

MT : METALLURGICAL ENGINEERING

Duration: Three Hours

Maximum Marks: 100

Read the following instructions carefully.

1. Write your name and registration number in the space provided at the bottom of this page.
2. Take out the **Optical Response Sheet (ORS)** from this Question Booklet **without breaking the seal**.
3. Do not open the seal of the Question Booklet until you are asked to do so by the invigilator.
4. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **ORS**. Also, using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your test paper code (MT).
5. This Question Booklet contains **16** pages including blank pages for rough work. After opening the seal at the specified time, please check all pages and report discrepancy, if any.
6. There are a total of 65 questions carrying 100 marks. All these questions are of objective type. Questions must be answered on the left hand side of the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number. **For each question darken the bubble of the correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.
7. Questions Q.1 – Q.25 carry 1-mark each, and questions Q.26 – Q.55 carry 2-marks each.
8. Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated.
9. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 carry 1-mark each, and questions Q.61 – Q.65 carry 2-marks each. The GA questions begin on a fresh page starting from page 10.
10. Unattempted questions will result in zero mark and wrong answers will result in **NEGATIVE** marks. For Q.1 – Q.25 and Q.56 – Q.60, $\frac{1}{3}$ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, $\frac{2}{3}$ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair, i.e. for Q.52 and Q.54, $\frac{2}{3}$ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.
11. Calculator is allowed whereas charts, graph sheets or tables are **NOT** allowed in the examination hall.
12. Rough work can be done on the question paper itself. Additionally, blank pages are provided at the end of the question paper for rough work.

Name									
Registration Number	MT								

Useful data

Universal gas constant (R) = $8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

1 Faraday (F) = 96500 Coulombs

Q. 1 – Q. 25 carry one mark each.

- Q.1 Which one of the following methods is **NOT** used for numerically solving an ordinary differential equation (ODE)? [Nptel Reference 1](#)
- (A) Euler's method (B) Runge-Kutta method
(C) Adam-Bashforth method (D) Newton-Raphson method [Nptel Reference 2](#)
- Q.2 If two systems P and Q are in thermal equilibrium with a third system M, then P and Q will also be in thermal equilibrium with each other. This is following [Nptel Reference 1](#)
- (A) First law of Thermodynamics (B) Second law of Thermodynamics [Nptel Reference 2](#)
(C) Third law of Thermodynamics (D) Zeroeth law of Thermodynamics
- Q.3 Humidification of the blast in the iron blast furnace leads to [Nptel Reference](#)
- (A) lowering of the raceway temperature
(B) increase in raceway temperature
(C) difficulty in pulverized coal injection (PCI)
(D) decrease of the oxygen content in the hot metal
- Q.4 Which one of the following refractory materials is **NOT** used in the BOF (LD) working lining? [Nptel Reference](#)
- (A) Tar-bonded dolomite (B) Pitch-bonded magnesite
(C) Fired and pitch-impregnated magnesite (D) Graphite-alumina composite
- Q.5 In the eutectoid steel, which one of the following structures **DOES NOT** form during continuous cooling? [Nptel Reference 1](#)
- (A) Fully pearlitic (B) Pearlitic + bainitic
(C) Fully bainitic (D) Martensitic [Nptel Reference 2](#)
- Q.6 Which one of the following is a ferrite stabilizer in steels? [Nptel Reference](#)
- (A) Ni (B) Cu (C) Cr (D) Mn
- Q.7 The angle between the line vector and the burgers vector of an edge dislocation is [Nptel Reference](#)
- (A) 0 degree (B) 90 degrees (C) 120 degrees (D) 180 degrees
- Q.8 In fracture toughness characterized by K_{IC} or J_{IC} , **I** in the subscript indicates loading by [Nptel Reference](#)
- (A) crack opening mode (B) forward shear mode
(C) parallel shear mode (D) perpendicular shear mode
- Q.9 In a brazing process the liquid metal fills the gap by which one of the following means? [Nptel Reference](#)
- (A) Capillary infiltration (B) Gravity infiltration
(C) Pressure infiltration (D) Vacuum infiltration

- Q.10 Which one of the following expands upon solidification?
 (A) Low carbon steel (B) High carbon steel Nptel Reference
 (C) White cast iron (D) Gray cast iron
- Q.11 For a simple cubic unit cell with unit vectors \mathbf{i} , \mathbf{j} and \mathbf{k} , the angle between lattice vectors [100] and [111] in degrees is
 (A) 35.2 (B) 54.7 (C) 60 (D) 90 Nptel Reference
- Q.12 The inflection point of a nonlinear function $U(r)$ is at
 (A) $U = 0$ (B) $\ln U = 0$ (C) $dU/dr = 0$ (D) $d^2U/dr^2 = 0$
 Nptel Reference1
 Nptel Reference2
- Q.13 One mole of element P is mixed with one mole of element Q. The entropy of mixing at 0 K is
 (A) 0 (B) $-R \ln 0.5$ (C) infinity (D) $-R \ln 2$ Nptel Reference
- Q.14 Zinc rod is immersed in dilute HCl (pure). If a very small amount of FeCl_3 is added to the solution, the corrosion rate of zinc
 (A) decreases (B) increases (C) remains constant (D) is zero (passivation)
 Nptel Reference 1
 Nptel Reference 2
- Q.15 A metal is electrochemically polarized to a potential which is higher than the standard reduction potential of the metal. The overvoltage will be
 (A) zero (B) negative Nptel Reference 1
 (C) positive (D) initially negative, then positive Nptel Reference 2
- Q.16 Aluminum is **NOT** commercially produced by carbo-thermic reduction primarily because
 (A) aluminum metal will have excessive dissolved oxygen Nptel Reference
 (B) it melts at too low a temperature
 (C) it does not vaporize at reasonable temperatures
 (D) $\text{Al-Al}_2\text{O}_3$ line is too low in the Ellingham diagram and needs excessively high temperatures
- Q.17 VOD process is preferred over AOD process for making extra-low carbon stainless steels because
 (A) p_{CO} can be lowered to a much lower level in the VOD than in the AOD Nptel Reference
 (B) AOD does not have adequate stirring
 (C) free-board needed for such operation is not available in the AOD
 (D) AOD refractory is not stable in contact with extra low carbon steel
- Q.18 In froth flotation, collector refers to a reagent which primarily
 (A) promotes bubble break-up and stabilizes the foam Nptel Reference 1
 (B) adsorbs on the surface of the mineral, and makes it hydrophobic Nptel Reference 2
 (C) promotes separation of the particles from the froth Nptel Reference 3
 (D) absorbs on the unwanted mineral and makes it sink

- Q.19 With the increase in the degree of supercooling, the growth rate of a nucleus follows which one of the following trends? Nptel Reference
- (A) First increases and then decreases
(B) First decreases and then increases
(C) Only increases
(D) Only decreases
- Q.20 For a fcc unit cell, the ratio of the number of tetrahedral voids to the number of atoms is Nptel Reference
- (A) 2:1
(B) 3:1
(C) 4:1
(D) 5:1
- Q.21 The material in which there is conduction primarily by holes is Nptel Reference1
- (A) conductor
(B) insulator
(C) p-type semiconductor
(D) n-type semiconductor Nptel Reference2
- Q.22 When load is applied to a material, 'instantaneous' strain develops with Nptel Reference
- (A) the speed of light
(B) half the speed of light
(C) the speed of sound
(D) infinite speed
- Q.23 For a given ductile material, which one of the following tensile properties obtained with non-standard specimen is **NOT** comparable to that obtained with standard specimen? Nptel Reference
- (A) Elongation to fracture
(B) Tensile strength
(C) Uniform elongation
(D) Yield strength
- Q.24 The nature of submerged arc welding flux with basicity index of 0.5 is Nptel Reference
- (A) neutral
(B) basic
(C) semi-basic
(D) acidic
- Q.25 Which one of the following carbon equivalent in steel is considered good for weldability? Nptel Reference
- (A) 1.0
(B) 0.8
(C) 0.6
(D) 0.4

Q. 26 to Q. 55 carry two marks each.

- Q.26 A box contains 5 white balls and 3 red balls. Two balls are withdrawn from the box randomly, one after another (without replacement). The probability that the two balls withdrawn are of different color is Nptel Reference
- (A) 15/64
(B) 25/64
(C) 25/56
(D) 30/56
- Q.27 For a reaction $A \rightarrow B$, if the rate of change in concentration of A (C_A), can be written as $-\frac{dC_A}{dt} = k.C_A^2$, then the change in concentration with time from initial concentration of A, C_{A0} , is given by Nptel Reference
- (A) $(1/C_A) - (1/C_{A0}) = k.t$
(B) $(C_{A0} - C_A) = k.t$
(C) $(C_{A0}^2 - C_A^2) = k.t$
(D) $\ln(C_{A0}/C_A) = k.t$

Q.28 $Y = k_1 \left[1 - \exp\left(-\frac{k_2 \Delta X}{k_3 X}\right) \right]$, where k_1 , k_2 and k_3 are constants. If $k_2 \Delta X \ll k_3 X$, the value of Y up to first order of approximation would be Nptel Reference

(A) $Y = k_1 \left[1 - \frac{k_2 \Delta X}{k_3 X} \right]$

(B) $Y = k_1 \left[1 + \frac{k_2 \Delta X}{k_3 X} \right]$

(C) $Y = k_1 \frac{k_2 \Delta X}{k_3 X}$

(D) $Y = -k_1 \frac{k_2 \Delta X}{k_3 X}$

Q.29 A large set of data for a given measurement has been found to be normally distributed around a mean μ , with standard deviation σ . Which of the following limits would have about 95% of the data points around the mean and rest outside? Nptel Reference 1

(A) $\mu - 0.5\sigma$ and $\mu + 0.5\sigma$

(B) $\mu - \sigma$ and $\mu + \sigma$

(C) $\mu - 2\sigma$ and $\mu + 2\sigma$

(D) $\mu - 3\sigma$ and $\mu + 3\sigma$ Nptel Reference 2

Q.30 During fully developed laminar flow in a circular pipe, the velocity profile is parabolic, and symmetric around the axis. The velocity at the tube wall is zero. The ratio of the average velocity to the maximum velocity is Nptel Reference

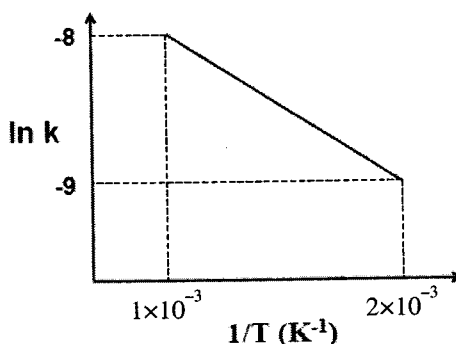
(A) 1/3

(B) 1/2

(C) 2/3

(D) 3/4

Q.31 If k is the rate constant for a reaction and T is the absolute temperature in the given figure, the activation energy for the reaction is Nptel Reference 1



Nptel Reference 2

(A) 1000 J/mol

(B) 2000 J/mol

(C) 4155 J/mol

(D) 8314 J/mol

Q.32 $2\text{Cu (s)} + 0.5\text{O}_2\text{ (g)} = \text{Cu}_2\text{O (s)}$ $\Delta G^0 = -162200 + 69.24T$, J Nptel Reference
 $2\text{Cu (l)} + 0.5\text{O}_2\text{ (g)} = \text{Cu}_2\text{O (s)}$ $\Delta G^0 = -188300 + 88.48T$, J

The molar free energy change at 1300 K for the transformation of solid Cu to liquid Cu will be

(A) 1050 J

(B) 960 J

(C) 544 J

(D) 445 J

Q.33 $\text{Al}_2\text{O}_3 + 6\text{H}^+ + 6\text{e} = 3\text{H}_2\text{O} + 2\text{Al}$ $\Delta G^0 = 897.3$ kJ

where, hydrogen ion concentration is unity. The reduction potential of the above reaction under standard state will be Nptel Reference

(A) -1.55 V

(B) -1.40 V

(C) 1.65 V

(D) 1.75 V

Q.34 $G = U + PV - TS$

Then which one of the following is **CORRECT**?

Nptel Reference

(A) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial S}{\partial P}\right)_T$

(B) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

(C) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial P}{\partial S}\right)_T$

(D) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial P}{\partial S}\right)_T$

Q.35 Match the metals in **Group I** with the corresponding ores in **Group II**.

Group I

- P. Lead
Q. Zinc
R. Uranium
S. Niobium

Group II

1. Columbite
2. Cassiterite
3. Galena
4. Pitchblende
5. Sphalerite

Nptel Reference

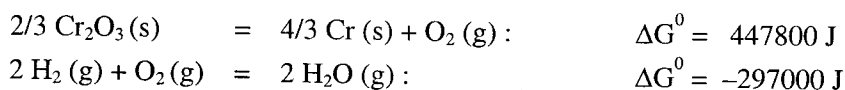
(A) P-3, Q-5, R-2, S-4

(B) P-3, Q-2, R-5, S-4

(C) P-3, Q-5, R-4, S-1

(D) P-3, Q-4, R-5, S-2

Q.36 For the following reactions, the standard free energy change is given at 1773 K as follows



Nptel Reference

If chromium oxide powder has to be reduced by hydrogen in a fluidized bed, the minimum $p_{\text{H}_2}/p_{\text{H}_2\text{O}}$ ratio that has to be maintained at the exit of the reactor is

- (A) 8.5 (B) 10.6 (C) 100.2 (D) 166.5

Q.37 The hydrogen content of steel in equilibrium with hydrogen gas at 1 bar pressure is 28 ppm at some temperature. Hydrogen content in the metal at the same temperature gets reduced to 1 ppm, when the equilibrium p_{H_2} changes to

- (A) 28 bar (B) 1/28 bar (C) $(1/28)^{1.5}$ bar (D) $(1/28)^2$ bar

Q.38 A furnace wall consists of two layers. The inside layer of 450 mm is made of light weight bricks of thermal conductivity 1 W/m.K and the outside layer of 900 mm is made of refractory of thermal conductivity 2 W/m.K. The hot face of the inside layer is at temperature 1300 K and the cold face of the outer layer is at 400 K. The temperature at the interface between the two layers is

- (A) 1000 K (B) 850 K (C) 700 K (D) 600 K Nptel Reference

Q.39 Match the heat treatment processes in **Group I** with resultant microstructure of steel in **Group II**.

Group I

- P. Martempering
Q. Normalising
R. Subcritical annealing for long time
S. Full annealing

Group II

1. Coarse Pearlite
2. Fine Pearlite
3. Tempered martensite
4. Spheroidised cementite in the matrix of ferrite

Nptel Reference 1

Nptel Reference 2

Nptel Reference 3

Nptel Reference 4

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

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

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

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

Q.40 In case of homogeneous nucleation, the critical edge length for a cube shaped nucleus is (γ : Energy per unit area of the interface between the product and the parent phase; Δg : Gibbs free energy change per unit volume) [Nptel Reference](#)

- (A) $-4\gamma/\Delta g$ (B) $-2\gamma/\Delta g$ (C) $\gamma/\Delta g$ (D) $-3\gamma/\Delta g$

Q.41 For a cubic metal with lattice parameter of 3.92 Å, the first four diffraction peaks from the X-ray powder diffraction pattern taken with CuK_α radiation ($\lambda = 1.5405 \text{ \AA}$) occur at 2θ values of 39.7, 46.2, 67.5, and 81.3 degrees. The crystal structure of the metal is [Nptel Reference1](#)

- (A) simple cubic (B) fcc (C) bcc (D) diamond cubic [Nptel Reference2](#)

Q.42 The largest size of immobilized segment of dislocation in a Frank Read (FR) source contained in a polycrystalline material is of the order of grain size. In a metal of 10 μm grain size, the shear stress required to operate such a FR source is 100 MPa. If the grain size in the same metal is reduced to 10 nm, the shear stress required to operate such FR source would be [Nptel Reference](#)

- (A) 10^2 MPa (B) 10^3 MPa (C) 10^5 MPa (D) 10^6 MPa

Q.43 Which one of the following reactions in fcc/bcc crystals with lattice parameter ' a ' is energetically favorable? [Nptel Reference](#)

- (A) $\frac{a}{2}[\bar{1}10] + \frac{a}{2}[0\bar{1}1]$ (B) $\frac{a}{2}[\bar{1}10] + \frac{a}{2}[\bar{1}10]$
 (C) $\frac{a}{2}[111] + \frac{a}{2}[11\bar{1}]$ (D) $\frac{a}{2}[111] + \frac{a}{2}[111]$

Q.44 Match the hardness test methods in **Group I** with the indenter used in **Group II**. [Nptel Reference 1](#)

Group I

- P. Brinell hardness
 Q. Vickers hardness
 R. Rockwell C hardness
 S. Rockwell B hardness

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

Group II

1. Brale indenter
 2. Square base diamond pyramid
 3. 10 mm diameter steel ball
 4. 1.6 mm diameter steel ball

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

[Nptel Reference 2](#)

Q.45 Assertion '**a**' : During casting of aluminium, grain refinement can be achieved by addition of certain alloying elements.

Reason '**r**' : The addition of the alloying element may result in the formation of deoxidation products or intermetallic compounds which may act as nucleation sites for grain refinement.

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

[Nptel Reference](#)

Q.46 Match those listed in **Group I** with the NDT methods listed in **Group II**.

Group I

- P. Penetrant
Q. Differential coil probe
R. Piezo-electric probe
S. Developer

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

Group II

1. Ultrasonic test
2. Dye-penetrant test
3. X-Ray radiography
4. Acoustic emission test

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

[Nptel Reference](#)

Q.47 Match the manufacturing process of **Group I** to be used for producing the product in **Group II**.

Group I

- P. Drawing
Q. Forging
R. Rolling
S. Stretch forming

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

Group II

1. Large curved disc
2. Tube
3. Crank shaft
4. Plate

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

[Nptel Reference](#)**Common Data Questions****Common data for Questions 48 and 49:**

An aluminium billet of 300 mm diameter is extruded with an extrusion ratio of 16.

Q.48 What is the diameter of the final product?

- (A) 150 mm (B) 75 mm (C) 59 mm (D) 19 mm

[Nptel Reference](#)

Q.49 What is the ideal extrusion pressure if the effective flow stress in compression is 250 MPa?

- (A) 693 MPa (B) 346 MPa (C) -346 MPa (D) -703 MPa

[Nptel Reference](#)**Common data for Questions 50 and 51:**

A binary phase diagram of components P and Q displays an eutectoid reaction with terminal solid solutions α on the P rich side and β on the Q rich side. At the eutectoid temperature, the solubilities of Q in α and β are 5 and 90 wt%, respectively. The densities of α and β phases are 9.5 and 2.49 g/cm³, respectively.

Q.50 At the eutectoid point, the alloy has α and β in the weight ratio 1:1. The eutectoid point occurs at composition

[Nptel Reference 1](#)

- (A) 46 wt % Q (B) 47.5 wt % Q (C) 50 wt % Q (D) 52.5 wt % Q

[Nptel Reference 2](#)

Q.51 At the eutectoid temperature, the ratio of α and β phases in the specimen observed under microscope is

- (A) 0.50 (B) 0.40 (C) 0.25 (D) 0.20

[Nptel Reference](#)

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

In an ideal blast furnace, the input and output are as follows:

Input:

Ore : Pure Fe_2O_3 , no gangue	:	1357 kg/ THM [#]
Coke : Pure C, no ash	:	400 kg/THM
Blast air : dry :	O_2 :	293 kg/THM
	N_2 :	964 kg/THM

Flux : nil

Output:

Hot Metal	:	5 wt% C, rest iron
Slag	:	nil
Top gas	:	CO , CO_2 , N_2

[#] THM refers to 1 ton hot metal (liquid pig iron); Atomic weights : C-12, O-16, Fe-56

- Q.52 The amount of oxygen in CO and CO_2 leaving with the top gas is [Nptel Reference 1](#)
- (A) 293 kg (B) 407 kg (C) 700 kg (D) 1050 kg [Nptel Reference 2](#)
- [Nptel Reference 3](#)
- Q.53 The CO/CO_2 molar ratio in the top gas is [Nptel Reference 1](#)
- (A) 0.9 (B) 1.0 (C) 1.1 (D) 1.5 [Nptel Reference 2](#)
- [Nptel Reference 2](#)

Statement for Linked Answer Questions 54 and 55:

Shear modulus of copper is 45 GPa. Lattice parameter of copper is 3.61 Å

- Q.54 The magnitude of burgers vector in copper is [Nptel Reference](#)
- (A) 2.54 Å (B) 2.39 Å (C) 2.20 Å (D) 2.18 Å
- Q.55 The elastic strain energy per unit length of dislocation line in copper is [Nptel Reference](#)
- (A) 34.8×10^{-10} N (B) 28.8×10^{-10} N (C) 24.8×10^{-10} N (D) 14.5×10^{-10} N

General Aptitude (GA) Questions**Q. 56 – Q. 60 carry one mark each.**

- Q.56 Choose the word from the options given below that is most nearly opposite in meaning to the given word:

Frequency

- (A) periodicity
- (B) rarity
- (C) gradualness
- (D) persistency

- Q.57 Choose the most appropriate word from the options given below to complete the following sentence:

It was her view that the country's problems had been _____ by foreign technocrats, so that to invite them to come back would be counter-productive.

- (A) identified
- (B) ascertained
- (C) exacerbated
- (D) analysed

- Q.58 There are two candidates P and Q in an election. During the campaign, 40% of the voters promised to vote for P, and rest for Q. However, on the day of election 15% of the voters went back on their promise to vote for P and instead voted for Q. 25% of the voters went back on their promise to vote for Q and instead voted for P. Suppose, P lost by 2 votes, then what was the total number of voters?

- (A) 100 (B) 110 (C) 90 (D) 95

- Q.59 The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair:

Gladiator : Arena

- (A) dancer : stage
- (B) commuter : train
- (C) teacher : classroom
- (D) lawyer : courtroom

- Q.60 Choose the most appropriate word from the options given below to complete the following sentence:

Under ethical guidelines recently adopted by the Indian Medical Association, human genes are to be manipulated only to correct diseases for which _____ treatments are unsatisfactory.

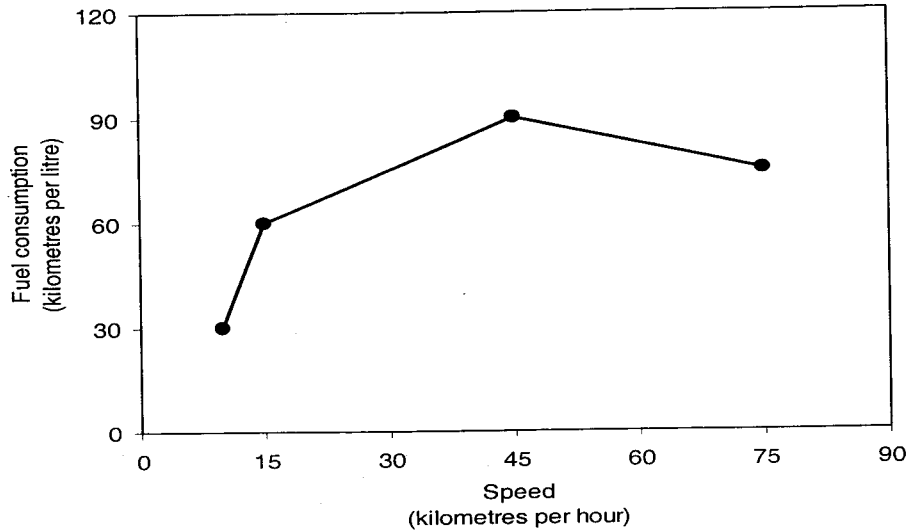
- (A) similar
- (B) most
- (C) uncommon
- (D) available

Q. 61 to Q. 65 carry two marks each.

- Q.61 Given that $f(y) = |y|/y$, and q is any non-zero real number, the value of $|f(q) - f(-q)|$ is

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

- Q.62 Three friends, R, S and T shared toffee from a bowl. R took $\frac{1}{3}^{\text{rd}}$ of the toffees, but returned four to the bowl. S took $\frac{1}{4}^{\text{th}}$ of what was left but returned three toffees to the bowl. T took half of the remainder but returned two back into the bowl. If the bowl had 17 toffees left, how many toffees were originally there in the bowl?
- (A) 38 (B) 31 (C) 48 (D) 41
- Q.63 The fuel consumed by a motorcycle during a journey while traveling at various speeds is indicated in the graph below.



The distances covered during four laps of the journey are listed in the table below

Lap	Distance (kilometres)	Average speed (kilometres per hour)
P	15	15
Q	75	45
R	40	75
S	10	10

From the given data, we can conclude that the fuel consumed per kilometre was least during the lap

- (A) P (B) Q (C) R (D) S
- Q.64 **The horse has played a little known but very important role in the field of medicine. Horses were injected with toxins of diseases until their blood built up immunities. Then a serum was made from their blood. Serums to fight with diphtheria and tetanus were developed this way.** It can be inferred from the passage, that horses were
- (A) given immunity to diseases
 (B) generally quite immune to diseases
 (C) given medicines to fight toxins
 (D) given diphtheria and tetanus serums
- Q.65 The sum of n terms of the series $4+44+444+\dots$ is
- (A) $(4/81) [10^{n+1} - 9n - 1]$
 (B) $(4/81) [10^{n-1} - 9n - 1]$
 (C) $(4/81) [10^{n+1} - 9n - 10]$
 (D) $(4/81) [10^n - 9n - 10]$

END OF THE QUESTION PAPER