MN : MINING ENGINEERING

Duration : Three Hours *Maximum Ma*

Read the following instructions carefully.

1. This question paper contains **16** printed pages including pages for rough work. Please check all pages and report discrepancy, if any.
2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **O**ptical **R**esponse **S**heet (**ORS**).
3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
4. All questions in this paper are of objective type.
5. Questions must be answered on **O**ptical **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.
6. There are a total of 60 questions carrying 100 marks. Questions 1 through 20 are 1-mark questions, questions 21 through 60 are 2-mark questions.
7. Questions 51 through 56 (3 pairs) are common data questions and question pairs (57, 58) and (59, 60) are linked answer questions. The answer to the second question of the above 2 pairs depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
8. Un-attempted questions will carry zero marks.
9. Wrong answers will carry NEGATIVE marks. For Q.1 to Q.20, ⅓ mark will be deducted for each wrong answer. For Q. 21 to Q. 56, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.57, Q.58), and (Q.59, Q.60) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.57 and Q.59, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.58 and Q.60.
10. Calculator (without data connectivity) is allowed in the examination hall.
11. Charts, graph sheets or tables are NOT allowed in the examination hall.
12. Rough work can be done on the question paper itself. Additionally, blank pages are given at the end of the question paper for rough work.

Q. 1 – Q. 20 carry one mark each.

Q.1 If **A** is an orthogonal matrix, then

(A) $A^T = A^{-1}$ (B) $A^T = -A^{-1}$ (C) $A = A^{-1}$ (D) $A = -A^{-1}$

Q.2 In a normal (Gaussian) distribution curve, the area between one standard deviation from mean on either side in percent is

(A) 50 (B) 68 (C) 86 (D) 95

Q.3 A measure of dispersion of a sample data set is

(A) mean (B) median (C) mode (D) standard deviation

Q.4 The value of $\lim_{x\to 2}\left(\frac{2\sqrt{4-x^2}}{5}\right)$ is

(A) $-\frac{2\sqrt{8}}{5}$ (B) 0 (C) $\frac{2\sqrt{8}}{5}$ (D) non-existent

Q.5 $\hat{\mathbf{i}}, \hat{\mathbf{j}}$ and $\hat{\mathbf{k}}$ represent the unit vectors in the positive x, y and z directions of a Cartesian coordinate system. Using the right-hand rule, $\hat{\mathbf{k}} \times \hat{\mathbf{j}}$ represents

(A) 0 (B) 1 (C) $-\hat{\mathbf{i}}$ (D) $\hat{\mathbf{i}}$

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 σ_1 is axial stress and σ_2 and σ_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.9 Pocket and Wing technique of pillar extraction is relevant to

(A) room and pillar method (B) bord and pillar method

(C) Wongawilli method (D) shortwall method

Q.10 A non-electric detonating relay does NOT contain

(A) delay element (B) fuse head

(C) metal sleeve (D) neoprene connecting tube

Q.11 An iron ore deposit has a mean grade of 63% Fe. During the course of mining, 30% fines by weight are generated at a grade of 72% Fe which are rejected. The effective mean grade of the deposit in Fe percentage is

(A) 59.1 (B) 53.1 (C) 50.4 (D) 41.4

Q.12 Koepe system of winding does NOT include

(A) tapper guide (B) limit switches (C) safety hook (D) brake

Q.13 A gas mask does NOT include

(A) check valve

(B) warning device

(C) face piece assembly

(D) coolant canister

Q.14 Resuing stoping method is adopted when ore body is

(A) flat and thick (B) very steep and thick

(C) flat and thin (D) very steep and thin

Q.15 Moody diagram represents resistance coefficient in terms of

(A) Reynolds number and asperity ratio (B) viscosity and aspect ratio

(C) surface tension and viscosity (D) Reynolds number and surface tension

Q.16 An area of 100 m^2 is measured on a plan having a R. F. of 1/800. If the R.F. were to be 1/2000, the area in m^2 would be

(A) 16 (B) 40 (C) 250 (D) 625

Q.17 As per the DGMS norms, the severity index is a measure of

(A) fatality rate (B) serious injury rate
(C) number of reportable injuries (D) accident proneness of mine

Q.18 A balanced transportation problem is characterized by

(A) total supply exceeds total demand
(B) total demand exceeds total supply
(C) total demand is equal to total supply
(D) total supply is either equal to or more than total demand

Q.19 In the context of project management techniques, the TRUE statement is

(A) CPM is stochastic and PERT is deterministic
(B) CPM is deterministic and PERT is stochastic
(C) Both CPM and PERT are deterministic
(D) Both CPM and PERT are stochastic

Q.20 For mining property appraisals, typical reports prepared are Bankable Feasibility Report (BFR), Conceptual Plan Report (CPR), Feasibility Report (FR) and Detailed Project Report (DPR). The chronological order for the preparation of these reports is

(A) CPR→FR→BFR→DPR (B) BFR→CPR→DPR→FR
(C) FR→BFR→CPR→DPR (D) CPR→BFR→ DPR→FR

Q. 21 to Q. 60 carry two marks each.

Q.21 The mean of the cubes of the first n natural numbers is

(A) $\frac{n(n+1)^2}{4}$ (B) $\frac{n(n+1)(n+2)}{8}$ (C) $\frac{n^4+1}{n}$ (D) $\frac{n^3}{4}$

Q.22 The sum of the eigenvalues of the matrix $\begin{bmatrix} 1 & 2 \\ 1 & 0 \end{bmatrix}$ is

(A) –3 (B) –1 (C) 1 (D) 3

Q.23 The value of $\nabla \cdot \mathbf{F}$ of a vector $\mathbf{F} = 4x^2\hat{\mathbf{i}} + 3xy^2\hat{\mathbf{j}} + xyz^3\hat{\mathbf{k}}$ at the point (1, 1, 2) is

(A) 24 (B) 26 (C) 30 (D) 32

Q.24 The function $f(x) = x^3(1-x)$ is integrated between 0 and 1 (both inclusive) using closed form method and also by Simpson's $\frac{1}{3}$ rule. The difference in the values obtained from these methods is

(A) 0 (B) $\frac{1}{480}$ (C) $\frac{1}{120}$ (D) $\frac{1}{20}$

Q.25 Water starts to flow into a sump initially containing 250 kL of water. The inflow rate of water is 4t L/min where t refers to time elapsed in min. If the pumping rate of water out of the sump is 250 L/min, the total volume of water in the sump after 3 hours in kL is

(A) 250.5 (B) 255.6 (C) 269.8 (D) 280.9

Q.26 There are 50 lemon trees in a reclaimed mine area. Each tree produces 800 lemons per year. For each additional tree planted in this area, considering all trees, the output number of fruits per tree drops by 10 lemons in a year. The number of trees that to be added to the existing reclaimed area in order to maximize the total number of lemons in the year is

(A) 10 (B) 15 (C) 16 (D) 26

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

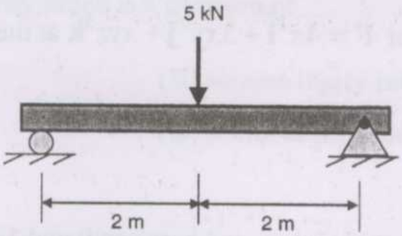
Q.28 The ratio of uniaxial compressive strength to uniaxial tensile strength of a sandstone specimen is 8:1. The theoretical value of angle of internal friction of the specimen in degree is

(A) 51 (B) 41 (C) 32 (D) 7

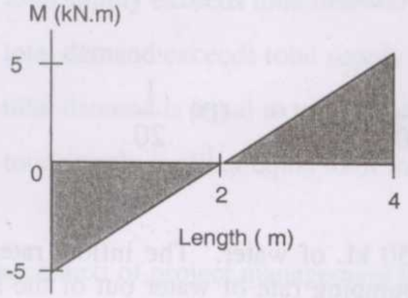
Q.29 A circular tunnel is made underground where far field vertical and horizontal stresses are P_o and KP_o respectively. The tangential stress ($\sigma_{\theta\theta}$) at the boundary of the tunnel for $\theta = 45^\circ$ from the horizontal plane is $3P_o$. The value of K is

(A) 0 (B) 1 (C) 2 (D) 3

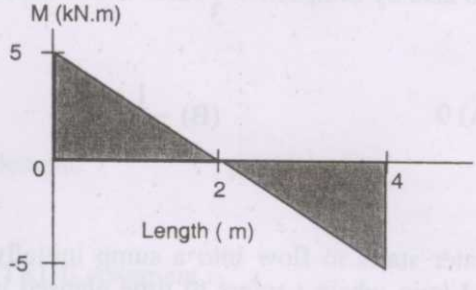
Q.30 The bending moment diagram for the shaft shown below resembles which one of the following graphs ?



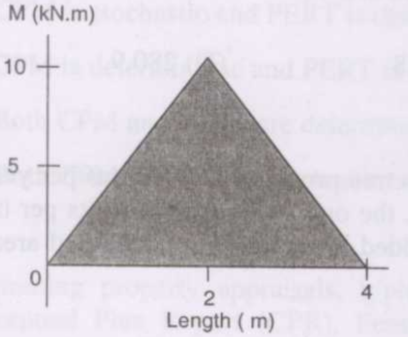
(A)



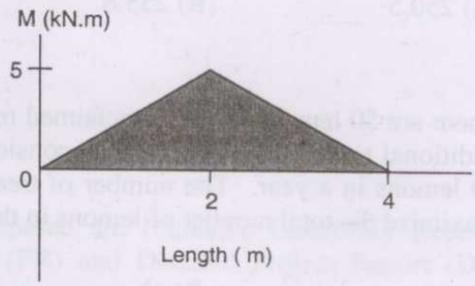
(B)



(C)



(D)



Q.31 A mining equipment has a life of 5 years with no salvage value. Assuming that the depreciation of the equipment is calculated by the straight line method, the average annual value of the equipment in percentage of its original value is

(A) 20 (B) 40 (C) 50 (D) 60

Q.32 Air flows at 2 m^3/s through a forcing fan duct of 0.3 m^2 having uniform cross-section. The duct resistance is 40 Ns^2m^{-8} and air density is 1.2 kg/m^3. The total pressure generated by the fan in Pa is

(A) 186.7 (B) 160.0 (C) 133.3 (D) 26.7

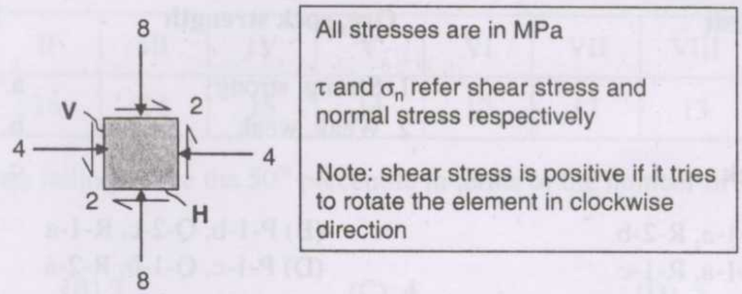
Q.33 Match the following in the context of Indian mining practice :

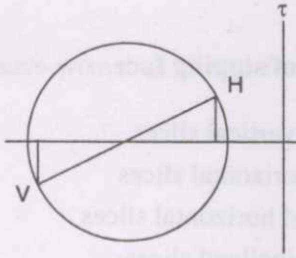
Equipment	**Power source**
P. Rocker shovel	1. Battery
Q. Locomotive	2. Compressed air
R. Shearer	3. Electricity (maximum voltage 6.6 kV AC)
S. Dragline (24 m^3 bucket capacity)	4. Electricity (maximum voltage 1.1 kV AC)

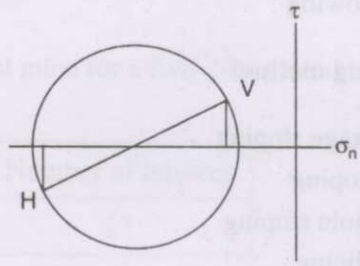
(A) P-1, Q-2, R-3, S-4 (B) P-2, Q-1, R-4, S-3

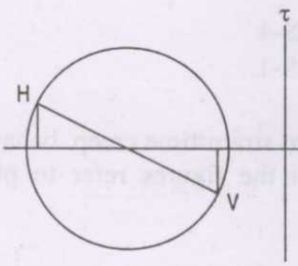
(C) P-2, Q-1, R-3, S-4 (D) P-1, Q-3, R-2, S-4

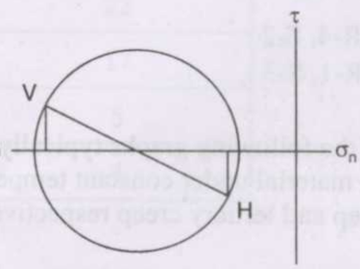
Q.34 The planes H and V represent the horizontal and vertical planes respectively as shown in the figure. Which one of the following Mohr circles represents the stress conditions applied in planes?



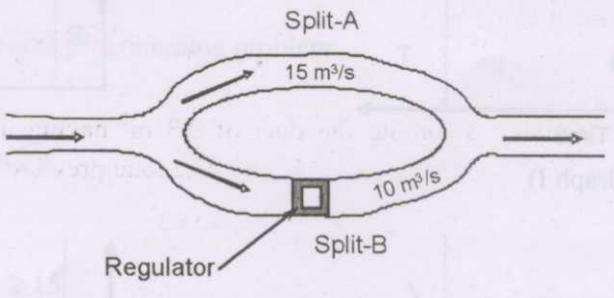
(A)


(B)


(C)


(D)


Q.35 Two splits A and B are ventilated from an intake airway. Resistances of the splits are 0.5 Ns^2m^{-8} and 0.8 Ns^2m^{-8} respectively. A regulator is placed in split B to maintain a flow of 15 m^3/s and 10 m^3/s in splits A and B respectively, as shown in the figure. The size of the regulator in m^2 is



(A) 2.10 (B) 1.30 (C) 1.20 (D) 1.13

Q.36 The concentration of OH^- ion in a mine water sample is 10^{-11} mol/L. The pH of the sample is

(A) 2 (B) 3 (C) 4 (D) 11

Q.37 A mine having a reserve of 320 Mt produces 4 Mt of ore at the end of 1st year. If the mine increases production by 10% every year, the percentage of the reserve that still remains at the end of 21st year is

(A) 50 (B) 35 (C) 25 (D) 20

Q.38 Match the following :

Type of deposit	Ore, rock strength	Mining meth
P. Flat, thin	1. Strong, strong	a. Sublevel stoping
Q. Massive	2. Weak, weak	b. Room and pillar
R. Steep, thick		c. Block caving

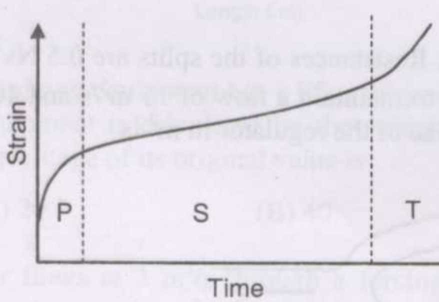
(A) P-1-c, Q-1-a, R-2-b (B) P-1-b, Q-2-c, R-1-a
(C) P-2-b, Q-1-a, R-1-c (D) P-1-c, Q-1-b, R-2-a

Q.39 Match the following :

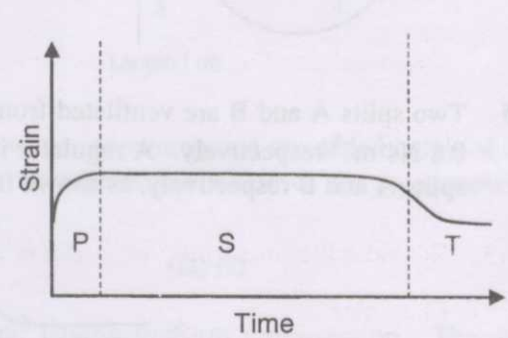
	Stoping method		Advance of stoping face
P.	Shrinkage stoping	1.	Sideward vertical slices
Q.	Rill stoping	2.	Upward horizontal slices
R.	Blasthole stoping	3.	Downward horizontal slices
S.	Top slicing	4.	Sideward inclined slices

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

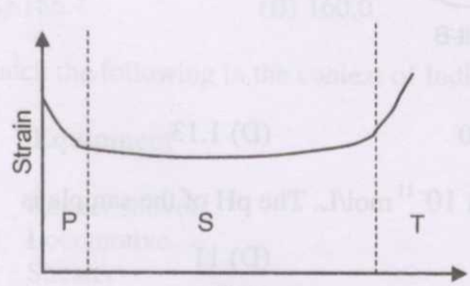
Q.40 Which one of the following graphs typically represents the standard strain-time creep behaviour of an isotropic rock material under constant temperature ? P, S and T in the figures refer to primary creep, secondary creep and tertiary creep respectively.



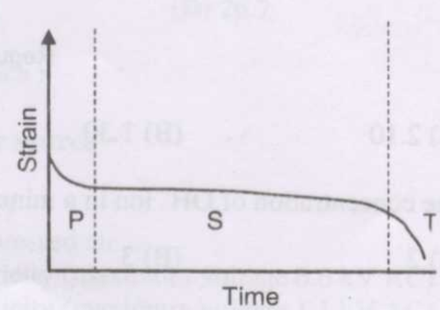
(Graph I)



(Graph II)



(Graph III)



(Graph IV)

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

Q.41 The following data represent the number of workers suffering from pneumokoniosis in 10 mines

Mine	I	II	III	IV	V	VI	VII	VIII	IX	X
Number	10	16	14	15	14	12	17	13	15	12

The number of mines falling above the 50th percentile in terms of the number of workers suffering from pneumokoniosis is

(A) 2 (B) 3 (C) 4 (D) 5

Q.42 Cause-wise data of injuries in an underground coal mine for a five-year period is given below:

Cause of injury	Number of injuries
Fall of roof	27
Fall of person	22
Rope haulage	17
Explosives	5
Other causes	4

The cumulative probability of injury due to fall of roof and fall of person is

(A) 0.65 (B) 0.50 (C) 0.36 (D) 0.29

Q.43 Consider the following linear programming problem:

Maximize

$$z = 3x + 2y$$

Subject to

$$3x + 2y \geq 15$$

$$2x + 3y \leq 6$$

$$x \geq 0, y \geq 0$$

The above linear programming problem has

(A) unique optimal solution (B) multiple optimal solutions

(C) unbounded solution (D) infeasible solution

Q.44 A mine workshop has 4 lathe machines and 4 tasks for completion. Each of the m[illegible]erform each of the 4 tasks. Each task can be assigned to one and only one machine. Estima[illegible]pees to complete each task is given in the matrix below.

		Machine			
		M1	M2	M3	M4
Task	T1	61	92	52	72
	T2	42	49	69	85
	T3	47	59	80	71
	T4	65	70	68	72

The total optimum cost in Rupees for assigning the tasks to the machines is

(A) 210 (B) 215 (C) 220 (D) 286

Q.45 A 1100 V, 3Φ power supply system of a mine draws a load of 185 kW. The ammeter reading shows 115 A. The power factor of the system is

(A) 0.84 (B) 0.73 (C) 0.64 (D) 0.48

Q.46 Two belt conveyors load a ground bunker, each at a rate of 400 tph, which is initially filled with 10000 t of coal. Coal is discharged from the bottom of the ground bunker onto a belt conveyor at a rate of 1200 tph. The time elapsed in hours before the bottom conveyor starts to operate below its rated capacity is

(A) 6.5 (B) 8.5 (C) 12.5 (D) 25.0

Q.47 The cash flow table of a manganese mine for a particular year is shown below:

Item	Amount (Rs. in lakhs)
Revenue	900
Cost (other than depreciation)	300
Depreciation	100
Profit before tax	500

If the corporate tax is 50% of the Profit before tax, the operating cash inflow in lakhs of Rupees is

(A) 400 (B) 350 (C) 250 (D) 200

Q.48 In an area within a surface mine, under static condition the following gases are found: NO_2, CO_2, O_3 and SO_2. Assuming no diffusion, reaction and bonding of the gases, the concentration of the gases from bottom upwards will be in the order of

(A) NO_2, CO_2, O_3 and SO_2
(B) SO_2, NO_2, CO_2 and O_3
(C) SO_2, O_3, NO_2 and CO_2
(D) NO_2, CO_2, SO_2 and O_3

Q.49 In a mine site, the cost of shaft sinking in lakhs of Rupees is given as 2.64D + 34.8, whe[illegible]aft depth in m. In the same site, the corresponding cost of driving an incline is 0.96L, w[illegible] length of the incline in m. Assuming L by D ratio is 3.0, the depth in m beyond which the sh[illegible] becomes more economical is

(A) 43 (B) 48 (C) 145 (D) 155

Q.50 Match the following :

	Seam characteristics		Coal mining method
P.	12 m thick flat seam	1.	Mechanized longwall
Q.	7 m thick seam at 65° inclination	2.	Descending shield
R.	3 m thick flat seam	3.	Mechanized integral caving
S.	7 m thick seam at 25° inclination	4.	Jankowice

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

Common Data Questions

Common Data for Questions 51 and 52:

Workmen arrive at a mine workshop to receive tools for maintenance. The inter-arrival time of workmen at the service counter is exponentially distributed with an average time of 10 min. The service time at the counter is also distributed exponentially with a mean time of 6 min.

Q.51 Probability that there is a queue (more than one workman) at the service counter is

(A) 0.24 (B) 0.36 (C) 0.40 (D) 0.60

Q.52 Average time spent by a workman waiting for his turn to be served in min is

(A) 9 (B) 12 (C) 15 (D) 18

Common Data for Questions 53 and 54:

A tacheometer is set up at a station 'B'. The RL of the station B is 150 m above the MSL. By holding a staff vertically at a station 'A', the following readings are taken:

Vertical angle	Staff readings (m)		
26°36′	Lower	Middle	Upper
	0.80	3.08	5.36

The multiplying factor and additive constant of the instrument are 100 and 1.9 m respectively.

Q.53 The horizontal distance between the stations A and B in m is

(A) 364.6 (B) 366.3 (C) 409.4 (D) 457.6

Q.54 If the height of the instrument is 1.2 m, the RL of the station 'A' above the MSL in m is

(A) 337.6 (B) 334.5 (C) 331.5 (D) 330.3

Common Data for Questions 55 and 56:

A turbine pump of efficiency 70% discharges water at the rate of 2100 L/min at a total head of

Q.55 If the pump is run by a motor of efficiency 90%, the input power required for the motor in kW

(A) 22.49 (B) 34.31 (C) 44.11 (D) 54.50

Q.56 If the velocity of water in suction and delivery pipes of the pump are 1.8 m/s and 2.5 m/s respectively, the diameter of suction and delivery pipes in cm are

(A) 15.73 and 13.35 (B) 7.86 and 6.67 (C) 5.78 and 6.02 (D) 4.97 and 4.22

Linked Answer Questions

Statement for Linked Answer Questions 57 and 58:

A fan running at a speed of 280 rpm circulates 105 m^3/s of air in a mine.

Q.57 If the power input to the motor for driving the fan is recorded to be 75 kW, with the combined efficiency of fan and motor at 70%, the fan pressure in Pa is

(A) 50 (B) 350 (C) 500 (D) 650

Q.58 If the fan pressure is to be increased by 200 Pa by changing the fan speed, the fan speed in rpm will become

(A) 768 (B) 549 (C) 392 (D) 332

Statement for Linked Answer Questions 59 and 60:

A surface mine blast design has 9 holes in a row, each of 8 m length and 200 mm diameter. The spacing and burden are 6 m and 5 m respectively. The length of subgrade drilling is 1 m and the density of in-situ rock is 2.43 t/m^3.

Q.59 Assuming no back break, the output per blast in t is

(A) 4593 (B) 5905 (C) 6124 (D) 6299

Q.60 Considering an explosive density of 0.9 t/m^3 and stemming length of 2 m, the powder factor from the blast in t/kg is

(A) 4.12 (B) 4.00 (C) 3.86 (D) 3.01

END OF THE QUESTION PAPER