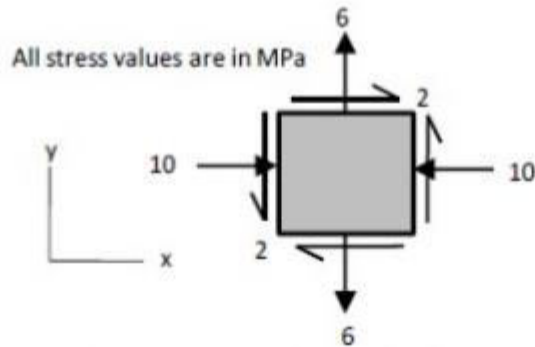
If the ratio of the tangential stress measured at the boundary points A and B is 3:1, the value of  $K$  is \_\_\_\_\_

Correct Answer :

0.6

Question Number : 59 Question Type : MCQ

Biaxial stresses at a point inside a pillar are shown in the figure.



The magnitude of the maximum shear stress in MPa and its direction with the  $x$ -axis in degrees at the same point respectively are

(A) 8.25, 37.98

(B) 7.49, 37.98

(C) 8.25, 52.02

(D) 7.49, 52.02

Options :

1. ✓ A

2. ✗ B

3. ✗ C

4. ✗ D

Question Number : 63 Question Type : NAT

The ratio of horizontal to vertical in-situ stresses,  $K$ , at a mine field varies with depth,  $D$  (in m) as

$$K = \frac{267}{D} + 1.25$$

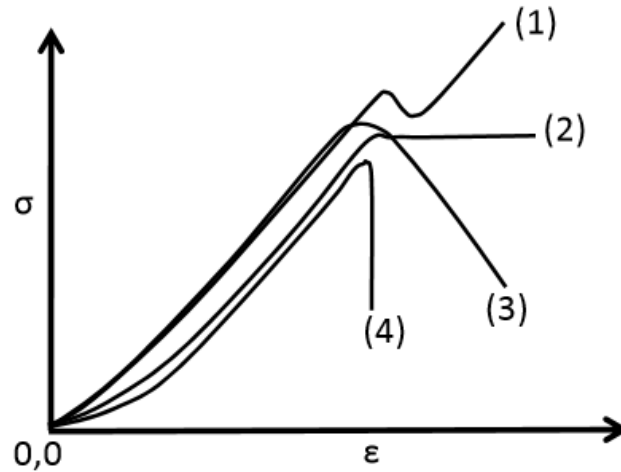
If the unit weight of overburden rock is  $25 \text{ kN/m}^3$ , the horizontal stress in MPa at a depth of 400 m is \_\_\_\_\_

Correct Answer :

19.10 to 19.25

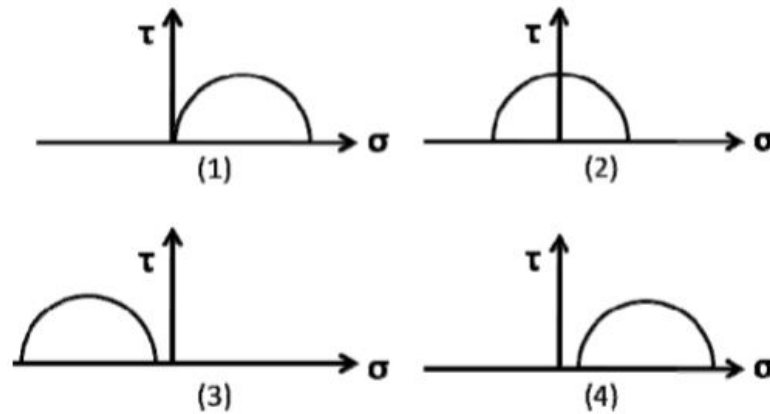
2016

Q.12 Out of the given stress-strain curves, identify the rock type that is most prone to rock burst.



- (A) (1) (B) (2) (C) (3) (D) (4)

Q.11 Identify the uniaxial compressive loading condition from the following four Mohr circles.



- (A) (1) (B) (2) (C) (3) (D) (4)

Q.9 Bieniawski's Rock Mass Rating considers the parameters: RQD, spacing of joints, condition of joints, ground water condition, and

- (A) tensile strength  
(B) uniaxial compressive strength  
(C) shear strength  
(D) buckling strength

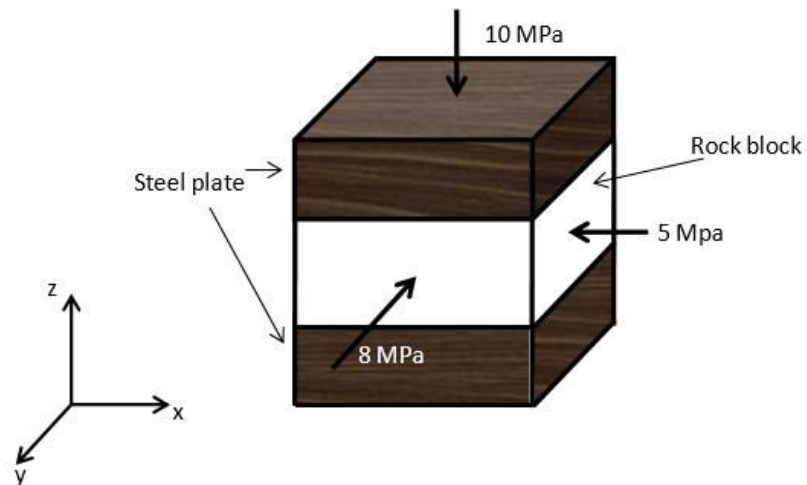
Q.10 A rockmass is subjected to hydrostatic pressure of 6 MPa. If each of the measured strains  $\epsilon_{xx} = \epsilon_{yy} = \epsilon_{zz}$ , is 2.0 mm/m, then the bulk modulus, in GPa, is \_\_\_\_\_

Q.13 A longwall panel of width 120 m is extracted at a depth of 200 m. Critical subsidence is reached when the panel length becomes 150 m. If the seam were to be worked at a depth of 300 m, critical subsidence would be observed at a panel length, in m, of \_\_\_\_\_.

Q.14 The support system followed along the goaf edge in a depillaring panel is

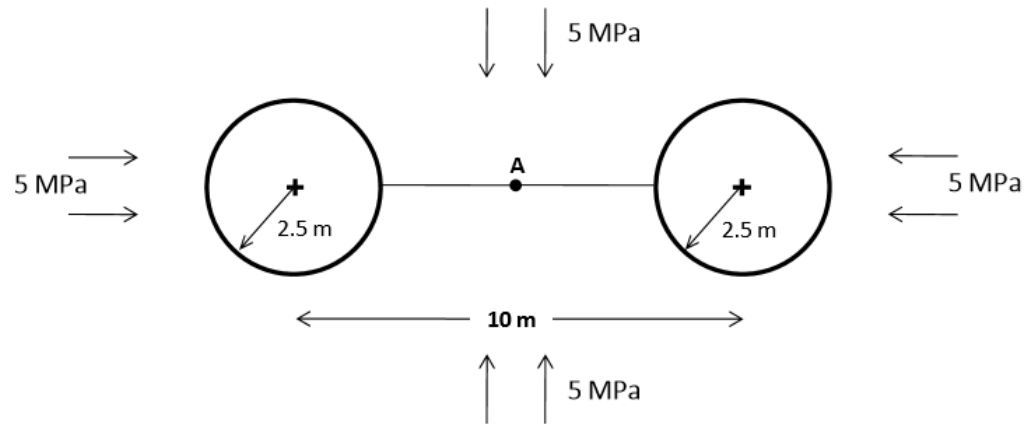
- (A) rope stitching
- (B) cable bolting
- (C) wooden/steel chock
- (D) hydraulic prop

Q.37 A cubical rock sample is enclosed between two fixed hard steel plates as shown in the figure below. The modulus of elasticity and Poisson's ratio of the rock are 2 GPa and 0.25, respectively. If the rock is subjected to the stresses as shown in the figure, the strain in x-direction, in mm/m, is \_\_\_\_\_.

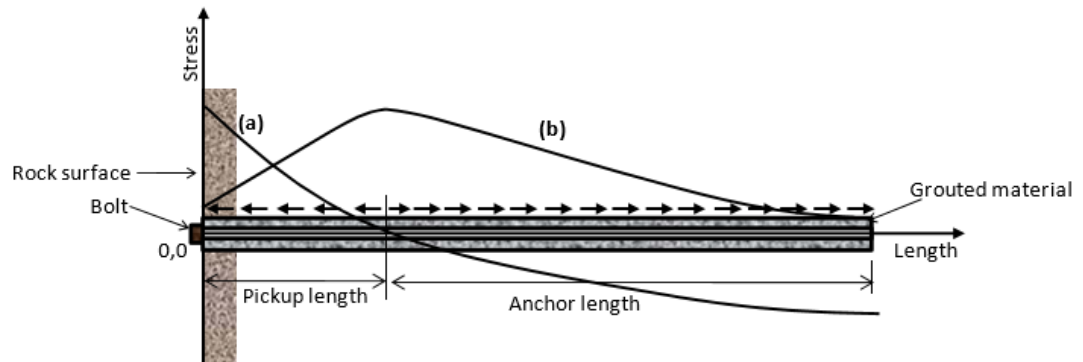




Q.38 In a hydrostatic stress field, point A is in the middle of two circular openings as shown in the figure. The radial stress, in MPa, at point A is \_\_\_\_\_.



Q.39 Curves (a) and (b) represent the stress distributions along the length of a 'full column grouted bolt' shown in the figure. Curves (a) and (b) are



- (A) Tensile stress, Compressive stress
- (B) Axial stress, Shear stress
- (C) Compressive stress, Tensile stress
- (D) Shear stress, Axial stress

Q.40 Match the following mechanical properties with the formulae

Mechanical property	Formula
P. Modulus of elasticity	1. $c + \sigma_n \tan \phi$
Q. Compressive strength	2. $\epsilon_{\text{lateral}} / \epsilon_{\text{longitudinal}}$
R. Shear Strength	3. $\sigma / \epsilon$
S. Poisson's ratio	4. $F_n / \pi r^2$

(A) P-1, Q-2, R-3, S-4

(B) P-1, Q-4, R-3, S-2

(C) P-3, Q-4, R-1, S-2

(D) P-3, Q-2, R-1, S-4

**2017**

**Question Number : 5**

**Correct : 1 Wrong : -0.33**

Components of a 2-D stress tensor in Cartesian coordinate are  $\sigma_{xx} = 5.0$  MPa,  $\sigma_{yy} = -10.0$  MPa, and  $\tau_{xy} = 2.0$  MPa. The traction vector ( $\vec{T}$ ) in MPa acting on a plane having outward normal

$\hat{n} = \frac{\sqrt{3}}{2}\hat{i} - \frac{1}{2}\hat{j}$  is

(A)  $\vec{T} = 3.33\hat{i} - 6.73\hat{j}$

(B)  $\vec{T} = 3.33\hat{i} + 6.73\hat{j}$

(C)  $\vec{T} = 1.73\hat{i} - 6.73\hat{j}$

(D)  $\vec{T} = 1.73\hat{i} + 6.73\hat{j}$

**Question Number : 6**

**Correct : 1 Wrong : -0.33**

If only two members form a truss joint and no external load or support reaction is applied to the joint, the members

(A) have infinite force

(B) have equal but opposite force

(C) are zero-force members

(D) have unequal forces



**Question Number : 7**

**Correct : 1 Wrong : -0.33**

A multi-point borehole extensometer is used to monitor

- (A) convergence between the roof and the floor
- (B) strain between fixed points along a borehole
- (C) strain between the anchor point and the reference point on the surface
- (D) changing distances between fixed points along a borehole

**Question Number : 8**

**Correct : 1 Wrong : 0**

The failure load of a point load test specimen having diameter 45 mm is 6000 N. The uncorrected point load index in MPa is \_\_\_\_\_

**Question Number : 28**

**Correct : 2 Wrong : 0**

The area of cross-section ( $x$ ) of four rock samples and the respective applied loads ( $y$ ) at failure under uniaxial loading are given below:

$x \text{ (cm}^2\text{)}$	7	10	13	16
$y \text{ (kN)}$	35	45	60	80

If the best fit line  $y = 4.88x$  represents the above data, the coefficient of determination ( $R^2$ ) of the best fit line is \_\_\_\_\_

**Question Number : 38****Correct : 2 Wrong : 0**

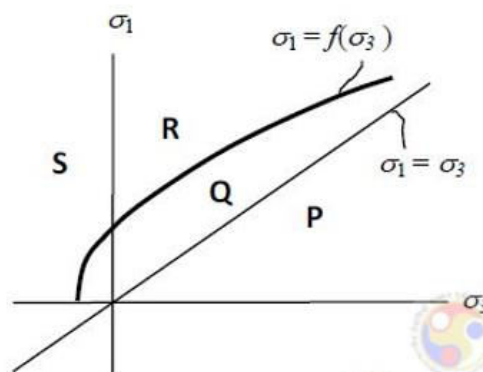
A bord and pillar panel is being planned at a depth of 300 m. The dimension of square pillar is 35 m centre-to-centre. The average unit weight of the overburden rock is  $25 \text{ kN/m}^3$ . If the strength of the pillar is 14.0 MPa, the gallery width in m for a safety factor of 1.3 is \_\_\_\_\_

**Question Number : 39****Correct : 2 Wrong : 0**

A sandstone sample having 15% moisture content and volume of  $75 \text{ cm}^3$  weighs 180 g. If the grain density is  $2.6 \text{ g/cm}^3$ , porosity of the sample in % is \_\_\_\_\_

**Question Number : 40****Correct : 2 Wrong : -0.66**

Let  $\sigma_1$  and  $\sigma_3$  are major and minor principal stresses respectively. The equation  $\sigma_1 = f(\sigma_3)$  denotes the failure envelop of a rock as shown in the figure. Match the zones (P, Q, R and S) with the legend code.

**Legend****Code**

- 1.
- 2.
- 3.
- 4.

**Name**

- Safe zone
- Tensile zone
- Infeasible zone
- Unsafe zone

- (A) P-1, Q-2, R-4, S-3  
(C) P-3, Q-1, R-2, S-4

- (B) P-3, Q-1, R-4, S-2  
(D) P-1, Q-4, R-3, S-2

**Question Number : 45**

**Correct : 2 Wrong : 0**

Ground reaction curve (GRC) of a tunnel roof under hydrostatic stress field is given by  $p_g = 10 - 0.75u$ , where  $p_g$  is the required support pressure in MPa and  $u$  is radial displacement in mm. A uniform support is installed at the boundary of the tunnel providing support reaction (SR) as  $p_s = 1.5u - 3.0$ , for  $u \geq 2$  mm. Considering GRC = SR, the support pressure in MPa is

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