QUESTION BOOKLET CODE **A**

2011 BT

Test Paper Code: BT

Time: 3 Hours **Max. Marks: 300**

INSTRUCTIONS

A. General:

1. This Booklet is your Question Paper. It contains **24** pages and has 100 questions.
2. The Question Booklet **Code** is printed on the right-hand top corner of this page.
3. The Question Booklet contains blank spaces for your rough work. No additional sheets will be provided for rough work.
4. **Clip board, log tables, slide rule, calculator, cellular phone and electronic gadgets in any form are NOT allowed.**
5. Write your **Name** and **Registration Number** in the space provided at the bottom.
6. All answers are to be marked only on the machine gradable Objective Response Sheet **(ORS)** provided along with this booklet, as per the instructions therein.
7. The Question Booklet along with the Objective Response Sheet **(ORS)** must be handed over to the Invigilator before leaving the examination hall.
8. Refer to **Special Instruction/Useful Data** on reverse of this sheet.

B. Filling-in the ORS:

9. Write your Registration Number in the boxes provided on the upper left-hand-side of the **ORS** and darken the appropriate bubble under each digit of your Registration Number using a **HB pencil**.
10. Ensure that the **code** on the **Question Booklet** and the **code** on the **ORS** are the same. If the codes do not match, report to the Invigilator immediately.
11. On the lower-left-hand-side of the **ORS**, write your Name, Registration Number, Name of the Test Centre and put your signature in the appropriate box with ball-point pen. Do not write these anywhere else.

C. Marking of Answers on the ORS:

12. Each question has **4 choices** for its answer: (A), (B), (C) and (D). Only **ONE** of them is the correct answer.
13. On the right-hand-side of **ORS**, for each question number, darken with a **HB Pencil** ONLY one bubble corresponding to what you consider to be the most appropriate answer, from among the four choices.
14. There will be **negative marking** for wrong answers.

MARKING SCHEME:

(a) For each correct answer, you will be awarded **3 (Three)** marks.
(b) For each wrong answer, you will be awarded **-1 (Negative one)** mark.
(c) Multiple answers to a question will be treated as a wrong answer.
(d) For each un-attempted question, you will be awarded **0 (Zero)** mark.

Name							
Registration Number							

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A

Special Instructions/ Useful Data

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A

Q.1 The *lac* repressor binds its operator with a $K_d = 10^{-10}$ M. In a strain of *E coli,* the intracellular repressor concentration is 10^{-12} M. Induction of the *lac* operon in this strain

(A) does not require lactose
(B) requires lactose
(C) requires glucose
(D) requires both glucose and lactose

Q.2 The DNA of an organism is 0.68 meters. What is the length of the DNA in kilobases?

(A) 2×10^8 (B) 2×10^6 (C) 2×10^5 (D) 2×10^3

Q.3 A segment of DNA (enclosed in the box) in a gene sequence

5'- GGA GTATCATT GCA -3'
3'- CCT CATAGTAA CGT- 5'

undergoes an inversion. The new gene sequence is

(A)
5'- GGA TTACTATG GCA -3'
3 - CCT AATGATAC CGT- 5'

(B)
5'- GGA CATAGTAA GCA -3'
3' - CCT GTATCATT CGT- 5'

(C)
5'- GGA AATGATAC GCA -3'
3' - CCT TTACTATG CGT- 5'

(D)
5'- GCA GTATCATT GGA -3'
3' -CGT CATAGTAA CCT- 5'

Q.4 The product of an enzyme reaction is estimated in a colorimeter. For a 1 cm path length cuvette, 20% of the incident light intensity is absorbed. If the path length is increased to 2 cm, the percentage of absorption is

(A) 36 (B) 40 (C) 64 (D) 90

Q.5 *Neisseria meningitides* is a

(A) Gram +ve bacillus
(B) Gram +ve coccus
(C) Gram –ve bacillus
(D) Gram –ve coccus

Q.6 An enzyme solution is sterilized by

(A) use of an autoclave
(B) ethylene oxide
(C) membrane filtration
(D) γ – radiation

Q.7 RNA interference is induced by

(A) double strand DNA
(B) double strand RNA
(C) both double strand DNA and RNA
(D) specific proteins

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Q.8 The detection and estimation of DNA products by Real Time PCR is achieved with

(A) Syber Green
(B) Ethidium Bromide
(C) Acridine Orange
(D) Green Fluorescent protein

Q.9 A peritrichous arrangement of flagella in bacilli is a

(A) single flagellum at one pole
(B) single flagellum at each pole
(C) cluster of flagella at one pole
(D) uniform distribution of flagella around the cell

Q.10 Fibroblast cells in culture survive limited number of passages due to

(A) exhaustion of nutrients
(B) contact inhibition
(C) shortening of telomeres
(D) loss of cell adherence

Q.11 Fetal Bovine Serum is a component of cell culture medium primarily to provide

(A) vitamins (B) growth factors (C) amino acids (D) trace elements

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Q.12 Identify the correct combination between the groups

Group I	**Group II**
P. Mast cells	**1.** Cytotoxic effect on tumour cells
Q. Macrophage	**2.** Release of histamine
R. Natural Killer cells	**3.** Production of immunoglobulins
S. B cells	**4.** Ingestion of particulate antigen

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

Q.13 Mad cow disease is caused by a

(A) bacterium (B) virus (C) viroid (D) prion

Q.14 The phenomenon in which one gene inhibits the expression of another gene is called

(A) dominance (B) epistasis (C) penetrance (D) expressivity

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Q.15 The major protease involved in apoptosis has at its active site

(A) serine (B) aspartate (C) cysteine (D) histidine

Q.16 The techniques to show that a protein is a homotetramer with a subunit molecular weight of 25 kDa are

(A) gel filtration and native PAGE
(B) affinity and ion exchange chromatography
(C) SDS-PAGE and gel filtration
(D) isoelectric focusing and SDS-PAGE

Q.17 A phage infects bacteria at a multiplicity of infection (moi) of 0.1. This means that

(A) every bacterium is infected by the phage
(B) one out of 10 bacteria is infected by the phage
(C) ten phage infect one bacterium
(D) only 1/10 of the phage population is infectious

Q.18 Which one of the following fatty acids has the highest melting temperature?

(A) Myristate (14:0) (B) Stearate (18:0) (C) Oleate (18:1) (D) Linoleate (18:2)

Q.19 Which one of the following lipids will **NOT** form a biological membrane?

(A) Phosphatidyl ethanolamine
(B) Cerebroside
(C) Triacylglycerol
(D) Sphingomyelin

Q.20 Transketolases and transaldolases are involved in

(A) oxidative phase of pentose phosphate pathway
(B) non-oxidative phase of pentose phosphate pathway
(C) Embden-Meyerhoff pathway
(D) glyoxalate pathway

Q.21 In which of the following conversion is ATP synthesized by substrate level phosphorylation?

(A) Isocitrate to α–ketoglutarate
(B) α–Ketoglutarate to succinyl CoA
(C) Succinyl CoA to succinate
(D) Succinate to fumarate

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Q.22 Which one of the following is **NOT** the function of Photosystem II?

(A) ATP synthesis
(B) Light collection
(C) NADPH synthesis
(D) Charge separation

Q.23 Which one is the **INCORRECT** statement?

(A) Cellulose has β–1,4 linkages
(B) Amylose has α–1,6 linkages
(C) Glycogen has α–1,4 and α–1,6 linkages
(D) Chitin has β–1,4 linkages

Q.24 O-glycosidic bonds are present in

(A) only polysaccharides but not glycoproteins
(B) both glycoproteins and polysaccharides
(C) DNA between base and sugar
(D) RNA between base and sugar

Q.25 Under physiological conditions when $[S] << K_M$, the catalytic efficiency is estimated by

(A) k_{cat} (B) K_M (C) k_{cat}/K_M (D) V_{max}

Q.26 Diacylglycerol is known to activate

(A) phospholipase A (B) phospholipase C (C) protein kinase A (D) protein kinase C

Q.27 The reagent required to cleave the carboxyl side of methionine is

(A) cyanogen bromide (B) trypsin (C) chymotrypsin (D) performic acid

Q.28 Hormones that act on cells near the point of their synthesis and not transported through blood circulation are

(A) prostaglandins and thromboxane
(B) estradiol and cortisol
(C) prednisolone and prednisone
(D) thyroxine and glucagon

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Q.29 Match the coenzymes in **Group I** with the corresponding units in **Group II**

Group I	**Group II**
P. Tetrahydrofolate	**1.** Acyl
Q. Biotin	**2.** Electrons
R. $FMNH_2$	**3.** One carbon unit
S. Coenzyme A	**4.** CO_2

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

Q.30 Bacteria, auxotrophic for fatty acids were grown at 40 °C in the presence of a mixture of fatty acids. Which of the fatty acid combinations will be incorporated into the membrane?

(A) Saturated and long chain fatty acids
(B) Saturated and short chain fatty acids
(C) Unsaturated and short chain fatty acids
(D) Unsaturated and long chain fatty acids

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Q.31 Which one of the following statements is **INCORRECT**?

(A) Mer B is a bacterial protein similar to eukaryotic actin
(B) FtsZ protein found in most of the bacteria is a tubulin homologue
(C) AmiC hydrolyzes peptidoglycan to separate daughter cells
(D) FtsZ is an inhibitor of Z ring assembly

Q.32 Massive doses of methylene blue are sometimes given for cyanide poisoning. Which one of the following statements is **INCORRECT**?

(A) Reduction potential of methylene blue is similar to oxygen
(B) Cyanide blocks transfer of electrons from cytochrome oxidase to oxygen
(C) In cyanide poisoning, all the respiratory chain components become reduced and electron transport stops
(D) Methylene blue can reduce the various components of the respiratory chain to restore ATP synthesis

Q.33 A disease manifests only in the homozygous recessive condition. A couple has two children. If both parents are heterozygous for the disease causing gene, what is the probability that both the children are normal? Assume that the disease causing gene is not sex linked.

(A) 1/16 (B) 3/16 (C) 9/16 (D) 12/16

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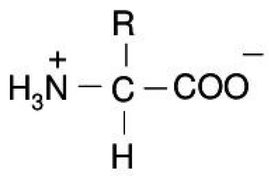
Q.34 Match the entries in **Group I** with those in **Group II**

Group I	**Group II**
P. Glucagon	**1.** Eicosanoid
Q. Prednisolone	**2.** Peptide
R. Prostaglandin E1	**3.** Catecholamine
S. Epinephrine	**4.** Steroid

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

Q.35 An amino acid has a non-ionizable R group. The pK_a for the NH_2 group is 9.4 and for the COOH group is 2.8. Consider the following statements:

P. At a pH of 6.1, 50% of the amino acid molecules will migrate towards the cathode when placed between two electrodes

Q. At a pH of 2.8, 50% of the amino acid molecules in solution are of the form 

R. The pI of the amino acid is 6.1

S. On titration of the amino acid solution with NaOH, the amino group is deprotonated before the carboxylic group

Which **PAIR** of the above statements is **CORRECT**?

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

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Q.36 A wild type (**W**) strain of a bacterium is red due to the conversion of a colourless precursor **X** to **R.** Two colourless mutants M1 and M2 (with mutations in Gene 1 and Gene 2, respectively) were obtained. The following chart shows the observed colour of the bacterium when grown in a medium supplemented with either X, Y or Z.

Strain \ Supplement	X	Y	Z
W	Red	Red	Red
M1	White	Red	White
M2	White	Red	Red

Which one of the following describes the correct pathway for red pigment synthesis?

(A) **X** —Gene 1→ **Y** —Gene 2→ **Z** → **R**

(B) **X** —Gene 2→ **Y** —Gene 1→ **Z** → **R**

(C) **X** —Gene 1→ **Z** —Gene 2→ **Y** → **R**

(D) **X** —Gene 2→ **Z** —Gene 1→ **Y** → **R**

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Q.37 Which one of the following is **NOT** an autoimmune disorder?

(A) AIDS
(B) Systemic Lupus Erythematosus
(C) Rheumatoid Arthritis
(D) Myesthenia Gravis

Q.38 Which one of the following is **NOT** common to both chloroplast and mitochondria?

(A) Electron transport
(B) Electron donor – acceptor pair
(C) Proton pump
(D) Independent genomes

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Q.39 Match the entries in **Group I** with those in **Group II**

Group I	**Group II**
P. LH	**1.** Corpus Luteum for production of estrogen and progesterone
Q. hCG	**2.** Leydig cells for production of testosterone
R. GnRH	**3.** Sertoli cells for maintenance of spermatogenesis
S. Testosterone	**4.** Pituitary gonadotrophs for production of LH and FSH

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

Q.40 A competitive reversible enzyme inhibitor

(A) increases K_M, decreases V_{max}
(B) increases V_{max}, decreases K_M
(C) increases K_M, does not change V_{max}
(D) increases V_{max}, does not change K_M

Q.41 Consider the following statements

Statement 1: A sudden 100 meter sprint by an athlete will increase the pH of blood.

Statement 2: Fate of pyruvate under anaerobic condition in skeletal muscle is lactate.

Which one of the following statement is **TRUE**?

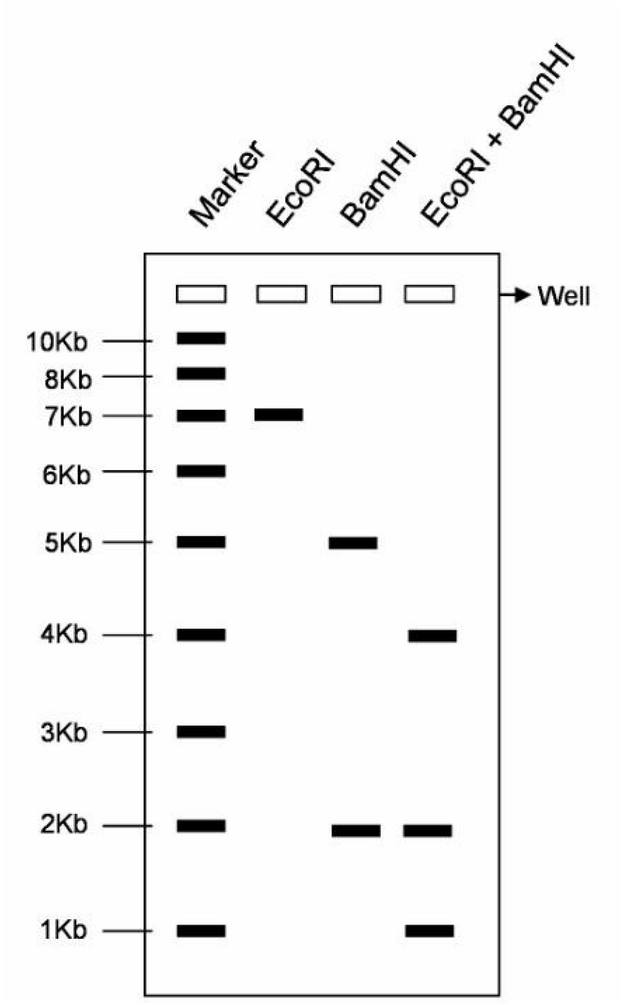
(A) Statement 1 and 2 are correct and 1 is the outcome of 2
(B) Statement 2 is incorrect and statement 1 is correct
(C) Statement 1 and 2 are correct and 1 is not the outcome of 2
(D) Statement 2 is correct and statement 1 is incorrect

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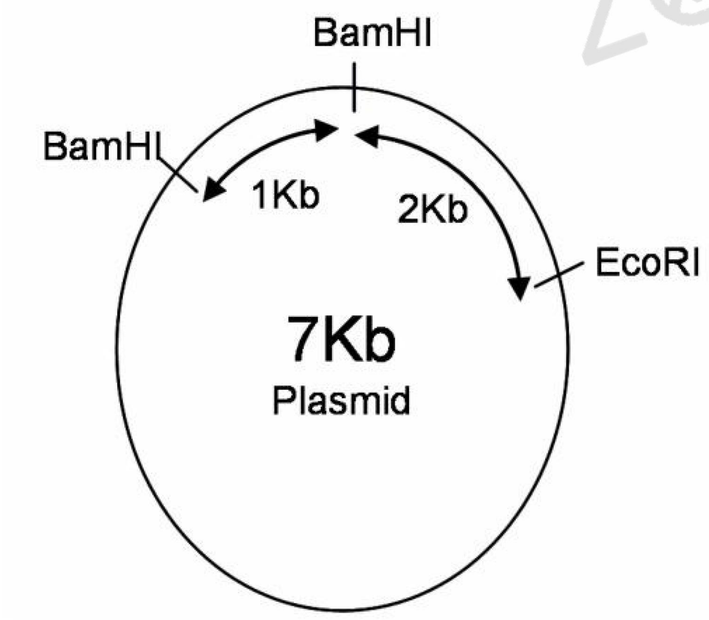
A

Q.42 A 7 kb circular plasmid was completely digested with either *Eco*RI or *Bam*HI or both. The digestion pattern is shown below.

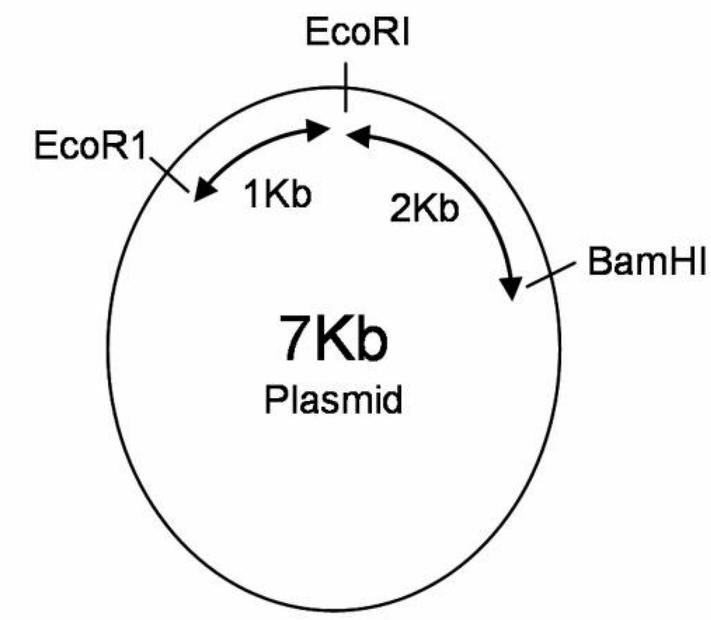


Which one of the following is the **CORRECT** restriction map of the plasmid?

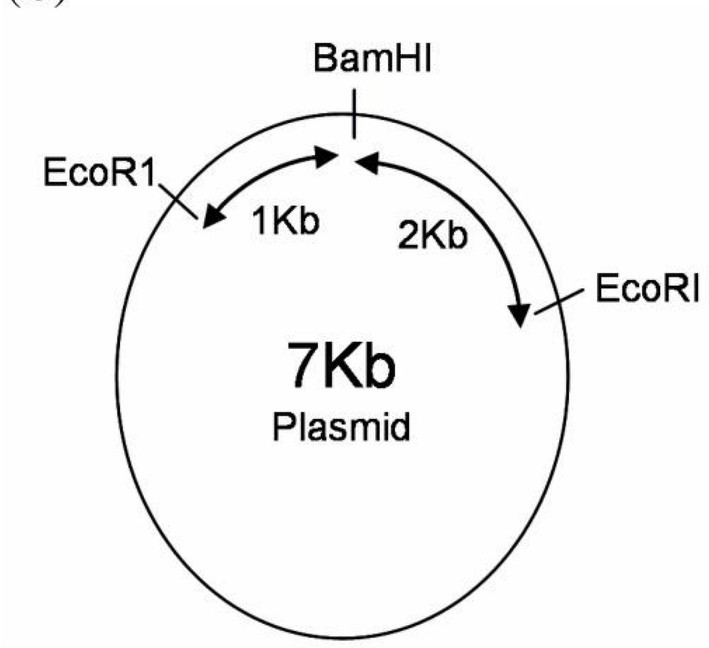
(A)



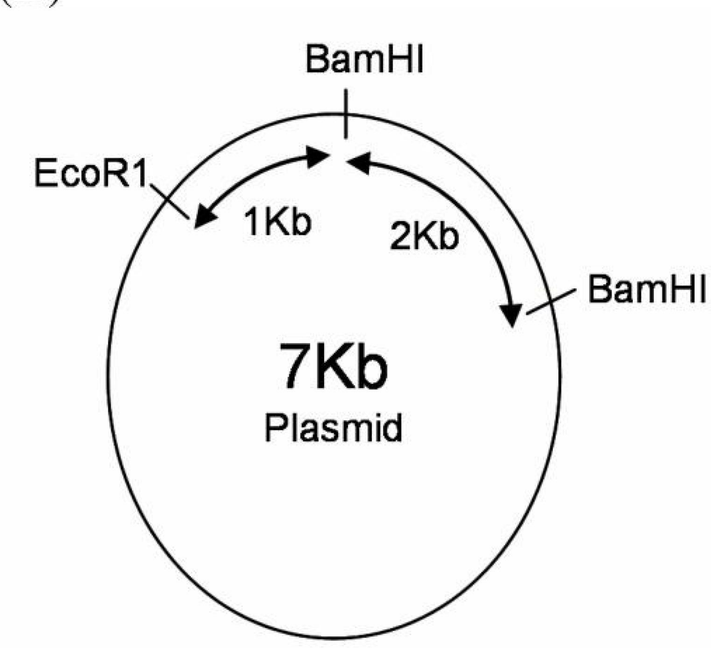
(B)



(C)



(D)



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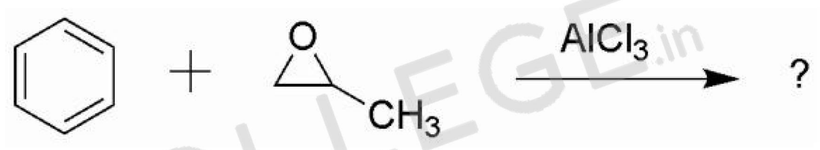
Q.43 Mitochondria were isolated and permeabilized with a detergent. They were incubated with succinate, ADP and P_i in the presence of O_2. ATP synthesis and O_2 consumption were measured. Which one of the following statements is **TRUE**?

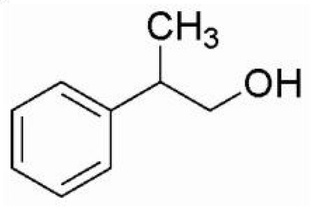
(A) ATP synthesis will occur but O_2 consumption will not occur
(B) O_2 consumption will occur but ATP synthesis will not occur
(C) Both O_2 consumption and ATP synthesis will occur
(D) Both O_2 synthesis and ATP synthesis will not occur

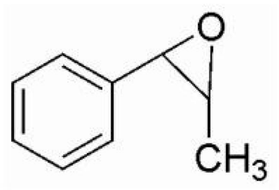
Q.44 The frequency of occurrence of a disease is one in a million individuals. This disease results from the homozygosity in a recessive allele. The population satisfies all the assumptions of the Hardy-Weinberg equilibrium. The frequency of the dominant allele and frequency of carriers of the disease respectively are

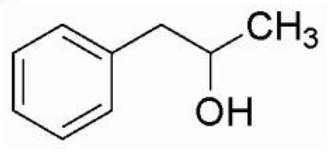
(A) 0.9 and 0.19
(B) 0.09 and 0.019
(C) 0.999 and 0.0019
(D) 0.009 and 0.00019

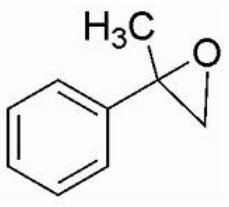
Q.45 Identify the major product of the following reaction



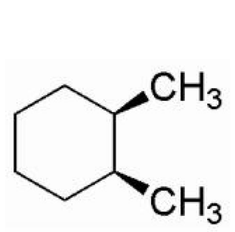
(A)


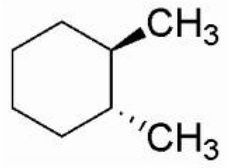
(B)


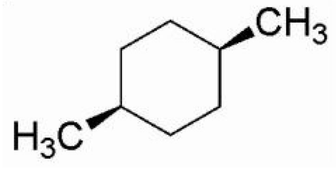
(C)


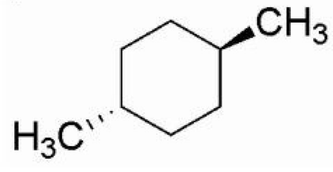
(D)


Q.46 Which one of the following compounds is optically active?

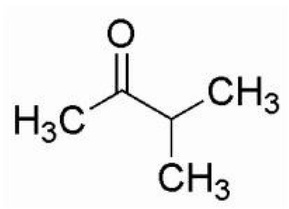
(A)


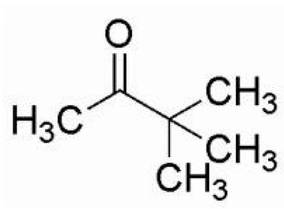
(B)


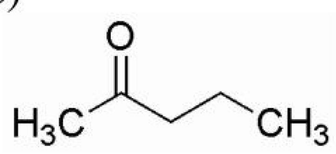
(C)


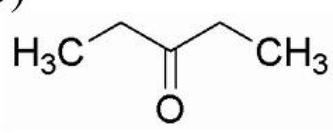
(D)


Q.47 Which one of the following compounds shows a fragmentation peak corresponding to an enolic species (m/z = 58) in the mass spectrum?

(A)


(B)


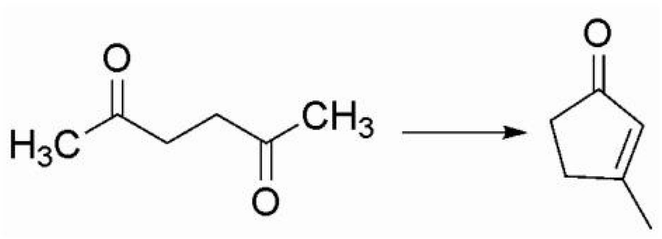
(C)


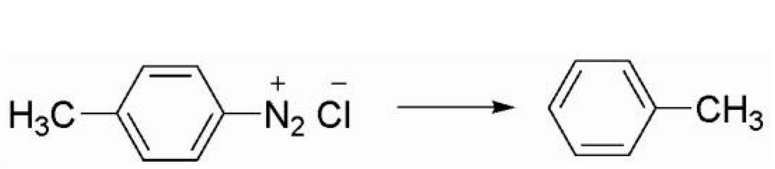
(D)


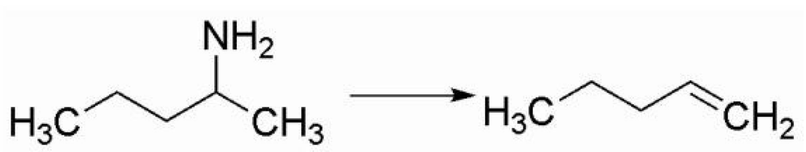
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Q.48 Correlate the reactions in **Group I** with the reagent(s) and condition(s) in **Group II**

Group I

P. 

Q. 

R. 

Group II

1. Excess CH_3I; Ag_2O, H_2O; heat

2. H_3PO_2, H_2O

3. NaOH, H_2O; heat

4. $CH_2 = PPh_3$

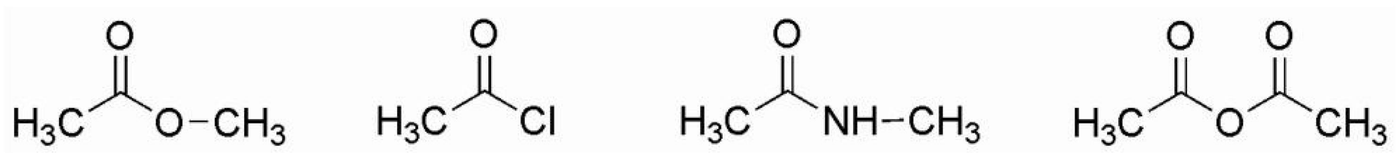
(A) **P-4**, **Q-3**, **R-2**
(B) **P-3**, **Q-1**, **R-4**
(C) **P-4**, **Q-3**, **R-1**
(D) **P-3**, **Q-2**, **R-1**

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Q.49 Synthetic rubber Buna-N is a copolymer of

(A) 1,3-butadiene and acrylonitrile
(B) 2-chloro-1,3-butadiene and acetonitrile
(C) 2-chloro-1,3-butadiene and acrylonitrile
(D) 1,3-butadiene and acetonitrile

Q.50 Arrange the following compounds in the increasing order of their reactivity towards hydrolysis

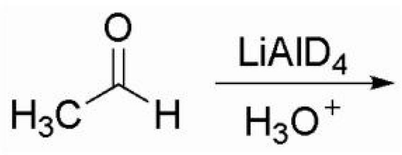
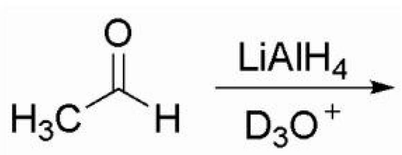
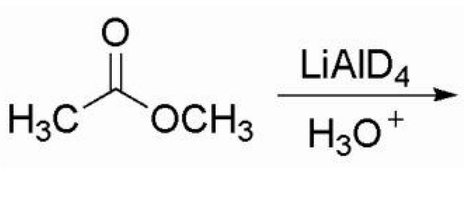


P **Q** **R** **S**

(A) **R < S< P< Q** (B) **P < R< S< Q** (C) **P < R< Q< S** (D) **R < P< S< Q**

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Q.51 Match the reactants and reagents in **Group I** with the product in **Group II**

	Group I		**Group II**
P.		**1.**	CH_3CD_2OH
Q.		**2.**	CH_3CHDOD
R.		**3.**	CH_3CH_2OD
		4.	CH_3CHDOH

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

Q.52 The total number of isomers exhibited by the complexes, $[Co(en)_2Br]^+$ and $[Co(en)_3]^{3+}$, respectively, are
{'en' is ethylene diamine}

(A) 3 and 2 (B) 2 and 2 (C) 2 and 3 (D) 3 and 3

Q.53 The order in which Δ_o increases for the homoleptic octahedral complexes of Fe^{3+} is

(A) $F^- < Br^- < CN^- < NCS^-$
(B) $Br^- < F^- < NCS^- < CN^-$
(C) $F^- < CN^- < Br^- < NCS^-$
(D) $Br^- < NCS^- < F^- < CN^-$

Q.54 The spin-only magnetic moments of $[Fe(CN)_6]^{4-}$ and $[FeCl_6]^{3-}$ in Bohr magnetons respectively, are

(A) 0 and 1.73 (B) 4.73 and 5.73 (C) 0 and 5.73 (D) 4.73 and 1.73

Q.55 A dilute solution of $MnCl_2$ is almost colourless. The reason for this is

(A) only spin forbidden transition
(B) only Lapporte forbidden transition
(C) odd number of unpaired spins
(D) both spin and Lapporte forbidden transition

Q.56 *Nitrobacter* oxidizes nitrite to nitrate. The number of electrons involved in this oxidation process is

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

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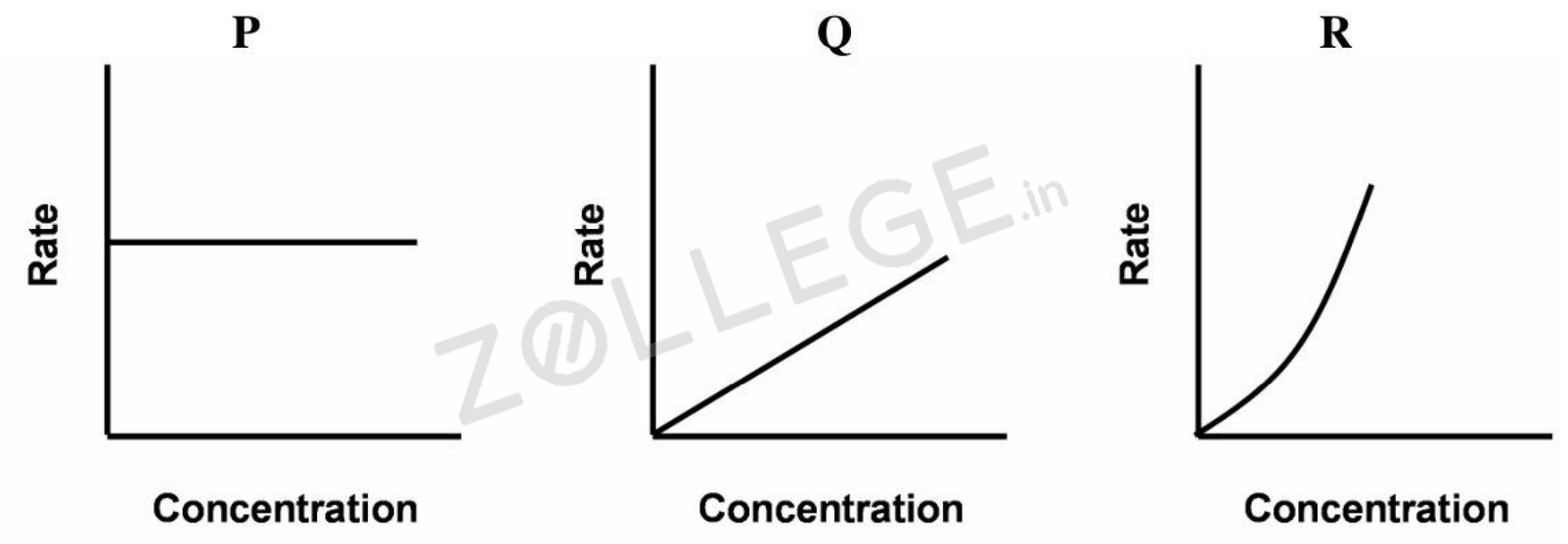
Q.57 The bond order in carbon monoxide (CO) decreases from three, when bonded to transition metals in their low oxidation states, because

(A) π – electrons of CO are donated to metal center
(B) σ – electrons of CO are donated to metal center
(C) p – electrons of metal center are transferred to empty π orbitals of CO
(D) d – electrons of metal center are transferred to empty π* orbitals of CO

Q.58 For $[ICl_4]^-$, the number of lone pairs present on the central atom, and the shape of the ion respectively, are

(A) 2, octahedral
(B) 1, trigonal bipyramidal
(C) 1, square pyramidal
(D) 0, tetrahedral

Q.59 The **CORRECT** orders of the reactions deduced from the graphs given below, are



(A) **P** – First order, **Q** – Zero order, **R** – Half order
(B) **P** – Zero order, **Q** – First order, **R** – Second order
(C) **P** – Pseudo-first order, **Q** – Second order, **R** – Third order
(D) **P** – Second order, **Q** – First order, **R** – Zero order

Q.60 A large hot water bath at a constant temperature of 360 K is kept in the laboratory. The water bath loses 60 Joules of heat energy to the surroundings which is at 300 K. Assuming that the heat transfer is a reversible process, the total entropy change (in J K^{-1}) would be

(A) + 0.33 (B) – 0.033 (C) + 0.20 (D) + 0.033

Q.61 The equilibrium constant for the reaction, $N_2(g) + 3\ H_2(g) \leftrightarrows 2\ NH_3(g)$ at 298 K, is K_p. The equilibrium constant for the reaction, $1/2\ N_2(g) + 3/2\ H_2(g) \leftrightarrows NH_3(g)$, at the same temperature is

(A) $K_p^{1/2}$ (B) K_p (C) K_p^2 (D) $K_p/2$

Q.62 The value of the equilibrium constant of an electrochemical cell reaction is 10 and its standard e.m.f. is 0.0148 V at 298 K. The number of electrons transferred in the overall cell reaction is

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

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Q.63 The difference in the number of nodes for the quantum numbers n = 4 and n = 1, for a 1-D box is

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

Q.64 An aqueous solution contains 0.01 mol of formic acid (pKa = 3.8) and 0.1 mol of sodium formate. The pH of this solution is

(A) 3.8 (B) 4.8 (C) 2.8 (D) 1.8

Q.65 An electron is released with a speed of 1600 m s^{-1} in the x-y plane. There is a uniform magnetic field of 1×10^{-3} T along the z- direction. The radius of the circular path that the electron will traverse will be close to
(Mass of the electron = 9×10^{-31} Kg, Charge of the electron = 1.6×10^{-19} C)

(A) 10 nm (B) 10 µm (C) 10 mm (D) 10 m

Q.66 A ball of mass 100 g is thrown vertically upwards with a velocity of 10 m s^{-1} from the top of a building 10 m high. The kinetic energy of the ball as it hits the ground is
(Acceleration due to gravity = 10 m s^{-2})

(A) 1 J (B) 15 J (C) 150 J (D) 1500 J

Q.67 A slab of material is kept within a region of a constant uniform electrostatic field (E_{out}). For the materials given in **Group I**, choose the **CORRECT** option from **Group II** that describes the field inside (E_{in}) the slab

Group I	**Group II**
P. Conductor	**1.** $E_{in} = 0$
Q. Dielectric	**2.** $E_{in} < E_{out}$
	3. $E_{in} > E_{out}$
	4. $E_{in} = E_{out}$

(A) **P – 1** and **Q – 2**
(B) **P – 2** and **Q – 4**
(C) **P – 4** and **Q – 3**
(D) **P – 3** and **Q – 1**

Q.68 In reverse bias, the current in a p-n junction diode is negligible because the

(A) currents due to the electron and the holes cancel each other
(B) current is only due to the holes and the current due to the electrons is shut off
(C) current due to the majority carriers is negligible and the current is only due to the minority carriers
(D) current due to the majority carriers reverses its direction

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Q.69 Exposure to X-rays is considered harmful due to their ability to ionize molecules in tissue. The following property of X-rays is directly responsible for this aspect

(A) X-rays have large amplitude
(B) X-rays have high frequency
(C) X-rays travel with a velocity of $3\times10^{8}\ \text{m s}^{-1}$
(D) The magnetic field associated with X-rays is large

Q.70 The electrical resistance of a metallic wire decreases with

(A) increasing temperature and increasing radius of the wire
(B) decreasing temperature and decreasing radius of the wire
(C) increasing temperature and decreasing radius of the wire
(D) decreasing temperature and increasing radius of the wire

Q.71 A stone of mass m is tied to a string of length l and is rotated in the horizontal plane at a constant angular velocity ω. When the length of the string is decreased to $\frac{l}{2}$, the angular velocity becomes

(A) $\frac{\omega}{2}$ (B) ω (C) 2ω (D) 4ω

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Q.72 A stick partially immersed in a half-filled glass of water appears broken at the air-water interface because of

(A) refraction of light
(B) total internal reflection
(C) diffraction of light
(D) dispersion of light

Q.73 Two independent and identical circular conducting loops have radius r. They are symmetrically placed parallel to the x-y plane about the z- axis with their centers at $(0, 0, \pm z_0)$. The currents in the loops are equal and counter-propagating. The magnetic field along the z-direction (B_z) at the origin is

(A) zero, as the B_z fields produced by the individual loops cancel each other
(B) non-zero, and two times the B_z field produced by the individual loops
(C) non-zero, and half the B_z field produced by the individual loop
(D) non-zero, and four times the B_z field produced by the individual loop

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Q.74 A satellite has an elliptical orbit around the earth. Its maximum distance from earth is d_1 and the minimum distance is d_2 and the corresponding tangential velocities are V_1 and V_2 respectively. The ratio of the velocities at these distances is

(A) $\frac{V_1}{V_2} = \frac{d_1}{d_2}$ (B) $\frac{V_1}{V_2} = \sqrt{\frac{d_2}{d_1}}$ (C) $\frac{V_1}{V_2} = \frac{d_2}{d_1}$ (D) $\frac{V_1}{V_2} = 1$

Q.75 The dimensions of the ratio $\frac{Stress}{Strain}$ are

(A) $ML^{-4}T^{-2}$ (B) $ML^{-1}T^{-2}$ (C) $ML^{-2}T^{-1}$ (D) $ML^{-2}T^{-2}$

Q.76 A large aircraft of mass 10^5 Kg travels at a speed of 600 km per hour. Assuming the surface area to be 600 m^2, the percentage difference between the speed of air on the upper and the lower surface of the aircraft is
(acceleration due to gravity = 10 m s^{-2}, air density = 1.2 Kg m^{-3})

(A) 5% (B) 25% (C) 50% (D) 95%

Q.77 The surface temperature of the Sun is around 6000 K and its peak wavelength of emission is 5000 Å. Given that the temperature of the Moon surface is 200 K, the peak wavelength of the radiation from the Moon is

(A) 3000 Å (B) 1200 Å (C) 15 µm (D) 60 µm

Q.78 Two waves on a string have a displacement given by

$$y_1 = y_0 \sin(kx - \omega t) \text{ and } y_2 = y_0 \cos(kx - \omega t + \phi)$$

If superposition of these waves results in a **null** displacement, then what should be the choice of ϕ?

(A) $\phi = 0$ (B) $\phi = \frac{\pi}{2}$

(C) $\phi = \pi$ (D) Such a ϕ is not possible

Q.79 An optical communication system operating at 1.5 µm is used to transmit a number of audio channels of bandwidth 8 KHz. Supposing that 1% of the optical source frequency is the available channel bandwidth, the number of audio channels that can be accommodated are

(A) 10 (B) 10^4 (C) 10^8 (D) 10^{12}

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Q.80 Consider the following statements

Statement 1: The large energy released in a nuclear fission reaction is due to the extraction of the binding energies of the nucleons.

Statement 2: The coulomb binding energies are comparable to the nuclear binding energy at an inter-nucleon distance of 1 femtometer.

(A) Statement 1 and 2 are true, and 2 is the correct explanation for 1
(B) Statement 1 and 2 are true, and 2 is not the correct explanation for 1
(C) Statement 1 is false and the statement 2 is true
(D) Statement 1 is true and the statement 2 is false

Q.81 Match the elements in **Group II** that are used widely in the devices listed in **Group I**

Group I	**Group II**
P. Detector	**1.** Soft-iron core
Q. Rectifier	**2.** Polymer
R. Transformer	**3.** Photodiode
S. Amplifier	**4.** Diode
	5. Transistor

(A) **P-4, Q-1, R-2, S-3**
(B) **P-2, Q-5, R-1, S-4**
(C) **P-1, Q-2, R-5, S-3**
(D) **P-3, Q-4, R-1, S-5**

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Q.82 The wattage rating of **Heater I** and **Heater II** are marked as 500 W and 1000 W, respectively and are specified for operation at 200 V. Both these heaters are connected in series to a 200 V dc supply. Which one of them will produce more heat and what is the total heat generated?

(A) Heater I produces more heat, and the total heat generated is 333 W
(B) Heater I produces more heat, and the total heat generated is 1500 W
(C) Heater II produces more heat, and the total heat generated is 333 W
(D) Heater II produces more heat, and the total heat generated is 1500 W

Q.83 For a real number x, let $[x]$ denote the greatest integer less than or equal to x. Let K be a real number and the function f is defined by $f(x) = \begin{cases} [x \sin(\pi x/2)] & \text{for } x < 1, \\ Kx + 1 & \text{for } x \geq 1. \end{cases}$

If $\lim_{x \to 1} f(x)$ exists, then the value of $f(2)$ is equal to

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

Q.84 The area of a circle is increasing at the rate of 10 cm^2/sec. If the initial area is 1 cm^2, then the time at which the perimeter of the circle equals $\sqrt{10\pi}$ cm is

(A) $\frac{1}{4}$ sec (B) $\frac{3}{20}$ sec (C) $\frac{2\pi - 5}{20}$ sec (D) $\frac{2}{5}$ sec

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Q.85 The value of the integral $\int_0^{2\pi}(1+\sin x+\sin^2 x)\,dx$ is

(A) 0 (B) π (C) 2π (D) 3π

Q.86 Three balls were chosen randomly from a bag containing 4 white balls and 6 red balls. The probability that exactly 2 white balls and 1 red ball were chosen is equal to

(A) $\frac{1}{12}$ (B) $\frac{1}{10}$ (C) $\frac{3}{10}$ (D) $\frac{2}{3}$

Q.87 Consider the following statement

"All peacocks dance and some elephants sing."

Which one of the following statements is the **NEGATION** of the above?

(A) Some peacocks sing and all elephants dance
(B) All peacocks do not dance and some elephants do not sing
(C) All peacocks sing and some elephants do not dance
(D) Some peacocks do not dance or all elephants do not sing

Q.88 The total number of relations on the set $\{a,b,c\}$ is equal to

(A) 2^3 (B) 2^6 (C) 2^9 (D) 2^{12}

Q.89 Given that $1+2i$ and 2 are roots of the cubic equation $x^3-4x^2+9x+K=0$ where K is a real number, then the value of K is equal to

(A) -10 (B) -6 (C) 6 (D) 10

Q.90 A frog is moving along a straight line by jumping. It always jumps the same distance which is a natural number. If the frog touches the ground exactly 12 times in a stretch of 90 units length, the size of each step is

(A) 6 units (B) 7 units (C) 8 units (D) 9 units

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Q.91 The value of the determinant $\begin{vmatrix} x & 2y & -3z \\ x^2 & 2y^2 & -3z^2 \\ x^3 & 2y^3 & -3z^3 \end{vmatrix}$ is

(A) $xyz(x-y)(x-z)(z-y)$
(B) $xyz(y-x)(x-z)(z-y)$
(C) $6xyz(x-y)(y-z)(z-x)$
(D) $6xyz(y-x)(x-z)(z-y)$

Q.92 Let l, k be real numbers such that the following non-homogeneous system of linear equations is consistent.

$$5x + 2y + 5z = 7$$
$$2x + z = l$$
$$2y + 2z - x = k$$

Then l and k satisfy

(A) $k + 3l = 7$ (B) $k = 0$ and $l = 1$ (C) $k = 1$ and $l = 0$ (D) $2l - k = 7$

Q.93 If the straight lines $\frac{x-1}{2} = \frac{2-y}{3} = \frac{3z-2}{2}$ and $\frac{2x-1}{3} = \frac{y+1}{k} = \frac{5-z}{5}$ are perpendicular to each other, then the value of k is equal to

(A) $-\frac{16}{3}$ (B) $-\frac{4}{3}$ (C) $-\frac{8}{9}$ (D) $-\frac{1}{9}$

Q.94 The value of $\cos\left(\cos^{-1}\left(-\frac{1}{2}\right) - \sin^{-1}(-1)\right)$ is equal to

(A) $-\frac{\sqrt{3}}{2}$ (B) $-\frac{1}{2}$ (C) $\frac{1}{2}$ (D) $\frac{\sqrt{3}}{2}$

Q.95 Consider the following data

8, 3, 4, 1, 6, 8

The mean deviation about the mean for the above data is equal to

(A) $\frac{13}{6}$ (B) $\frac{7}{3}$ (C) $\frac{15}{6}$ (D) $\frac{8}{3}$

Q.96 The area of the triangle whose vertices have the coordinates $(2, 6)$, $(0, 0)$ and $(3, 1)$ is

(A) $\frac{1}{2}$ sq. units (B) $\frac{3}{2}$ sq. units (C) 8 sq. units (D) 10 sq. units

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Q.97 The coordinates of a point that divides the line segment joining the points $(-1, 2)$ and $(1, -4)$ internally in the ratio $2:3$ are

(A) $\left(-\frac{1}{5}, -\frac{2}{5}\right)$ (B) $\left(\frac{1}{5}, -\frac{8}{5}\right)$ (C) $\left(\frac{1}{5}, -1\right)$ (D) $\left(\frac{7}{5}, -\frac{11}{5}\right)$

Q.98 For $x > 0$, define $f(x) = x^2 - 3x - 4$. Invoking the chain rule, the derivative of the inverse function f^{-1} at $x = 0$ is

(A) $-\frac{1}{3}$ (B) $\frac{1}{5}$ (C) 3 (D) -5

Q.99 Let K be a real number and let the function F be defined by $F(x) = \int_0^{x^2} \left(K\, t^2 + t + 1\right) dt$. If the derivative of F at $x = 1$ is π, then the value of K is equal to

(A) $2\pi - 3$ (B) $\frac{3}{2}(2\pi - 3)$ (C) $\frac{\pi - 4}{2}$ (D) $\pi - 2$

Q.100 The maximum value of the function $f(x) = \sin(\pi\, x) - \pi\, x + 2$ on the interval $[-1, 1]$ is equal to

(A) $2 - \pi$ (B) $\pi + 2$ (C) 2 (D) 4

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A

SPACE FOR ROUGH WORK

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