GATE – Mining Engineering

(Topic Wise Questions 2007-2017)

Topic: Underground Hazards and Rescue

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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.10 The amount of total stone dust required in kg for a secondary/heavy type stone dust barrier in a roadway of size $4.0 \text{ m} \times 3.0 \text{ m}$ is

(A) 1320   (B) 4680   (C) 5200   (D) 6600

Q.51 A single lamp placed centrally at the roof provides 40 lux illumination vertically below, at the floor of an underground workshop. The workshop is of dimensions $20.0 \text{ m} \times 20.0 \text{ m}$ with height 4.0 m. Assuming uniform spherical dispersion of luminous intensity, the floor level illumination in lux at any corner of the workshop is

(A) 23.2   (B) 10.9   (C) 3.0   (D) 0.8

Q.54 A jackhammer operates at a corner of a square field of side 50 m. At the diagonally opposite corner, the SPL sensed is 82.3 dB. The SPL at any of the other two corners of the field in dB is

(A) 86.3   (B) 85.3   (C) 83.6   (D) 81.2

Q.56 In an experiment to determine rock thermal conductivity a disc of rock specimen is placed between two solid brass cylinders and one dimensional heat flow is created as shown. The readings of the thermocouple sensors with respect to zero potential are shown in the figure. Brass thermal conductivity is 90 W/m °C, and the thermocouple constant is 40 μ V/°C. The rock thermal conductivity in W/m °C and the heat flux in W/m^2 respectively are
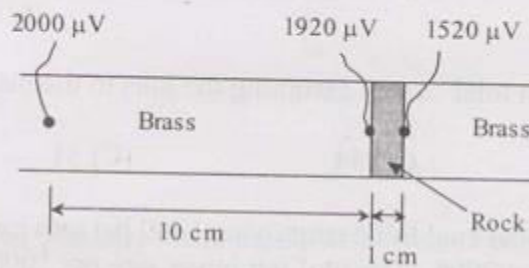
(A) 1.8, 1800   (B) 0.6, 1020   (C) 3.2, 540   (D) 2.1, 670

2008

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.35 Precipitation of metallic ions in mine water drainage is carried out by

(A) $CaSO_4$ and $MgSO_4$
(C) $Ca(OH)_2$ and $NaOH$

(B) $CaCO_3$ and $MgCO_3$
(D) $CaCO_3$ and $MgSO_4$

Q.36 In a mine, a control chart constructed for fixed carbon has upper and lower limits of 49% and 41% respectively. On a day, the five group average values of fixed carbon are 42%, 43%, 40%, 50% and 49.5%. If the process control rule of the mine is to have not more than 2 out of 5 samples to be out of the control chart, the process on that day is

(A) Above upper and below lower control limits
(B) Above upper control limits
(C) Below lower control limits
(D) Within upper and lower control limits

Q.42 Determine the correctness or otherwise of the following **Assertion [a]** and the **Reason [r]**

Assertion: While stonedust barrier may be effective against a coal dust explosion, the same is not true in case of firedamp explosions.

Reason: In general firedamp explosions are much more powerful than coal dust explosions.

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

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

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

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.46 Total number of injuries in an opencast coal mine employing 800 persons is 16 in a year. As per DGMS norms, the injury rate per 1000 persons employed is

(A) 13   (B) 15   (C) 20   (D) 25

2009

Q.13 A gas mask does NOT include

(A) check valve

(B) warning device

(C) face piece assembly

(D) coolant canister

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) ascenssionally 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.2 A coolant is a desirable component in the design of a Self-Contained Breathing Apparatus since

(A) surroundings can be hot and humid during rescue

(B) a rescue worker generates large amount of metabolic heat

(C) exhaled air CO_2 absorption is an exothermic reaction

(D) exhaled air water vapour has to be condensed

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.7   At a surface mine office the independent Sound Pressure Levels (SPL) measured in dB(A) on account of 3 drill machines are 85, 88 and 85. If all the three machines work simultaneously, the combined SPL, in dB(A), is

(A) 91   (B) 90   (C) 92   (D) 94

Q.19   For electric signaling systems in underground coal mines, the statement that is NOT true is

(A) all signaling equipment must be intrinsically safe
(B) the signaling circuit must be connected to ground
(C) the source of current should be an approved dry battery
(D) DC bells or relays when connected in parallel should be supplied from a single source of current

Q.26   A flammable mixture has 70% CH_4 and 30% CO. The lower flammability limits for these gases are 5% and 13% respectively. For the mixture, the lower flammability limit in % is

(A) 6.13   (B) 8.72   (C) 10.25   (D) 12.16

Q.36   A high volume air sampler is operated for 8 hours in a mine with the flow rate of air varying from 1.5 m^3/min to 1.3 m^3/min. The empty weight of the filter paper is 2.30 g and the final weight is 2.65 g. The mean concentration of the Suspended Particulate Matter (SPM) during the study period in $\mu g/m^3$ is

(A) 591   (B) 550   (C) 545   (D) 521

2011

Q.19   The type of fire extinguisher that must NOT be used in case of fire in an electric substation located in an underground metal mine is

(A) multi-purpose dry chemical extinguisher   (B) CO_2 snow extinguisher
(C) dry chemical powder extinguisher   (D) foam extinguisher

Q.20   ISO 9000 Quality Systems DO NOT contain

(A) legal provisions   (B) measurement   (C) document control   (D) standardization

Q.25 Proximate analysis of 50 g of a coal sample shows the following:

Moisture = 0.80 g
Ash = 7.85 g
Volatile matter = 15.90 g

The fixed carbon in percentage on a dry, ash free basis is

(A) 83   (B) 66   (C) 55   (D) 45

Q.41 An air sample taken from the return airway of a district contains the following gases. The Graham's ratio for the district is

Gas	Concentration (%)
CO_2	0.40
H_4	1.17
O_2	19.92
N_2	78.49
CO	0.02

(A) 5.6   (B) 4.8   (C) 3.0   (D) 2.3

Q.42 An incandescent headlight of a mining vehicle is of spot beam type with a beam angle of 30^0. The spherical surface in m^2 subtended by the lighted beam at a distance of 5 m from the headlight is

(A) 7.5   (B) 15   (C) 21   (D) 25

2012

Q.9 In a surface mine, sound pressure level at a location generated by operation of a dozer and a drill respectively are 80 dBA and 60 dBA, when operated independently. The sound pressure generated by the dozer compared to the drill is higher by a factor of

(A) 10   (B) 20   (C) 100   (D) 200

Q.15 Nystagmus is a miner's disease associated with

(A) lever   (B) lung   (C) eye   (D) stomach

Q.19 The match the following

Mine gas		**Principal constituent**	
P	Stink damp	1	CO
Q	White damp	2	H_2S
R	Black damp	3	CH_4
S	Fire damp	4	CO_2

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

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

Q.22 A Dragger Gas Mask DOES NOT filter

(A) water vapour   (B) nitrous fumes
(C) carbon monoxide   (D) carbon dioxide

Q.26 The injury rates of mine workers in an underground coal mine based on age group are given below:

Age group of mine workers	Age-specific injury rate (per 1000 persons)	Age-specific population in the mine
18 − 32	1.8	1000
33 − 46	2.5	500
47 − 60	4.5	300

The injury rate per 1000 persons employed in the mine for the total population is

(A) 0.24   (B) 2.44   (C) 8.80   (D) 24.40

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.11   The pressure on a phreatic surface is

   (A) less than atmospheric pressure
   (B) greater than atmospheric pressure
   (C) equal to atmospheric pressure
   (D) independent of atmospheric pressure

Q.21   In an experiment to study coal dust explosibility, it is found that at least 3.0 g of limestone dust should be added to a sample of 2.0 g of coal dust to ensure that propagation of flame does not take place. The explosibility factor of coal dust is

   (A) 60.00   (B) 20.00   (C) 6.70   (D) 1.50

Q.23   A mine worker inhales normal air; whereas, the exhaled air contains 16.65% O_2 and 3.83% CO_2. The respiratory quotient of breathing for the worker is

   (A) 0.23   (B) 0.89   (C) 0.99   (D) 1.13

Q.27   In an experiment to determine specific gravity of a soil sample, the following data is obtained:

Mass of empty pycnometer	20.4 g
Mass of pycnometer with soil sample	51.6 g
Mass of pycnometer with soil sample filled with water	88.6 g
Mass of pycnometer filled with water	70.4 g

The specific gravity of the sample is _____

Q.39 Given the following,

Rescue apparatus	Characteristic
P. Draeger BG-4	1. Open circuit chemical oxygen self-rescuer
Q. MSA IW-65	2. Filter type self-rescuer
R. Draeger Pulmotor	3. Self-contained breathing apparatus
S. Oxyboks	4. Resuscitation apparatus

the correct match is

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

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

Q.40 Given the following,

Equation/formula/law	Application
P. Bernoulli equation	1. Pressure loss in laminar flow of fluid
Q. Poiseuille equation	2. Drag loss due to regular obstructions in fluid flow
R. Bromilow's formula	3. Energy conservation in ideal fluid flow
S. Stokes law	4. Terminal settling velocity of fine particles in fluid

the correct match is

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

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

2014

Q.9 Bypass valve in a compressed oxygen type self-contained breathing apparatus is meant to

(A) release accumulated nitrogen in the breathing bag

(B) release excess pressure in the breathing bag

(C) supply oxygen directly to wearer in case pressure reducing valve does not function

(D) flush out the apparatus with oxygen on opening the cylinder valve

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.19 Cyclone, bag filter and scrubber can be used for control of

(A) water pollution   (B) air pollution

(C) soil pollution   (D) noise pollution

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.49

An illumination source S shown in the figure emits light equally in all directions. At a point A on the floor, the illuminance is 5.0 lux. The illuminance at point B on the floor in lux is _____

Q.50 Two machines A and B while operating simultaneously produce a sound pressure level of 85 dBA at a point. When the machine A stops, the sound pressure level at that point reduces to 80 dBA. The sound pressure level at the same point due to machine A operating alone in dBA is

(A) 70.0   (B) 75.0   (C) 80.0   (D) 83.3

Q.51 A waste water effluent has BOD_5 of 80 mg/L and the reaction rate constant is 0.16 per day. The ultimate BOD in mg/L is

(A) 85   (B) 100   (C) 120   (D) 145

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 : 33 Question Type : NAT

An underground coal mine employing 1200 persons experiences 2 fatal injuries, 6 serious injuries and 8 reportable injuries during the year 2013. The total injury rate per 1000 persons employed for the year is _____

Correct Answer :
13.0 to 13.6

Question Number : 34 Question Type : MCQ

In self-contained chemical-oxygen self-rescuer, oxygen is produced by

(A) Hopcalite   (B) potassium peroxide
(C) sodium hydroxide   (D) Protosorb

Options :
1. ✖ A
2. ✔ B
3. ✖ C
4. ✖ D

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 m^3/min. The PM_{10} concentration of the area in $\mu g\ m^{-3}$ is _____

Correct Answer :
220 to 228

2016

Q.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

2017

In an underground coal mine a driller, wearing personal protective equipment, was going to workplace along the travelling roadway. A piece of rock fell down from the roof and hit the person on head causing serious injury. The cause of accident is

(A) unsafe act of the driller   (B) job stress
(C) unsafe act and unsafe condition   (D) unsafe condition

The results of the crossing point temperature experiments for coal A and B are shown in the figure.
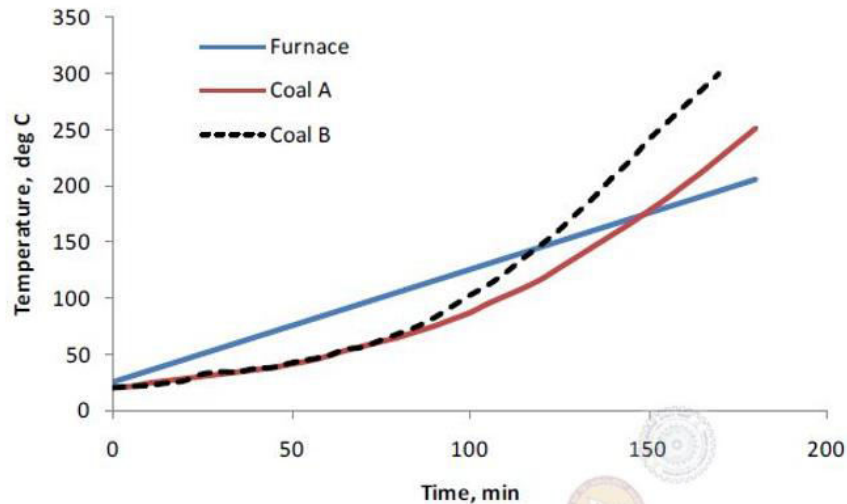
The correct interpretation of the plot is that

(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

500 coal miners were randomly selected from an underground coal mine. It was found that 50 workers experienced an injury in the year 2014. The distribution of injury based on younger age group ($age \leq 40$ years) and older age group ($age > 40$ years) generated the following cross classification table.

Age group	Number of workers		Row total
	Injured	Non-injured	
Younger age group	20	130	150
Older age group	30	320	350
Column total	50	450	500

The odds of injury for the younger age group compared to the older age group is _____