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Answers/explanations of GATE 2020

Metallurgical Engineering (MT)

Date of Exam: 1/2/2020

Forenoon Session

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With M. FACT (Metallurgy Fact)

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Q.1 The sum of the first n terms in the sequence 8, 88, 888, 8888, is _____.

- (A) $\frac{81}{80}(10^n - 1) + \frac{9}{8}n$ (B) $\frac{81}{80}(10^n - 1) - \frac{9}{8}n$
(C) $\frac{80}{81}(10^n - 1) + \frac{8}{9}n$ (D) $\frac{80}{81}(10^n - 1) - \frac{8}{9}n$

Ans: (D)

Q.2 P, Q, R and S are to be uniquely coded using α and β . If P is coded as $\alpha\alpha$ and Q as $\alpha\beta$, then R and S respectively, can be coded as _____.

- (A) $\beta\alpha$ and $\beta\beta$ (B) $\alpha\beta$ and $\beta\beta$
(C) $\beta\beta$ and $\alpha\alpha$ (D) $\beta\alpha$ and $\alpha\beta$

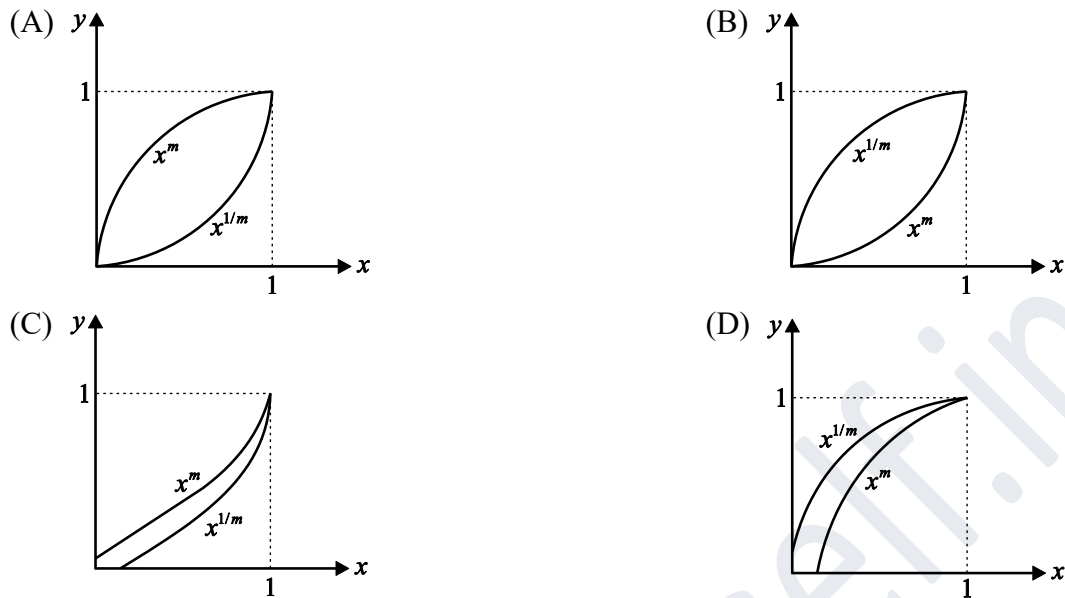
Ans: (A)

Q.3 Jofra Archer, the England fast bowler is _____ than accurate

- (A) More fast (B) More faster
(C) Less fast (D) Faster

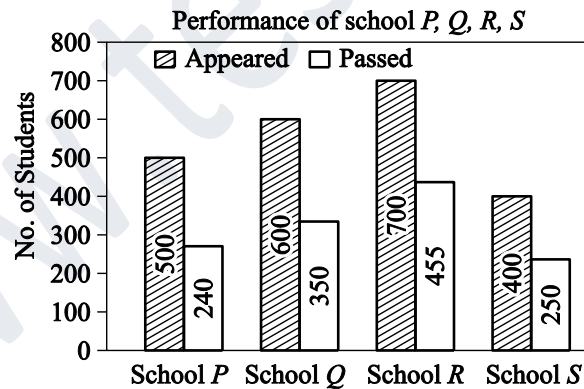
Ans: (A)

Q.4 Select the graph that schematically represents both $y = x^m$ and $y = x^{1/m}$ properly in the interval $0 \leq x \leq 1$, for integer values of m , where $m > 1$.



Ans: (B)

Q.5 The bar graph shows the data of students who appeared and passed in an examination for four schools P , Q , R and S . The average of success rates (in percentage) of these four schools is _____.



- (A) 59.3 % (B) 58.8 %
(C) 59.0 % (D) 58.5 %

Ans: (C)

Q.6 He is known for his unscrupulous ways, he always sheds _____ tears to deceive people.

- (A) Crocodile (B) Fox's
(C) Fox (D) Crocodile's

Ans: (A)

Q.7 Define $[x]$ as the greatest integer less than or equal to x for each $x \in (-\infty, \infty)$, If $y = [x]$, then area under y for $x \in [1, 4]$ is _____.

- (A) 4 (B) 3
(C) 6 (D) 1

Ans: (C)

Q.8 Select the word that fits the analogy :

Build : Building :: Grow : _____.

- (A) Growth (B) Grew
(C) Grewed (D) Grown

Ans: (A)

Q.9 Crowd funding deals with mobilization of funds for a project from a large number of people, who would be willing to invest smaller amounts through web-based platforms in the project.

Based on above paragraph, which of the following is correct about crowd funding?

- (A) Funds raised through voluntary contributions on web-based platforms.
(B) Funds raised through unwilling contributions on web-based platforms.
(C) Funds raised through large contributions on web-based platforms.
(D) Funds raised through coerced contributions on web-based platforms.

Ans: (A)

Q.10 I do not think you know the case well enough to have opinions. Having said that, I agree with your other point.

What does the phrase “having said that” mean in the given text?

- (A) As opposed to what I have said
- (B) Despite what I have said
- (C) Contrary to what I have said
- (D) In addition to what I have said

Ans: (B)

Technical Section: Metallurgical Engineering

Q.1 Two solid spheres X and Y of identical diameter are made of different materials having thermal diffusivities $100 \times 10^{-6} \text{ m}^2 \text{ s}^{-1}$ and $125 \times 10^{-6} \text{ m}^2 \text{ s}^{-1}$ respectively. Both spheres are heated in a furnace maintained at 1000 K. If the centre of the sphere X reaches 800 K in 1 hour, time required for the centre of sphere Y to reach 800 K is

- (A) 4 hours.
- (B) 2 hours
- (C) 1 hour
- (D) 16 hours.

Ans: (A)

As we know that:

$$\alpha \propto \frac{1}{t}$$

Q.2 The indenter used in Rockwell hardness measurements on C scale is

- (A) 1/16-in. steel ball

- (B) Diamond cone.
- (C) 10 mm steel ball.
- (D) Diamond pyramid.

Ans: (B)

Q.3 In green sand casing, which one of the following is NOT a part of the gating system?

- (A) Rouring basin (B) Riser
- (C) Sprue (D) Runner

Ans: (B)

Q.4 In cold-rolling, for the sheet to be drawn into rolls, the angle of contact (or angle of bite) should be less than or equal to __--degree (round off to one decimal place).

Given, the coefficient of friction between sheet and roll is 0.1

Ans: (5.7-5.8)

$$\tan \alpha = \mu = 0.1$$

$$\alpha = 5.71$$

Q.5 Cupola is a furnace used to produce

- (A) Copper alloys
- (B) Cast irons.
- (C) Aluminium alloys.
- (D) Plain carbon steels.

Ans: (B)

- Q.6** A component subjected to tensile stress in a mechanical device is monitored periodically for cracks by NDT. The NDT technique can only detect cracks (both surface and internal) which are larger than 1 mm. Keeping a 10 % margin of safety, the maximum allowed tensile stress on the component will be _____ MPa.

(Round off to the nearest integer).

Given, fracture toughness $K_{IC} = 30 \text{ MPa m}^{1/2}$ and assume crack geometry factor of unity.

Ans: (480-490)

Given $c = 0.001 \text{ m}$

$$K_{IC} = \sigma \sqrt{\pi c}$$

$$\sigma = \frac{30}{\sqrt{\pi \times 0.001}} = 535.23 \text{ MPa}$$

But the given that 10% margin of safety, thus

$$\sigma = 535.23 - 53.523 \approx 481.71 \text{ MPa}$$

- Q.7** An iron plate with a total exposed surface area of 50 cm^2 undergoes atmospheric corrosion. If 200 g of weight is lost over a period of 10 years, then the corrosion rate is _____ $\text{kg-m}^{-2} \cdot \text{year}^{-1}$ (round off to the nearest integer).

Ans: (11420)

$$r = \frac{i}{A} = \frac{W}{ZtA} = \frac{W}{\left(\frac{M}{nF}\right)tA} = \frac{200 \times 10^{-3}}{\left(\frac{26}{2 \times 96500}\right) \times 10 \times 50 \times 10^{-4}} = 11420$$

Q.8 Given the three vectors $X = -i - j + k$, $Y = -i + 2j + k$ and $Z = i + k$ which one of the following statements is TRUE?

- (A) X makes an angle of 30° with the normal to the plane containing Y and Z.
- (B) X, Y and Z are mutually perpendicular.
- (C) X, Y and Z are coplanar.
- (D) Z makes an angle of 60° with the normal to the plane containing X and Y.

Ans: (B)

Q.9 The number of independent elastic constants of an isotropic material is:

- (A) 4
- (B) 2
- (C) 1
- (D) 3

Ans: (B)

Q.10 A heavily cold-worked metal will

- (A) Yield a coarser recrystallized grain size.
- (B) Have a higher energy barrier for nucleation of recrystallized grains.
- (C) Possess a lower driving force for recrystallization
- (D) Recrystallize at lower temperatures.

Ans: (D)

Q.11 Which one of the following processes is an example of an electrolytic cell?

- (A) Sacrificial cathodic protection system
- (B) Discharging of a rechargeable battery
- (C) Corrosion of a metal rod in ambient atmosphere
- (D) Charging of a rechargeable battery

Ans: (D)

Q.12 For a material to exhibit super plasticity, one of the requirements is:

- (A) High modulus of elasticity
- (B) Coarse- grained microstructure
- (C) High strain-rate sensitivity
- (D) Low strain-hardening exponent

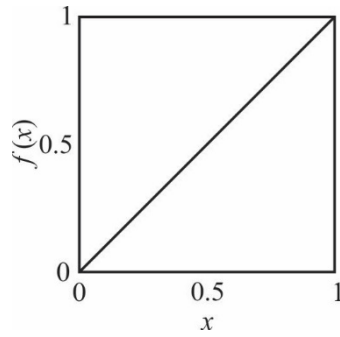
Ans: (C)

Q.13 Angle between two height boring tetrahedral bonds in Si having a diamond cubic structure is:

- (A) 135.5°
- (B) 120°
- (C) 102.5°
- (D) 109.5°

Ans: (D)

Q.14 For the function $f(x)$ given in the figure, the value of $\int_0^1 (1 - f(x)) dx$ is ____ (round off to one decimal place).



Ans: (0.5)

Given function of graph will be

$$f(x) = x$$

$$\int_0^1 (1 - x) dx = 0.5$$

Q.15 A dielectric material is:

- (A) Two coupled electrical conductors
- (B) Electrical conductor
- (C) Metallic magnet
- (D) Electrical insulator

Ans: (D)

Q.16 The number of atoms per unit area in (100) plane of Pb is _____ nm⁻²

(Round off to the nearest integer).

Given, crystal structure and atomic radius of Pb are FCC and 0.175 nm respectively.

Ans: (8)

The number of atoms per unit area

$$= \frac{2}{a^2} = \frac{2}{\left(\frac{4r}{\sqrt{2}}\right)^2} = 8.16$$

Q.17 A slip system consists of a slip plane and a slip direction. Which one of the following is NOT a valid slip system in a FCC copper crystal?

- (A) $(1\bar{1}\bar{1})[101]$
- (B) $(\bar{1}11)[011]$
- (C) $(111)[\bar{1}\bar{1}0]$
- (D) $(\bar{1}\bar{1}\bar{1})[10\bar{1}]$

Ans: (B)

Q.18 The sequence of precipitation during aging of Al- 4 wt. % Cu alloy is:

- (A) GP zone $\rightarrow \theta \rightarrow \theta' \rightarrow \theta''$
- (B) GP zone $\rightarrow \theta' \rightarrow \theta'' \rightarrow \theta$
- (C) GP zone $\rightarrow \theta'' \rightarrow \theta' \rightarrow \theta$
- (D) $\theta'' \rightarrow \theta' \rightarrow \text{GP zone} \rightarrow \theta$

Ans: (C)

Q.19 The general solution to the following homogeneous ODE,

$$\frac{d^2 y}{dt^2} + 4 \frac{dy}{dt} + 3y = 0$$

Is,

$$y(t) = c_1 e^{\lambda_1 t} + c_2 e^{\lambda_2 t}$$

The values of λ_1 and λ_2 are:

- (A) 1 and -3 (B) 1 and 3
(C) -3 and -3 (D) -1 and -3

Ans: (D)

Q.20 When 1 mole of C_3H_8 at 300 K is burnt with stoichiometric amount of oxygen at 300 K to form CO_2 and H_2O , the adiabatic flame temperature is 5975 K. If C_3H_8 is burnt under the same conditions but with excess oxygen, the adiabatic flame temperature will be

- (A) Lower than 5975 K irrespective of the amount of excess oxygen.
(B) Higher or lower than 5975 K depending on the amount of excess oxygen.
(C) Equal to 5975 K irrespective of the amount of excess oxygen.
(D) Higher than 5975 K irrespective of the amount of excess oxygen.

Ans: (A)

Q.21 The dye penetrant test for detecting flaws is based on:

- (A) Capillary action (B) Magnetism
(C) X-ray absorption (D) Sound propagation

Ans: (A)

Q.22 For the function $y = a^x$, the derivative $\frac{dy}{dx}$ at $x = 1$ is:

- (A) 1 (B) a
(C) a^2 (D) $a \ln a$

Ans: (D)

Q.23 The functions $y = e^x$ and $y = e^{-x}$ intersect at the point:

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

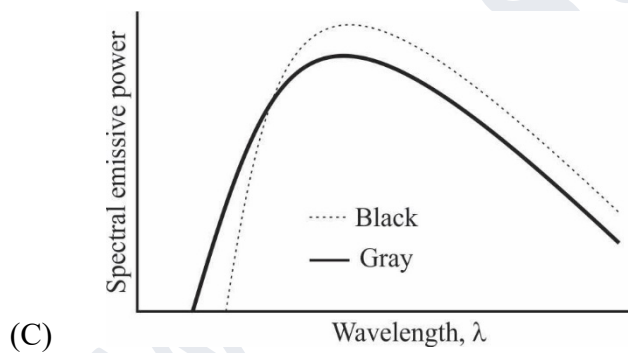
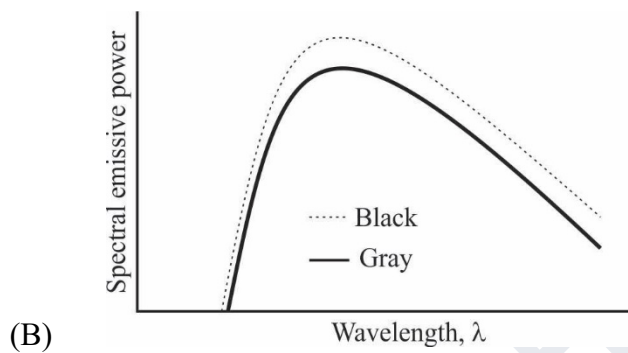
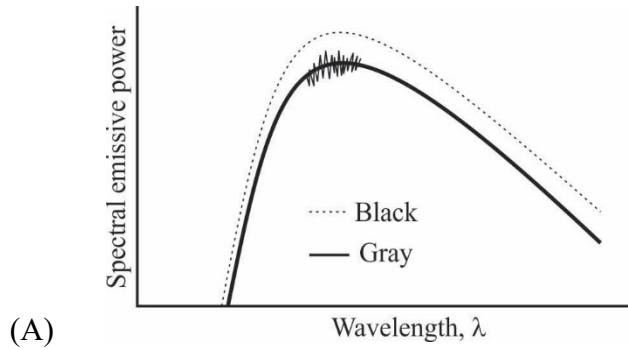
Ans: (A)

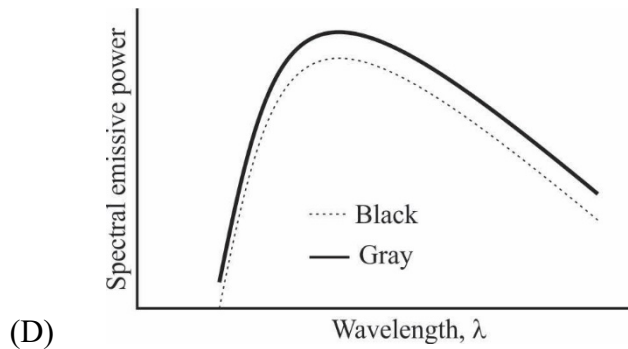
Q.24 Which one of the following statements regarding selective leaching of a binary alloy is TRUE?

- (A) The more electronegative element is leached.
(B) The lower atomic weight element is leached.
(C) The element with lower density is leached.
(D) The element having higher diffusivity is leached

Ans: (A)

Q.25 Select the correct spectra (Shown on a log – log scale in the figure) for emission from a gray surface and a black body, both maintained at 1000 K.





Ans: (B)

Q.26 Which one of the following dislocation reactions is NOT feasible in a FCC crystal?

- (A) $\frac{1}{6}[11\bar{2}] + \frac{1}{3}[111] \rightarrow \frac{1}{2}[110]$
- (B) $\frac{1}{2}[\bar{1}01] \rightarrow \frac{1}{6}[\bar{2}11] + \frac{1}{6}[\bar{1}\bar{1}2]$
- (C) $\frac{1}{2}[1\bar{1}0] + \frac{1}{2}[1\bar{1}0] \rightarrow [1\bar{1}0]$
- (D) $\frac{1}{2}[0\bar{1}1] \rightarrow \frac{1}{6}[1\bar{2}1] + \frac{1}{6}[\bar{1}\bar{1}2]$

Ans: (C)

Q.27 In a top gated mold, liquid metal enters the mold cavity as a freely falling stream under gravity from a height of 0.5 m. Ignore the fluid friction due to viscosity and the drag due to change in the direction of flow. If the volume of the mold cavity is 10 m^3 , then the time required to fill the mold is _____s(round off to nearest integer).

Given :

1. Acceleration due to gravity is 9.8 m.s^{-2} .

2. Cross – sectional area of gate is 0.2 m^2 .

Ans: (16)

$$t = \frac{V}{A\sqrt{2gh}} = \frac{10}{0.2 \times \sqrt{2 \times 9.8 \times 0.5}} = 15.97 \text{ s}$$

- Q.28** Crack growth is being continuously measured in a test specimen subjected to constant amplitude cyclic stress with a mean stress of zero. The crack growth rate is related to the stress intensity range, ΔK as

$$\frac{da}{dN} \propto (\Delta K)^3,$$

Where, a is the crack length and N is the number of cycles. When the crack length increases by a factor of two, the crack growth rate will increase by a factor of _____ (round off to one decimal place).

Ans: (2.8-2.9)

$$\frac{da}{dN} \propto (\sqrt{a})^3$$

- Q.29** The steady state creep rate of a material increases by a factor of 20 when the temperature is increased from 890 K to 980 K. The creep rate at a temperature of _____ K (round off to the nearest integer) will be 5 times the creep rate at 890 K.

Ans: (935-940)

Use the given below formula:

$$\dot{\varepsilon} = A \exp - \frac{Q}{RT}$$

Q.30 Radius of the largest interstitial atom that can be accommodated in an octahedral void in BCC iron without distorting the lattice is _____ nm(round off to three decimal places).

Assume hard sphere model and radius of Fe atom as 0.124 nm.

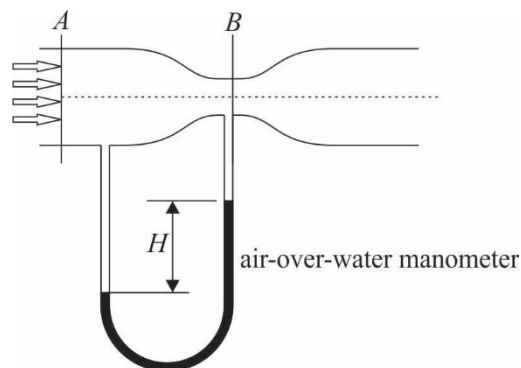
Ans: (0.019-0.020)

$$r = 0.155R = 0.155 \times 0.124 = 0.01922$$

Q.31 Figure shows schematic of a venturimeter. The cross sectional area is 100 mm^2 at A and is 50 mm^2 at B. If air is flowing through the venturimeter at a flow rate of $10^{-3} \text{ m}^3 \cdot \text{s}^{-1}$, the height H in the air – over water manometer is _____ mm (round off to the nearest integer).

Assume:

- (A) Incompressible flow with no friction losses.
- (B) Density of air is 1 kg m^{-3} .
- (C) Density of water is 1000 kg m^{-3} .
- (D) Acceleration due to gravity is 9.8 m s^{-2} .



Ans: (15000-15050)

$$P_A + \frac{1}{2}\rho v_A^2 = P_B + \frac{1}{2}\rho v_B^2$$

After using continuity equation:

$$A_A v_A = A_B v_B$$

We get,

$$v_A = \sqrt{\frac{2gH}{\left(\frac{A_A}{A_B}\right)^2 - 1}}$$

$$\frac{Q}{\rho A_A} = \sqrt{\frac{2gH}{\left(\frac{A_A}{A_B}\right)^2 - 1}}$$

$$\frac{10^{-3}}{100 \times 10^{-6}} = \sqrt{\frac{2gH}{\left(\frac{100}{50}\right)^2 - 1}}$$

$$H = 15.3 \text{ m} = 15300 \text{ mm}$$

Q.32 Two plates of composition Fe – 10 wt.% Ni and Fe – 20 wt.% Cr – 5 wt.% Ni are fusion – welded using a filler rod of composition 20 wt.% Ni – 80 wt.% Cr. Contribution to dilution of the weld pool is 20 % from each plate. The Ni content in the weld pool is _____ wt.% (round off to the nearest integer).

Ans: (*)

Q.33 Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion [a]: The rate of homogenization in a dilute substitutional solid

Solution of B in A is controlled by the diffusivity of B

Reason [r]: Atomic migration cannot occur along dislocations and grain boundaries.

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

Ans: (C)

Q.34 Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion [a]: Low – alloy steels used for medium – temperature creep resistance often have additions of strong carbide – forming elements.

Reason [r]: During creep deformation, the particles with higher misfit with the matrix, lose coherency.

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

Ans: (D)

Q.35 Iron is corroding in fresh water which has dissolved oxygen concentration of 15 mM. The anodic current density at an over potential of 120 mV is _____

A. cm^{-2} (round off to three decimal places).

1. Anodic Tafel slope is 0.06 V.
2. Diffusion coefficient of oxygen is $2.42 \times 10^{-5} \text{ cm}^2 \cdot \text{s}^{-1}$
3. Diffusion layer thickness is 0.06 cm.

Ans: (0.042-0.045)

Use the given formula:

$$i = \frac{\alpha D n F C}{x}$$

Q.36 If liquid copper is cooled to 1353 K, magnitude of the driving force for liquid to transform to solid is _____ $\text{J} \cdot \text{mol}^{-1}$ (round off to one decimal place).

Given, melting temperature and enthalpy of melting of copper are 1356 K and $13 \text{ kJ} \cdot \text{mol}^{-1}$ respectively.

Ans: (28.7-28.8)

$$\Delta G_v = \frac{\Delta T \Delta H_f}{T_m}$$

Q.37 Match the products in Column I with the manufacturing processes in Column II

Column I	Column II
(P) Blades of a gas turbine	1. Sand casting
(Q) Seamless tubing	2. Extrusion
(R) Automotive cylinder blocks	3. Powder metallurgy and wire drawing
(S) Tungsten filament	4. Investments casting

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

Ans: (B)

Q.38 A galvanic cell is formed by connecting $Zn(E_{Zn^{2+}/Zn}^0 = -0.76V)$ And $Fe(E_{Fe^{2+}/Fe}^0 = -0.44V)$ wires immersed in their respective ion solutions. The cell discharge spontaneously with a voltage of 0.5 V. The ratio of the concentration of $[Fe^{2+}]$ to $[Zn^{2+}]$ ions in the cell is of the order of;

Given, $R = 8.314 J.mol^{-1}.K^{-1}$, $F = 96500 C.mol^{-1}$, $T = 298 K$

- (A) 10^6
(B) 10^7
(C) 10^{-5}
(D) 10^{-6}

Ans: (A)

Q.39 Match the materials in Column I with their common applications in Column II.

Column I	Column II
(P) Gray iron	1. Cladding for uranium fuel in nuclear reactor
(Q) Ductile iron	2. Base structure of heavy machines

- | | |
|------------------------------|---------------------------------------|
| (R) Zirconium alloy | 3. Valves and pump bodies |
| (S) Beryllium – Copper alloy | 4. Jet aircraft landing gear bearings |
- (A) P – 4, Q – 2, R – 1, S – 3
- (B) P – 2, Q – 3, R – 1, S – 4
- (C) P – 1, Q – 3, R – 2, S – 4
- (D) P – 2, Q – 1, R – 4, S – 3

Ans: (B)

Q.40 M and N are 3×3 matrices. If the $\det(M)$ is -9 and the $\det(N)$ is -14 , then the $\det(NM)$ is _____ (round off to the nearest integer).

Ans: (126)

Q.41 The production process of cylindrical pipes results in a statistical scatter in their diameter which is modelled by a normal distribution with a mean value of 10 mm. If the area under the normal curve between 9 mm and 10 mm is 0.35, then the probability of producing pipes of diameter greater than 11 mm is _____ (round off to two decimal places).

Ans: (*0.65)

Q.42 $f(x) = x \ln(x) + (1-x) \ln(1-x) + 3x(1-x)$ has ____ at $x = 0.5$

- (A) A local maximum
- (B) A point of inflection
- (C) A local minimum
- (D) A non-zero slope

Ans: (A)

Q.43 Match the processes in Column I with the most appropriate mechanisms in Column II.

Column I	Column II.
(P) Blast furnace iron making process	1. Metallothermic reduction
(Q) Hall-Heroult's process	2. Oxidation
(R) Basic oxygen furnace steel making process	3. Carbothermic reduction
(S) Kroll's process	4. Fused salt electrolysis

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

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

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

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

Ans: (A)

Q.44 Zone refining of Si results in residual P content of 0.1 parts per billion by weight. The electrical conductivity of this zone refined Si is $__\Omega^{-1} \text{ m}^{-1}$ (round off to two decimal places).

Given:

1. Avogadro number is 6.02×10^{23}
2. Density of Si is 2.33 g.cm^{-3}
3. Atomic weight of P is 30.97.

4. Charge of electron is $1.6 \times 10^{-19} \text{ A.s}$
5. Mobility of electron is $0.2 \text{ m}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$

Ans: (0.145-0.146)

$$0.1 \text{ ppm} = \frac{0.1}{10^9} = 10^{-10}$$

$$\rho = \frac{nM}{N_A V}$$

$$\frac{n}{V} = 4.5313 \times 10^{28}$$

$$\sigma = ne\mu_e = 0.145$$

Q.45 A basic Oxygen Furnace operator, at the end of oxygen blow, measures the dissolved oxygen content in the steel as 0.03 wt. % and the steel temperature as 1800 K. The carbon content [C] in the steel is ____ wt. % (round off to two decimal places).

Assume:

1. Equilibrium between dissolved carbon [C], dissolved oxygen [O], and Co (gas) at 1 atmosphere.
2. Henry's law is valid for both [C] and [O]

Given:



$$\Delta G^0 = -19840 - 40.65T \text{ J}$$

$$R = 8.314 \text{ J.mol}^{-1} \cdot \text{K}^{-1}$$

Ans: (0.06-0.08)

Q.46 The solution (using trapezoidal rule) of the integral

$$\int_0^1 e^{-x^2} dx$$

By dividing the range 0 to 1 into two equal intervals is ____ (round off to two decimal places).

Ans: (0.73-0.74)

Q.47 Match the reactors in **Column I** with the corresponding products in Column II.

Column I	Column II
(P) COREX	1. Sponge iron
(Q) MIDREX	2. Copper matte
(R) Flash smelting reactor	3. Hot metal or pig iron
(S) Submerged arc furnace	4. Ferrochrome

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

Ans: (D)

Q.48 A metal oxidizes at 1200 K with a parabolic rate constant of $3 \times 10^{-6} \text{ g}^2 \cdot \text{cm}^{-4} \cdot \text{s}^{-1}$. Time taken for the oxide film to grow to a thickness of $2 \mu\text{m}$ is ____ s (round off to two decimal places).

Given, density of oxide is $6.5 \text{ g} \cdot \text{cm}^{-3}$.

Ans: (0.55-0.56)

Q.49 1000 kg of liquid steel containing 0.03 wt. % S needs to be desulphurized using a slag to bring the Sulphur content down to 0.015 wt. %. The quantity of slag needed is ___ kg (round off to the nearest integer).

Assume:

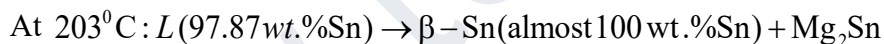
- (A) Thermodynamic equilibrium
- (B) No Sulphur in the slag prior to desulphurization treatment

Given the equilibrium Sulphur partition ration between slag and steel.

$$\frac{(\text{wt.}\%S)_{\text{in slag}}}{[\text{wt.}\%S]_{\text{in steel}}} \text{ is } 50.$$

Ans: (20)

Q.50 The Mg-Sn phase diagram exhibits two eutectics on either side of the high melting intermetallic line compound, Mg_2Sn , as given below.



After the eutectic reaction has gone to completion and equilibrium has been attained at a temperature just below 561°C , the amount of eutectic constituent present in the alloy, Mg-50 wt. % Sn, is approximately ___ (in wt. %).

Given, atomic weight of Sn is 118.7 and Mg is 24.3

- (A) 25
- (B) 75
- (C) 62
- (D) 38

Ans: (D)

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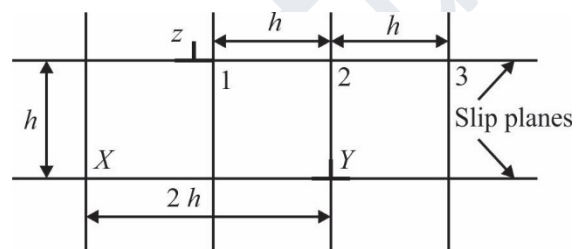
$$Mg_2Sn = \frac{118.7}{2 \times 24.3 + 118.7} \times 100 = 70.95\%$$

Now using the Lever's rule:

$$f_e = \frac{50 - 36.9}{70.95 - 36.9 \times 100} = 38\%$$

- Q.51** In the edge dislocation configuration given in the figure, dislocations X and Y are fixed and separated by a distance $2h$ on the same slip plane. Dislocation Z is free to glide on a parallel slip plane. The two slip planes are separated by a distance h . Which one of the following statements is TRUE regarding the stability of dislocation Z at positions 1, 2 and 3?

Assume all dislocations have identical Burgers vector.



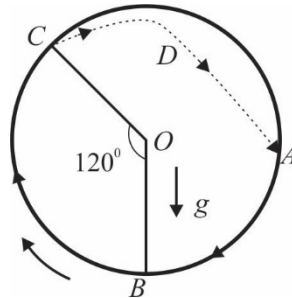
- (A) Position 1: stable equilibrium; Position 2: unstable; Position 3: stable
- (B) Position 1: unstable equilibrium; Position 2: unstable; Position 3: unstable
- (C) Position 1: unstable equilibrium; Position 2: stable; Position 3: unstable
- (D) Position 1: stable equilibrium; Position 2: unstable; Position 3: unstable

Ans: (D)

- Q.52** For effective comminution in a ball mill, it is desired that the balls travelling along the mill wall leave the wall at point C and travel freely in air along the path CDA, as shown in the figure. If $\angle BOC$ is 120° , the rotational speed of the mill is ____ rpm (rounded off to one decimal place) by performing suitable force balance at point C.

Assume:

- (A) There is no slip between the ball and mill wall.
- (B) O is the rotational axis of the mill and OB is parallel to the vector g .
- (C) Inner diameter of ball mill is 3.26 m.
- (D) Acceleration due to gravity g is 9.8 ms^{-2}



Ans: (81-82)

Q.53 Match the elements in **Column I** with their electronic behavior given in Column II.

Column: I

- (P) Copper
- (Q) Iron
- (R) Mercury
- (S) Silicon

Column: II

- 1. Ferromagnetic
 - 2. Superconducting
 - 3. Semiconducting
 - 4. Diamagnetic
- (A) P-4, Q-1, R-2, S-3

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

Ans: (A)

Q.54 X-ray diffraction pattern from an elemental metal with a FCC crystal structure shows the first peak at a Bragg angle $\theta = 24.65^\circ$. The lattice parameter of this metal is ____ nm.

Given, wavelength of the X-ray used is 0.1543 nm.

- (A) 0.185
- (B) 0.262
- (C) 0.370
- (D) 0.320

Ans: (D)

Q.55 The divergence of the vector field $(x^3 + y^3)i + 3xy^2j + 3zy^2k$ is:

- (A) $12xyz$
- (B) $3(x + y)^2$
- (C) $3x^2 + 6y^2 + 9xy + 6yz$
- (D) $3y^2 + 6xy + 6x^2$


Ans: (B)

Note: Kindly wait till the official answers come. These are temporary answers.

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