

PAPER : IIT-JAM 2011
BIOTECHNOLOGY-BT

INSTRUCTIONS:

- (i) This test paper has a total of 100 questions.
 - (ii) Each question has **4 choices** for its answer : (a), (b), (c) and (d). Only **one** of them is the correct answer.
 - (iii) For each correct answer, you will be awarded **3 (three)** marks.
 - (iv) For each wrong answer, you will be awarded **-1 (Negative one)** mark.
 - (v) Multiple answers to a question will be treated as a wrong answer.
 - (vi) For each un-attempted question, you will be awarded **0 (zero)** mark.
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1. Mitochondria were isolated and permeabilized with a detergent. They were incubated with succinate, ADP and P_i in the presence of O₂. ATP synthesis and O₂ consumption were measured. Which one of the following statements is *true*?
 - (a) ATP synthesis will occur but O₂ consumption will not occur
 - (b) O₂ consumption will occur but ATP synthesis will not occur
 - (c) both O₂ consumption and ATP synthesis will occur
 - (d) both O₂ synthesis and ATP synthesis will not occur
 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
 3. A segment of DNA (underlined) in a gene sequence $5' - \text{GGAGTATCATTGCA} - 3'$ $3' - \text{CCTCATAGTAACGT} - 5'$ undergoes an inversion. The new gene sequence is
 - (a) $5' - \text{GGATTACTATGGCA} - 3'$ $3' - \text{CCTAATGATACCGT} - 5'$
 - (b) $5' - \text{GGACATAGTAAGCA} - 3'$ $3' - \text{CCTGTATCATTCGT} - 5'$
 - (c) $5' - \text{GGAAATGATACGCA} - 3'$ $3' - \text{CCTTTACTATGCGT} - 5'$
 - (d) $5' - \text{GGAGTATCATTGGA} - 3'$ $3' - \text{CCTCATAGTAACCT} - 5'$
 4. The product of an enzyme reaction is estimated in a colorimeter. For a 1cm path length cuvette, 20% of the incident light intensity is absorbed. If the path length is increased to 2cm, the percentage of absorption is
 - (a) 36
 - (b) 40
 - (c) 64
 - (d) 90
 5. *Neisseria meningitides* is a
 - (a) Gram +ve bacillus
 - (b) Gram +ve coccus
 - (c) Gram -ve bacillus
 - (d) Gram -ve coccus
 6. An enzyme solution is sterilized by
 - (a) use of an autoclave
 - (b) ethylene oxide
 - (c) membrane filtration
 - (d) γ -radiation
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7. RNA interference is induced by
(a) double strand DNA (b) double strand RNA
(c) both (a) and (b) (d) specific proteins
8. The detection and estimation of DNA products by Real Time PCR is achieved with
(a) SYBR green (b) Ethidium bromide
(c) Acridine orange (d) Green fluorescent protein
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
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
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
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 |
- Codes:
(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
13. Mad cow disease is caused by a
(a) bacterium (b) virus
(c) viroid (d) prion
14. The phenomenon in which one gene inhibits the expression of another gene is called
(a) dominance (b) epistasis
(c) penetrance (d) expressivity
15. The major protease involved in apoptosis has at its active site
(a) serine (b) aspartate
(c) cysteine (d) histidine
16. The techniques to show that a protein is a homotetramer with a subunit molecular weight of 25kDa 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

17. A phage infects bacteria at a multiplicity of infection (moi) of 0.1. This means that
- every bacterium is infected by the phage
 - one out of 10 bacteria is infected by the phage
 - ten phage infect one bacterium
 - only 1/10 of the phage population is infectious
18. Which one of the following fatty acids has the highest melting temperature?
- Myristate (14 : 0)
 - Stearate (18 : 0)
 - Oleate (18 : 1)
 - Linoleate (18 : 2)
19. Which one of the following lipids will not form a biological membrane?
- phosphatidyl ethanolamine
 - cerebroside
 - triacylglycerol
 - sphingomyelin
20. Transketolases and transaldolases are involved in
- oxidative phase of pentose phosphate pathway
 - non-oxidative phase of pentose phosphate pathway
 - Embden-Meyerhoff pathway
 - glyoxylate pathway
21. In which of the following conversion is ATP synthesized by substrate level phosphorylation?
- isocitrate to α -ketoglutarate
 - α -ketoglutarate to succinyl CoA
 - succinyl CoA to succinate
 - succinate to fumarate
22. Which one of the following is not the function of photosystem II?
- ATP synthesis
 - light collection
 - NADPH synthesis
 - charge separation
23. Which one is the *incorrect* statement?
- cellulose has β -1, 4 linkages
 - amylose has α -1, 6 linkages
 - glycogen has α -1, 4 and α -1, 6 linkages
 - chitin has β -1, 4 linkages
24. O-glycosidic bonds are present in
- only polysaccharides but not glycoproteins
 - both glycoproteins and polysaccharides
 - DNA between base and sugar
 - RNA between base and sugar
25. Under physiological conditions when $[S] \ll K_M$ the catalytic efficiency is estimated by
- k_{cat}
 - K_M
 - k_{cat}/K_M
 - V_{max}
26. Diacylglycerol is known to activate
- phospholipase A
 - phospholipase C
 - protein kinase A
 - protein kinase C
27. The reagent required to cleave the carboxyl side of methionine is
- cyanogen bromide
 - trypsin
 - chymotrypsin
 - performic acid
28. Hormones that act on cells near the point of their synthesis and not transported through blood circulation are
- prostaglandins and thromboxane
 - estradiol and cortisol
 - prednisolone and prednisone
 - thyroxine and glucagon



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

Group I

- P. Tetrahydrofolate
Q. Biotin
R. FMNH₂
S. Coenzyme A

Group II

1. Acyl
2. Electrons
3. One carbon unit
4. CO₂

Codes:

- (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

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
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
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.
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
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 |
- Codes:
(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
35. An amino acid has a non-ionizable R group. The pK_a for the NH₂ 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 which 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 $\text{H}_3\text{N}^+-\text{C}(\text{R})\text{H}-\text{COO}^-$

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 statement is *correct*?

- (a) Q, R (b) P, S (c) P, R (d) Q, S

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) $X \xrightarrow{\text{Gene 1}} Y \xrightarrow{\text{Gene 2}} Z \longrightarrow R$

(b) $X \xrightarrow{\text{Gene 2}} Y \xrightarrow{\text{Gene 1}} Z \longrightarrow R$

(c) $X \xrightarrow{\text{Gene 1}} Z \xrightarrow{\text{Gene 2}} Y \longrightarrow R$

(d) $X \xrightarrow{\text{Gene 2}} Z \xrightarrow{\text{Gene 1}} Y \longrightarrow R$

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

(a) AIDS

(b) Systemic Lupus erythematosus

(c) Rheumatoid Arthritis

(d) Myasthenia Gravis

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

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

Codes:

(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

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

41. Consider the following statements

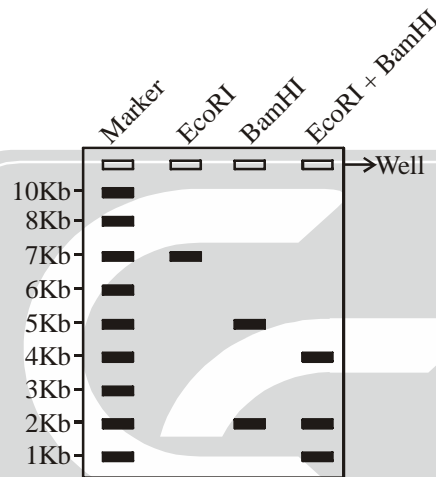
Statement 1: A sudden 100 meter sprint by an athlete will increase the pH of blood.

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

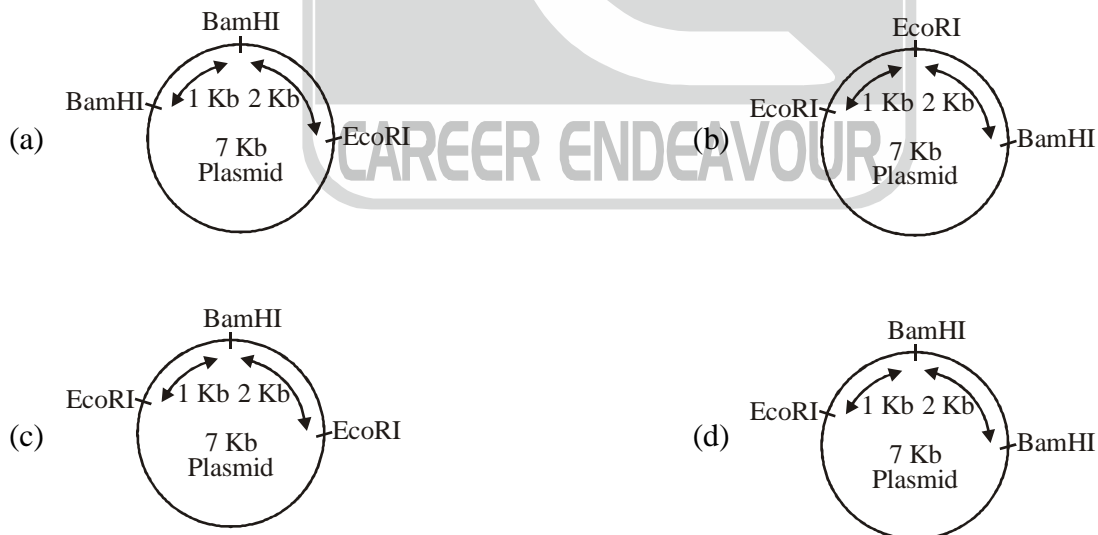
Which one of the following statement is *true*?

- (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

42. A 7kb circular plasmid was completely digested with either EcoRI or BamHI or both. The digestion pattern is shown below.



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


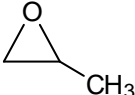


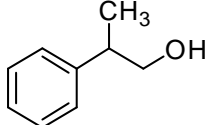
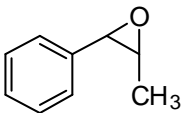
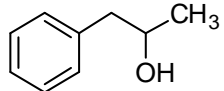
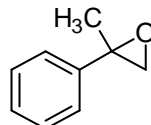
43. The *lac* repressor binds its operator with a $K_d = 10^{-10}$ M. In a strain of *E. coli*, the intracellular repressor concentration is 10^{-12} M. Induction of the *lac* operon in this strain

- (a) does not require lactose
- (b) requires lactose
- (c) requires glucose
- (d) requires both glucose and lactose

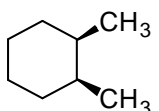
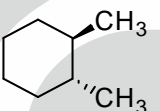
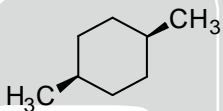
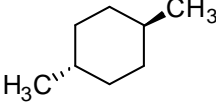
44. The frequency of occurrence of a disease is one in a million individuals. This disease results from the homozygosity in a recessive allele. The population satisfies all the assumptions of the Hardy-Weinberg equilibrium. The frequency of the dominant allele and frequency of carriers of the disease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

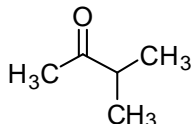
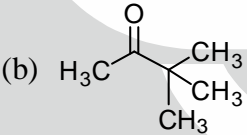
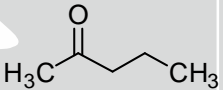
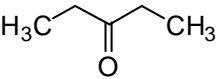
45. Identify the major product of the following reaction  +  $\xrightarrow{\text{AlCl}_3}$?

- (a)  (b)  (c)  (d) 

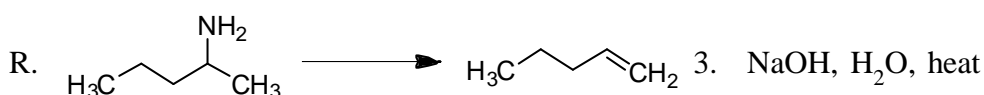
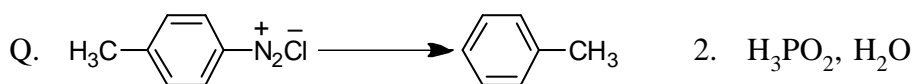
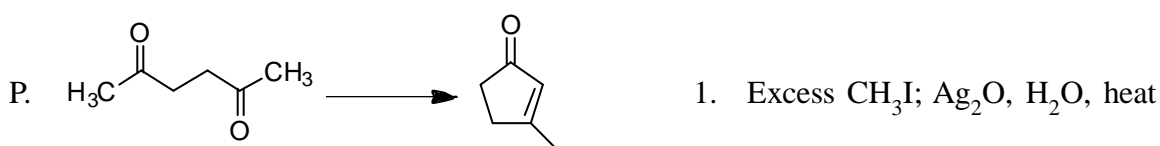
46. Which one of the following compounds is optically active?

- (a)  (b)  (c)  (d) 

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) 

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



(a) P-4, Q-3, R-2

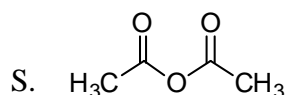
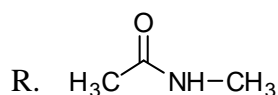
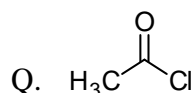
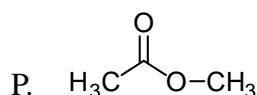
4. $\text{CH}_2 = \text{PPh}_3$

(c) P-4, Q-3, R-1

(b) P-3, Q-1, R-4

(d) P-3, Q-2, R-1

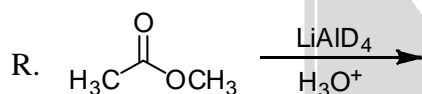
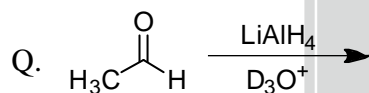
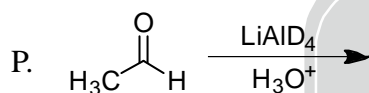
49. Synthetic Rubber Buna-N is a copolymer of
 (a) 1, 3-butadiene and acrylonitrile (b) 2-chloro-1, 3-butadiene and acetonitrile
 (c) 2-chloro-1, 3-butadiene and acrylonitrile (d) 1, 3-butadiene and acetonitrile
50. Arrange the following compounds in the increasing order of their reactivity towards hydrolysis



- (a) $\text{R} < \text{S} < \text{P} < \text{Q}$ (b) $\text{P} < \text{R} < \text{S} < \text{Q}$
 (c) $\text{P} < \text{R} < \text{Q} < \text{S}$ (d) $\text{R} < \text{P} < \text{S} < \text{Q}$
51. Match the reactants and reagents in Group I with the product in Group II

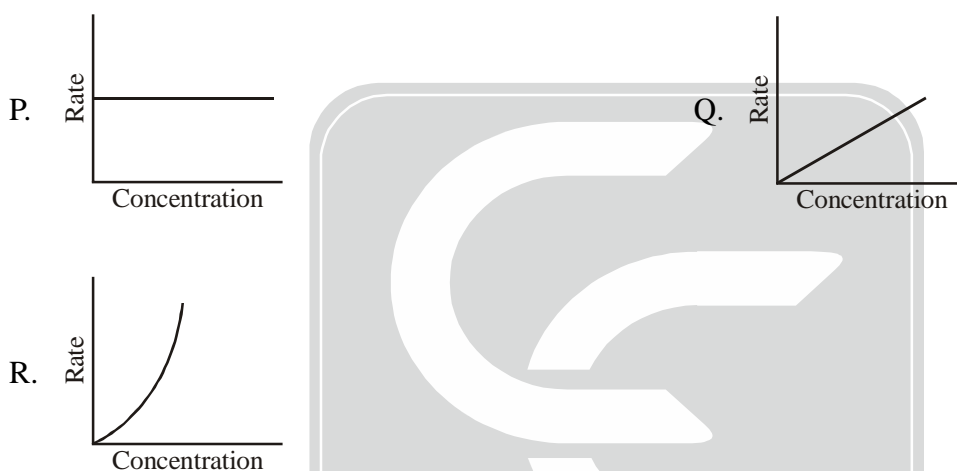
Group I

Group II



- (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
52. The total number of isomers exhibited by the complexes, $[\text{Co}(\text{en})_2\text{Br}]^+$ and $[\text{Co}(\text{en})_3]^{3+}$, respectively, are {'en' is ethylene diamine}
 (a) 3 and 2 (b) 2 and 2 (c) 2 and 3 (d) 3 and 3
53. The order in which Δ_0 increases for the homoleptic octahedral complexes of Fe^{3+} is
 (a) $\text{F}^- < \text{Br}^- < \text{CN}^- < \text{NCS}^-$ (b) $\text{Br}^- < \text{F}^- < \text{NCS}^- < \text{CN}^-$
 (c) $\text{F}^- < \text{CN}^- < \text{Br}^- < \text{NCS}^-$ (d) $\text{Br}^- < \text{NCS}^- < \text{F}^- < \text{CN}^-$
54. The spin-only magnetic moments of $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{FeCl}_6]^{2-}$ 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
55. A dilute solution of MnCl_2 is almost colourless. The reason for this is
 (a) only spin forbidden transition
 (b) only Laporte forbidden transition
 (c) odd number of unpaired spins
 (d) both spin and Laporte forbidden transition
56. *Nitrobacter* oxidizes nitrite to nitrate. The number of electrons involved in this oxidation process is
 (a) 1 (b) 2 (c) 3 (d) 4

57. The bond order in carbon monoxide (CO) decreases from three, when bonded to transition metals in their low oxidation states, because
- π -electrons of CO are donated to metal center
 - σ -electrons of CO are donated to metal center
 - p -electrons of metal center are transferred to empty π orbitals of CO
 - d -electrons of metal center are transferred to empty π^* orbitals of CO
58. For $[\text{ICl}_4]^-$, the number of lone pairs present on the central atom, and the shape of the ion respectively, are
- 2, octahedral
 - 1, trigonal bipyramidal
 - 1, square pyramidal
 - 0, tetrahedral
59. The *correct* orders of the reactions deduced from the graphs given below, are



- P-First order, Q-Zero order, R-Half order
 - P-Zero order, Q-First order, R-Second order
 - P-Pseudo-first order, Q-Second order, R-Third order
 - P-Second order, Q-First order, R-Zero order
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 300K. Assuming that the heat transfer is a reversible process, the total entropy change (in J K^{-1}) would be
- +0.33
 - 0.033
 - +0.20
 - +0.033
61. The equilibrium constant for the reaction, $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ at 298K, is K_p . The equilibrium constant for the reaction, $1/2\text{N}_2(\text{g}) + 3/2\text{H}_2(\text{g}) \rightleftharpoons \text{NH}_3(\text{g})$, at the same temperature is
- $K_p^{1/2}$
 - K_p
 - K_p^2
 - $K_p/2$
62. The value of the equilibrium constant of an electrochemical cell reaction is 10 and its standard e.m.f. is 0.0148V at 298K. The number of electrons transferred in the overall cell reaction is
- 2
 - 1
 - 4
 - 3
63. The difference in the number of nodes for the quantum numbers $n = 4$ and $n = 1$, for a 1 - D box is
- 1
 - 2
 - 3
 - 4

64. An aqueous solution contains 0.01 mol of formic acid ($pK_a = 3.8$) and 0.1 mol of sodium formate. The pH of the solution is
 (a) 3.8 (b) 4.8 (c) 2.8 (d) 1.8
65. An electron is released with a speed of 1600 ms^{-1} in the x - y plane. There is a uniform magnetic field of $1 \times 10^{-3} \text{ T}$ along the z -direction. The radius of circular path that the electron will traverse will be close to (Mass of the electron = $9 \times 10^{-31} \text{ kg}$, Charge of the electron = $1.6 \times 10^{-19} \text{ C}$)
 (a) 10 nm (b) 10 μm (c) 10 mm (d) 10 m
66. A ball of mass 100 g is thrown vertically upwards with a velocity of 10 ms^{-1} from the top of a building 10m high. The kinetic energy of the ball as it hits the ground is (Acceleration due to gravity = 10 ms^{-2})
 (a) 1 J (b) 15 J (c) 150 J (d) 1500 J
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. $E_{\text{in}} = 0$ |
| Q. Dielectric | 2. $E_{\text{in}} < E_{\text{out}}$ |
| | 3. $E_{\text{in}} > E_{\text{out}}$ |
| | 4. $E_{\text{in}} = E_{\text{out}}$ |
| (a) P-1 and Q-2 | (b) P-2 and Q-4 |
| (c) P-4 and Q-3 | (d) P-3 and Q-1 |
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
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 $3 \times 10^8 \text{ ms}^{-1}$
 (d) the magnetic field associated with X-rays is large
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
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 $l/2$, the angular velocity becomes
 (a) $\omega/2$ (b) ω (c) 2ω (d) 4ω

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
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 centres 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
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) $\frac{V_1}{V_2} = 1$
75. The dimensions of the ratio $\frac{\text{Stress}}{\text{Strain}}$ are
- (a) $ML^{-4}T^{-2}$ (b) $ML^{-1}T^{-2}$ (c) $ML^{-2}T^{-1}$ (d) $ML^{-2}T^{-2}$
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 ms^{-2} , air density = 1.2 Kg m^{-3})
- (a) 5% (b) 25% (c) 50% (d) 95%
77. The surface temperature of the Sun is around 6000K and its peak wavelength of emission is 5000 \AA . Given that the temperature of the Moon surface is 200K, the peak wavelength of the radiation from the Moon is
- (a) 3000 \AA (b) 1200 \AA (c) 15 \mu m (d) 60 \mu m
78. Two waves on a string have a displacement given by $y_1 = y_0 \sin(kx - \omega t)$ 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) $\phi = \pi/2$ (c) $\phi = \pi$
(d) Such a ϕ is not possible
79. An optical communication system operating at 1.5 \mu m 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}

86. Three balls were chosen randomly from a bag containing 5 white balls and 6 red balls. The probability that exactly 2 white balls and 1 red ball were chosen is equal to
 (a) $1/12$ (b) $1/10$ (c) $3/10$ (d) $2/3$
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
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}
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
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
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) $6xyz(y-x)(x-z)(z-y)$
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) $2l - k = 7$
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) $-16/3$ (b) $-4/3$ (c) $-8/9$ (d) $-1/9$



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) $\frac{\sqrt{3}}{2}$
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) 13/6 (b) 7/3 (c) 15/6 (d) 8/3
96. The area of the triangle whose vertices have the coordinates (2, 6), (0, 0) and (3, 1) is
 (a) 1/2 sq. units (b) 3/2 sq. units (c) 8 sq. units (d) 10 sq. units
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) $\left(\frac{7}{5}, -\frac{11}{5}\right)$
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
99. Let K be a real number and let the function F be defined by $F(x) = \int_0^{x^2} (Kt^2 + t + 1)dt$. 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) $\pi - 2$
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