

## GATE 2014: General Instructions during Examination

1. Total duration of the GATE examination is **180** minutes.
2. The clock will be set at the server. The countdown timer at the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You need not terminate the examination or submit your paper.
3. Any useful data required for your paper can be viewed by clicking on the **Useful Common Data** button that appears on the screen.
4. Use the scribble pad provided to you for any rough work. Submit the scribble pad at the end of the examination.
5. You are allowed to use a non-programmable type calculator, however, sharing of calculators is not allowed.
6. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

 You have not visited the question yet.

 You have not answered the question.

 You have answered the question.

 You have NOT answered the question, but have marked the question for review.

 You have answered the question, but marked it for review.

The **Marked for Review** status for a question simply indicates that you would like to look at that question again. *If a question is answered, but marked for review, then the answer will be considered for evaluation unless the status is modified by the candidate.*

### Navigating to a Question :

7. To answer a question, do the following:
  - a. Click on the question number in the Question Palette to go to that question directly.
  - b. Select an answer for a multiple choice type question by clicking on the bubble placed before the 4 choices, namely A, B, C and D. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
  - c. Click on **Save & Next** to save your answer for the current question and then go to the next question.
  - d. Click on **Mark for Review & Next** to save your answer for the current question and also mark it for review, and then go to the next question.

**Caution:** Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on a question number without saving the answer to the previous question.

You can view all the questions by clicking on the **Question Paper** button. This feature is provided, so that if you want you can just see the entire question paper at a glance.

### Answering a Question :

8. Procedure for answering a multiple choice (MCQ) type question:
  - a. Choose one answer from the 4 options (A,B,C,D) given below the question, click on the bubble placed before the chosen option.
  - b. To deselect your chosen answer, click on the bubble of the chosen option again or click on the **Clear Response** button.
  - c. To change your chosen answer, click on the bubble of another option.
  - d. To save your answer, you **MUST** click on the **Save & Next** button.
9. Procedure for answering a numerical answer type question:
  - a. To enter a number as your answer, use the virtual numerical keypad.
  - b. A fraction (e.g. -0.3 or -.3) can be entered as an answer with or without '0' before the decimal point. As many as four decimal points, e.g. 12.5435 or 0.003 or -932.6711 or 12.82 can be entered.
  - c. To clear your answer, click on the **Clear Response** button.
  - d. To save your answer, you **MUST** click on the **Save & Next** button
10. To mark a question for review, click on the **Mark for Review & Next** button. *If an answer is selected (for MCQ) or entered (for numerical answer type) for a question that is **Marked for Review**, that answer will be considered in the evaluation unless the status is modified by the candidate.*
11. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.
12. Note that **ONLY** Questions for which answers are *saved* or *marked for review after answering* will be considered for evaluation.

### Choosing a Section :

13. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing will be highlighted.
14. A checkbox is displayed for every optional Section, if any, in the Question Paper. To select the optional Section for answering, click on the checkbox for that Section.
15. If the checkbox for an optional Section is not selected, the **Save & Next** button and the **Mark for Review & Next** button will **NOT** be enabled for that Section. You will

only be able to see questions in this Section, but you will not be able to answer questions in the Section.

16. After clicking the **Save & Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.
17. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

### **Changing the Optional Section :**

18. After answering the chosen optional Section, partially or completely, you can change the optional Section by selecting the checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section. If you do not want to reset the Section and want to continue answering the previously chosen optional Section, then click on the **BACK** button.
19. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.
20. You can shuffle between different Sections or change the optional Sections any number of times.

# GATE 2014 Examination

## MT: Metallurgical Engineering

Duration: 180 minutes

Maximum Marks: 100

### Read the following instructions carefully.

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen.
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory.  
The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.  
The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.
5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type (MCQ)** and **numerical answer type**.
9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (○) placed before the choice.
10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices. **For these questions, the answer should be entered** by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of  $\frac{1}{3}$  marks for a 1-mark question and  $\frac{2}{3}$  marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.
13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

### Declaration by the candidate:

“I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition”.

**Q. 1 – Q. 5 carry one mark each.**

- Q.1 A student is required to demonstrate a high level of comprehension of the subject, especially in the social sciences.

The word closest in meaning to comprehension is

- (A) understanding (B) meaning (C) concentration (D) stability

- Q.2 Choose the most appropriate word from the options given below to complete the following sentence.

One of his biggest \_\_\_\_\_ was his ability to forgive.

- (A) vice (B) virtues (C) choices (D) strength

- Q.3 Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently.

Which one of the statements below is logically valid and can be inferred from the above sentences?

- (A) Rajan has decided to work only in a group.  
 (B) Rajan and Sajan were formed into a group against their wishes.  
 (C) Sajan had decided to give in to Rajan's request to work with him.  
 (D) Rajan had believed that Sajan and he would be working together.

- Q.4 If  $y = 5x^2 + 3$ , then the tangent at  $x = 0, y = 3$

- (A) passes through  $x = 0, y = 0$  (B) has a slope of +1  
 (C) is parallel to the  $x$ -axis (D) has a slope of -1

- Q.5 A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of Rs 800Q, where Q is the daily production in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes?

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

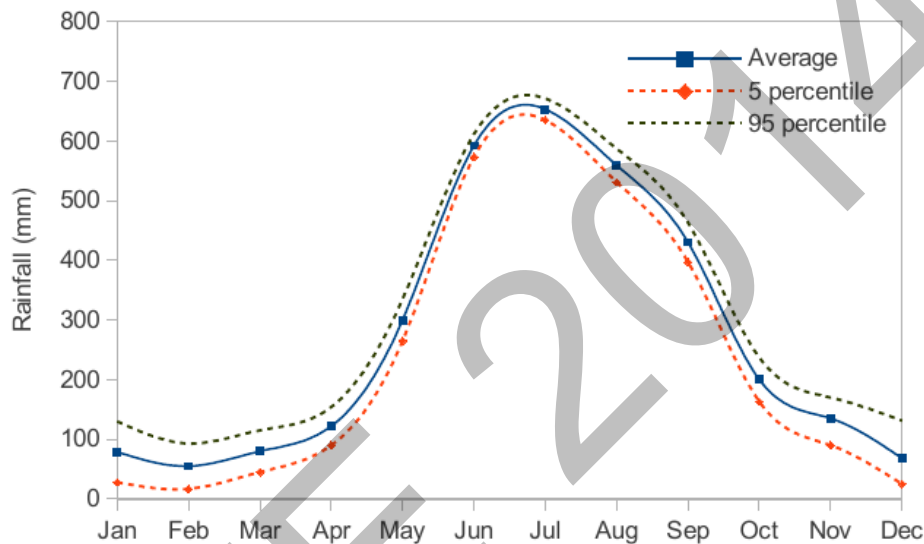
- Q.6 Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK

- (A) ALRVX (B) EPVZB (C) ITZDF (D) OYEIK

- Q.7 Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storeyed building (the ground floor is numbered 1, the floor above it 2, and so on). Anuj lives on an even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

- Q.8 The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?
- Q.9 One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than 6 ft. There are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage of people taller than 6 ft?
- (A) 3.0 (B) 2.5 (C) 1.5 (D) 1.25
- Q.10 The monthly rainfall chart based on 50 years of rainfall in Agra is shown in the following figure. Which of the following are true? ( $k$  percentile is the value such that  $k$  percent of the data fall below that value)

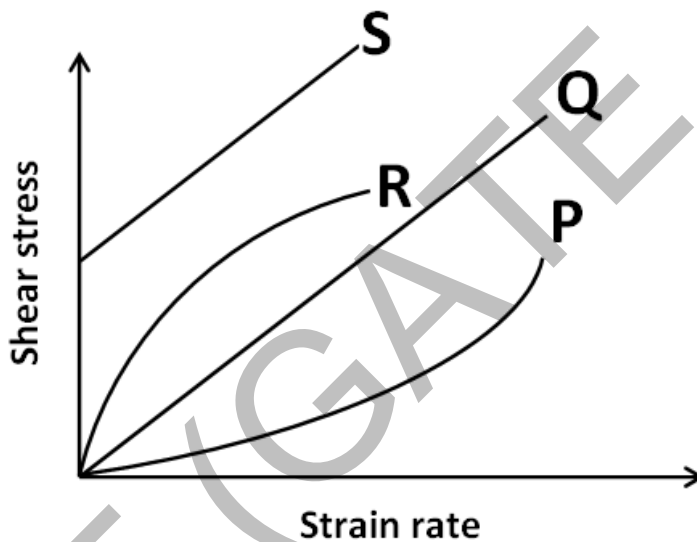


- (i) On average, it rains more in July than in December  
(ii) Every year, the amount of rainfall in August is more than that in January  
(iii) July rainfall can be estimated with better confidence than February rainfall  
(iv) In August, there is at least 500 mm of rainfall
- (A) (i) and (ii) (B) (i) and (iii)  
(C) (ii) and (iii) (D) (iii) and (iv)

**END OF THE QUESTION PAPER**

**Q. 1 – Q. 25 carry one mark each.**

- Q.1 Which one of the following factors is **NOT** desirable for effective phosphorus removal in BOF steelmaking process?
- (A) Higher FeO level in slag  
 (B) Higher basicity  
 (C) Higher temperature  
 (D) Lower temperature
- Q.2 Which one of the following microstructures of a Ni-base superalloy imparts the highest creep resistance?
- (A) Fine grained equiaxed  
 (B) Coarse grained equiaxed  
 (C) Columnar  
 (D) Single crystal
- Q.3 Which one of the following plots relating shear stress with strain rate represents Newtonian behaviour of a fluid?



- (A) P                      (B) Q                      (C) R                      (D) S
- Q.4 The respective units for dislocation density and stress intensity factor are
- (A)  $m^{-2}$  and  $MPa \cdot m$     (B)  $m^{-2}$  and  $MPa \cdot m^{1/2}$     (C)  $m^{-2}$  and  $MPa \cdot m^{1/2}$     (D)  $m^{-2}$  and  $MPa \cdot m$
- Q.5 Which one of the following is **NOT** an intensive property?
- (A) Temperature            (B) Pressure            (C) Volume            (D) Refractive index

Q.6 Identify the wave equation among the following equations.

(A)  $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$

(B)  $\frac{\partial^2 f}{\partial x^2} = A \frac{\partial f}{\partial t}$

(C)  $\frac{\partial^2 f}{\partial x^2} = A^2 \frac{\partial^2 f}{\partial t^2}$

(D)  $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial x \partial y} + \frac{\partial^2 f}{\partial y^2} = 0$

Q.7 Which one of the following metal forming processes is the earing defect associated with?

(A) Deep drawing

(B) Rolling

(C) Forging

(D) Wire drawing

Q.8 The Pilling-Bedworth ratio is defined as

(A) the molar weight of an oxide divided by the molar weight of the metal consumed in oxide formation.

(B) the volume of the oxide divided by the volume of the metal consumed in oxide formation.

(C) the density of the oxide divided by the density of the metal consumed in oxide formation.

(D) the molar Gibbs energy of the oxide divided by the Gibbs energy of the metal consumed in oxide formation.

Q.9 A tensile specimen was deformed at a constant crosshead speed of 6 mm/min. The strain rate at the start of the testing was  $5 \times 10^{-3} \text{ s}^{-1}$ . The initial gauge length of the specimen (in mm) was \_\_\_\_\_

Q.10 If all the elements of one row of a  $3 \times 3$  matrix are multiplied by 3, the determinant of the matrix changes by a factor of \_\_\_\_\_

Q.11 As mercury is cooled from room temperature to 3 K, its electrical behaviour changes from that of

(A) conductor to insulator

(B) semiconductor to insulator

(C) conductor to superconductor

(D) semiconductor to superconductor

Q.12 Which one of the following refers to the ability of a material to absorb energy when deformed elastically?

(A) Toughness

(B) Fracture toughness

(C) Resilience

(D) Hardness

Q.13 In the trapezoidal rule for numerical integration of a function, the nature of approximation used for the function in each interval is

(A) constant

(B) linear

(C) parabolic

(D) cubic



- Q.14 Which one of the following NDT techniques **CANNOT** be used to detect an internal crack in a steel shaft?
- (A) Liquid penetrant inspection                      (B) Radiography  
(C) Ultrasonic testing                                      (D) X-ray tomography
- Q.15 Two identical engineering components are made from alloys X and Y. The  $K_{IC}$  of alloy X is greater than that of alloy Y. If these components are subjected to the same stress during operation under Mode I loading, which one of the following statements is **TRUE**?
- (A) Component made from alloy X can tolerate a larger flaw size compared to that made from Y  
(B) Component made from alloy Y can tolerate a larger flaw size compared to that made from X  
(C) Both can tolerate same flaw size  
(D) None of the above
- Q.16 Which one of the following minerals is a source of titanium?
- (A) Haematite                      (B) Magnetite                      (C) Ilmenite                      (D) Pyrolusite
- Q.17 A steel rod was subjected to a fluctuating stress cycle that varied between a maximum of 400 MPa in tension to a minimum of 300 MPa in compression. What is the stress amplitude, in MPa? \_\_\_\_\_
- Q.18 Which one of the following can avoid weld decay of austenitic stainless steels?
- (A) Reducing carbon content  
(B) Increasing carbon content  
(C) Eliminating strong carbide formers  
(D) Decreasing chromium content
- Q.19 Identify the **INCORRECT** statement with respect to grain growth.
- (A) As the average grain size increases, the grain boundary energy per unit area decreases.  
(B) The driving force for grain growth is the decrease in grain boundary energy per unit volume of the material.  
(C) Higher the temperature, the faster is the grain growth.  
(D) Impurity atoms segregated at grain boundaries can retard grain growth.
- Q.20 Identify the type of the following invariant reaction:
- $$\text{liquid 1} + \text{solid 1} \rightleftharpoons \text{solid 2}$$
- (A) Eutectic                      (B) Eutectoid                      (C) Peritectic                      (D) Peritectoid
- Q.21 What is the median value of the following set of numbers? \_\_\_\_\_  
1, 3, 5, 9, 6, 4, 8.

- Q.22 Which one of the following welding processes uses a non-consumable electrode?
- (A) Gas tungsten arc welding  
(B) Gas metal arc welding  
(C) Submerged arc welding  
(D) Flux cored arc welding
- Q.23 Which one of the following processes is performed for inclusion modification in ladle metallurgy of steelmaking?
- (A) Aluminum wire injection  
(B) Calcium wire injection  
(C) Oxygen top blowing  
(D) Oxygen bottom blowing
- Q.24 If a vector  $\vec{a}$  is defined as gradient of a scalar field  $\phi$  such that  $\vec{a} = \vec{\nabla}\phi$ , then which one of the following is equal to the curl of  $\vec{a}$  ?
- (A)  $\nabla^2\phi$                       (B) 0                      (C)  $\vec{\nabla}\phi$                       (D)  $\phi$
- Q.25 Which one of the following signals from a specimen is used in a scanning electron microscope to get quantitative elemental analysis?
- (A) Secondary electrons                      (B) Backscattered electrons  
(C) X-rays                      (D) Transmitted electrons

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

- Q.26 A metal powder with an apparent density of  $2.5 \text{ g/cm}^3$  was compacted in a cylindrical die to a green density of  $5.5 \text{ g/cm}^3$ . If the height of the green sample was 12 mm, then the fill height of powder (in mm) would have been \_\_\_\_\_
- Q.27 A tensile specimen was deformed to a true strain of 0.405. The change in the gauge length was 5 mm. The final gauge length of the specimen, in mm, is
- (A) 10                      (B) 12                      (C) 15                      (D) 18
- Q.28 If  $\vec{r}$  is a position vector relative to the origin in three dimensional space, then  $\vec{\nabla} \cdot \vec{r}$  is
- (A) 0                      (B) 1                      (C) 2                      (D) 3
- Q.29 The activity coefficient of Q in a liquid Q-R alloy is represented by the following equation at a given temperature.

$$\ln \gamma_Q = 0.6x_R^2 - 0.2x_R^3$$

What is the activity of Q in an alloy of composition  $x_R = 0.6$  at the same temperature? \_\_\_\_\_

- Q.30 Two Cu-Ni alloys, one with 47 wt.% Ni and the other with 53 wt.% Ni, are kept in separate crucibles and are allowed to equilibrate at the same temperature  $T_1$  between the liquidus and the solidus. The two alloys have
- (A) the same weight fraction of the liquid but the liquid compositions are different.  
 (B) the same composition of the liquid but the weight fractions of the liquid are different.  
 (C) the same weight fractions of the liquid and the solid.  
 (D) different compositions and weight fractions of the liquid.

- Q.31 Dissociation of a dislocation into two partials in an FCC metal is given by the following equation.

$$\frac{a}{2} [1\bar{1}0] \rightarrow \frac{a}{6} [2\bar{1}1] + \frac{a}{6} [1\bar{2}\bar{1}]$$

On which plane do these two partial dislocations lie?

- (A)  $(\bar{1}11)$                       (B)  $(111)$                       (C)  $(1\bar{1}1)$                       (D)  $(11\bar{1})$
- Q.32 Match the types of corrosion in **Group I** with their examples in **Group II**.

**Group I**

- P. Galvanic corrosion  
 Q. Filiform corrosion  
 R. Stress corrosion cracking  
 S. Crevice corrosion

**Group II**

1. Season cracking in brass  
 2. Nut-bolt assembly with gasket  
 3. Brass fittings joined with lead-tin solder  
 4. Painted food can

- (A) P-4, Q-1, R-2, S-3                      (B) P-3, Q-1, R-4, S-2  
 (C) P-3, Q-4, R-1, S-2                      (D) P-4, Q-2, R-3, S-1
- Q.33 What is the theoretical requirement of air (in  $m^3$  at STP) for the complete combustion of  $100 m^3$  (at STP) of a fuel consisting of pure  $CH_4$ ? Assume that air contains 21 vol.% of oxygen. \_\_\_\_\_
- Q.34 An electrolytic refining cell for copper consists of an alloy with activity of copper  $a_{Cu} = 0.8$  as the anode, and pure copper as the cathode. What is the absolute value of the cell potential (in millivolts) at  $25^\circ C$ , given that copper is divalent? Faraday constant is  $96500 C/mol$  and the universal gas constant is  $8.314 J/(mol.K)$ . \_\_\_\_\_
- Q.35 Match the alloy names listed in **Group I** with the main elements present in them listed in **Group II**.

**Group I**

- P. Babbitt  
 Q. Muntz metal  
 R. Invar  
 S. Inconel

**Group II**

1. Fe-Ni  
 2. Ni-Cr-Fe  
 3. Cu-Zn  
 4. Sn-Sb-Cu

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

Q.36 What is the hydrostatic stress for the state of stress represented by  $\sigma_{ij}$  given below? \_\_\_\_\_

$$\sigma_{ij} = \begin{vmatrix} 100 & 50 & 50 \\ 50 & 125 & 75 \\ 50 & 75 & 75 \end{vmatrix}$$

Q.37 Assume that Sievert's law holds for solubility of hydrogen dissolved in a thin metal foil. If the partial pressure of hydrogen in contact with the foil is increased by a factor of 4, the solubility increases by a factor of \_\_\_\_\_

Q.38 A body starts yielding when it is subjected to a stress state with principal stresses of 250 MPa, 50 MPa and -50 MPa. What is the yield strength of the material, in MPa, if Tresca yield criterion is obeyed? \_\_\_\_\_

Q.39 Determine the correctness or otherwise of the following **Assertion(a)** and **Reason (r)**:

**Assertion (a):** Deoxidation and decarburisation of liquid steel are done by vacuum treatment process.

**Reason (r):** Decreased partial pressure of CO(g) promotes deoxidation and decarburisation.

(A) **a** is false but **r** is true

(B) **a** is true but **r** is false

(C) **a** is true and **r** is also true, but **r** is not the reason for **a**

(D) **a** is true and **r** is also true, and **r** is the reason for **a**

Q.40 In a sand casting of a rectangular slab, the thickness of the solidified layer after 2 minutes is known to be 3 cm. Based on Chvorinov's rule, the solidified thickness (in cm) after 4 minutes is \_\_\_\_\_

Q.41 A rod of a metal with Young's modulus of 200 GPa is pulled in tension to a stress of 400 MPa. What is the elastic strain (in %) that is recovered, when the rod is completely unloaded? \_\_\_\_\_

Q.42 Match the following strengthening methods (**Group I**) in metallic alloys with typical mechanisms responsible (**Group II**) for them.

**Group I**

- P. Grain size strengthening
- Q. Work hardening
- R. Dispersion strengthening
- S. Solid solution hardening

**Group II**

1. Orowan looping
2. Suzuki interaction
3. Lomer-Cottrell barrier
4. Dislocation pileup at grain boundaries

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

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

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

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

Q.43 Match the operations listed in **Group I** with the types of processes listed in **Group II**.

**Group I**

- P. Blast Furnace Ironmaking  
 Q. BOF Steelmaking  
 R. Hall-Heroult Process  
 S. Bayer Process

**Group II**

1. Refining  
 2. Electrolysis  
 3. Smelting  
 4. Leaching

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

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

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

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

Q.44 Determine the correctness or otherwise of the following **Assertion (a)** and **Reason (r)**.

**Assertion (a):** Peak aging time for an Al-4 wt.% Cu alloy is indicated by a maximum in the hardness.

**Reason (r):** The maximum volume fraction of the  $\theta$  precipitates is formed at the peak aging time.

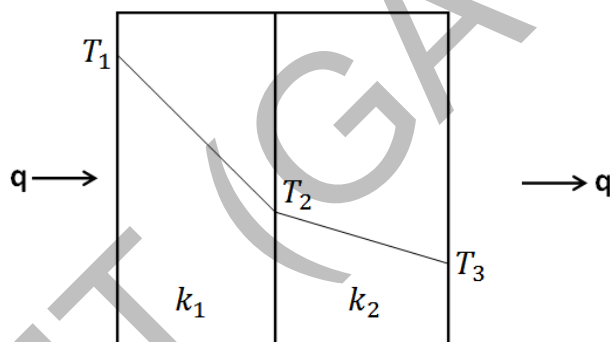
(A) **a** is true but **r** is false

(B) **a** is false but **r** is true

(C) both **a** and **r** are true, and **r** is the reason for **a**

(D) both **a** and **r** are true, but **r** is not the reason for **a**

Q.45 Consider a steady state heat flux across a rectangular slab composed of two layers of equal width as shown in the figure below. The thermal conductivities are in the ratio of  $\frac{k_2}{k_1} = 10$ . If the first layer experiences a temperature drop ( $T_1 - T_2$ ) of 50 K, what is the temperature drop ( $T_2 - T_3$ ), in K, across the second layer? \_\_\_\_\_



Q.46 Determine the correctness or otherwise of the following **Assertion (a)** and **Reason (r)**.

**Assertion (a):** During welding of aluminium alloys by the gas tungsten arc welding process, direct current reverse polarity (DCRP) mode is used.

**Reason (r):** DCRP facilitates breaking up of the oxide film on the workpiece surface.

(A) **a** is true but **r** is false

(B) **a** is false but **r** is true

(C) both **a** and **r** are true, and **r** is the reason for **a**

(D) both **a** and **r** are true, but **r** is not the reason for **a**

Q.47 Match the elements in **Group I** with their corresponding crystal structures in **Group II**.

<b>Group I</b>	<b>Group II</b>
P. Tungsten	1. HCP
Q. Nickel	2. Simple cubic
R. Magnesium	3. BCC
S. Polonium	4. FCC

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

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

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

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

Q.48 The atomic radius of aluminium is 1.431 Å. The interplanar spacing of (111) planes in aluminium, in Å, is \_\_\_\_\_

Q.49 The flow curve of an annealed metal is expressed as  $\sigma = 200\varepsilon^{0.25}$ , where  $\sigma$  is in MPa. If a rod of this metal is subjected to a true strain of  $\varepsilon = 0.3$  by extrusion, the ideal plastic work of deformation per unit volume (in MJ/m<sup>3</sup>) is \_\_\_\_\_

Q.50 Two phases  $\alpha$  and  $\beta$  are in thermodynamic equilibrium. If  $x$  and  $y$  are the only components present in the phases  $\alpha$  and  $\beta$  and if  $\mu_i^j$  represents the chemical potential of component  $i$  in phase  $j$ , then the condition for equilibrium is

(A)  $\mu_x^\alpha = \mu_y^\beta$  and  $\mu_x^\beta = \mu_y^\alpha$

(B)  $\mu_\beta^x = \mu_\alpha^y$  and  $\mu_\alpha^x = \mu_\beta^y$

(C)  $\mu_x^\alpha = \mu_x^\beta$  and  $\mu_y^\alpha = \mu_y^\beta$

(D)  $\mu_x^\alpha = \mu_y^\alpha$  and  $\mu_x^\beta = \mu_y^\beta$

Q.51 The important factors for producing low silicon pig iron in a blast furnace are

(A) higher temperature and higher basicity

(B) lower temperature and lower basicity

(C) lower temperature and higher basicity

(D) higher temperature and lower basicity

Q.52 The following power series  $P(x)$  will converge absolutely if  $|x|$  is less than:

$$P(x) = \sum_{n=0}^{\infty} 4^n x^n$$

(A) 0.25

(B) 0.5

(C) 2

(D) 4

Q.53 The specific heat ( $C_p$ ) of pure iron expressed in J/(mol.K) as a function of temperature T (in K) is given as:

$$C_p = 17.49 + 24.77 \times 10^{-3} T$$

What is the change in the enthalpy of pure iron (in J/mol) when it is heated from 25°C to 700°C?

\_\_\_\_\_

Q.54 The magnitude of the gradient of the function  $f(x, y) = x^2 + y^2 + xy + x$  evaluated at (1, 1) is

\_\_\_\_\_

- Q.55 A glass fibre reinforced epoxy composite is made with 60 wt.% unidirectional continuous glass fibres. The elastic moduli of the glass fibre and the epoxy matrix are 72.5 and 2.4 GPa, respectively. What is the elastic modulus of this composite along the fibre direction, in GPa? The densities of glass fibre and epoxy are  $2.58 \text{ g/cm}^3$  and  $1.14 \text{ g/cm}^3$ , respectively. \_\_\_\_\_

**END OF THE QUESTION PAPER**

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