

GATE 2016 MN

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Q.1 – Q.5 carry one mark each.

- 1) The volume of a sphere of diameter 1 unit is _____ than the volume of a cube of side 1 unit.

a) least b) less c) lesser d) low

(GATE MN 2016)

- 2) The unruly crowd demanded that the accused be _____ without trial.

a) hanged b) hanging c) hankering d) hung

(GATE MN 2016)

- 3) Choose the statement(s) where the underlined word is used correctly:

- (I) A prune is a dried plum.
(II) He was lying prone on the floor.
(III) People who eat a lot of fat are prone to heart disease.

a) (I) and (III) only b) (III) only c) (II) and (III) only d) (II) only

(GATE MN 2016)

- 4) **Fact:** *If it rains, then the field is wet.*

Read the following statements:

- (i) It rains
(ii) The field is not wet
(iii) The field is wet
(iv) It did not rain

Which one of the options given below is **NOT** logically possible, based on the given fact?

a) If (ii), then (iv). b) If (i), then (iii). c) If (ii), then (i). d) If (iii), then (iv).

(GATE MN 2016)

- 5) A window is made up of a square portion and an equilateral triangle portion above it. The base of the triangular portion coincides with the upper side of the square. If the perimeter of the window is 6 m, the area of the window in m^2 is _____.

a) 1.43

b) 2.06

c) 2.68

d) 2.88

(GATE MN 2016)

Q.6 – Q.10 carry two mark each.

- 6) Students taking an exam are divided into two groups, P and Q, such that each group has the same number of students. The performance of each of the students in a test was evaluated out of 200 marks. It was observed that the mean of group P was 105, while that of group Q was 85. The standard deviation of group P was 25, while that of group Q was 5. Assuming that the marks were distributed on a normal distribution, which of the following statements will have the highest probability of being **TRUE**?
- a) No student in group Q scored less marks than any student in group P.
 b) No student in group P scored less marks than any student in group Q.
 c) Most students of group Q scored marks in a narrower range than students in group P.
 d) The median of the marks of group P is 100.

(GATE MN 2016)

- 7) A smart city integrates all modes of transport, uses clean energy and promotes sustainable use of resources. It also uses technology to ensure safety and security of the city, something which critics argue, will lead to a surveillance state.

Which of the following can be logically inferred from the above paragraph?

- (i) All smart cities encourage the formation of surveillance states.
 (ii) Surveillance is an integral part of a smart city.
 (iii) Sustainability and surveillance go hand in hand in a smart city.
 (iv) There is a perception that smart cities promote surveillance.

- a) (i) and (iv) only b) (ii) and (iii) only c) (iv) only d) (i) only

(GATE MN 2016)

- 8) Find the missing sequence in the letter series.

B, FH, LNP, _____

- a) SUWY b) TUUW c) TVXZ d) TWXZ

(GATE MN 2016)

- 9) The binary operation \square is defined as $a \square b = ab + (a + b)$, where a and b are any two real numbers. The value of the identity element of this operation, defined as the number x such that $a \square x = a$, for any a , is _____.

- a) 0 b) 1 c) 2 d) 10

(GATE MN 2016)

- 10) Which of the following curves represents the function

$$y = \ln \left(\left| e^{\lceil \sin(|x|) \rceil} \right| \right) \quad \text{for } |x| < 2\pi?$$

Here, x represents the abscissa and y represents the ordinate.

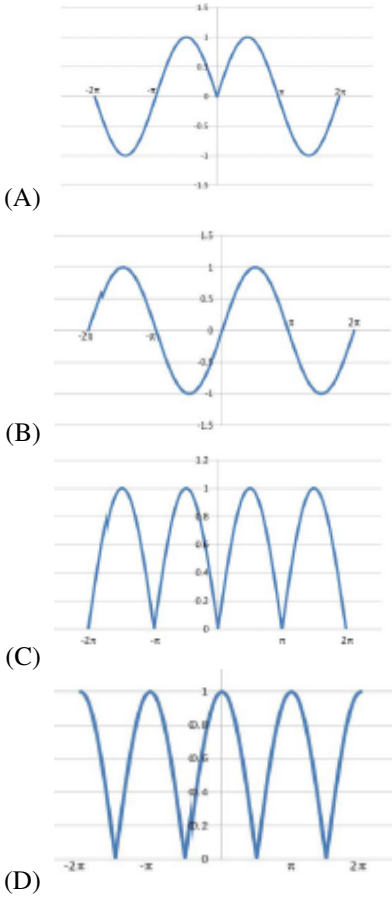


Fig. 10: Different curve plots (A) to (D).

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END OF THE QUESTION PAPER

Q.1 – Q.25 carry one mark each.

1) The differential of the equation, $x^2 + y^2 = 1$, with respect to x is

- a) $-x/y$ b) x/y c) $-y/x$ d) y/x

(GATE MN 2016)

2) If $[A][B] = [I]$ then

- a) $[B] = [A]^T$ b) $[A] = [B]^T$ c) $[B] = [A]^{-1}$ d) $[B] = [A]$

(GATE MN 2016)

3) $X^4 + C$ is the general integral of

- a) $3 \int x^3 dx$ b) $\frac{1}{4} \int x^3 dx$ c) $\int x^3 dx$ d) $4 \int x^3 dx$

(GATE MN 2016)

4) $\sinh(x)$ is

- a) $\frac{e^x - e^{-x}}{4}$ b) $\frac{e^x - e^{-x}}{2}$ c) $\frac{e^x + e^{-x}}{2}$ d) $\frac{e^x + e^{-x}}{4}$

(GATE MN 2016)

5) Identify the correct statement.

NONEL is used for surface connection of the blast holes in order to

- a) achieve better water resistance over detonating fuse
b) have a precise delay timing
c) provide noiseless shock front movement
d) avoid deflagration

(GATE MN 2016)

6) Identify the pattern of surface blasting given in the figure. The values of delay time, in ms, are given against each blasthole.

- a) V-cut c) row to row
b) extended V-cut d) en echelon

(GATE MN 2016)

7) Identify the initiation sequence which is **NOT** possible for surface blasting.

- a) Detonating fuse \Rightarrow Nonel \Rightarrow Electronic detonator
b) Electric detonator \Rightarrow Nonel \Rightarrow Detonating fuse
c) Electric detonator \Rightarrow Detonating fuse \Rightarrow Nonel
d) Electronic detonator \Rightarrow Detonating fuse \Rightarrow Nonel

(GATE MN 2016)

8) Parallel holes at right angles to the face with some holes uncharged are associated with the following shot hole pattern

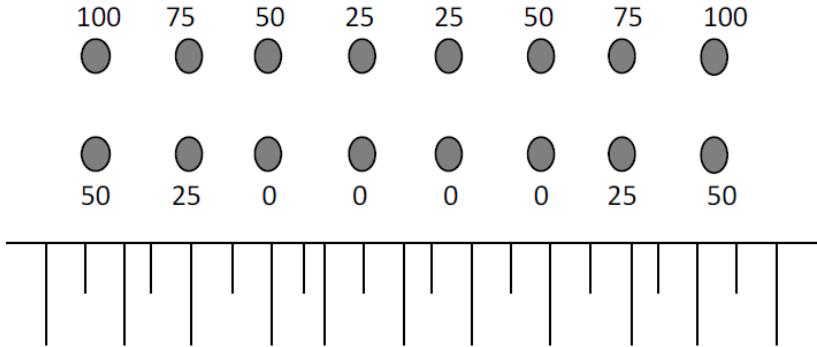


Fig. 6: blast.

- a) drag cut b) wedge cut c) pyramid cut d) burn cut
(GATE MN 2016)

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

- a) tensile strength c) shear strength
b) uniaxial compressive strength d) buckling strength
(GATE MN 2016)

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 _____.

(GATE MN 2016)

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

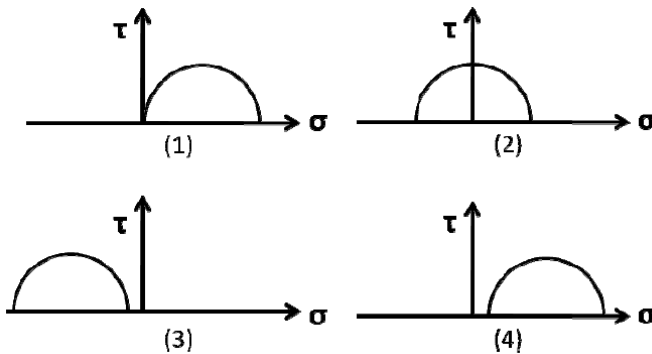


Fig. 11: mohr circles.

a) (1)

b) (2)

c) (3)

d) (4)

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

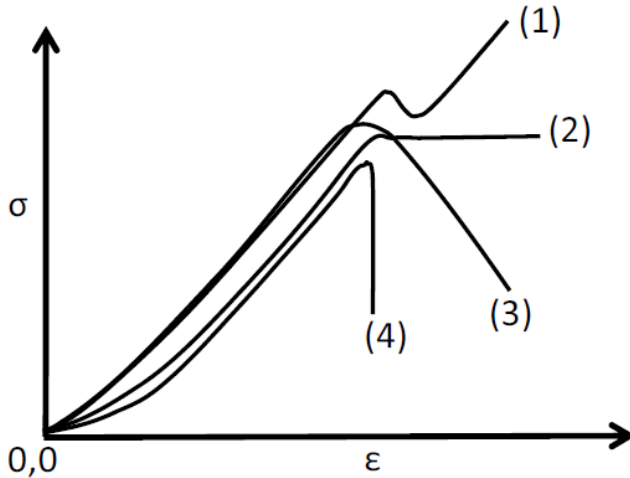


Fig. 12: stress strain.

a) (1)

b) (2)

c) (3)

d) (4)

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- 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 _____.

(GATE MN 2016)

- 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

(GATE MN 2016)

- 15) Which one of the following ropes **CANNOT** be an effective cable bolt?

- a) locked coil wire rope
- b) Langs lay wire rope
- c) ordinary lay wire rope
- d) bird-caged wire rope

(GATE MN 2016)

16) In metalliferous mines, the sublevel interval does **NOT** depend on

- a) capacity of drilling equipment
- b) capacity of loading equipment
- c) strength of rib pillar
- d) strength of wall rock

(GATE MN 2016)

17) Jack hammer does **NOT** contain

- a) pawl and ratchet
- b) gear box
- c) rifle bar
- d) piston

(GATE MN 2016)

18) At the inlet of a mine roadway, the dry and wet bulb temperatures of air are 38°C and 29°C , respectively. At the outlet, the corresponding temperatures are 32°C and 29°C , respectively. The process of heat transfer in the airway is described as

- a) evaporative cooling
- b) sensible cooling
- c) sensible heating
- d) dehumidification

(GATE MN 2016)

19) Underground coal mines are in principle ventilated by exhausting system, so that

- a) spontaneous heating risk is reduced
- b) fumes can be quickly removed in case of an underground fire
- c) build-up of methane concentration is decreased
- d) cool and fresh intake air can enter underground

(GATE MN 2016)

20) Identify the **WRONG** statement.

Pit bottom air lock

- a) prevents the short circuiting of air when the flow is reversed in coal mines
- b) has at least three doors
- c) has at least one door that has provision for latching
- d) all doors are in principle designed to open towards high pressure side of the air

(GATE MN 2016)

21) Identify the **WRONG** statement.

The “temperature inversion” of the atmosphere in surface mines aggravates the problem of

- a) airborne dust
- b) noise
- c) ground vibrations
- d) visibility

(GATE MN 2016)

22) In a CO self rescuer, the purpose of the calcium bromide and lithium chloride mixture

is to

- a) dry the incoming air
- b) convert the CO catalytically to CO_2
- c) absorb and thereby neutralise CO
- d) cool the inhaled air from excess exothermic heat due to chemical reaction

(GATE MN 2016)

23) IRR of a project is the discount rate at which

- a) profit after tax is zero
- b) written down value of the project is zero
- c) revenue from the project is zero
- d) NPV is zero

(GATE MN 2016)

24) For the critical path network shown, the slack for the activity 'b', in months, is

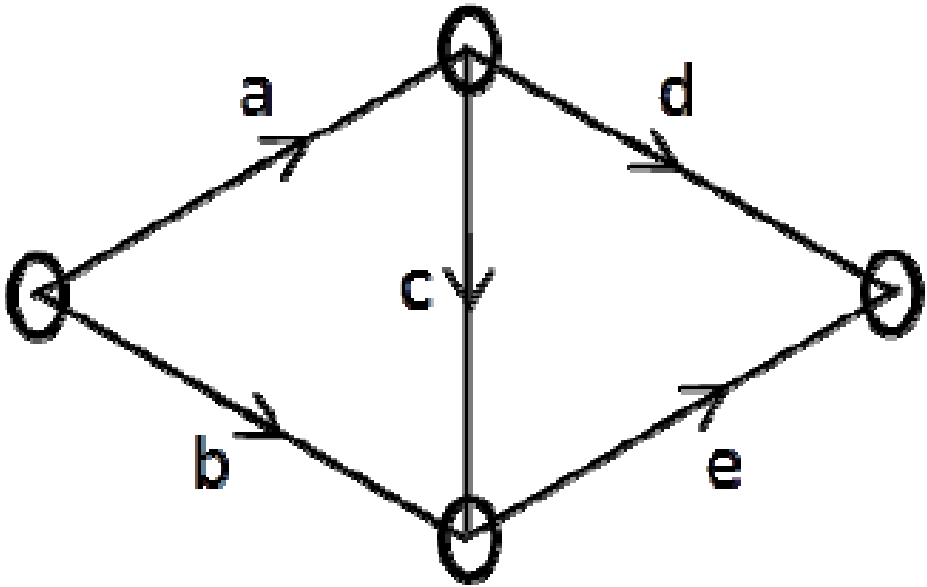


Fig. 24: network.

- a) 4
- b) 6
- c) 9
- d) 13

(GATE MN 2016)

25) The three axes comprising the numerical codification of resources, as per the UNFC, are

- a) Economic Viability, Geological Assessment, Geotechnical Assessment
- b) Geological Assessment, Environmental Assessment, Feasibility Assessment

- c) Feasibility Assessment, Geological Assessment, Mining Assessment
 d) Economic Viability, Geological Assessment, Feasibility Assessment

(GATE MN 2016)

Q.26 – Q.55 carry two marks each.

- 26) Equations of two planes are $z = 4$ and $z = 4 + 3x$. The included angle between the two planes in degrees, is _____. (GATE MN 2016)
- 27) A force $\mathbf{P} = 2\hat{i} - 5\hat{j} + 6\hat{k}$ acts on a particle. The particle is moved from point A to point B, where the position vectors of A and B are $6\hat{i} + \hat{j} - 3\hat{k}$ and $4\hat{i} - 3\hat{j} - 2\hat{k}$ respectively. The work done is _____.

(GATE MN 2016)

- 28) The value of x in the simultaneous equations is _____

$$3x + y + 2z = 3$$

$$2x - 3y - z = -3$$

$$x + 2y + z = 4$$

(GATE MN 2016)

- 29) Two persons P and Q toss an unbiased coin alternately on an understanding that whoever gets the head first wins. If P starts the game, then the probability of P winning the game is _____. (GATE MN 2016)

- 30) Data pertaining to a surface bench blast is given below:

Burden = 3.0 m

Sub-grade drilling = 1.0 m

Spacing = 4.0 m

Collar stemming = 4.0 m

Bench height = 10.0 m

Air decking length = 1.0 m

Density of rock = 2000 kg/m³

Linear charge concentration = 10 kg/m

The powder factor of the blast, in kg/tonne, is _____. (GATE MN 2016)

- 31) Match the following for a typical slurry explosive.

Chemical		Purpose	
P.	Calcium nitrate	1.	Cross linking agent
Q.	Potassium dichromate	2.	Gelling agent
R.	TNT	3.	Oxidiser
S.	Starch	4.	Fuel

- a) P-1, Q-2, R-3, S-4
 b) P-2, Q-4, R-3, S-1
 c) P-3, Q-1, R-4, S-2
 d) P-4, Q-3, R-2, S-1

(GATE MN 2016)

- 32) A 10 m thick coal block is excavated by a contractor at a cost of Rs. 40 per m³. The excavated area, measured in the mine plan, is found to be 50 cm². If the mine plan has been drawn to a scale of 1 : 1000, the payment to be made to the contractor, in lakhs of Rs., is _____. (GATE MN 2016)

- 33) Two vertical shafts of a mine have the following parameters:

Shaft	Shaft-A	Shaft-B
Collar RL (m)	0.0	0.0
Depth (m)	250	200
Northing (m)	200	100
Easting (m)	100	-100

The gradient of the drift connecting the shaft bottoms, in degrees, is _____.
(GATE MN 2016)

34) For a station 'A' on the Earth's surface, as shown in the figure, match the following

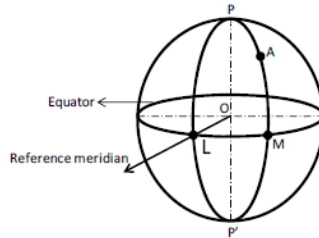


Fig. 34: earth.

Arc	
Q.	MA
R.	LM
S.	PA

Description	
1.	Longitude
2.	Co-latitude
3.	Latitude

- a) Q-2, R-3, S-1 b) Q-3, R-1, S-2 c) Q-2, R-1, S-3 d) Q-3, R-2, S-1

(GATE MN 2016)

35) Match the following for the prismatic compass shown below

Component	
P.	X1
Q.	X2
R.	X3
S.	X4

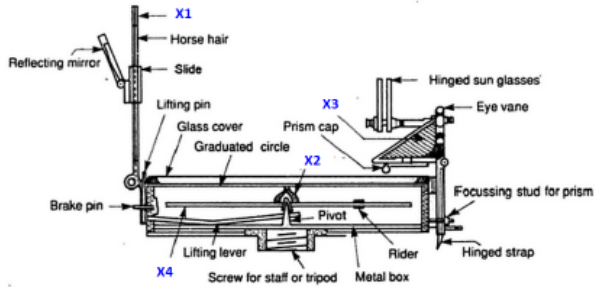
Name	
1.	Agate bearing
2.	Object vane
3.	Magnetic needle
4.	Prism

- a) P-1, Q-2, R-3, S-4
b) P-1, Q-3, R-2, S-4
c) P-2, Q-1, R-4, S-3
d) P-3, Q-1, R-4, S-2

(GATE MN 2016)

36) A ladder placed against a frictionless wall at an inclination of 60° with horizontal, is in a state of limiting equilibrium. The ladder has a length of 13 m and a uniform mass of 4 kg/m. The coefficient of friction between the ladder and the floor is _____.

(GATE MN 2016)



Component

Name

P.	X1	1. Agate bearing
Q.	X2	2. Object vane
R.	X3	3. Magnetic needle
S.	X4	4. Prism

Fig. 35: prismatic compass.

- 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 _____.

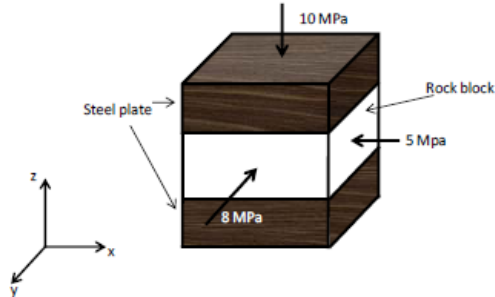


Fig. 37: rock cube.

(GATE MN 2016)

- 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 _____.

(GATE MN 2016)

- 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

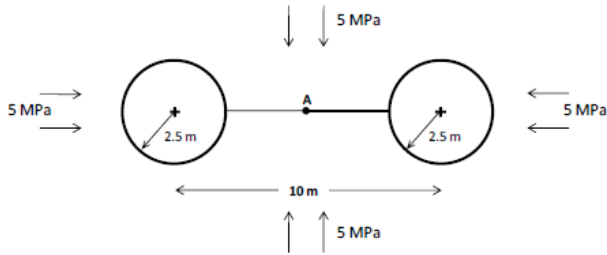


Fig. 38: openings.

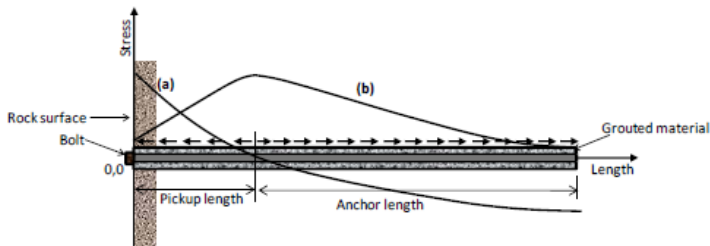


Fig. 39: grouted bolt.

- a) Tensile stress, Compressive stress c) Compressive stress, Tensile stress
b) Axial stress, Shear stress d) Shear stress, Axial stress

(GATE MN 2016)

40) Match the following mechanical properties with the formulae

Mechanical property		Formula	
P.	Modulus of elasticity	1.	$c + \sigma_t \tan \varphi$
Q.	Compressive strength	2.	$\epsilon_{\text{lateral}} / \epsilon_{\text{longitudinal}}$
R.	Shear Strength	3.	σ / ϵ
S.	Poisson's ratio	4.	$F_s / (\pi r^2)$

- a) P-1, Q-2, R-3, S-4
b) P-1, Q-3, R-2, S-4
c) P-3, Q-4, R-1, S-2
d) P-3, Q-2, R-1, S-4

(GATE MN 2016)

- 41) A skip of 10 tonne capacity hoists ore through a 1000 m deep shaft at a speed of 20 m/s. The skip accelerates and decelerates at 2.0 m/s^2 . The loading and unloading times for the skip are 2.5 min and 1.5 min, respectively. The maximum hourly capacity of the hoisting system, in tonnes, is _____. (GATE MN 2016)

42) Match the following:

Haulage unit	
P.	Friction winder
Q.	Drum winder
R.	Direct rope haulage
S.	Endless rope haulage

Safety device	
1.	Run-away switch
2.	Lilly controller
3.	Regenerative braking
4.	Monkey/back catch

- a) P-1, Q-2, R-3, S-4
- b) P-3, Q-2, R-1, S-4
- c) P-1, Q-3, R-4, S-2
- d) P-2, Q-3, R-1, S-4

(GATE MN 2016)

- 43) In the gear assembly shown, the rpm of Gear 1 is 600. The number of teeth in Gear 1, Gear 2, Gear 3, Gear 4, Gear 5 and Gear 6 is 30, 45, 15, 20, 10 and 30, respectively. The rpm of Gear 6 is _____.

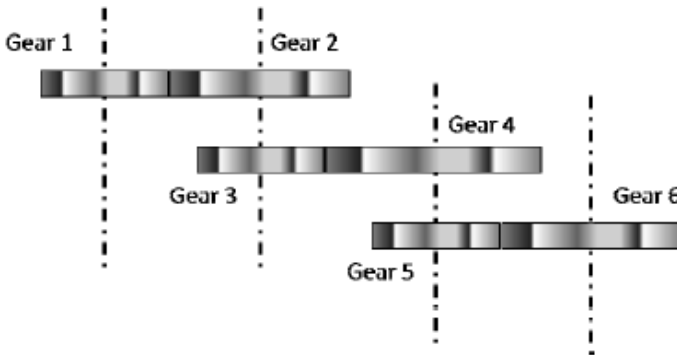


Fig. 43: gears.

(GATE MN 2016)

- 44) An operating surface mine is proposed to be deepened by 30 m as shown in the figure. If the density of the ore is 2.4 tonne/m^3 , the incremental stripping ratio for the deepening, in m^3/tonne , is _____.

(GATE MN 2016)

- 45) From an openpit sump, mine water is lifted using a 250 m long straight pipeline laid along a gradient of 34° . The pumping rate is 500 gpm (1 gallon = 3.8 litres). Additional head loss due to pipe friction can be considered to be 10% of the head lifted. At an overall efficiency of 70%, the electric power consumed by the pump, in kW, is _____.

(GATE MN 2016)

- 46) With reference to Coward diagram, match the following in the context of explosibility of a mixture of 'normal air' and 'methane'.

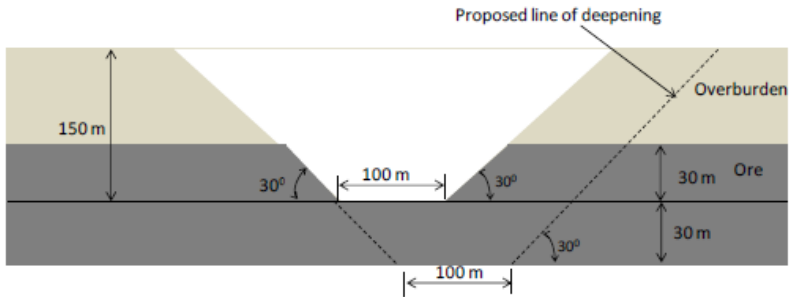


Fig. 44: deepening.

(O ₂ %, CH ₄ %)	
P.	20.5, 2.4
Q.	19.0, 9.5
R.	17.0, 19.0
S.	20.0, 19.5

Mixture status	
1.	Impossible mixture
2.	Non-explosive
3.	Potentially explosive
4.	Explosive

- a) P-2, Q-4, R-3, S-1
- b) P-2, Q-3, R-1, S-4
- c) P-2, Q-4, R-1, S-3
- d) P-3, Q-2, R-1, S-4

(GATE MN 2016)

- 47) A U-tube manometer is subjected to differential pressure as shown. If specific gravity of kerosene is 0.8, the value of $(P_1 - P_2)$, in Pa, is _____.

(GATE MN 2016)

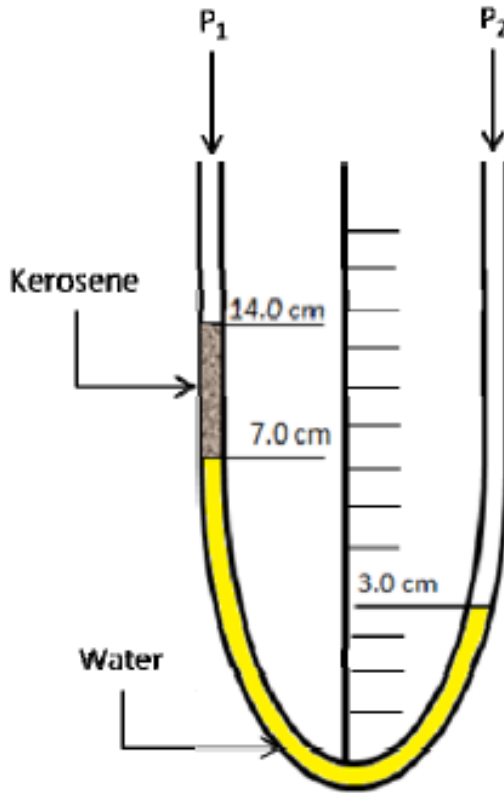


Fig. 47: frame.

- 48) An air stream having an enthalpy of $100 \text{ kJ/kg}_{\text{da}}$ is flowing at $20 \text{ kg}_{\text{da}} \text{ s}^{-1}$. It is cooled by water at temperature 10°C circulating in a cooling coil at a flow rate of 10.0 L s^{-1} . If the return temperature of water is 20°C , the enthalpy of the cooled air, in kJ/kg_{da} , is _____.
(Specific heat of water: $4.18 \text{ kJ/(kg } ^\circ\text{C)}$; kg_{da} : kg of dry air.) (GATE MN 2016)
- 49) The static pressure characteristic of a mine fan is as shown. If the mine resistance is $0.3 \text{ N s}^2/\text{m}^8$, the quantity generated by the fan, in m^3/s , is _____.
(GATE MN 2016)
- 50) In the context of ventilation plan symbols, match the following:

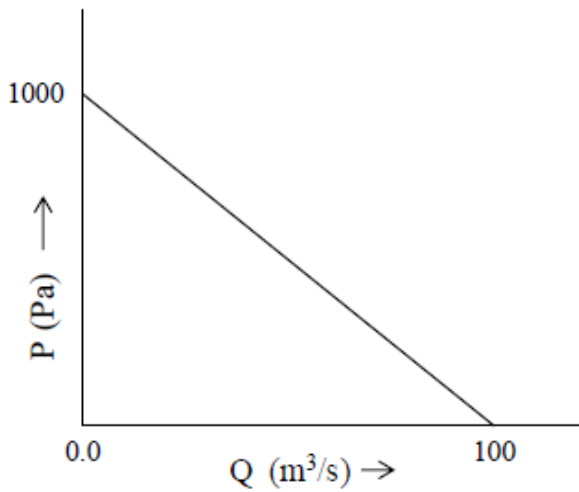


Fig. 49: graph.

Symbol	
P.	
Q.	
R.	
S.	

Description	
1.	Temporary stopping
2.	Regulator
3.	Air-crossing
4.	Ventilation stopping

- a) P-3, Q-4, R-2, S-1
- b) P-2, Q-3, R-1, S-4
- c) P-1, Q-3, R-4, S-2
- d) P-3, Q-2, R-1, S-4

(GATE MN 2016)

- 51) A mill concentrate, having 25% copper, is proposed to be sold at Rs. 1,25,000 per tonne. The grade of the deposit is 0.8% Cu and the overall cost of mining and milling is Rs. 2,520 per tonne of ore. At a recovery of 75%, the estimated profit, in Rs./tonne of concentrate, is _____. (GATE MN 2016)
- 52) Copper grade distribution in an ore body has the probability density function, $f(x)$, as shown in the figure. The average grade of the deposit, in % Cu, is _____.

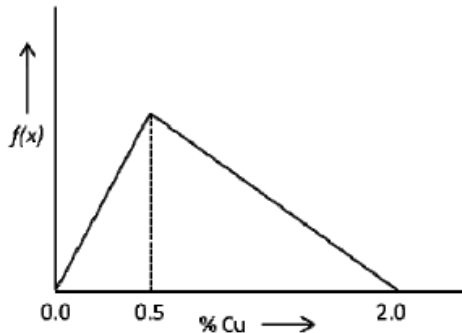


Fig. 52: q52.

(GATE MN 2016)

- 53) The semivariogram shown belongs to a bauxite deposit. The expected difference in the Al_2O_3 (%) values between two boreholes separated by a distance of 200 m is _____.

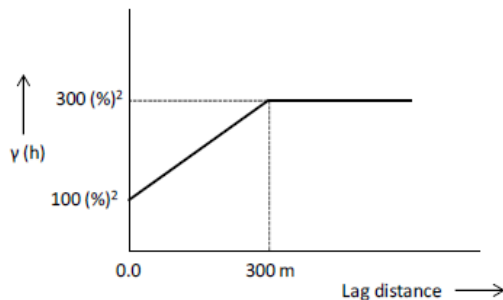


Fig. 53: q53.

(GATE MN 2016)

- 54) A surface mine has 15 identical dumpers and two shovels. For shovel 1, the dumper cycle time is 30 min and the shovel loading time is 5 min. For shovel 2, the dumper cycle time is 32 min and the shovel loading time is 4.0 min. Based on match factor optimisation (equitable match factor), the ideal allocation of dumpers to shovel 1 and shovel 2, respectively, is _____.

a) 6, 9

b) 7, 8

c) 9, 6

d) 8, 7

(GATE MN 2016)

55) The composited grade value, in %, between the RLs 10 m to 20 m for the following borehole configuration is _____.

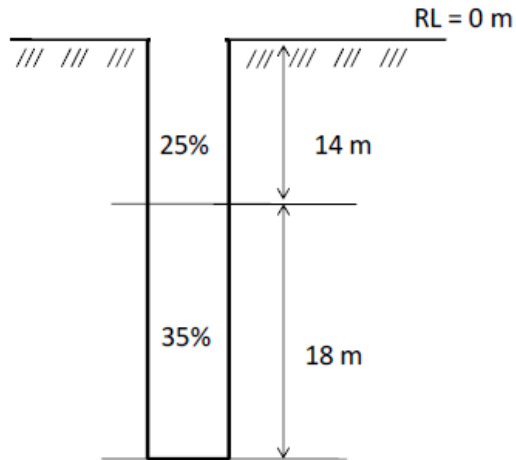


Fig. 55: borehole.

(GATE MN 2016)

END OF THE QUESTION PAPER