

GATE – Mining Engineering

(Topic Wise Questions 2007-2017)

Topic: Underground Mine

Ventilation

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GATE SYLLABUS:

Ventilation, Underground Hazards and Surface Environment:

Underground atmosphere; Heat load sources and thermal environment, air cooling; Mechanics of air flow, distribution, natural and mechanical ventilation; Mine fans and their usage; Auxiliary ventilation; Ventilation planning.

Subsurface hazards from fires, explosions, gases, dust and inundation; Rescue apparatus and practices; Safety in mines, accident analysis, noise, mine lighting, occupational health and risk.

Air, water and soil pollution: causes, dispersion, quality standards, reclamation and control.

2007

Q.50 Identify the INCORRECT statement

- (A) Evasee is meant to minimise exit shock losses
- (B) Evasee efficiency is primarily a function of divergence angle and area ratio
- (C) Evasee produces an inevitable increase in friction losses
- (D) Evasee installation leads to reduction in the fan total pressure

Q.55 At a fan drift pressure of 450 Pa, 50 m³/s of air flows through a mine. When the fan stops, 10 m³/s of air still flows in the same direction. The mine resistance in N s²/m⁸ is

- (A) 0.1731 (B) 0.1800 (C) 0.1875 (D) 0.2372

Common Data Questions

Common Data for Questions 71,72,73: In a straight duct of length 200 m a fan operates 50 m away from the inlet such that the mean air velocity in the duct is 8.0 m/s at a density of 1.1 kg/m³. The friction pressure loss per m length of the duct is 3.0 Pa and the entry shock factor is 1.2. Answer the following in terms of guage pressure values in Pa.

Q.71 The total pressure at the outlet of the duct is

- (A) -35.2 (B) 35.2 (C) 192.2 (D) 635.2

Q.72 The total pressure at the inlet side of the fan is

- (A) -192.2 (B) -150.0 (C) 150.0 (D) 192.2

Q.73 The total pressure generated by the fan is

- (A) 600.0 (B) 635.2 (C) 677.4 (D) 682.2

2008

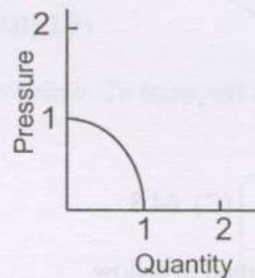
Q.4 A phreatic surface experiences a pressure

- (A) Less than atmospheric pressure
- (B) Equal to atmospheric pressure
- (C) More than barometric pressure
- (D) Less than barometric pressure

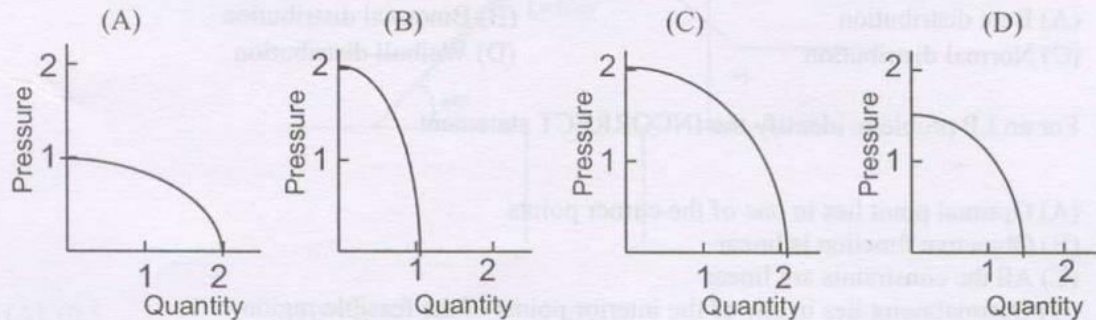
Q.12 Effective temperature is estimated from

- (A) Wet-bulb temperature, relative humidity, and air velocity
- (B) Dry-bulb temperature, relative humidity, and air velocity
- (C) Dry-bulb temperature, wet-bulb temperature, and air velocity
- (D) Dry-bulb temperature, wet-bulb temperature, and relative humidity

Q.13 Pressure-quantity characteristic of a mine fan is given below:



The combined characteristic of two such identical fans installed in parallel is



Q.45 For a person working in an atmosphere containing 21% O_2 , the exhaled air contains 4.5% CO_2 and 16% O_2 . The respiratory quotient of breathing is

- (A) 0.21
- (B) 0.9
- (C) 0.28
- (D) 1.11

Q.43 Match the following:

Component of flame safety lamp

Purpose of component

P Asbestos rings

1 Dissipation of heat of flue gas

Q Wire gauges

2 Formation of air-tight joints

R Outer glass

3 Arrest of explosion inside the lamp

S Combustion chimney

4 Separation of inlet air from flue gas

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

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

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

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

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

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

Statement for Linked Answer Questions 57 and 58:

A fan running at a speed of 280 rpm circulates $105 \text{ m}^3/\text{s}$ 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

2010

Q.1 Ascensionally ventilated coal mine inclines ideally should have higher methane layering number when compared to descensionally ventilated inclines. The reason is

- (A) in ascensionally ventilated incline density of air is higher
(B) ascensionally ventilated incline creates conditions for improved turbulent mixing of methane layer
(C) methane drainage is not practiced in ascensionally ventilated incline
(D) descensionally ventilated incline creates conditions for improved turbulent mixing of methane layer

Q.3 Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion : Both intake and return side stoppings must be closed simultaneously in the event of sealing off a coal mine panel with explosion hazard following a fire.

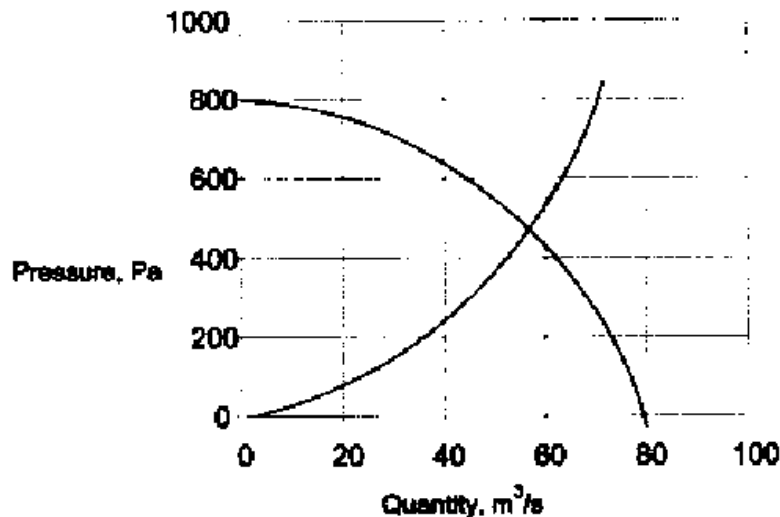
Reason : By continuously ventilating the area till simultaneous closure of the stoppings, the possibility of an explosion hazard due to gas build-up is avoided.

- (A) [a] is true but [r] is false
(B) Both [a] and [r] are true and [r] is the correct reason for [a]
(C) Both [a] and [r] are true and [r] is not the correct reason for [a]
(D) Both [a] and [r] are false

Q.5 An air quality parameter required to be monitored under the Indian National Ambient Air Quality Standards is

- (A) As (B) Pb (C) Hg (D) Silica

Q.47 The main fan operating point of a ventilation system is shown in the figure below. If an NPV of 200 Pa assists the ventilation system, the resultant pressure (Pa) and quantity (m^3/s) generated by the fan respectively are



- (A) 500,68 (B) 600,63 (C) 640,55 (D) 400,63

Statement for Linked Answer Questions 54 and 55:

Air at a density of 1.2 kg/m^3 flows in a straight duct such that the velocity at the centre is 12.5 m/s . The method factor for the velocity profile is known to be 0.80 .

Q.54 The velocity pressure value in the duct in Pa is

- (A) 31 (B) 47 (C) 60 (D) 83

Q.55 The air flow encounters a symmetric expansion such that the cross-sectional area of the duct becomes double. The static pressure value at the inlet and outlet of the expansion are 60 Pa and 90 Pa , respectively. Neglecting friction, the shock pressure loss on account of expansion in Pa is

- (A) 15 (B) 22 (C) 38 (D) 46

2011

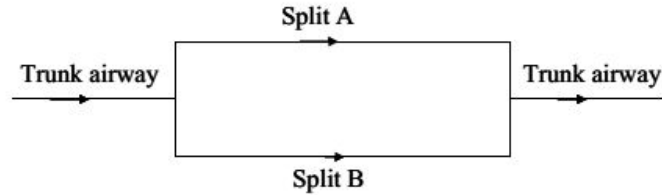
Q.13 A centrifugal fan rotating at 500 rpm delivers $70 \text{ m}^3/\text{s}$ of air. If the speed is reduced to 200 rpm , the quantity of air delivered in m^3/s will be

- (A) 175 (B) 55 (C) 28 (D) 11

- Q.17 Mean air temperature of a 450 m deep downcast shaft is 29°C and that of the upcast shaft is 37°C . The height of the motive column in m is
 (A) 8.2 (B) 9.5 (C) 11.6 (D) 12.8
- Q.18 The total pressure and the static pressure measured at a point in a ventilation duct are 20 mm and 10 mm of water gauge respectively. If density of air is 1.2 kg/m^3 , the velocity of the air in m/s is
 (A) 14.08 (B) 12.78 (C) 8.53 (D) 6.24
- Q.21 Air samples collected from the intake and the return gates of a retreating longwall face show methane concentration values of 0.1 % and 0.8 % respectively. The production from the longwall face is 2000 tonne/day and the air quantity circulating the face is $15\text{ m}^3/\text{s}$. The rate of methane emission in m^3 per tonne of coal produced is
 (A) 11.0 (B) 9.5 (C) 5.5 (D) 4.5
- Q.38 A toxic gas flows into a mine working place at the rate of $2.52\text{ m}^3/\text{min}$. The concentration of the gas in the intake air is 0.25%. The minimum quantity of intake air in m^3/min required to dilute the gas to its threshold limit value of 1.0 % is
 (A) 123 (B) 252 (C) 295 (D) 333
- Q.39 An exhaust fan attached to an evasee of 18 m^2 cross-sectional area at the outlet circulates $150\text{ m}^3/\text{s}$ of air at the pressure of 1000 Pa in a mine ventilation system. The ratio of the inlet to outlet area of the evasee is 1:4 and the density of air is 1.2 kg/m^3 . The quantity of air circulated in the mine in absence of evasee is $120\text{ m}^3/\text{s}$. The evasee efficiency in % is
 (A) 57.6 (B) 43.2 (C) 39.06 (D) 37.7
- Q.40 A fan circulates $24\text{ m}^3/\text{s}$ of air at a pressure of 1200 Pa in a ventilation district. It is intended to reduce the air quantity to $16\text{ m}^3/\text{s}$ by placing a regulator. Assuming the pressure remains unchanged, the size of the regulator in m^2 is
 (A) 1.48 (B) 0.74 (C) 0.37 (D) 0.18

Common Data for Questions 50 and 51:

A mine ventilation system consists of two splits A and B with resistances of $0.8 \text{ N s}^2 \text{ m}^{-8}$ and $3.2 \text{ N s}^2 \text{ m}^{-8}$, respectively as shown in figure. Trunk airways have resistance of $0.2 \text{ N s}^2 \text{ m}^{-8}$. The main mine fan is generating pressure of 500 Pa.



- Q.50 The air quantities in m^3/s circulated in the splits A and B respectively are
(A) 20 and 30 (B) 30 and 20 (C) 20 and 10 (D) 40 and 10
- Q.51 The flows in the two splits are equalized by placing a booster fan in split B. Assume that the fan pressure does not change after installation of the booster fan. The size of the booster fan in Pa is
(A) 749.05 (B) 850.08 (C) 950.02 (D) 1000.50

2012

- Q.42 In a longwall panel, the main gate road is 1000 m long, 4.5 m wide and 2 m high. The gate road is to be used for airflow at the rate of $17 \text{ m}^3/\text{s}$. Considering a coefficient of resistance of airways of 0.01, the pressure in Pa required to maintain the airflow in the gate road is
(A) 51.83 (B) 463.84 (C) 875.98 (D) 7885.32

Statement for Linked Answer Questions 54 and 55:

In a mine between upcast shaft and downcast shaft, two airways are connected in parallel and their resistances are 100 and $120 \text{ N s}^{-2} \text{ m}^{-8}$ respectively. The resistance of upcast shaft, downcast shaft and the fan drifts are 10 , 20 and $5 \text{ N s}^{-2} \text{ m}^{-8}$ respectively. The fan drift air pressure is $15 \text{ MN}/\text{m}^2$.

- Q.54 The rate of airflow through the mine in m^3/s is
(A) 4.16 (B) 18.26 (C) 240.35 (D) 333.33
- Q.55 The rate of airflow through the split airway having resistance of $100 \text{ N s}^{-2} \text{ m}^{-8}$ in m^3/s is
(A) 0.42 (B) 0.79 (C) 2.19 (D) 7.90

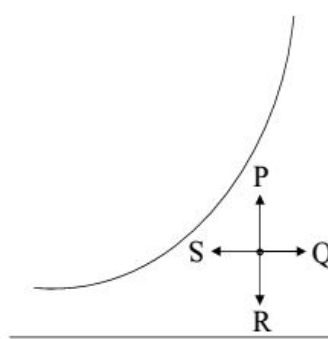
2013

- Q.1 In the Coward flammability diagram, the respective percentages of methane and oxygen at the nose limit are
(A) 14.2, 0.0 (B) 14.1, 18.2 (C) 5.8, 12.1 (D) 5.0, 19.2

Q.9 Incubation period is NOT related to

- (A) crossing point temperature of coal
- (B) panel size
- (C) seam thickness
- (D) explosibility of coal dust

Q.41 Four psychrometric processes P, Q, R and S are shown in the psychrometric chart below.



These processes respectively represent

- (A) dehumidification, humidification, sensible heating, sensible cooling
- (B) sensible heating, humidification, dehumidification, sensible cooling
- (C) dehumidification, sensible heating, sensible cooling, humidification
- (D) humidification, sensible heating, dehumidification, sensible cooling

Common Data for Questions 48 and 49:

Pressure characteristic of a mine fan is given by, $P = -0.06Q^2 + 400$, where P is the pressure in Pa and Q the quantity in m^3/s . The resistance of the mine is $0.19 \text{ N s}^2/m^8$.

Q.48 The mine quantity in m^3/s is

- (A) 160.0
- (B) 53.5
- (C) 45.9
- (D) 40.0

Q.49 An identical fan is installed in the mine to operate in series with the existing fan. The new mine quantity in m^3/s is

- (A) 75.6
- (B) 56.7
- (C) 50.8
- (D) 30.2

2014

Q.17 For Indian coal mines, the 'maximum allowable concentration' of respirable dust containing 7.5% free silica in mg/m^3 is

- (A) 2.0
- (B) 2.2
- (C) 2.5
- (D) 2.7

Q.24 An underground coal mine panel produces 520 tonnes per day deploying 220, 200 and 192 persons in three shifts. As per CMR 1957, the minimum quantity of air in m^3/min to be delivered at the last ventilation connection of the panel is _____

Q.44 Match the following in the context of underground mine environment

Instrument	Measuring parameter
P. Haldane apparatus	I. Humidity
Q. Godbert-Greenwald apparatus	II. Air velocity
R. Hygrometer	III. Mine air composition
S. Anemometer	IV. Ignition point temperature

(A) P-II, Q-I, R-III, S-IV

(B) P-III, Q-IV, R-I, S-II

(C) P-IV, Q-II, R-III, S-I

(D) P-I, Q-III, R-IV, S-II

Q.45 A mine airway having cross-section of $2.2 \text{ m} \times 2.2 \text{ m}$ and length 500 m contains a bend. Given that the airway friction factor is $0.01 \text{ N s}^2 \text{ m}^{-4}$, shock loss factor for the bend is 0.07 and density of air is 1.2 kg/m^3 , the equivalent length of the airway in m is _____

Q.46 In order to estimate the NVP in a mine, measurements are made at the main fan as shown below.

Fan speed (RPM)	Fan drift pressure (Pa)	Fan quantity (m^3/s)
800	655	82.2
950	730	85.5

The NVP in Pa is _____

Q.47 The resistances of two splits A and B are $0.35 \text{ N s}^2 \text{ m}^{-8}$ and $0.05 \text{ N s}^2 \text{ m}^{-8}$ respectively. The combined resistance of the shafts and trunk airways is $0.4 \text{ N s}^2 \text{ m}^{-8}$. A booster fan is planned to be installed in split A to increase the quantity flowing through it. Assuming that the surface fan continues to operate at a constant pressure of 1000 Pa, the critical pressure of the booster fan in Pa is _____

Q.48 A pitot tube is inserted in a ventilation duct with the nose facing the air flow. A vertical U-tube manometer filled with alcohol (specific gravity 0.8) has been used for pressure measurements such that 10.2 mm is read as the total pressure and 8.8 mm as the static pressure. Given the density of air to be 1.2 kg/m^3 , the air velocity at the nose of the pitot tube in m/s is _____

2015

Question Number : 30 Question Type : NAT

A gas mixture contains CH_4 , C_2H_6 and H_2 with respective concentrations of 75%, 15% and 10% by volume. The lower explosibility limit of CH_4 , C_2H_6 and H_2 are 5.0%, 3.3% and 4.2% respectively. The lower explosibility limit of the gas mixture, in percentage, is _____

Correct Answer:

4.2 to 5.0

Question Number : 31 Question Type : NAT

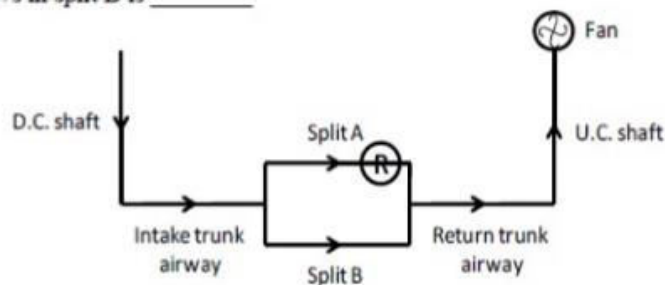
Intake air containing 0.2% methane enters a section of an underground mine where emission rate of methane is $0.05 \text{ m}^3/\text{s}$. Assuming that the threshold limit value of methane is 1.25%, the minimum quantity of fresh air required in m^3/s is _____

Correct Answer :

4.6 to 4.9

Question Number : 44 Question Type : NAT

For the ventilation system shown, the combined resistance of the trunk airways and the shafts is $2.2 \text{ N s}^2/\text{m}^8$. The resistances of splits A and B are $0.5 \text{ N s}^2/\text{m}^8$ and $0.8 \text{ N s}^2/\text{m}^8$ respectively. A regulator of size 2.0 m^2 is placed in split A. Considering the fan generates a pressure of 1000 Pa, the air flow in m^3/s in split B is _____



Correct Answer :

10.2 to 10.8

Question Number : 45 Question Type : NAT

A mine fan running at 300 rpm delivers $150 \text{ m}^3/\text{s}$ of air at a pressure of 900 Pa. Fan and motor efficiencies are 75% and 90% respectively. If the fan speed is reduced to 250 rpm, the saving in electric power input to the motor in kW is _____

Correct Answer :

82 to 86

Question Number : 50 Question Type : NAT

A mine air sample contains CH_4 , CO , H_2 , N_2 and O_2 . The mine air analysis using Haldane apparatus gives the following results expressed in percentage of total sample volume.

Total contraction after combustion	: 10.0
CO_2 formed after combustion	: 6.0
O_2 consumed in combustion	: 9.5

The percentage of CH_4 in the sample analysed is _____

Correct Answer:

3.8 to 4.2

Question Number : 54 Question Type : NAT

Airborne PM_{10} concentration in a residential area is monitored for 24 hours by a respirable dust sampler. Initial and final weights of the filter paper are 2.3125 g and 2.6996 g respectively. The average airflow rate during sampling is $1.2 \text{ m}^3/\text{min}$. The PM_{10} concentration of the area in $\mu\text{g m}^{-3}$ is _____

Correct Answer :

220 to 228

2016

Q.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

Q.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

Q.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

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

(O_2 %, CH_4 %)

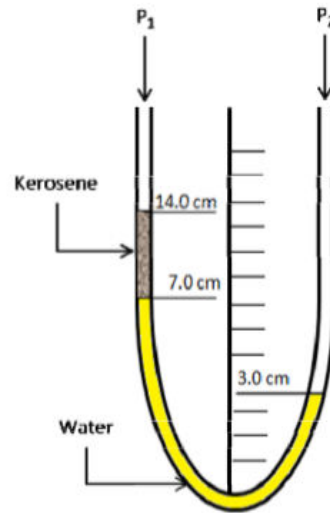
- P. 20.5, 2.4
- Q. 19.0, 9.5
- R. 17.0, 19.0
- S. 20.0, 19.5

Mixture status

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

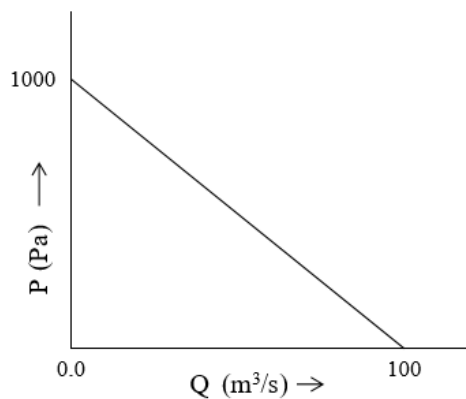
- (A) P-2, Q-4, R-3, S-1
- (B) P-2, Q-3, R-1, S-4
- (C) P-2, Q-4, R-1, S-3
- (D) P-3, Q-2, R-1, S-4

- Q.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 _____.







- Q.48 An air stream having an enthalpy of 100 kJ/kgda, is flowing at 20 kgda/s. It is cooled by water at temperature $10^{\circ}C$ circulating in a cooling coil at a flow rate of 10.0 l/s. If the return temperature of water is $20^{\circ}C$, the enthalpy of the cooled air, in kJ/kgda, is _____.
(Specific heat of water: $4.18 \text{ kJ/kg}^{\circ}C$; kgda: kg of dry air).

- Q.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 _____.



Q.50 In the context of ventilation plan symbols, match the following:

Symbol	Description
P. 	1. Temporary stopping
Q. 	2. Regulator
R. 	3. Air-crossing
S. 	4. Ventilation stopping

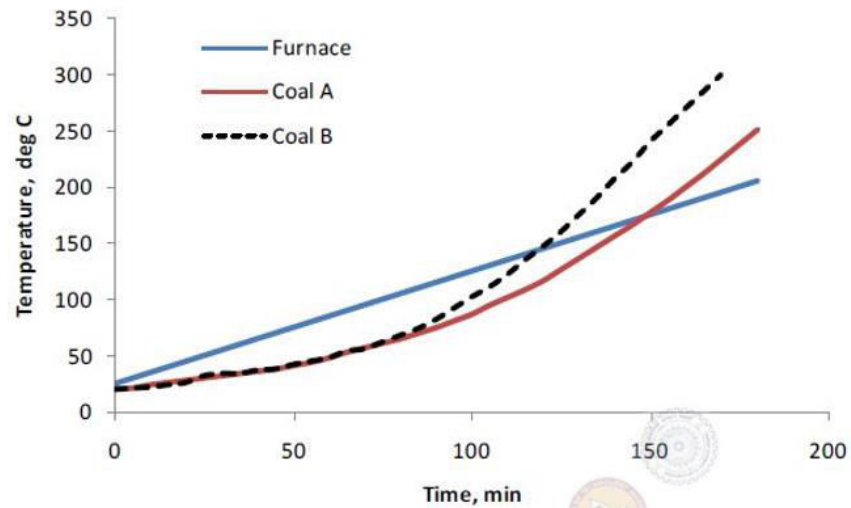
- (A) P-3, Q-4, R-2, S-1
- (B) P-2, Q-3, R-1, S-4
- (C) P-1, Q-3, R-4, S-2
- (D) P-3, Q-2, R-1, S-4

2017

Question Number : 21

Correct : 1 Wrong : -0.33

The results of the crossing point temperature experiments for coal A and B are shown in the figure.

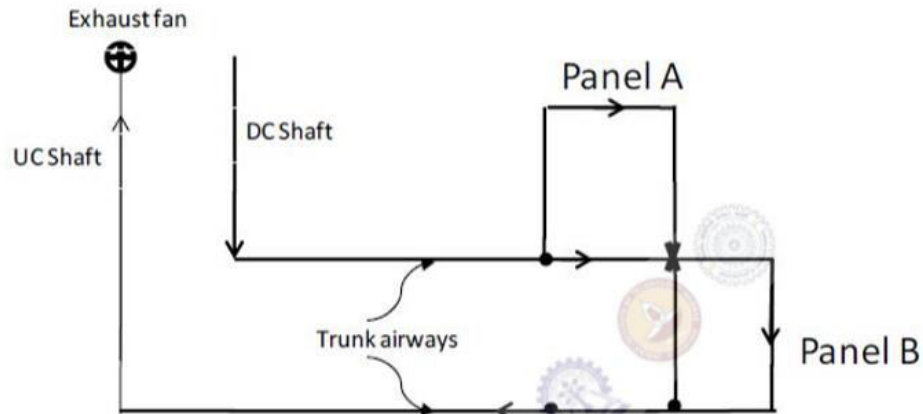


The correct interpretation of the plot is that

- (A) coal A is more prone to spontaneous heating than coal B
- (B) coal B is more prone to spontaneous heating than coal A
- (C) coal A is more prone to coal dust explosion than coal B
- (D) coal B is more prone to coal dust explosion than coal A

Question Number : 48**Correct : 2 Wrong : 0**

In a mine, 200 and 250 persons are deployed in the Panels A and B (shown in figure) respectively in the largest shift. The panels produce 400 and 500 tonne/day respectively. The resistances of panels A and B are $0.3 \text{ N s}^2 \text{ m}^{-8}$ and $0.4 \text{ N s}^2 \text{ m}^{-8}$ respectively and the combined resistance of shaft and trunk airways is $0.5 \text{ N s}^2 \text{ m}^{-8}$. The operating static pressure of the fan in Pa to provide the minimum air quantities in the panels as per CMR 1957 is _____

**Question Number : 49****Correct : 2 Wrong : 0**

In an auxiliary ventilation system, a fan is installed inside a 100 m long and 600 mm diameter duct to ventilate a blind heading face. The frictional coefficient of the duct is $0.0066 \text{ N s}^2 \text{ m}^{-4}$ and the static pressure characteristic of the fan is represented by:

$$P_s = 5Q^2 - 250Q + 1000$$

where, P_s is in Pa and Q is in m^3/s . The quantity of air delivered by the fan in m^3/s is _____