Q. 1 – Q. 5 carry one mark each.

Q.1 "Going by the _____ that many hands make light work, the school _____ involved all the students in the task."

The words that best fill the blanks in the above sentence are

(A) principle, principal
(B) principal, principle
(C) principle, principle
(D) principal, principal

Q.2 "Her _____ should not be confused with miserliness; she is ever willing to assist those in need."

The word that best fills the blank in the above sentence is

(A) cleanliness (B) punctuality (C) frugality (D) greatness

Q.3 Seven machines take 7 minutes to make 7 identical toys. At the same rate, how many minutes would it take for 100 machines to make 100 toys?

(A) 1 (B) 7 (C) 100 (D) 700

Q.4 A rectangle becomes a square when its length and breadth are reduced by 10 m and 5 m, respectively. During this process, the rectangle loses 650 m^2 of area. What is the area of the original rectangle in square meters?

(A) 1125 (B) 2250 (C) 2924 (D) 4500

Q.5 A number consists of two digits. The sum of the digits is 9. If 45 is subtracted from the number, its digits are interchanged. What is the number?

(A) 63 (B) 72 (C) 81 (D) 90

Q. 6 – Q. 10 carry two marks each.

Q.6 For integers a, b and c, what would be the minimum and maximum values respectively of $a + b + c$ if $\log|a| + \log|b| + \log|c| = 0$?

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

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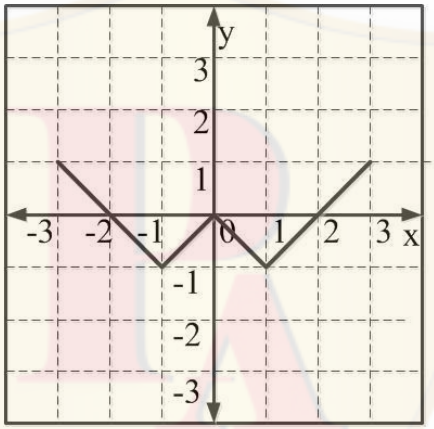
Q.7 Given that a and b are integers and $a + a^2 b^3$ is odd, which one of the following statements is correct?

(A) a and b are both odd
(B) a and b are both even
(C) a is even and b is odd
(D) a is odd and b is even

Q.8 From the time the front of a train enters a platform, it takes 25 seconds for the back of the train to leave the platform, while travelling at a constant speed of 54 km/h. At the same speed, it takes 14 seconds to pass a man running at 9 km/h in the same direction as the train. What is the length of the train and that of the platform in meters, respectively?

(A) 210 and 140
(B) 162.5 and 187.5
(C) 245 and 130
(D) 175 and 200

Q.9 Which of the following functions describe the graph shown in the below figure?



(A) $y = \big||x| + 1\big| - 2$
(B) $y = \big||x| - 1\big| - 1$
(C) $y = \big||x| + 1\big| - 1$
(D) $y = \big||x - 1| - 1\big|$

Q.10 Consider the following three statements:
(i) Some roses are red.
(ii) All red flowers fade quickly.
(iii) Some roses fade quickly.

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

(A) If (i) is true and (ii) is false, then (iii) is false.
(B) If (i) is true and (ii) is false, then (iii) is true.
(C) If (i) and (ii) are true, then (iii) is true.
(D) If (i) and (ii) are false, then (iii) is false.

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XL-P: Q. 1 – Q. 5 carry one mark each & Q. 6 – Q. 15 carry two marks each

Q.1 For the complete combustion of graphite and diamond in oxygen individually, the standard enthalpy change (ΔH^o_{298}) values are –393.5 kJ mol^{-1} and –395.4 kJ mol^{-1}, respectively. Then, the ΔH^o_{298} for the conversion of graphite into diamond is

(A) +1.9 kJ mol^{-1} (B) –1.9 kJ mol^{-1} (C) +3.8 kJ mol^{-1} (D) –3.8 kJ mol^{-1}

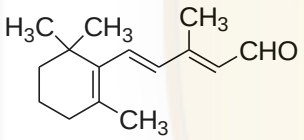
Q.2 For a 4*s* orbital of hydrogen atom, the magnetic quantum number (m_l) is

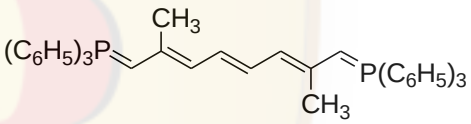
(A) 4 (B) 3 (C) 1 (D) 0

Q.3 Hybridization of xenon in XeF_2 is

(A) sp (B) sp^2 (C) sp^3 (D) sp^{3}d

Q.4 Two equivalents of **P** react with one equivalent of **Q** to produce a major product **R**.

P = 

Q = 

The number of double bonds present in the major product **R** is _____.

Q.5 The total number of possible stereoisomers for the compound with the structural formula $CH_3CH(OH)CH{=}CHCH_2CH_3$ is _____.

Q.6 Among B–H, C–H, N–H and Si–H bonds in BH_3, CH_4, NH_3 and SiH_4, respectively, the polarity of the bond which is shown **INCORRECTLY** is

(A) $B^{\delta+}–H^{\delta-}$ (B) $C^{\delta-}–H^{\delta+}$ (C) $N^{\delta-}–H^{\delta+}$ (D) $Si^{\delta-}–H^{\delta+}$

Q.7 Among the following statements,

(i) $[NiCl_4]^{2-}$ (atomic number of Ni = 28) is diamagnetic
(ii) Ethylamine is a weaker Lewis base compared to pyridine
(iii) $[NiCl_2\{P(C_6H_5)_3\}_2]$ has two geometrical isomers
(iv) Bond angle in H_2O is greater than that in H_2S,

the **CORRECT** one is

(A) (i) (B) (ii) (C) (iii) (D) (iv)

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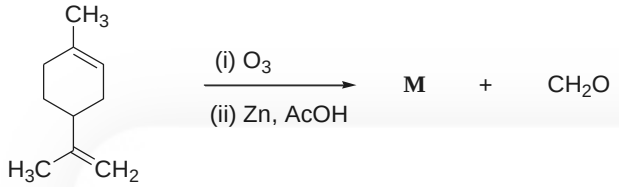
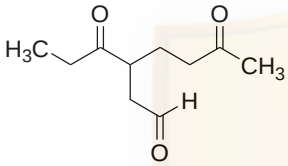
Q.8 In $[Mn(H_2O)_6]^{2+}$ (atomic number of Mn = 25), the d-d transitions according to crystal field theory (CFT) are

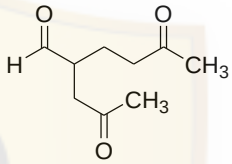
(A) Laporte forbidden and spin forbidden
(B) Laporte allowed and spin allowed
(C) Laporte forbidden and spin allowed
(D) Laporte allowed and spin forbidden

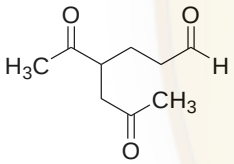
Q.9 The major product **M** in the reaction

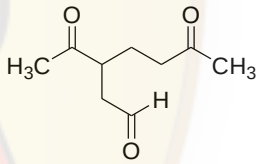


is

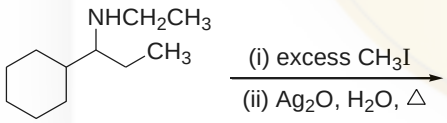
(A)


(B)


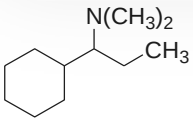
(C)


(D)


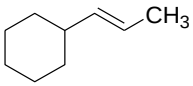
Q.10 The two major products of the reaction



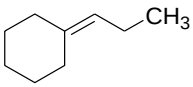
are

(A)


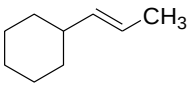
and $CH_2=CH_2$

(B)


and $N(CH_3)_2CH_2CH_3$

(C)


and $N(CH_3)_2CH_2CH_3$

(D)


and $HN(CH_3)CH_2CH_3$

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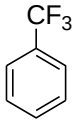
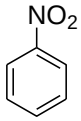
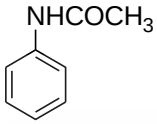
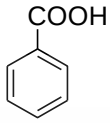
Q.11 The compound, which upon mono-nitration using a mixture of HNO_3 and H_2SO_4, does **NOT** give the *meta*-isomer as the major product, is

(A) 

(B) 

(C) 

(D) 

Q.12 The standard reduction potential (E^o) for the conversion of $Cr_2O_7^{2-}$ to Cr^{3+} at 25 °C in an aqueous solution of pH 3.0 is 1.33 V. The concentrations of $Cr_2O_7^{2-}$ and Cr^{3+} are 1.0×10^{-4} M and 1.0×10^{-3} M, respectively. Then the potential of this half-cell reaction is (**Given:** Faraday constant = 96500 C mol^{-1}, Gas constant R = 8.314 J K^{-1} mol^{-1})

(A) 1.04 V (B) 0.94 V (C) 0.84 V (D) 0.74 V

Q.13 The solubility product (K_{sp}) of $Mg(OH)_2$ at 25 °C is 5.6×10^{-11}. Its solubility in water is **S** $\times 10^{-2}$ g/L, where the value of **S** is _____ (up to two decimal places).
(**Given:** Molecular weight of $Mg(OH)_2$ = 58.3 g mol^{-1})

Q.14 The activation energy (E_a) values for two reactions carried out at 25 °C differ by 5.0 kJ mol^{-1}. If the pre-exponential factors (A_1 and A_2) for these two reactions are of the same magnitude, the ratio of rate constants (k_1/k_2) is _____ (up to two decimal places).
(**Given:** Gas constant R = 8.314 J K^{-1} mol^{-1})

Q.15 One mole of helium gas in an isolated system undergoes a reversible isothermal expansion at 25 °C from an initial volume of 2.0 liters to a final volume of 10.0 liters. The change in entropy (ΔS) of the surroundings is _____ J K^{-1} (up to two decimal places).
(**Given:** Gas constant R = 8.314 J K^{-1} mol^{-1})

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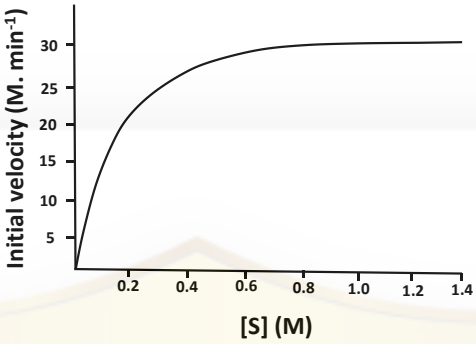
Q. 1 – Q. 10 carry one mark each & Q.11 - Q.20 carry two marks each.

Q.1 To which one of the following classes of enzymes does chymotrypsin belong?

(A) Oxidoreductase (B) Hydrolase (C) Transferase (D) Isomerase

Q.2 The substrate saturation profile of an enzyme that follows Michaelis-Menten kinetics is depicted in the figure. What is the order of the reaction in the concentration range between 0.8 to 1.4 M?

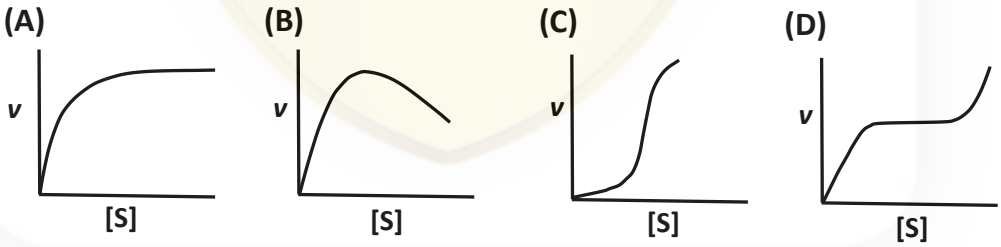


(A) Zero (B) Fraction (C) First (D) Second

Q.3 Which one of the following conformations of glucose is most stable?

(A) Boat (B) Half Chair (C) Chair (D) Planar

Q.4 Which one of the following profiles represent the phenomenon of cooperativity?



Q.5 Which one of the following amino acids is responsible for the intrinsic fluorescence of proteins?

(A) Pro (B) Met (C) His (D) Trp

Q.6 The glycosylation of the proteins occurs in_____.

(A) glyoxysomes (B) lysosomes
(C) Golgi apparatus (D) plasma membrane

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Q.7 Which one of the following properties of the myeloma cells is used in the hybridoma technology to generate monoclonal antibody?

(A) lack of thymidylate synthase
(B) over-expression of hypoxanthine-guanine phosphoribosyl transferase
(C) over-expression of inosine 5´-monophosphate cyclohydrolase
(D) lack of hypoxanthine-guanine phosphoribosyl transferase

Q.8 The movement of protons through the F_oF_1-ATPase during mitochondrial respiration is required for ____

(A) the increase in pH of mitochondrial matrix.
(B) changing the conformation of F_oF_1-ATPase to expel the ATP.
(C) importing P_i from inter membrane space.
(D) decreasing the affinity of ADP to F_oF_1-ATPase.

Q.9 The number of $NADP^+$ molecules required to completely oxidize one molecule of glucose to CO_2 through pentose phosphate pathway is ____ (correct to integer number).

Q.10 Measurement of the absorbance of a solution containing NADH in a path length of 1cm cuvette at 340 nm shows the value of 0.31. The molar extinction coefficient of NADH is 6200 M^{-1} cm^{-1}. The concentration of NADH in the solution is ___ µM (correct to integer number).

Q. 11 – Q. 20 carry two marks each.

Q.11 Among the reagents given below which one of the combination of reagents will **NOT** break the disulphide bonds in the immunoglobulin molecules?

(P) Reduced glutathione (Q) Dithiothritol
(R) Sodium dodecyl sulphate (S) Methionine

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

Q.12 Match the protein elution condition given in **Group I** with the appropriate chromatography matrices from **Group II**.

	Group I		Group II
P	Increasing concentration of sodium chloride	**i**	Phenyl-Sepharose
Q	Increasing concentration of histidine	**ii**	Chromatofocusing
R	Decreasing concentration of ammonium sulphate	**iii**	DEAE-Sephacryl
S	Decreasing concentration of H^+	**iv**	Ni-NTA

(A) P-iii; Q-iv; R-i; S-ii (B) P-ii; Q-iv; R-i; S-iii
(C) P-i; Q-ii; R-iii; S-iv (D) P- iv; Q-ii; R-iii; S-i

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Q.13 Which one of the following is **NOT** a neurotransmitter?

(A) Adrenaline (B) Glutamate (C) Histamine (D) Histidine

Q.14 The type-II hypersensitivity reaction is mainly mediated by____.

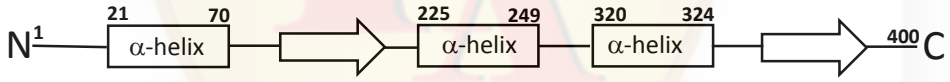
(A) IgE (B) IgM (C) IgA (D) T cells

Q.15 Which one the following reaction mechanisms drives the conversion of low energy 3-phosphoglyceraldehyde to high energy 1,3-bisphosphoglycerate?

(A) Oxidation without anhydride bond formation
(B) Oxidation coupled with anhydride bond formation
(C) Substrate level phosphorylation
(D) Formation of carboxylate

Q.16 A polymerase reaction is carried out for 10 cycles in a volume of 1 ml with 5 molecules of template DNA. Assuming that the efficiency of the reaction is 100 %, the number of molecules of DNA present in 100 μl at the end of the reaction is ___ (correct to integer number).

Q.17 The secondary structure topology diagram of 400 amino acid long "Protein-X" is depicted in the figure. The start and end amino acid residue numbers of each α-helix are marked. The percentage (correct to integer number) of residues forming α-helix is____.



Q.18 An enzyme follows Michaelis-Menten kinetics with substrate S. The fraction of the maximum velocity (V_{max}) will be observed with the substrate concentration [S] = $4K_m$ is _____ (correct to one decimal place). (K_m is Michaelis-Menten constant)

Q.19 The mass spectrum of benzoic acid will generate the fragment as a base peak (100% relative abundance) of *m/z* (mass to charge ratio) at ____ (correct to integer number).

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Q.20 The standard free energy (ΔG´) values of reactions catalyzed by citrate lyase and citrate synthetase are -670 and -8192 cal/mol, respectively.

$$\text{Citrate} \xrightleftharpoons{\text{Citrate lyase}} \text{Acetate + Oxaloacetate} \quad \Delta G_1' = -670 \text{ cal/mole}$$

$$\text{Acetyl-CoA + Oxaloacetate + } H_2O \xrightleftharpoons{\text{Citrate synthetase}} \text{Citrate + CoA} \quad \Delta G_2' = -8192 \text{ cal/mole}$$

The standard free energy (in cal/mol) of acetyl-CoA hydrolysis is ___ (correct to integer number).

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XL-R: Q. 1 – Q. 10 carry one mark each & Q. 11 – Q. 20 carry two marks each.

Q.1 Which of the following genera produces dimorphic seeds that help to broaden the time of germination in a variable habitat?

(A) *Xanthium* (B) *Pisum* (C) *Mangifera* (D) *Linum*

Q.2 The genes for microRNA (miRNA) in plants are usually transcribed by

(A) RNA polymerase I
(B) RNA polymerase II
(C) RNA polymerase III
(D) RNA polymerase IV

Q.3 Which of the statements is **TRUE** for transposable elements *Ac* and *Ds*?

(A) Both *Ac* and *Ds* are autonomous because they encode their own transposase
(B) Both *Ac* and *Ds* are non-autonomous because they do not encode their own transposase
(C) Only *Ac* is autonomous because it encodes its own transposase
(D) Only *Ds* is autonomous because it encodes its own transposase

Q.4 Identify the **CORRECT** statement.

(A) Receptor-like kinases play role in gametophytic self-incompatibility in Brassicaceae
(B) Receptor-like kinases play role in sporophytic self-incompatibility in Solanaceae
(C) Ribonucleases play role in sporophytic self-incompatibility in Brassicaceae
(D) Ribonucleases play role in gametophytic self-incompatibility in Solanaceae

Q.5 Which of the following statements is **TRUE** for an ecotone?

(A) An ecotone is the synonym of an ecosystem
(B) An ecotone is an interface zone of two or more ecosystems
(C) An ecotone is a special feature of land biomes
(D) An ecotone is exclusively characterized by decreased biodiversity

Q.6 Acid rain with a pH of 4.0 is more acidic than the rain with a pH of 6.0 by

(A) 2 times (B) 10 times (C) 100 times (D) 1000 times

Q.7 Which of the following plants produces Ylang-ylang oil?

(A) *Cananga odorata*
(B) *Carcum copticum*
(C) *Pandanus odoratissimus*
(D) *Pimenta racemosa*

Q.8 Identify the **INCORRECT** statement in connection with polar transport of auxin.

(A) The putative influx carrier AUX1 is a cytosolic protein
(B) Polar auxin transport in root tends to be both acropetal and basipetal in direction
(C) Naphthylphthalamic acid (NPA) is an inhibitor of polar auxin transport
(D) AUX1 and PIN1 proteins are located in the opposite ends of a cell for polar transport

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Q.9 Which of the following stains is used to visualize callose under the microscope?

(A) Alcian blue (B) Aniline blue (C) Toluidine blue (D) Thymol blue

Q.10 The coding sequence of a gene *XLR18* has the single ORF of 783 bp. The approximate molecular weight of the XLR18 protein in kDa is _____.

Q.11 Statements given below are either **TRUE** (**T**) or **FALSE** (**F**). Select the **CORRECT** combination.

P. Mitosis occurs exclusively in diploid mother cell
Q. Mitosis occurs both in diploid and haploid mother cells
R. Meiosis occurs exclusively in diploid mother cell
S. Meiosis occurs both in diploid and haploid mother cells

(A) P-T, Q-F, R-T, S-F
(B) P-F, Q-T, R-F, S-T
(C) P-T, Q-F, R-F, S-T
(D) P-F, Q-T, R-T, S-F

Q.12 You are asked to design a genetic construct for high-level expression of a gene encoding the therapeutic protein 18 (TP18) via plastid transformation. Select the **CORRECT** set of genetic elements for this construct.

(A) Actin1 promoter → TP18 coding sequence → Actin1 transcription terminator
(B) Ubiquitin1 promoter → TP18 coding sequence → Ubiquitin1 transcription terminator
(C) rbcS promoter → TP18 coding sequence → rbcS transcription terminator
(D) rbcL promoter → TP18 coding sequence → rbcL transcription terminator

Q.13 Select the **CORRECT** combination of the following statements.

P. The cyclic electron transport chain involving PSI results in net production of both ATP and NADPH
Q. The cyclic electron transport chain involving PSI results in net production of ATP
R. Rubisco enzyme usually converts RuBP and CO_2 into 2-phosphoglycolate and 3-phosphoglycerate
S. Rubisco enzyme usually converts RuBP and O_2 into 2-phosphoglycolate and 3-phosphoglycerate

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

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Q.14 Match the fruit characters with their families and representative plant species.

Fruit character	**Family**	**Plant species**
P. Syconus	1. Moraceae	i. *Canavalia ensiformis*
Q. Capsule, opening by apical pores or valves	2. Fabaceae	ii. *Artabotrys odoratissimus*
R. Legume	3. Papaveraceae	iii. *Ficus religiosa*
S. An etaerio of drupe	4. Annonaceae	iv. *Papaver somniferum*
		v. *Pistacia vera*
		vi. *Citrus aurantium*

(A) P-2-iv, Q-3-ii, R-1-vi, S-4-v
(B) P-1-iii, Q-3-iv, R-2-i, S-4-ii
(C) P-3-i, Q-2-iii, R-4-ii, S-1-vi
(D) P-4-v, Q-1-ii, R-2-v, S-3-i

Q.15 Select the **CORRECT** combination by matching the disease, affected plant and the causal organism.

Disease	**Affected plant**	**Causal organism**
P. Black rot	1. Corn	i. *Fusarium oxysporum* f.sp. *cubense*
Q. Loose smut	2. Banana	ii. *Acidovorax avenae* subsp. *citrulli*
R. Panama wilt	3. Watermelon	iii. *Botryosphaeria obtusa*
S. Bacterial fruit blotch	4. Apple	iv. *Ustilago maydis*
		v. *Plasmopara viticola*
		vi. *Venturia inaequalis*

(A) P-2-v, Q-1-iv, R-3-iii, S-4-vi
(B) P-2-ii, Q-1-i, R-4-iii, S-3-i
(C) P-4-iii, Q-1-iv, R-2-i, S-3-ii
(D) P-4-vi, Q-1-iii, R-3-ii, S-2-v

Q.16 Select the **CORRECT** combination by matching **Group-I** with **Group-II**.

Group-I	**Group-II**
P. Photorespiration	1. Glutamate → 2-Oxglutarate
Q. Respiration	2. Acetyl-CoA → Malonyl-CoA
R. Amino acid degradation	3. 2-Oxglutarate → Succinyl-CoA
S. Fatty acid synthesis	4. Glycine → Serine

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

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Q.17 Match the plant alkaloids with their uses and source species.

Alkaloid	**Use**	**Source species**
P. Codeine	1. Stimulant	i. *Hyoscyamus niger*
Q. Caffeine	2. Analgesic	ii. *Catharanthus roseus*
R. Scopolamine	3. Antineoplastic	iii. *Cola nitida*
S. Vinblastine	4. Anticholinergic	iv. *Papaver somniferum*
		v. *Coptis japonica*
		vi. *Senecio jacobaea*

(A) P-2-iv, Q-1-iii, R-4-i, S-3-ii
(B) P-4-iii, Q-2-v, R-1-vi, S-3-i
(C) P-2-v, Q-1-vi, R-3-iv, S-4-ii
(D) P-3-ii, Q-4-iii, R-1-iv, S-2-i

Q.18 Identify the **CORRECT** combination of statements with respect to chemical defense in plants.

P. Pisatin, a phytoalexin produced by *Ricinus communis* is a constitutive defense compound
Q. *Phaseolus vulgaris* produces Phaseolus agglutinin I, which is toxic to the cowpea weevil
R. A single step non-enzymatic hydrolysis of cyanogenic glycoside releases the toxic hydrocyanic acid (HCN) to protect plant against herbivores and pathogens
S. Avenacin, a triterpenoid saponin from oat prevents infection by *Gaeumannomyces graminis*, a major pathogen of cereal roots

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

Q.19 In garden pea, dwarf plants with terminal flowers are recessive to tall plants with axial flowers. A true-breeding tall plant with axial flowers was crossed with a true-breeding dwarf plant with terminal flowers. The resulting F_1 plants were testcrossed, and the following progeny were obtained:

Tall plants with axial flowers = 320
Dwarf plants with terminal flowers = 318
Tall plants with terminal flowers = 79
Dwarf plants with axial flowers = 83

The map distance between the genes for plant height and flower position is_____cM.

Q.20 Two true-breeding snapdragon (*Antirrhinum majus*) plants, one with red flowers and another with white flowers were crossed. The F_1 plants were all with pink flowers. When the F_1 plants were selfed, they produced three kinds of F_2 plants with red, pink and white flowers in a 1:2:1 ratio. The probability that out of the five plants picked up randomly, two would be with pink flowers, two with white flowers and one with red flowers is _____%.

END OF THE QUESTION PAPER

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XL (S): Q. 1 – Q. 10 carry one mark each & Q. 11 – Q. 20 carry two marks each.

Q.1 David Baltimore's classification of viruses is based on differences in

(A) host cell receptors used by viruses
(B) the pathways required to synthesize virus mRNA
(C) the modes of transmission of viruses
(D) the envelope proteins on the surface of viruses

Q.2 Which of the following immune system components can function as an opsonin?

(A) Antibodies (B) T-cell receptors
(C) Histamines (D) Interferons

Q.3 The oral polio vaccine (OPV) consists of

(A) live attenuated virus (B) killed virus
(C) viral toxin (D) viral capsid subunit

Q.4 Which of the following eukaryotic cellular components carries out intracellular degradation during autophagy?

(A) Nucleus (B) Golgi bodies (C) Ribosomes (D) Lysosomes

Q.5 Analysis of DNA sequences suggest that eukaryotic mitochondrial genomes primarily originated from

(A) fungi (B) protozoa (C) algae (D) bacteria

Q.6 Binomial nomenclature has NOT yet been adopted for

(A) bacteria (B) fungi (C) viruses (D) protozoa

Q.7 Which of the following is NOT an accepted method for sterilization?

(A) Autoclaving (B) X-rays
(C) Gamma rays (D) UV rays

Q.8 The primary product of nitrogen fixation is

(A) N_2 (B) NH_4^+ (C) NO_2^- (D) NO_3

Q.9 In humans, the key stages in the life cycle of malarial parasites occur in

(A) red blood cells and the liver
(B) red blood cells and platelets
(C) red blood cells and the pancreas
(D) red blood cells and the gut

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Q.10 You have a 50 mg/mL stock solution of arginine. To prepare 1 liter of growth medium for an arginine auxotroph that requires 70 µg/mL of arginine, the volume of this stock solution that should be added is _____ mL (up to 1 decimal point) .

Q.11 Accumulating evidence suggest that Domain Archaea is more closely related to Domain Eukarya than to Domain Bacteria. Which of the following properties are shared between eukaryotes and archaea ?

(i) Protein biogenesis
(ii) Presence of sterol containing membranes
(iii) Ribosomal subunit structures
(iv) Adaptation to extreme environmental conditions
(v) Fatty acids with ester linkages in the cell membrane

(A) (ii), (iii) and (v)
(B) (i), (ii), (iv), and (v)
(C) (i) and (iii)
(D) (iii) and (iv)

Q.12 Match the antimicrobial agents in group I with their category/mode of action in group II.

Group I	Group II
(i) Fluoroquinolones	(p) beta lactam antimicrobial
(ii) Amphotericin B	(q) inhibition of protein synthesis
(iii) Tetracycline	(r) inhibition of nucleic acid synthesis
(iv) Amoxicillin	(s) antifungal agent

(A) (i)-(q), (ii)-(s), (iii)-(r), (iv)-(p)
(B) (i)-(s), (ii)-(r), (iii)-(p), (iv)-(q)
(C) (i)-(r), (ii)-(s), (iii)-(q), (iv)-(p)
(D) (i)-(s), (ii)-(r), (iii)-(q), (iv)-(p)

Q.13 Match the microorganisms to their predominant modes of transmission.

Microorganism	Mode of Transmission
(i) *Bordetella pertussis*	(p) Vector-borne
(ii) Dengue virus	(q) Blood-borne
(iii) *Entamoeba histolytica*	(r) Droplet infection
(iv) Hepatitis B virus	(s) Contaminated food

(A) (i)-(r), (ii)-(p), (iii)-(s), (iv)-(q)
(B) (i)-(s), (ii)-(q), (iii)-(p), (iv)-(r)
(C) (i)-(q), (ii)-(p), (iii)-(s), (iv)-(r)
(D) (i)-(s), (ii)-(r), (iii)-(p), (iv)-(q)

Q.14 Match the precursors/intermediates with the corresponding metabolic pathways.

Precursor/Intermediates	Metabolic pathway
(i) Inosine monophosphate	(p) L-methionine biosynthesis
(ii) Ornithine	(q) L-tryptophan biosynthesis
(iii) Chorismate	(r) Purine biosynthesis
(iv) Homocysteine	(s) L-arginine biosynthesis

(A) (i)-(q), (ii)-(r), (iii)-(s), (iv)-(p)
(B) (i)-(p), (ii)-(r), (iii)-(s), (iv)-(q)
(C) (i)-(r), (ii)-(p), (iii)-(s), (iv)-(q)
(D) (i)-(r), (ii)-(s), (iii)-(q), (iv)-(p)

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Q.15 Match the scientists to their area of major contribution

Scientists	Area of major contribution
(i) Antonie van Leeuwenhoek	(p) Taxonomy
(ii) Carl Linnaeus	(q) Antimicrobial agents
(iii) Sir Alexander Fleming	(r) Vaccination
(iv) Louis Pasteur	(s) Microscopy

(A) (i)-(s), (ii)-(q), (iii)-(p), (iv)-(r)
(B) (i)-(s), (ii)-(p), (iii)-(q), (iv)-(r)
(C) (i)-(p), (ii)-(s), (iii)-(r), (iv)-(q)
(D) (i)-(q), (ii)-(p), (iii)-(r), (iv)-(s)

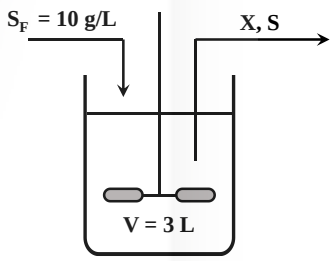
Q.16 Which of the following combinations would improve the resolution of a microscope?

(i) Increasing the half aperture angle of the objective lens
(ii) Decreasing the wavelength of the illumination source
(iii) Decreasing the numerical aperture of the objective lens
(iv) Decreasing the refractive index of immersion medium

(A) (i) and (ii) (B) (ii) and (iii) (C) (ii) and (iv) (D) (i) and (iii)

Q.17 Active transport involves the movement of a biomolecule against a concentration gradient across the cell membrane using metabolic energy. If the extracellular concentration of a biomolecule is 0.005M and its intracellular concentration is 0.5M, the least amount of energy that the cell would need to spend to transport this biomolecule from the outside to the inside of the cell is _____ kcal/mol (up to 2 decimal points).
(Temperature T = 298K and universal gas constant R= 1.98 cal/mol·K)

Q.18 A continuous cell culture being carried out in a stirred tank reactor is described in terms of its cell mass concentration X and substrate concentration S. The concentration of the substrate in the sterile feed stream is S_F = 10 g/L and yield coefficient $Y_{x/s}$ = 0.5. The flow rates of the feed stream and the exit stream are equal (F=5 mL/min) and constant. If the specific growth rate (h^{-1}) $\mu = \frac{0.3\,S}{(1+S)}$, the steady state concentration of S is _____ g/L (up to 1 decimal point).



Q.19 The initial concentration of cells (N_0) growing unrestricted in a culture is 1.0×10^6 cells/mL. If the specific growth rate (μ) of the cells is 0.1 h^{-1}, the time required for the cell concentration to become 1.0×10^8 cells/mL is _____ hours (up to 2 decimal points).

Q.20 The following stoichiometric equation represents the conversion of glucose to lactic acid in a cell:

$$\text{Glucose} + 2\text{Pi} + 2\text{ADP} \rightarrow 2\text{Lactate} + 2\text{ATP} + 2H_2O$$

If the free energy of conversion of glucose to lactic acid only is $\Delta G^0 = -47000$ cal/mol, the efficiency of energy transfer is _____ % (up to 1 decimal point).
(ΔG^0 for ATP hydrolysis is –7.3 kcal/mol)

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XL (T): Q. 1 – Q. 10 carry one mark each & Q. 11 – Q. 20 carry two marks each.

Q.1 Animals belonging to phylum Echinodermata are closer to chordates than other invertebrate phyla. Which ONE of the following reasons can account for this relatedness?

(A) Highly evolved nervous system
(B) Radially symmetric body plan
(C) Deuterostomic development
(D) Well-developed muscles

Q.2 A zoologist recovered some tissue from preserved skin of a woolly mammoth. Further genetic analysis requires DNA isolation and increasing its amount. Which ONE of the following techniques would be most useful for increasing the amount of DNA?

(A) RFLP analysis
(B) Polymerase chain reaction (PCR)
(C) Electroporation
(D) Chromatography

Q.3 In a chemical reaction where the substrate and product are in equilibrium in solution, what will occur if an enzyme is added?

(A) The equilibrium of the reaction will not change.
(B) There will be a decrease in product formed.
(C) Additional substrate will be formed.
(D) The free energy of the system will change.

Q.4 Tay-Sachs disease is a human genetic disorder that is associated with defects in which ONE of the following cellular organelles?

(A) Endoplasmic reticulum
(B) Mitochondria
(C) Golgi apparatus
(D) Lysosome

Q.5 Increase in the existent population of grey peppered moth, *Biston betularia*, during industrial revolution in Britain is an example of which ONE of the following evolutionary processes?

(A) Neutral selection
(B) Disruptive selection
(C) Directional selection
(D) Stabilizing selection

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Q.6 Which ONE of the following is NOT a characteristic of a cancer cell?

(A) Increase in cell motility
(B) Loss of contact inhibition
(C) Decrease in apoptosis
(D) Uncontrolled meiosis

Q.7 Cardiac and cerebral tissues are derived from the following germ layers respectively

(A) Ectoderm and mesoderm
(B) Mesoderm and ectoderm
(C) Mesoderm and endoderm
(D) Endoderm and ectoderm

Q.8 An animal's ability to escape from a predator by using the explored knowledge of home area is an example of

(A) Latent learning
(B) Insight learning
(C) Mimicry
(D) Imprinting

Q.9 Bowman's capsules are present in which ONE of the following organs/ tissues?

(A) Renal cortex
(B) Urinary bladder
(C) Renal medulla
(D) Ureter

Q.10 Which ONE of the following is the primary function of lung surfactants?

(A) Remove dust particles from bronchi
(B) Provide immunity to respiratory tract
(C) Prevent alveoli from collapsing by decreasing surface tension
(D) Aid in carbon dioxide exchange

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Q.11 Match the disorders/diseases listed in Column I to their respective causative agents listed in Column II.

	Column I		Column II
I)	African tick bite fever	i)	*Trypanosoma gambiense*
II)	Yellow fever	ii)	Zika virus
III)	Microcephaly	iii)	*Rickettsia sp.*
IV)	Sleeping sickness	iv)	Flavivirus

(A) I-iv, II-iii, III-ii, IV-i
(B) I-iii, II-iv, III-ii, IV-i
(C) I-iii, II-iv, III-i, IV-ii
(D) I-iii, II-i, III-iv, IV-ii

Q.12 Glucose monomers are joined together by glycosidic linkages to form a cellulose polymer. During this process, changes in the free energy, total energy, and entropy respectively are represented correctly by which ONE of the following options?

(A) $+\Delta G, +\Delta H, +\Delta S$.
(B) $+\Delta G, -\Delta H, -\Delta S$.
(C) $-\Delta G, +\Delta H, +\Delta S$.
(D) $+\Delta G, +\Delta H, -\Delta S$.

Q.13 In *Drosophila melanogaster*, a mutation in *Ultrabithorax* which defines the third segment of the thorax or T3 leads to development of four winged flies, as the halteres develop into a second pair of wings. Which ONE of the following phenotypes in fly will result from overexpression of *Ultrabithorax* in the second thoracic segment?

(A) Four winged flies.
(B) Two wings and two halteres flies.
(C) Flies with four halteres.
(D) Flies with two halteres.

Q.14 Which ONE of the following is TRUE in case of respiratory acidosis?

(A) Increased rate of ventilation is a cause of respiratory acidosis
(B) Blood pH more than 7
(C) Increased levels of carbon dioxide in blood
(D) Acidosis can be compensated through reduction of bicarbonate levels in plasma

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Q.15 Match the proteins / molecules listed in column I with the cellular location mentioned in the column II.

	Column I		Column II
I)	Galactosyl transferase	(i)	Vesicles
II)	Cytochrome oxidase	(ii)	Cytosol
III)	Clathrin	(iii)	Golgi complex
IV)	Tubulin	(iv)	Mitochondria

(A) I-ii; II-iii; III-i; IV-iv
(B) I-iii; II-iv; III-i; IV-ii
(C) I-iii; II-iv; III-ii; IV-i
(D) I-iv; II-iii; III-ii; IV-i

Q.16 In an experiment, nucleus from a Drosophila oocyte was transplanted into the anterior part of another oocyte, at a region opposite to the existing nucleus. Which ONE of the following phenotypes will the developing egg show?

(A) A ventralized egg with no dorsal appendages
(B) A dorsalized egg with two dorsal appendages
(C) A ventralized egg with two dorsal appendages
(D) A dorsalized egg with four dorsal appendages

Q.17 Match the organisms listed in Column I with the features listed in Column II

	Column I		Column II
I)	Tapeworm	(i)	Bioluminescence
II)	Jellyfish	(ii)	Viviparous
III)	Trichinella	(iii)	Lateral heart
IV)	Earthworm	(iv)	Microvilli on the body surface

(A) I-iii; II-i; III-iv; IV-ii
(B) I-ii; II-iv; III-i; IV-iii
(C) I-iv; II-i; III-ii; IV-iii
(D) I-iv; II-iii; III-ii; IV-i

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Q.18 Which ONE of the following statements is NOT part of the classical Darwinian theory of evolution by natural selection?

(A) A trait which is constantly used will get inherited by next generation.
(B) Phenotypic variations exist among the individuals of a population of a species
(C) Individuals that best fit into a given environment are more likely to survive
(D) Each population can randomly acquire a distinct and separate suite of variations.

Q.19 A population of rabbits was determined to have a birth rate of 200 and mortality rate of 50 per year. If the initial population size is 4000 individuals, after 2 years of non-interfered breeding the final population size will be _____.

Q.20 In a population which is in Hardy-Weinberg equilibrium, the frequency of occurrence of a disorder caused by recessive allele (q) is 1 in 1100. The frequency of heterozygotes in the population will be _____. (Give the answer to three decimal places).

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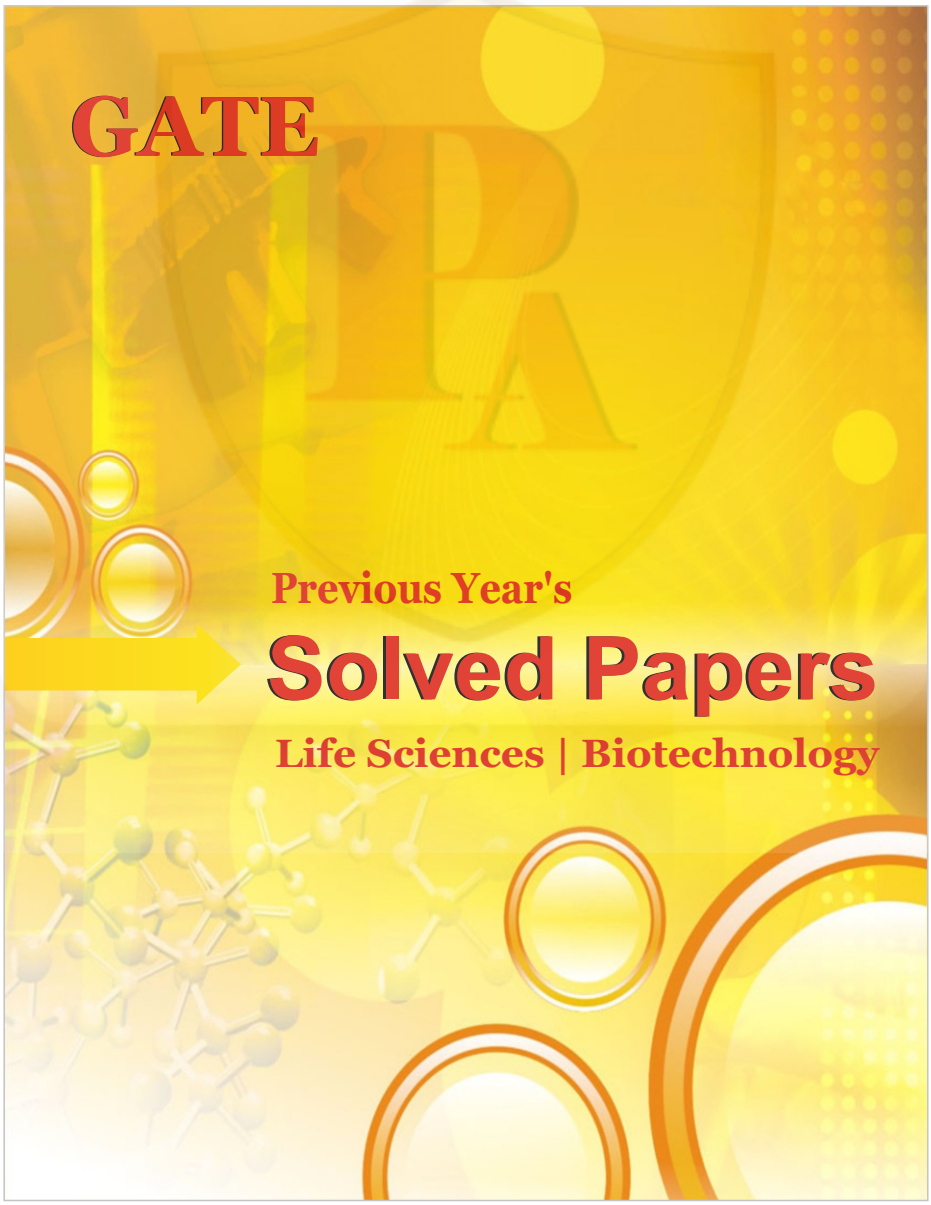

Q.No.	Type	Section	Key/Range	Marks
1	MCQ	GA	A	1
2	MCQ	GA	C	1
3	MCQ	GA	B	1
4	MCQ	GA	B	1
5	MCQ	GA	B	1
6	MCQ	GA	A	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	B	2
10	MCQ	GA	C	2
1	MCQ	XL-P	A	1
2	MCQ	XL-P	D	1
3	MCQ	XL-P	D	1
4	NAT	XL-P	11 to 11	1
5	NAT	XL-P	4 to 4	1
6	MCQ	XL-P	D	2
7	MCQ	XL-P	D	2
8	MCQ	XL-P	A	2
9	MCQ	XL-P	D	2
10	MCQ	XL-P	A	2
11	MCQ	XL-P	C	2
12	MCQ	XL-P	B	2
13	NAT	XL-P	1.39 to 1.43	2

Q.No.	Type	Section	Key/Range	Marks
14	NAT	XL-P	7.39 to 7.54	2
15	NAT	XL-P	-13.40 to -13.36	2
1	MCQ	XL-Q	B	1
2	MCQ	XL-Q	A	1
3	MCQ	XL-Q	C	1
4	MCQ	XL-Q	C	1
5	MCQ	XL-Q	D	1
6	MCQ	XL-Q	C	1
7	MCQ	XL-Q	D	1
8	MCQ	XL-Q	B	1
9	NAT	XL-Q	12 to 12	1
10	NAT	XL-Q	50 to 50	1
11	MCQ	XL-Q	A	2
12	MCQ	XL-Q	A	2
13	MCQ	XL-Q	D	2
14	MCQ	XL-Q	B	2
15	MCQ	XL-Q	B	2
16	NAT	XL-Q	512 to 512	2
17	NAT	XL-Q	20 to 20	2
18	NAT	XL-Q	0.8 to 0.8	2
19	NAT	XL-Q	77 to 77	2
20	NAT	XL-Q	-8862 to -8862	2
1	MCQ	XL-R	A	1

Q.No.	Type	Section	Key/Range	Marks
2	MCQ	XL-R	B	1
3	MCQ	XL-R	C	1
4	MCQ	XL-R	D	1
5	MCQ	XL-R	B	1
6	MCQ	XL-R	C	1
7	MCQ	XL-R	A	1
8	MCQ	XL-R	A	1
9	MCQ	XL-R	B	1
10	NAT	XL-R	28.00 to 31.00	1
11	MCQ	XL-R	D	2
12	MCQ	XL-R	D	2
13	MCQ	XL-R	C	2
14	MCQ	XL-R	B	2
15	MCQ	XL-R	C	2
16	MCQ	XL-R	D	2
17	MCQ	XL-R	A	2
18	MCQ	XL-R	B	2
19	NAT	XL-R	20.25 to 20.25	2
20	NAT	XL-R	11.00 to 12.00	2
1	MCQ	XL-S	B	1
2	MCQ	XL-S	A	1
3	MCQ	XL-S	A	1
4	MCQ	XL-S	D	1

Q.No.	Type	Section	Key/Range	Marks
5	MCQ	XL-S	D	1
6	MCQ	XL-S	C	1
7	MCQ	XL-S	D	1
8	MCQ	XL-S	B	1
9	MCQ	XL-S	A	1
10	NAT	XL-S	1.38 to1.42	1
11	MCQ	XL-S	C	2
12	MCQ	XL-S	C	2
13	MCQ	XL-S	A	2
14	MCQ	XL-S	D	2
15	MCQ	XL-S	B	2
16	MCQ	XL-S	A	2
17	NAT	XL-S	2.60 to 2.80	2
18	NAT	XL-S	0.5 to 0.5	2
19	NAT	XL-S	45.50 to 46.50	2
20	NAT	XL-S	30.5 to 31.5	2
1	MCQ	XL-T	C	1
2	MCQ	XL-T	B	1
3	MCQ	XL-T	A	1
4	MCQ	XL-T	D	1
5	MCQ	XL-T	C	1
6	MCQ	XL-T	D	1
7	MCQ	XL-T	B	1

Q.No.	Type	Section	Key/Range	Marks
8	MCQ	XL-T	A	1
9	MCQ	XL-T	A	1
10	MCQ	XL-T	C	1
11	MCQ	XL-T	B	2
12	MCQ	XL-T	D	2
13	MCQ	XL-T	C	2
14	MCQ	XL-T	C	2
15	MCQ	XL-T	B	2
16	MCQ	XL-T	D	2
17	MCQ	XL-T	C	2
18	MCQ	XL-T	A	2
19	NAT	XL-T	5270 to 5310	2
20	NAT	XL-T	0.056 to 0.062	2
1	MCQ	XL-U	B	1
2	MCQ	XL-U	A	1
3	MCQ	XL-U	C	1
4	MCQ	XL-U	A	1
5	MCQ	XL-U	D	1
6	MCQ	XL-U	D	1
7	NAT	XL-U	1.55 to 1.65	1
8	NAT	XL-U	103.0 to 103.2	1
9	NAT	XL-U	54 to 56	1
10	NAT	XL-U	0 to 0	1

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Q.No.	Type	Section	Key/Range	Marks
11	MCQ	XL-U	B	2
12	MCQ	XL-U	C	2
13	MCQ	XL-U	C	2
14	MCQ	XL-U	A	2
15	MCQ	XL-U	D	2
16	MCQ	XL-U	A	2
17	MCQ	XL-U	B	2
18	NAT	XL-U	9.8 to 10.2	2
19	NAT	XL-U	1.6 to 1.8	2
20	NAT	XL-U	10 to 10	2

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