

# GATE



**Metallurgical Engineering  
Previous Year Question Papers  
With Answers  
(2016-2012)**

**Q. 1 – Q. 5 carry one mark each.**

Q.1 If I were you, I \_\_\_\_\_ that laptop. It's much too expensive.

- (A) won't buy (B) shan't buy  
(C) wouldn't buy (D) would buy

Q.2 He turned a deaf ear to my request.

What does the underlined phrasal verb mean?

- (A) ignored (B) appreciated (C) twisted (D) returned

Q.3 Choose the most appropriate set of words from the options given below to complete the following sentence.

\_\_\_\_\_ is a will, \_\_\_\_\_ is a way.

- (A) Wear, there, their (B) Were, their, there  
(C) Where, there, there (D) Where, their, their

Q.4  $(x \% \text{ of } y) + (y \% \text{ of } x)$  is equivalent to \_\_\_\_\_.

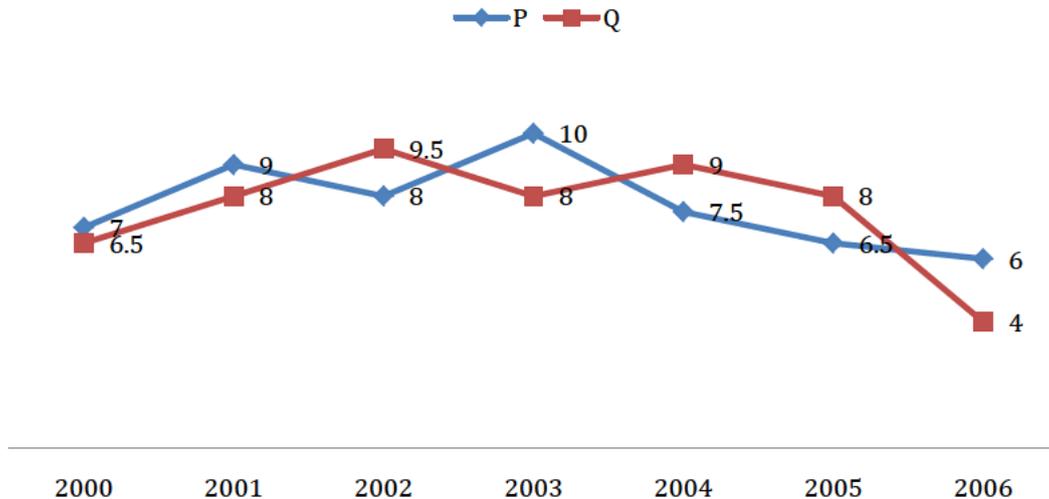
- (A) 2 % of  $xy$  (B) 2 % of  $(xy/100)$  (C)  $xy$  % of 100 (D) 100 % of  $xy$

Q.5 The sum of the digits of a two digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number.

- (A) 39 (B) 57 (C) 66 (D) 93

**Q. 6 – Q. 10 carry two marks each.**

- Q.6 Two finance companies, P and Q, declared fixed annual rates of interest on the amounts invested with them. The rates of interest offered by these companies may differ from year to year. Year-wise annual rates of interest offered by these companies are shown by the line graph provided below.



If the amounts invested in the companies, P and Q, in 2006 are in the ratio 8:9, then the amounts received after one year as interests from companies P and Q would be in the ratio:

- (A) 2:3  
 (B) 3:4  
 (C) 6:7  
 (D) 4:3
- Q.7 Today, we consider Ashoka as a great ruler because of the copious evidence he left behind in the form of stone carved edicts. Historians tend to correlate greatness of a king at his time with the availability of evidence today.

Which of the following can be logically inferred from the above sentences?

- (A) Emperors who do not leave significant sculpted evidence are completely forgotten.  
 (B) Ashoka produced stone carved edicts to ensure that later historians will respect him.  
 (C) Statues of kings are a reminder of their greatness.  
 (D) A king's greatness, as we know him today, is interpreted by historians.

- Q.8 Fact 1: Humans are mammals.  
Fact 2: Some humans are engineers.  
Fact 3: Engineers build houses.

If the above statements are facts, which of the following can be logically inferred?

- I. All mammals build houses.
- II. Engineers are mammals.
- III. Some humans are not engineers.

- (A) II only. (B) III only.  
(C) I, II and III. (D) I only.

- Q.9 A square pyramid has a base perimeter  $x$ , and the slant height is half of the perimeter. What is the lateral surface area of the pyramid?

- (A)  $x^2$  (B)  $0.75x^2$  (C)  $0.50x^2$  (D)  $0.25x^2$

- Q.10 Ananth takes 6 hours and Bharath takes 4 hours to read a book. Both started reading copies of the book at the same time. After how many hours is the number of pages **to be** read by Ananth, twice that **to be** read by Bharath? Assume Ananth and Bharath read all the pages with constant pace.

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

**END OF THE QUESTION PAPER**

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**Useful Data:**

Gas constant (R)	8.314 J.mol <sup>-1</sup> K <sup>-1</sup>
Acceleration due to gravity (g)	9.81 m <sup>2</sup> .s <sup>-1</sup>
Atomic weight of oxygen	16 g.mol <sup>-1</sup>
Atomic weight of silicon	28 g.mol <sup>-1</sup>
Atomic weight of iron	56 g.mol <sup>-1</sup>

**Q. 1 – Q. 25 carry one mark each.**

- Q.1 For the transformation shown below, if one of the eigenvalues is 6, the other eigenvalue of the matrix is \_\_\_\_\_

$$\begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} 5 & -2 \\ -2 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

- Q.2 The solution of the differential equation

$$\frac{d^2y}{dx^2} = \frac{dy}{dx} \text{ is}$$

- (A)  $y = e^x + C$  (B)  $y = e^{-x} + C$   
 (C)  $y = C_1 e^{-x} + C_2$  (D)  $y = C_1 e^x + C_2$

[where, C, C<sub>1</sub> and C<sub>2</sub> are constants]

- Q.3 If  $\vec{V} = x^2y \hat{i} + y^2x \hat{j} + xyz \hat{k}$ , the divergence of  $\vec{V}$  is

- (A)  $x^3y + y^3x + xyz^2$   
 (B)  $x^2y + y^2x + xyz$   
 (C)  $5xy$   
 (D) 0

- Q.4 The first law of thermodynamics can be stated as

- (A)  $dE = \delta Q - \delta W$   
 (B)  $dQ = dE - \delta W$   
 (C)  $\delta W = dQ + dE$   
 (D)  $dW = \delta Q - \delta E$

[where, E, Q and W denote internal energy, heat and work, respectively]

- Q.5 In a typical Ellingham diagram for the oxides, the  $C + O_2 = CO_2$  line is nearly horizontal because

- (A) The slope of the line is equal to the enthalpy change at standard state, which is approximately zero in this case  
 (B) The slope of the line is equal to the entropy change at standard state, which is approximately zero in this case  
 (C) CO<sub>2</sub> shows non-ideal behaviour  
 (D) CO<sub>2</sub> is a gaseous oxide

- Q.6 Activation energy of a chemical reaction, homogeneous or heterogeneous, is graphically estimated from a plot between
- (A)  $k$  versus  $T$  (B)  $1/k$  versus  $T$   
(C)  $1/k$  versus  $\ln T$  (D)  $\ln k$  versus  $1/T$

[where,  $k$  is the rate constant and  $T$  is the absolute temperature]

- Q.7 The passive film in stainless steel forms above the
- (A) Primary passive potential  
(B) Breakdown potential  
(C) Trans-passive potential  
(D) Pitting potential
- Q.8 During the roasting of a sulfide ore of a metal  $M$ , the possible solid phases are  $M$ ,  $MS$ ,  $MO$  and  $MSO_4$ . Assuming that both  $SO_2$  and  $O_2$  are always present in the roaster, the solid phases that can co-exist at thermodynamic equilibrium are
- (A)  $M$ ,  $MS$ ,  $MO$ ,  $MSO_4$   
(B)  $M$ ,  $MO$ ,  $MSO_4$   
(C)  $MS$ ,  $MO$ ,  $MSO_4$   
(D)  $M$ ,  $MSO_4$
- Q.9 Match the entities in **Column I** with the corresponding processes in **Column II**.

**Column I**

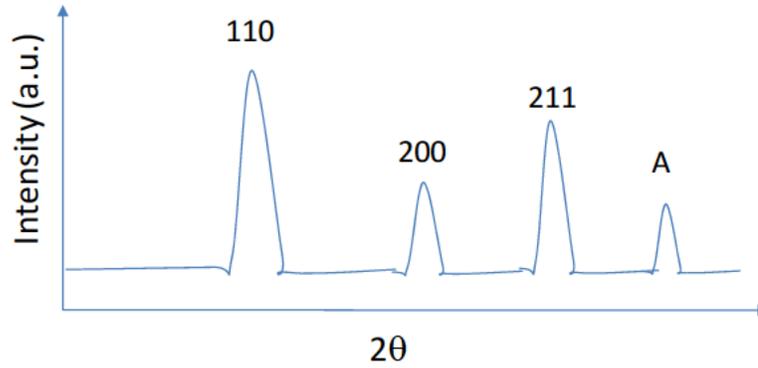
- [P] Xanthate salts  
[Q] Thiobacillus Ferrooxidans  
[R] Hydrocyclone  
[S] Anode effect

**Column II**

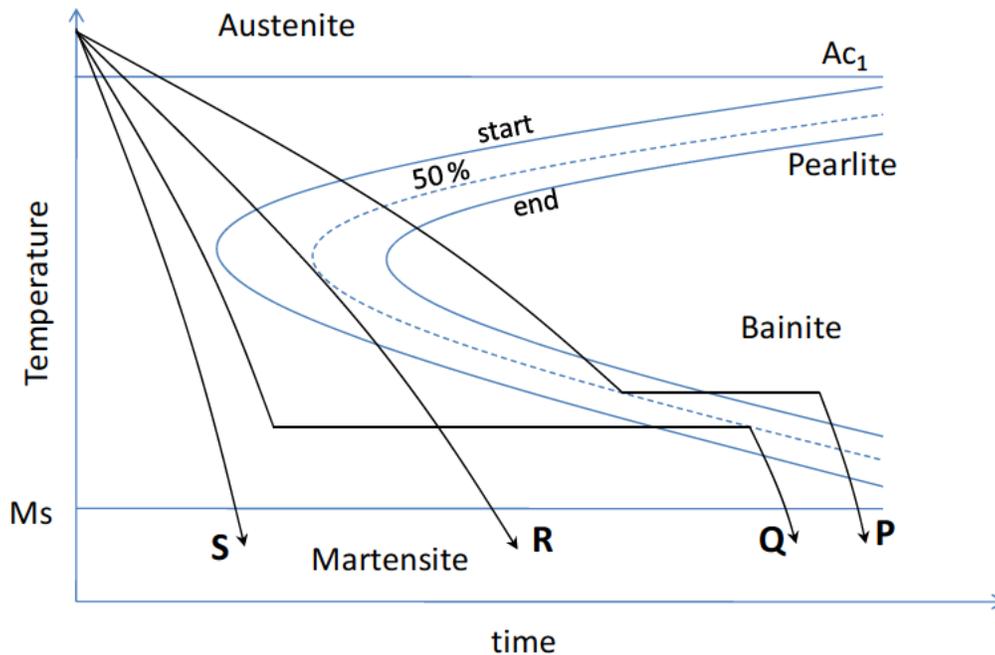
- [1] Extraction of Al  
[2] Flotation  
[3] Classification  
[4] Bacterial Leaching

- (A) P-4, Q-2, R-3, S-1  
(B) P-2, Q-4, R-3, S-1  
(C) P-3, Q-4, R-1, S-2  
(D) P-4, Q-1, R-2, S-3
- Q.10 A substance is used to monitor composition and temperature in
- (A) BOF (B) Ladle refining furnace  
(C) Continuous casting mould (D) Blast furnace
- Q.11 The chemical formula of **wüstite** is
- (A)  $FeS_2$   
(B)  $Fe_2O_3$   
(C)  $Fe_3O_4$   
(D)  $Fe_{1-x}O$
- Q.12 The lattice parameter of face-centered cubic iron ( $\gamma$ -Fe) is 0.3571 nm. The radius (in nm) of the octahedral void in  $\gamma$ -Fe is \_\_\_\_\_

- Q.13 For an ideal hexagonal-closed packed structure, the  $c/a$  ratio and packing efficiency respectively are
- (A) 1.633 and 52% (B) 1.633 and 74%  
 (C) 1.733 and 68% (D) 1.733 and 74%
- Q.14 A schematic of X-ray diffraction pattern of a single phase cubic polycrystal is given below. The miller indices of **peak A** is

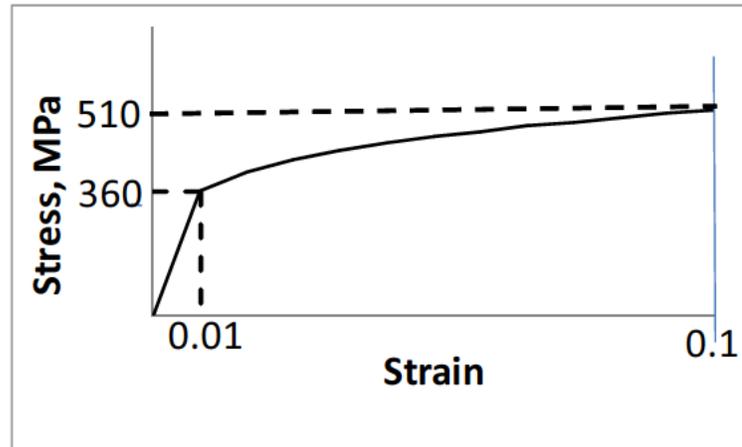


- (A) 210 (B) 220  
 (C) 222 (D) 310
- Q.15 Which of the following cooling curves (shown in schematic) in an eutectoid steel will produce 50% bainitic structure?



- (A) P (B) Q (C) R (D) S

- Q.16 The Burger's vector of a dislocation in a cubic crystal (with lattice parameter  $a$ ) is  $\frac{a}{2}[110]$  and dislocation line is along  $[112]$  direction. The angle (in degrees) between the dislocation line and its Burger's vector is \_\_\_\_\_
- Q.17 For the tensile stress-strain curve of a material shown in the schematic, the resilience (in MPa) is \_\_\_\_\_



- Q.18 A plastically deformed metal crystal at low temperature exhibits wavy slip line pattern due to
- Dislocation pile-up
  - Large number of slip systems
  - Low stacking fault energy
  - Dislocation climb
- Q.19 Creep resistance decreases due to
- Small grain size
  - Fine dispersoid size
  - Low stacking fault energy
  - High melting point
- Q.20 The operation **NOT** associated with casting is
- Gating
  - Fettling
  - Stack Moulding
  - Calendaring

Q.21 Of the following welding processes

- [P] Laser Beam Welding  
 [Q] Submerged Arc Welding  
 [R] Metal Inert Gas Welding

the width of the heat-affected zone in decreasing order is

- (A)  $P > Q > R$  (B)  $Q > R > P$   
 (C)  $R > P > Q$  (D)  $P > R > Q$

Q.22 Railway tracks are typically manufactured using

- (A) Forging (B) Extrusion  
 (C) Deep Drawing (D) Rolling

Q.23 For dye-penetrant test, identify the **CORRECT** statement

- (A) Pre- and post-cleaning of parts are not required  
 (B) Internal defects can be detected  
 (C) Surface oxides helps in crack identification  
 (D) Dye with low contact angle is required

Q.24 Aluminium powder having an apparent density of  $810 \text{ kg.m}^{-3}$  is compacted in a cylindrical die at 600 MPa. The density of the as-pressed aluminium compact is  $1755 \text{ kg.m}^{-3}$ . If the height of the as-pressed compact is 12 mm, the fill height (in mm) required is \_\_\_\_\_

Q.25 A rolling mill has a roll diameter of 200 mm. If coefficient of friction is 0.1, then the maximum possible reduction (in mm) during rolling of a 250 mm thick plate is \_\_\_\_\_

**Q. 26 – Q. 55 carry two marks each.**

Q.26 A hot body cools according to the following equation

$$\frac{dT}{dt} = -cT$$

where, T is the instantaneous temperature at time t, and the constant  $c = 0.05 \text{ s}^{-1}$ . Reduce the differential equation into its finite difference form **using forward difference**. For maintaining numerical stability, the maximum value of the time step  $\Delta t$  (in seconds) is \_\_\_\_\_

Q.27 Solve the equation  $x = e^{-x}$  using Newton-Raphson method. Starting with an initial guess value  $x_0 = 0$ , the value of x after the first iteration is \_\_\_\_\_

Q.28 A coin is tossed three times. It is known that out of the three tosses, one is a **HEAD**. The probability of the other two tosses also being **HEADS** is \_\_\_\_\_

Q.29 The vector parallel to the plane  $3x - 2y + z = -1$  is

- (A)  $\hat{i} + \hat{j} - \hat{k}$   
 (B)  $3\hat{i} - 2\hat{j} + \hat{k}$   
 (C)  $-\hat{i} + \hat{j} - \hat{k}$   
 (D)  $3\hat{i} - 2\hat{j} + 2\hat{k}$

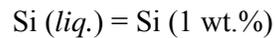
Q.30 The value of the integral

$$\int_0^{\pi/2} x \sin x \, dx = \underline{\hspace{2cm}}$$

Q.31 The grain sizes (in  $\mu\text{m}$ ) measured at five locations in an alloy sample are: 16, 14, 18, 15 and 13. The mean, median and standard deviation of grain sizes respectively are (in  $\mu\text{m}$ )

- (A) 15.2, 15 and 1.7  
 (B) 15.2, 15 and 1.9  
 (C) 15.8, 15 and 1.9  
 (D) 15.2, 16 and 1.7

Q.32 The change of standard state from pure liquid to 1 wt.% for Si dissolved in liquid Fe at 1873 K is expressed as



Given that the activity coefficient of Si at infinite dilution in Fe is  $10^{-3}$ , the standard Gibbs free energy change (in kJ) for this equilibrium is                     

Q.33 The following experimental data are available for a hypothetical binary liquid system **A-B** at 1073 K

Atom fraction of A	0.2	0.4	0.5	0.7	1.0
Partial pressure of A (bar)	0.01	0.04	0.06	0.07	0.08

When the atom fraction of **A** is 0.4, the activity of **A** in the liquid is

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