

The stations that are free from local attraction are

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- a) P and Q
b) Q and R
c) R and S
d) S and T

5) The plane stress condition is given by

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- a) $\epsilon_{zz} = 0, \gamma_{yz} = 0, \gamma_{zx} = 0$
b) $\sigma_{zz} = 0, \tau_{yz} = 0, \tau_{zx} = 0$
c) $\sigma_{zz} \neq 0, \tau_{yz} \neq 0, \tau_{zx} \neq 0$
d) $\epsilon_{zz} \neq 0, \gamma_{yz} \neq 0, \gamma_{zx} \neq 0$

6) Match the following metals with their corresponding minerals.

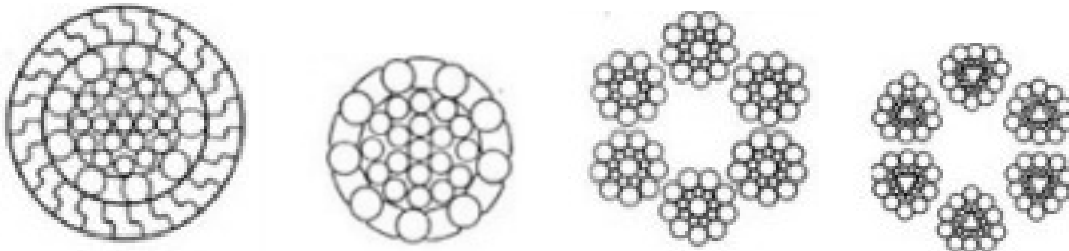
Metal	Mineral
P. Copper	1. Galena
Q. Tungsten	2. Sphalerite
R. Lead	3. Chalcopryrite
S. Zinc	4. Wolframite

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

7) Match the wire rope types with their corresponding cross-sectional diagrams.

Fig. 7. *



Rope type	Diagrams
P. Round strand	1.
Q. Half-locked coil	2.
R. Flattened strand	3.
S. Full locked coil	4.

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

8) The 'ratchet and pawl mechanism' in a jack hammer drill

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- a) forces down the piston
b) provides a twisting force to the drill steel
c) engages rifle bar with rifle nut
d) prevents reverse rotation of rifle bar

9) Post-pillar method of stoping is a variant of

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- a) cut and fill stoping
b) sublevel stoping
c) vertical crater retreat method
d) sublevel caving

10) Cross-measure borehole method is used for

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- a) rock slope monitoring
b) methane drainage
c) connecting two drifts
d) subsidence monitoring

11) The dry and wet bulb temperatures at the inlet of the airstream are 30°C and 25°C respectively. The corresponding values at the outlet of the airstream are 26°C and 25°C respectively. The psychrometric process that occurs in the airstream is described as

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- a) latent cooling
b) sensible cooling
c) condensation
d) evaporative cooling

12) For a mixture of inflammable gases, the lower and upper explosibility limits can be computed using

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- a) Dalton's law
b) Graham's law
c) Le Chatelier relation
d) Boyle's law

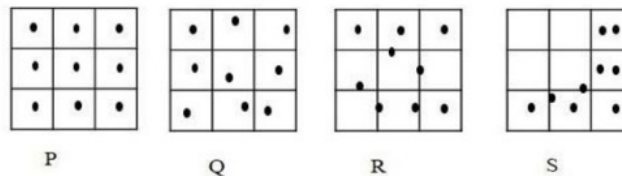
13) The code for the lowest category of mineral resources under United Nations Framework Classification (UNFC) system is

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- a) 444
b) 123
c) 334
d) 111

14) Match the following sampling patterns with the corresponding sampling types.

Fig. 14. *



Sampling Pattern	Sampling Type
P.	1. Regular
Q.	2. Biased
R.	3. Stratified random
S.	4. Random

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

15) In the context of gas testing using flame safety lamp, the correct statement is

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- a) Each accumulation test has to be necessarily followed by percentage test
- b) Accumulation test is always done after percentage test
- c) Either percentage test or accumulation test can be done first
- d) Percentage test is done only in the event of accumulation test giving negative result

16) For x in the range of $[-3, 3]$, the maximum value for the function $f(x) = x^3 - 6x^2 + 9x + 15$ is _____ (round off to 1 decimal place).

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17) A rock sample has coefficient of thermal diffusivity $1.282 \times 10^{-6} m^2/s$, specific heat $900 J/(kg^\circ C)$ and density $2600 kg/m^3$. The coefficient of thermal conductivity of the rock sample in $W/(m^\circ C)$ is _____ (round off to 1 decimal place).

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18) A random variable X has the following probability mass function.

X	3	6	8	12
f(x)	1/2	1/4	1/8	1/8

The expected value of the variable X is _____ (round off to 1 decimal place).

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19) A random sample has five observations as shown below. 11, 12, 14, 15, 13 The coefficient of variation of the sample is _____ (round off to 3 decimal places).

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20) Rock strata has unit weight of $25 kN/m^3$ and Poisson's ratio $1/3$. At a depth of 200 m, the horizontal stress in MPa is _____ (round off to 1 decimal place).

(GATE MN 2020)

21) A shovel of bucket capacity $4.2 m^3$ makes 900 passes per day with a fill factor of 0.8. If the swell factor of the rock is 1.4, then in-situ volume handled by the shovel in a month of 24 working days in m^3 is _____ (round off to 1 decimal place).

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22) A cylindrical sample of granular material has the following measurements: Length: 10 cm Diameter: 5 cm Weight: 350 g Assume the sample is completely dry with specific gravity of solid grains 2.8. The void ratio of the sample is _____ (round off to 3 decimal places).

(GATE MN 2020)

23) The following consecutive readings were taken at uniform intervals with a level and a levelling staff on continuously sloping ground. 0.405, 1.035, 1.654, 0.240, 0.615, 1.125, 0.800, 1.125 The number of change points is _____.

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24) The cost of a slurry pump is Rs. 50,000 and it has an estimated life of 7 years. If the salvage value is Rs. 8,000, the annual depreciation following straight-line depreciation method, in Rupees, is _____ (round off to 1 decimal place).

(GATE MN 2020)

25) In a mine bench, the shovel loading time follows exponential distribution with a mean loading time of 5 min per dumper. The arrival rate of dumpers that are identical in capacity, follows Poisson distribution with a mean arrival rate of 8 per hour. The probability that the shovel remains idle is _____ (round off to 2 decimal places).

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26) For $w = \frac{e^t - t}{e^t + t}$, the value of $\frac{dw}{dt}$ is

(GATE MN 2020)

a) $\frac{2e^t(t^2+1)}{(e^t-t^2)^2}$

c) $\frac{2e^t(t^2-1)}{(e^t+t^2)^2}$

b) $\frac{2e^t(t-1)}{(e^t+t)^2}$

d) $\frac{2e^t(t+1)}{(e^t-t)^2}$

- 27) For the differential equation $y\sqrt{1-x^2}dy + x\sqrt{1-y^2}dx = 0$, assuming the constant of integration to be C , the general solution is

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- a) $\frac{1}{\sqrt{1-x^2}} + \frac{1}{\sqrt{1-y^2}} = C$ c) $\sqrt{1-x} + \sqrt{1-y} = C$
 b) $y\sqrt{1-x^2} + x\sqrt{1-y^2} = C$ d) $\sqrt{1-x^2} + \sqrt{1-y^2} = C$

- 28) A belt-drive used for power transmission between two parallel shafts has a belt of mass 1.2 kg/m , and the maximum allowable belt tension is 2250 N . If the centrifugal tension is one third of the maximum allowable belt tension, the speed at which maximum power is transmitted by the belt, in m/s , is

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- a) 46.48 c) 25.00
 b) 38.73 d) 35.36

- 29) An air receiver of a compressor, having volume 0.5 m^3 , supplies air for charging ANFO in drill holes. During the charging process the absolute pressure of the air receiver falls from 900 kPa to 700 kPa . Assuming the entire process is isothermal, the volume of air supplied by the receiver at 100 kPa ambient pressure, in m^3 is

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- a) 1.00 c) 0.64
 b) 0.39 d) 4.48

- 30) A conveyor belt consumes 60 kW power while running at a speed of 3.0 m/s . The angle of lap is 180° and the coefficient of friction between belt and pulley is 0.2 . The maximum tension (kN) in the belt is

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- a) 21.7 c) 82.9
 b) 61.7 d) 42.9

- 31) A linear programming problem is stated below. Maximize $Z = 3x_1 + 5x_2$ subject to, $2x_1 + x_2 \leq 8$
 $6x_1 + 8x_2 \leq 30$ $x_1, x_2 \geq 0$ The objective function has

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- a) infinite number of solutions c) unique solution
 b) unbounded solution d) infeasible solution

- 32) An explosive mixture has 80 g of ammonium nitrate (NH_4NO_3) and 14 g of fuel oil ($\text{C}_{10}\text{H}_{20}$). The oxygen balance in the mixture is

(GATE MN 2020)

- a) surplus by 32 g c) surplus by 16 g
 b) deficient by 24 g d) deficient by 32 g

- 33) A cylindrical sample of cross-sectional area A , length L , and Young's Modulus E , is subjected to a constant uniaxial load P . Within the elastic limit of loading, the total strain energy stored is

(GATE MN 2020)

a) $\frac{2P^2L}{AE}$
 b) $\frac{P^2L}{2AE}$

c) $\frac{PL}{A^2E}$
 d) $\frac{P^2L}{AE}$

- 34) A surface mine production system along with the reliability of the individual components is shown below. The system reliability is _____ (round off to 3 decimal places).

(GATE MN 2020)

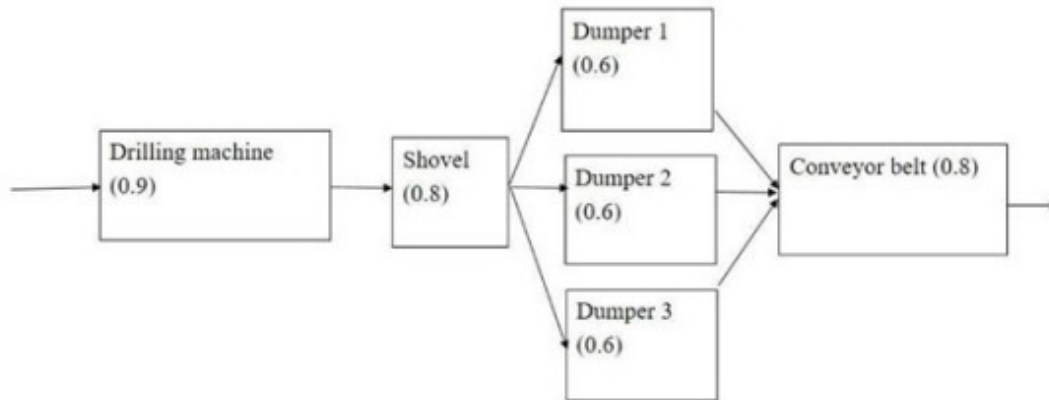


Fig. 34. *

- 35) The selling price of one rock bolt (in Rs.) is given as, $S = (200 - 10n^{-0.5})$ where n is the number of bolts produced. The manufacturing cost of rock bolts has a fixed component of Rs. 15000, and a variable component of Rs. 100 per bolt. The minimum break-even production, in number of rock bolts, is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 36) Two underground mines are separated by a horizontal coal barrier of 60 m thickness. One mine is inundated, whereas the other mine has a blind heading of dimensions 4.0 m wide and 2.5 m height terminating at the barrier. The overall in-situ shear strength of the coal mass is 500 kPa. Assume that the failure mode is in shear. At a factor of safety of 10, the maximum water head that can be withstood by the coal barrier, in m, is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 37) Air enters from ambient atmosphere into a level duct of uniform cross-section area 0.2 m^2 at a flow rate of $2.0 \text{ m}^3/\text{s}$ and density of 1.2 kg/m^3 . The entry shock loss factor is 1.0 and the resistance of the duct per meter length is $1.0 \text{ N s}^2/\text{m}^8$. The static pressure measured at a distance of 20 m from the duct entrance in Pa, is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 38) A sealed-off area air sample consists of 16.0% O_2 , 3.0% CO_2 and the rest is N_2 . Assume that the standard composition of atmospheric air is 21.0% O_2 and 79.0% N_2 . The percentage of blackdamp in the air sample is _____ (round off to 2 decimal places).

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- 39) A diesel loader produces 60 l/s of exhaust fumes containing 5000 ppm of CO. The incoming air has 10 ppm of CO. The minimum amount of air flow in m^3/s that is needed at the loader to dilute CO to a permissible level of 50 ppm is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 40) The equation for peak particle velocity (PPV) from blast induced ground vibration is given by $PPV = k \left(\frac{D}{\sqrt{Q}} \right)^B$, where k and B are site constants. In a field study, the following readings are recorded.

Sensor No.	PPV in mm/s	Sensor distance from blast site (D) in m	Charge per delay (Q) in kg
1	5.5	200	100
2	3.4	300	100

The value of B is _____ (round off to 3 decimal places).

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- 41) An underground copper mine sends 2500 tonnes of ore per day to the concentrator plant having an average grade of 1.2% Cu. The plant produces concentrate of 25.0% Cu with a recovery of 93.0%. The solids portion of tailings generated from the plant per day in tonnes is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 42) A mine gallery is supported by regularly placed roof bolts of 100 kN allowable pull force per bolt, as shown below. Assuming unit weight of the immediate roof is $25kN/m^3$, the factor of safety of the support system is _____ (round off to 2 decimal places).

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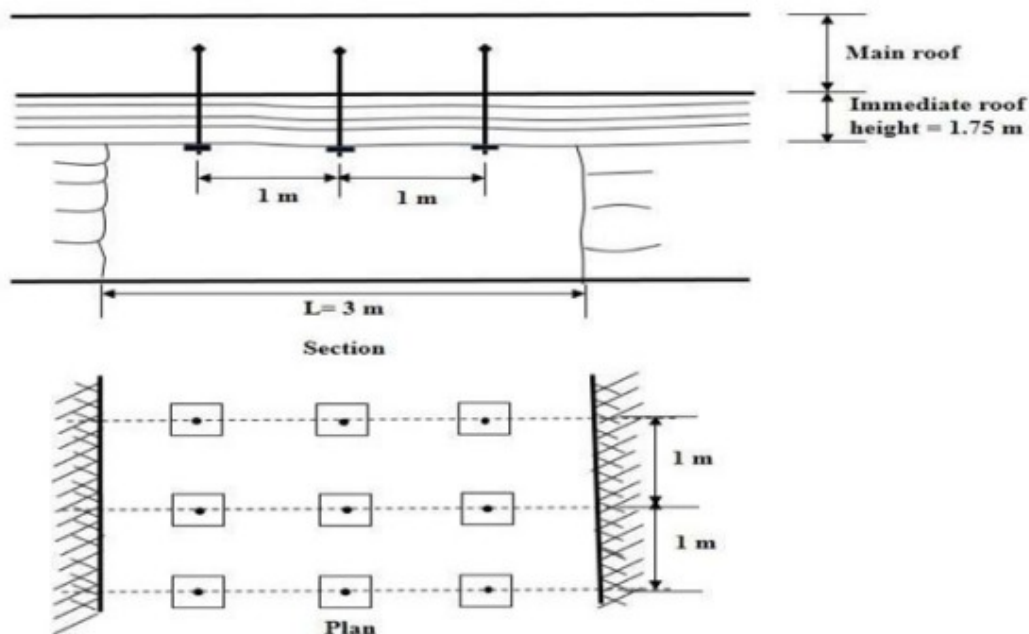


Fig. 42. *

- 43) The slip circle of radius 30.0 m in an overburden slope is shown with the centre of slip circle at point O. The tension crack is completely filled with water. For one meter width of the slope, the moment exerted by the force of water about O in kN-m is _____ (round off to 1 decimal place).

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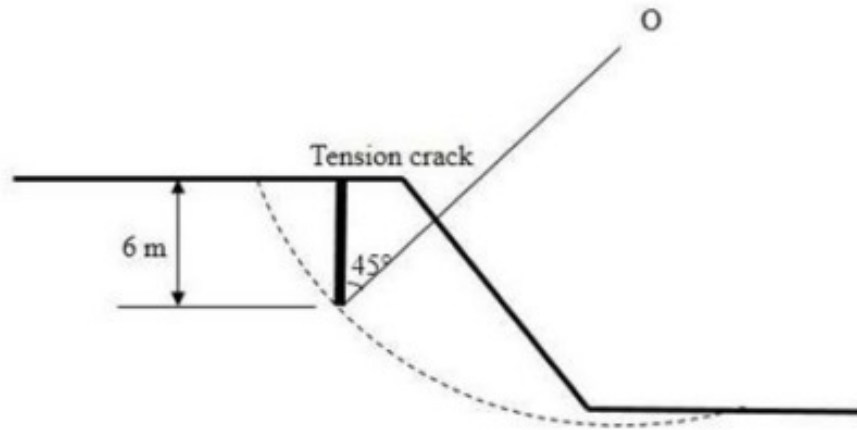


Fig. 43. *

- 44) The function values at four points of x are shown in the table. The area under the function, using trapezoidal method, is _____ (round off to 1 decimal place).

X	2	4	8	9
$f(x)$	8	12	9	10

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- 45) A particle starting from rest moves in a straight line such that after time, t (*seconds*), the acceleration becomes $(6 - t/4) \text{ cm/s}^2$. When the acceleration becomes zero, the velocity of the particle in cm/s is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 46) A parallelepiped has edge vectors as shown below. $\mathbf{A} = -4\hat{i} - 10\hat{j} - \hat{k}$ $\mathbf{B} = 7\hat{i} + 9\hat{j} - 2\hat{k}$ $\mathbf{C} = 3\hat{i} + 9\hat{j} + 4\hat{k}$
The volume of the parallelepiped is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 47) For a development heading, the blasting parameters are Cross-section: $6.0 \text{ m} \times 5.0 \text{ m}$ Total number of holes: 72 Number of trimmer holes: 30 Depth of each hole: 3.5 m Charge per hole (*except trimmers*): 3.5 kg Charge per trimmer hole: 1.8 kg Pull per round: 90% of hole depth The powder factor for the development round in m^3/kg is _____ (round off to 2 decimal places).

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- 48) The following figure represents the observations from the level survey of an underground gallery. If the reduced level of station A is 100.0 m, the reduced level of station D in m is _____ (round off to 1 decimal place).

(GATE MN 2020)

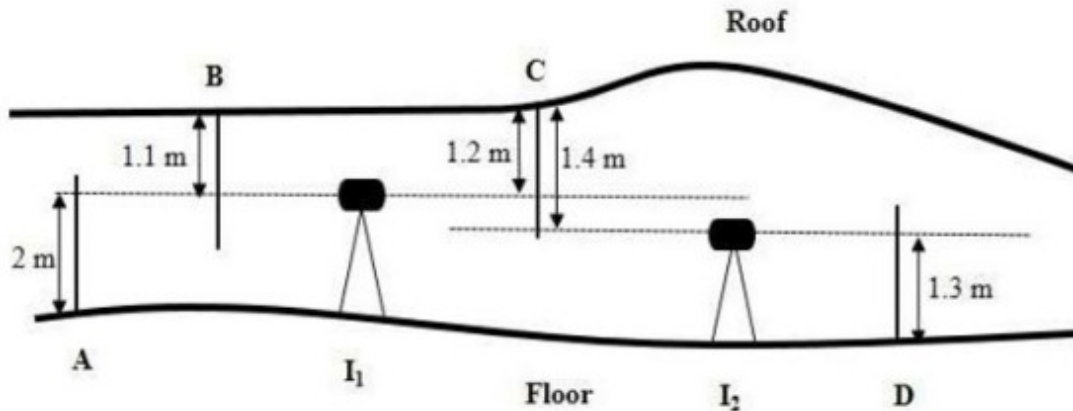


Fig. 48. *

- 49) A tacheometer was setup at station P and the following readings were taken at two stations A and B with the staff held vertical and the line of sight horizontal.

Line	Bearing	Staff intercept
PA	210°	1.2 m
PB	135°	1.4 m

The additive and multiplying constants of the tacheometer are 0 and 100, respectively. The length of AB in m is _____ (round off to 1 decimal place).

(GATE MN 2020)

- 50) The geometry of a simple planar curve (ADB) is shown below. The value of the mid-ordinate of the curve in m is _____ (round off to 1 decimal place).

(GATE MN 2020)

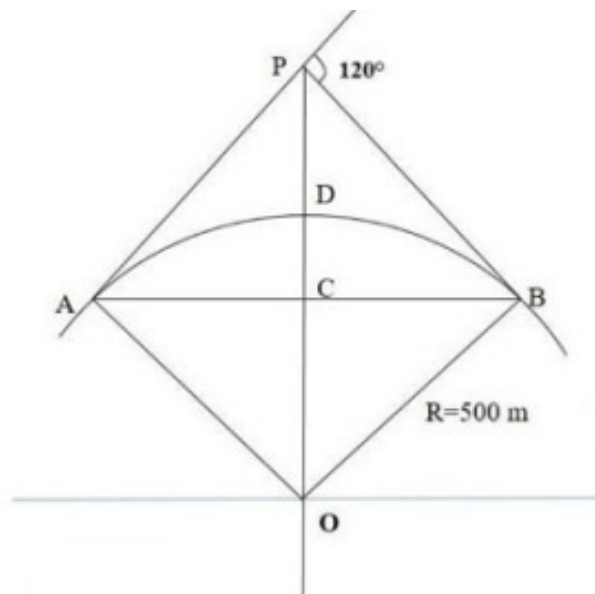


Fig. 50. *

- 51) A steel cube of side 50 mm is subjected to a uniform pressure of 200 MPa acting on each face. The Young's modulus and Poisson's ratio of the material are 200 GPa and 0.25, respectively. The decrease in the side of the cube in mm is _____ (round off to 3 decimal places).

(GATE MN 2020)

- 52) In the figure shown below, the friction coefficient between the block and the inclined plane is 0.2, and all the pulleys are weightless. The weight of the block is 10 N. The minimum force P in Newtons that is needed to slide the block up the inclined plane is _____ (round off to 2 decimal places).
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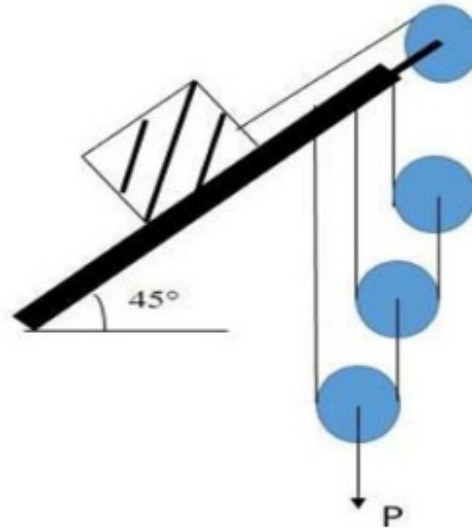


Fig. 52. *

- 53) An assignment problem is given below with the cost of assignment as shown.
If only one task can be assigned to one group, the minimum cost of assignment is _____.

Task	T1	T2	T3	T4
Group				
G1	6	10	5	4
G2	4	100	6	4
G3	6	9	6	2
G4	3	7	6	4

(GATE MN 2020)

- 54) A vertical stoping block of length 60.0 m, height 40.0 m, and average width 1.5 m has sharp boundary walls. However, the mining width of the stoping block is 2.0 m. The tonnage factors are 3.0 tonne/m^3 for ore and 2.5 tonne/m^3 for wall rocks. The average grade of ore is 10.0%. The overall grade of ore mined on account of dilution in percentage is _____ (round off to 2 decimal places).

(GATE MN 2020)

- 55) A bauxite ore body has four boreholes as shown below. For each borehole, the grade of alumina, the thickness of the ore body, and the triangular area of influence are as shown. The average grade of ore body in the region ABCD in percentage is _____ (round off to 1 decimal place).

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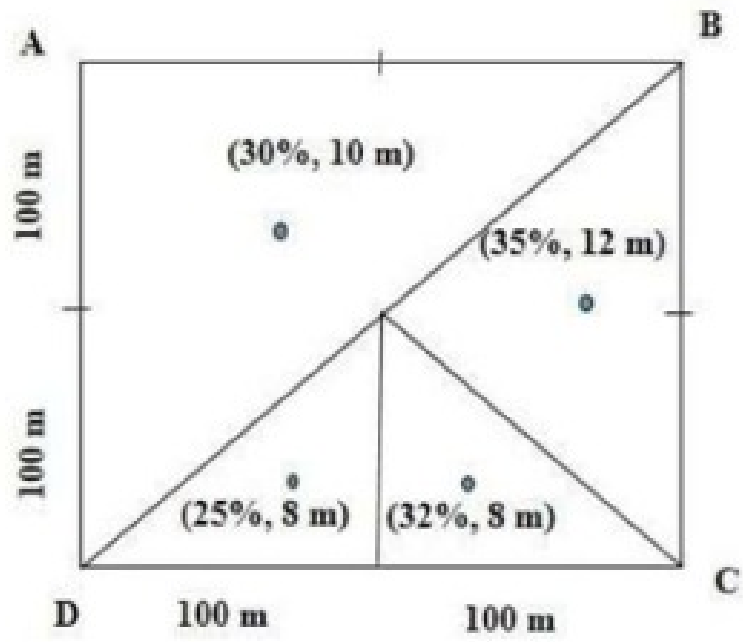


Fig. 55. *