JAM 2006

BIOTECHNOLOGY TEST PAPER

1. Lysine is an amino acid with three ionizable groups. These are the α-COOH, α-amino and ε-amino groups with pKa values of 2.2, 9.2 and 10.8, respectively. The isoelectric point (pI) for lysine is
   (A) 5.7
   (B) 6.5
   (C) 9.2
   (D) 10.0
2. Which of the following pair of vitamins participates as cofactors in the cellular oxidation-reduction reactions?
   (A) Pyridoxine and folate
   (B) Riboflavin and cobalamine
   (C) Ascorbate and nicotinamide
   (D) Thiamine and pantothenate
3. Erythrocyte glucose transporter specifically transports glucose down its concentration gradient and exhibits hyperbolic saturation kinetics. This is an example of
   (A) Active mediated transport
   (B) Passive mediated transport
   (C) Non-mediated transport
   (D) Group translocation
4. The oligosaccharide part of glycoproteins is either N-linked or O-linked. The amino acid residues through which these oligosaccharides are attached to polypeptide are
   (A) Asn and Thr
   (B) Asp and Ser
   (C) Ser and Lys
   (D) Gln and Ser
5. Choose the right combination of components required to set up a polymerase chain reaction from the following
   (A) Template DNA, two primers, dNTPs and DNA ligase
   (B) Template DNA, two primers, NTPs and DNA ligase
   (C) Template RNA, two primers, NTPs and DNA polymerase
   (D) Template DNA, two primers, dNTPs and DNA polymerase

6. The DNA restriction site recognized by the enzyme *Hind* III is $-\frac{\mathbf{AAGCTT}}{\mathbf{TTCGAA}}$. Which of the following sequence contained in a double stranded DNA is cut by *Hind* III?

   (P) ATGCCTTAAGATGC (Q) ATGCTTCGAAATGC

   (R) ATGCAAGCTTATGC (S) ATGCGAATTCATGC

   (A) Only Q
   (B) Both Q and R
   (C) Only R
   (D) All of them
7. A bacterial culture contained $32x10^6$ cells after 2.5 hours of exponential growth. If the doubling time was 30 min, what was the initial population number in this culture?
   (A) $20x10^4$ cells
   (B) $10x10^5$ cells
   (C) $40x10^5$ cells
   (D) $16x10^6$ cells

8. The correct match between Group I and Group II is

	Group I		Group II
P.	Amphotericin B	1.	Reverse transcriptase inhibition
Q.	Azidothymidine (AZT)	2.	Sterol binding and disruption of membrane permeability
R	Nalidixic acid	3.	Blocks glycosylation
S.	Tunicamycin	4.	DNA gyrase inhibition

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

9. Most accurate method to determine the molecular weight of a given polypeptide is
   (A) Gel permeation chromatography
   (B) SDS-PAGE
   (C) Analytical ultracentrifugation
   (D) MALDI-TOF mass spectrometry
10. The quantity of bacteriophages in a given sample is best given as
   (A) Colony forming units (CFU)
   (B) Minimum inhibitory concentration (MIC)
   (C) Plaque forming units (PFU)
   (D) Lethal dose 50% (LD_{50})
11. Inter-conversion of glucose and fructose occurs with an equilibrium constant of 1.0. Glucose isomerase catalyzes this reaction. The final concentration of fructose at equilibrium from 40 mM glucose is
   (A) 40 mM
   (B) 20 mM
   (C) 10 mM
   (D) 0 mM
12. Cori cycle integrates body metabolism to
   (A) resynthesize glucose from lactate in the liver
   (B) oxidize acetyl CoA in the muscle
   (C) generate urea in the kidney
   (D) generate glucose from acetyl CoA in the liver
13. In a molecule of glycogen we find
   (A) one reducing end and one non-reducing end
   (B) many reducing ends and one non-reducing end
   (C) one non-reducing end and many branch points
   (D) one reducing end and many non-reducing ends
14. ABO blood group classification is based on the surface antigen of erythrocytes. The nature of this antigen is
   (A) peripheral membrane protein
   (B) integral membrane protein
   (C) sphingoglycolipid
   (D) glycoprotein
15. The citric acid cycle is a metabolic device to oxidize acetyl CoA and conserve the liberated free energy for ATP generation. In this cycle there are
   (A) two decarboxylations and two oxidations
   (B) two decarboxylations and four oxidations
   (C) one decarboxylation and three oxidations
   (D) one decarboxylation and one oxidation

16. In an enzyme catalyzed reaction, doubling the amount of enzyme leads to a change in which of the following?
    (A) V_{max}
    (B) k_{cat}
    (C) k_{cat}/K_m
    (D) K_m
17. Growing *E. coli* cells, when shifted from 37°C to 20°C, maintain their membrane fluidity by modifying the following parameters
    (A) Fatty acid chain length and sterol content
    (B) Fatty acid chain length and unsaturation
    (C) Fatty acid unsaturation and sterol content
    (D) *E. coli* cannot maintain membrane fluidity
18. Discharge of proton concentration gradient across membrane is coupled to the formation of ATP from ADP and inorganic phosphate. This process occurs in which of the following?
    P. Oxidative phosphorylation
    Q. Substrate level phosphorylation
    R. Photophosphorylation
    S. Protein phosphorylation
    (A) Q and S
    (B) Q and R
    (C) P and Q
    (D) P and R
19. Forging of an ecosystem on which of the following is an example of 'primary succession'?
    P. Freshwater lake
    Q. Bare rock
    R. Sand-dune
    S. Abandoned field
    (A) P,R,S
    (B) P,Q,S
    (C) P,Q,R
    (D) Q,R,S
20. Gardeners pinch off the tips of plants to stimulate their side growth. Which one of the following is implicated in this phenomenon?
    (A) Abscisic acid
    (B) Auxin
    (C) Cytokinin
    (D) Gibberellin
21. Pure plasmid DNA was isolated from a bacterium. Restriction enzyme digestion of this plasmid with either *Bam* HI or *Eco* RI resulted in two DNA fragments. A double digestion of the same plasmid with both these enzymes resulted in three DNA fragments. From this we can conclude that the isolated plasmid DNA is
    (A) Double stranded and linear
    (B) Double stranded and circular
    (C) Single stranded and linear
    (D) Single stranded and circular

22. The taxonomic resolution between Archaea and Eubacteria was highlighted using the following by Carl Woese
    (A) Serological techniques
    (B) Protein electrophoresis patterns
    (C) Gram staining
    (D) rRNA studies
23. Which one of the following statements is true with regard to the nature of viroids and prions?
    (A) Viroids are DNA and prions are RNA
    (B) Viroids are protein and prions are RNA
    (C) Viroids are RNA and prions are protein
    (D) Both are made of protein
24. How many types of leukocytes are present in the mammalian circulatory system?
    (A) Two
    (B) Three
    (C) Four
    (D) Five
25. Choose the combination of statements that are correct for the cerebrum of the human brain
    P. It is the largest part of brain
    Q. Controls the pituitary hormone secretion
    R. Involved in coordinating the movements of the body
    S. Receives and processes the sensory information
    (A) PQ
    (B) QR
    (C) PS
    (D) QS
26. The synthesis of proteins requires 20 standard amino acids in the living systems. However, some organisms use selenocysteine as an additional amino acid for synthesizing proteins. Selenocysteine is biosynthesized from
    (A) Cysteine
    (B) Serine
    (C) Threonine
    (D) Proline
27. A mRNA coding for a secretory protein, when translated using free ribosome under *in vitro* conditions, resulted in a 40 kDa protein. The same mRNA when translated using the rough endoplasmic reticulum resulted in a 36 kDa protein. The difference in the molecular weight of the two polypeptides is due to the loss of a
    (A) 2 kDa peptide from N-terminus and a 2 kDa peptide from the C-terminus
    (B) 1 kDa peptide from N-terminus and a 3 kDa peptide from the C-terminus
    (C) 4 kDa peptide from the N-terminus
    (D) 4 kDa peptide from the C-terminus
28. Which of the following can be used for transferring the DNA into the host cells?
    P. Transformation
    Q. Sonication
    R. Transfection
    S. Electroporation
    (A) Only P can be used
    (B) Only Q & R can be used
    (C) Only Q, R & S can be used
    (D) Only P, R & S can be used

29. Choose the statement that is **NOT** correct for the cytoskeletal protein actin
    (A) α-actins are found in various types of muscles
    (B) Polymerization of pure actin *in vitro* requires GTP
    (C) Actin filaments have a slow growing *minus* end and a fast growing *plus* end
    (D) Cytochalasins are the inhibitors for actin polymerization
30. Mast cells contain vesicles that store large amounts of histamine. After staining with eosin, these vesicles are stained red in colour. Identify which of the following interactions is involved between histamine and eosin?
    (A) Hydrophobic interaction
    (B) Electrostatic interaction
    (C) Covalent bonding
    (D) Hydrogen bonding
31. A culture of the *Bacillus brevis* when transferred to moisture free conditions
    (A) utilizes glucose as the only carbon source
    (B) undergoes division thus increasing it's number
    (C) undergoes sporulation
    (D) all of the above are observed
32. The purification of an antigen using the corresponding antibodies conjugated to agarose is an example of
    (A) Affinity chromatography
    (B) Gel filtration chromatography
    (C) Ion exchange chromatography
    (D) Hydrophobic interaction chromatography
33. Choose the correct match from A, B, C & D

Group I	**Group II**
P. 5' capping of mRNA	1. 5-methyl guanosine
Q. Ribozyme	2. Polyadenylate transferase
R. Promoter	3. Spliceosome
S. Poly-$(A)^+$ tail	4. 7-methyl guanosine
	5. RNA polymerase
	6. Catalytic RNA
	7. Polyadenylate polymerase

(A)	(B)	(C)	(D)
P-1	P-4	P-1	P-4
Q-6	Q-6	Q-5	Q-3
R-5	R-5	R-3	R-6
S-2	S-7	S-7	S-2

34. Choose the correct match from A, B, C & D

Group I	**Group II**
P. IgA	1. Basophils
Q. IgE	2. δ heavy chain
R. IgG	3. Secretory component
S. IgM	4. Pentamer
	5. Crosses placenta

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

35. Choose the correct combination of statements from the following for MHC II protein
P. Has α_1, α_2, β_1 and β_2 domains
Q. α_1 and β_1 are the polymorphic domains
R. Involved in presenting antigen to cytotoxic T cells
S. Only α chain is glycosylated
(A) QR
(B) RS
(C) PS
(D) PQ

36. Identify the amino acid with uncharged polar side chain
(A) Proline
(B) Tryptophan
(C) Glutamine
(D) Arginine

37. The A_{260}/A_{280} ratio of a DNA sample was observed to be 1.2. An increase in this ratio can be obtained by subjecting the DNA sample to
(A) phenol extraction
(B) trichloroacetic acid treatment
(C) butanol extraction
(D) all of the above can be used

38. Which of the following statements is **FALSE** for the nitric oxide gas?
(A) An intracellular signaling molecule
(B) Deamination of histidine results into nitric oxide production
(C) Stimulates guanylyl cyclase to produce cGMP
(D) Can be produced by activated neutrophils

39. G-proteins are involved in relaying signals through G-protein linked receptors. Which of the following forms of G-protein is considered to be in active state?
(A) G-protein - ADP
(B) G-protein - ATP
(C) G-protein - GDP
(D) G-protein - GTP

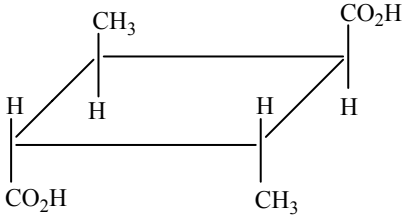
40. Choose the correct match from A, B, C & D

Group I	**Group II**
P. Epinephrine	1. Uterine contractions
Q. Parathormone	2. Water resorption
R. Oxytocin	3. Ca^{2+} uptake
S. Luteinizing hormone	4. Glycogen breakdown
	5. Thyroid hormone synthesis
	6. Progesterone secretion

(A)	(B)	(C)	(D)
P-1	P-5	P-5	P-4
Q-2	Q-6	Q-2	Q-3
R-5	R-1	R-3	R-1
S-6	S-2	S-4	S-6

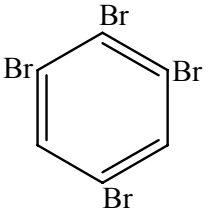
41. The 'A' fragment of diphtheria toxin catalyzes the addition of an ADP-ribose group to the eukaryotic elongation factor EF-2. The source for the ADP-ribose group is
(A) FAD
(B) FMN
(C) NAD^+
(D) $NADP^+$

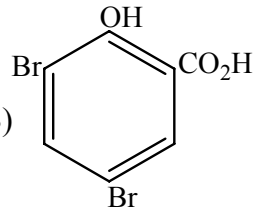
42. The nucleotide sequence of DNA involved in binding to a transcription factor can be determined by
    (A) DNA footprinting
    (B) S_1 nuclease treatment
    (C) DNA fingerprinting
    (D) Northern hybridization
43. A culture of *Mycobacterium leprae* was subjected to alkaline ethanol extraction prior to acid fast staining. The colour of the culture following staining will be
    (A) Red
    (B) Green
    (C) Yellow
    (D) Blue
44. The primer of the lagging strand during DNA replication is removed by
    (A) 3' to 5' exonuclease activity of DNA polymerase III
    (B) DNA primase
    (C) 5' to 3' exonuclease activity of DNA polymerase I
    (D) 3' to 5' exonuclease activity of DNA polymerase I
45. Compare the CH_3-C bond lengths in propene with that of ethane
    (A) bond length shorter in propene
    (B) bond lengths are equal
    (C) bond length longer in propene
    (D) bond lengths cannot be compared
46. 2,4-Dimethylcyclobutane-1,3-dicarboxylic acid is optically inactive because it has

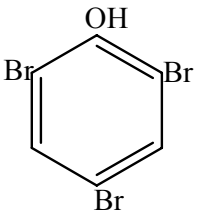


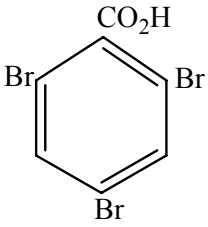
    (A) plane of symmetry
    (B) centre of symmetry
    (C) the capability of rotating plane polarized light
    (D) neither a plane nor a centre of symmetry
47. Compare the pK_a values of the following acids:
    (i) formic acid (ii) acetic acid (iii) *mono*chloroacetic acid (iv) *di*chloroacetic acid
    (A) (iv) < (iii) < (i) < (ii)
    (B) (i) > (ii) > (iii) > (iv)
    (C) (i) < (ii) < (iii) > (iv)
    (D) (iv) < (iii) < (i) < (ii)

48. Excess Br_2 water reacts with salicylic acid: predict the product

(A) 

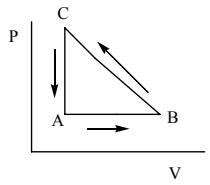
(B) 

(C) 

(D) 

49. By heating a mixture of methylamine and chloroform with ethanolic KOH a typical product is produced. Hydrolysis of the product with HCl gives back methylamine. Identify the typical product?
    (A) NH_2OH
    (B) $(CN)_2$
    (C) N_2H_4
    (D) CH_3NC
50. What organic compound would be obtained when diazonium sulfate solution is boiled or steam distilled?
    (A) aniline
    (B) biphenyl
    (C) phenol
    (D) benzoic acid
51. To determine the strength of glycine in water a mixture of an aqueous solution of glycine and formalin is titrated against standard NaOH because
    (A) basic character of the amine group of glycine is suppressed
    (B) nitrogen is removed from glycine
    (C) formalin stabilizes the zwitterionic form of glycine
    (D) a new inner salt of glycine results
52. Ethylenediaminetetraacetic acid (EDTA) forms a chelate compound with Mg(II) ion in water at pH 10. How many ring structures are produced surrounding the Mg(II) ion by the EDTA molecule?
    (A) 4
    (B) 5
    (C) 6
    (D) 2
53. $K_4[Fe(CN)_6]$ produces intense blue coloured compound with Fe(III) ions in solution. The colour is due to
    (A) crystal defects in the blue compound
    (B) d-d transition in Fe(III) ions only
    (C) the electron transfer from one oxidation state of iron ion to the other
    (D) evolution of solvated electron in aqueous medium

54. The stretching frequency for free CO molecule is ~2143 cm^{-1}. In $Fe(CO)_5$ molecule the stretching frequency for CO becomes
    (A) ~2240 cm^{-1}
    (B) ~2030 cm^{-1}
    (C) remain unchanged
    (D) cannot be predicted
55. The degree of hydration for the compounds NaCl, KCl, $MgCl_2$ and $BaCl_2$ follows the order
    (A) $MgCl_2 > BaCl_2 < NaCl > KCl$
    (B) $MgCl_2 < BaCl_2 > NaCl = KCl$
    (C) $NaCl > KCl > BaCl_2 > MgCl_2$
    (D) $MgCl_2 > BaCl_2 > NaCl > KCl$
56. Yellow CrO_4^{2-} is easily converted to orange $Cr_2O_7^{2-}$ by any acid. This transformation is
    (A) dimerisation reaction
    (B) disproportionation reaction
    (C) oxidation reaction
    (D) reduction reaction
57. Upon mixing and aqueous solution of blue $CuSo_4$ solution with excess KCN, which on of the following complex compound is produced?
    (A) $K_4[Cu(CN)_4]$
    (B) $K_3[Cu(CN)_4]$
    (C) $K_4[Cu(CN)_6]$
    (D) $[Cu(CN)_2(OH)_2]$
58. Consider the cyclic process ABCA on a sample of 2.0 mol of an ideal gas as shown in figure.



    The temperatures of the gas at A and B are 300 K and 500 K, respectively. A total of 1200 J heat is withdrawn from the sample in the process. Find the work done by the gas in part BC (R = 8.3 J/mol-K)
    (A) 4520 J
    (B) 0
    (C) -4520 J
    (D) -9000 J
59. If heat is supplied to an ideal gas in an isothermal process
    (A) the gas will do positive work
    (B) the internal energy of the gas will increase
    (C) the gas will do negative work
    (D) the said process is not possible

60. The flow of solvent molecules from pure solvent side to the solution side takes place during osmosis. This causes a decrease in the difference of chemical potential of solvent on either side
    (A) hydrostatic pressure increases on either sides
    (B) false
    (C) chemical potential has no role to play
    (D) true

61. The ionization energy of a hydrogen atom is 13.6 eV. The first excitation potential of the hydrogen atom is
    (A) higher than 13.6 eV
    (B) lower than 13.6 eV
    (C) same
    (D) twice the ionization energy
62. Under standard condition can $KMnO_4$ produce O_2 from water in the presence of a mineral acid? (Given half cell potential 1.51 V for MnO_4^-/Mn^{2+} and O_2/H_2O in acid 1.22 V)
    (A) the reaction is not possible
    (B) the reaction needs air
    (C) the reaction is possible
    (D) the reaction needs photon
63. The hydrolysis of ethyl acetate by acetic acid produced in the reaction also catalyzes the reaction. If the initial concentration of ethyl acetate is 'a' and that of acetic acid is 'b' & 'x' is the amount of ethyl acetate hydrolyzed at time 't'. The rate of reaction will be
    (A) k(a+x)(b+x)
    (B) k(a-x)(b+x)
    (C) k(a-x)(b-x)
    (D) k(a+x)(b-x)
64. On passing monochromatic light through a 0.04 molar solution in a cell of 1 cm path length, the intensity of the transmitted light was reduced to 50%. Calculate the molar extinction coefficient of the solute in the solution (given log 2 = 0.3010).
    (A) 0.75 liter mol^{-1} cm^{-1}
    (B) 75 liter mol^{-1} cm^{-1}
    (C) 750 liter mol^{-1} cm^{-1}
    (D) 7.5 liter mol^{-1} cm^{-1}
65. Kilowatt-hour is the unit of
    (A) Power
    (B) Energy
    (C) Current
    (D) Voltage
66. The dimensional formula of surface tension in terms of the dimensions of mass (M), length (L) and time (T) is
    (A) MT^{-2}
    (B) MLT^{-2}
    (C) MT^{-1}
    (D) $ML^{-1}T^{-2}$
67. Which of the following statements is FALSE?
    (A) Light rays travel through vacuum.
    (B) Gamma rays travel through vacuum.
    (C) Sound waves travel through vacuum.
    (D) Sound waves travel through solids.
68. A body moves from A to B in a straight line with a uniform speed of 60 m/s and returns to B with a uniform speed of 40 m/s. The average speed of the body for the complete motion is
    (A) 50 m/s
    (B) 45 m/s
    (C) zero
    (D) 48 m/s

69. Two particles have their masses and the kinetic energies **both** in the ratio 1:2. Then the ratio of their de Broglie wavelengths will be
    (A) 1:2
    (B) 1:4
    (C) 2:1
    (D) 4:1
70. Four equal resistances are connected in such a way that they form a square loop. If the value of each resistance is R, the resistance between any two diagonally opposite points will be
    (A) $\sqrt{2}R$
    (B) $\frac{R}{2\sqrt{2}}$
    (C) $\frac{R}{4}$
    (D) R
71. One kilogram of cotton and one kilogram of iron have the same weight. If they are placed on an equal-arm balance kept in air, which of the following statements is TRUE?
    (A) Both the arms will be at the same level.
    (B) The arm with the cotton will be at the lower level.
    (C) The arm with the iron will be at the lower level.
    (D) The arms keep oscillating.
72. A radioactive material containing N_0 number of nuclei at time t=0 decays with a decay constant λ. The number of nuclei that will undergo decay in time t is
    (A) $N_0 e^{\lambda t}$
    (B) $N_0 e^{-\lambda t}$
    (C) $N_0\left(1-e^{-\lambda t}\right)$
    (D) $N_0 \lambda t$
73. An alternating current $I = I_0 \sin \omega t$, where ω is the angular frequency, is passed through a resistor whose resistance is R. The thermal energy developed in the resistor during one time period (T) of the alternating current is
    (A) $I_0^{\,2} RT$
    (B) $\frac{I_0^{\,2} RT}{4}$
    (C) zero
    (D) $\frac{I_0^{\,2} RT}{2}$
74. Impurity energy levels in the case of an n-type semiconductor are situated
    (A) Just above the top of the valence band.
    (B) Just below the bottom of the conduction band.
    (C) Exactly at the middle of the gap between the valence and conduction bands.
    (D) Within the conduction band.

75. The separation between the slits in the Young's double slit apparatus is 0.1 mm. If the wavelength of light used is 500 nm, the separation between the successive bright fringes of the interference pattern obtained on a screen kept at a distance of 1 m from the slits is
    (A) 50 mm
    (B) 10 mm
    (C) 5 mm
    (D) 2.5 mm
76. If the radii of orbits of two planets around the sun are in the ratio 1:4, their time periods of revolution about the sun will be in the ratio
    (A) 1:8
    (B) 1:6
    (C) 1:4
    (D) 1:2
77. The ratio of the molar heat capacities at constant pressure and at constant volume (C_p/C_v) of a diatomic gas at room temperature is
    (A) 5/2
    (B) 7/5
    (C) 7/2
    (D) 5/3
78. The radii of curvature of a biconvex lens are 24 cm each. If the refractive index of the material of the lens is 1.6, the focal length of the length is
    (A) 20 cm
    (B) zero
    (C) 7.5 cm
    (D) 12 cm
79. Total internal reflection occurs when
    (A) Light enters a rarer medium from a denser medium and the angle of incidence is more than the critical angle.
    (B) Light enters a denser medium from a rarer medium and the angle of incidence is more than the critical angle.
    (C) Light enters a rarer medium from a denser medium and the angle of incidence is less than the critical angle.
    (D) Light enters a denser medium from a rarer medium and the angle of incidence is less than the critical angle.
80. A uniform solid sphere of a conducting material is given a charge $+Q$. Which of the following statements is FALSE?
    (A) No work needs to be done to move a unit positive charge on the surface of the sphere.
    (B) Electrostatic potential at the centre of the sphere is zero.
    (C) Electric field at the centre of the sphere is zero.
    (D) Electric field is zero everywhere inside the sphere.
81. A solid block of a material floats in water (density of water = 1 g/cm^3) with 60 % of its volume submerged in water. If it floats in an oil with 90 % of its volume submerged, the density of the oil is
    (A) 0.67 g/cm^3
    (B) 0.50 g/cm^3
    (C) 1.50 g/cm^3
    (D) 1.00 g/cm^3

82. Two infinitely long straight wires carrying steady currents I_1 and I_2 in the same direction are kept parallel to each other, with a distance of separation d between them. Then,
(A) There is no force between the wires.
(B) There is a repulsive force between the wires.
(C) There is a force parallel to the wires, between them.
(D) There is a force of attraction between the wires.

83. If the points $(x, 0.1)$, (2, 3) and (4, 5) are collinear, then the value of x is
(A) –1.1
(B) –0.9
(C) 0.9
(D) 1.1

84. Let $\bar{a} = \bar{i} + \bar{j} + \bar{k}$ and $\bar{b} = \bar{i} + 2\bar{j} + 3\bar{k}$ be two vectors. The sine of the angle between $\bar{a}$ and $\bar{b}$ is:
(A) $\frac{\pi}{2}$
(B) $\sqrt{\frac{6}{7}}$
(C) $\sqrt{\frac{5}{7}}$
(D) $\sqrt{\frac{1}{7}}$

85. The angle between the lines $\frac{x-1}{1} = \frac{y+2}{-2} = \frac{z-3}{3}$ and $\frac{x+1}{6} = \frac{y-2}{2} = \frac{z+3}{4}$ is:
(A) $\frac{\pi}{2}$
(B) $\frac{\pi}{6}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{3}$

86. Let a and b be two non-zero real numbers such that $z = a + ib$ and $z_1 = iz$. Which of the following statements is TRUE:
(A) The principal part of the arguments of z and z_1 differ by $\frac{\pi}{2}$
(B) The principal part of the arguments of z and z_1 differ by π
(C) z_1 is the complex conjugate of z
(D) z_1 is a pure imaginary number

87. Four horses A, B, C and D participated in a race. Horses A and B have equal chances to win. C is twice as likely to win as A and D is twice as likely to win as C. The probability that either B or C wins is

(A) $\frac{1}{8}$

(B) $\frac{2}{8}$

(C) $\frac{3}{8}$

(D) $\frac{5}{8}$

88. The component (value) which is independent of x in the expansion of $\left(1+\sqrt{x}+\frac{1}{\sqrt{x}}\right)^4$ is:

(A) 7
(B) 12
(C) 18
(D) 19

89. The area of the region bounded by the circle $x^2+y^2=a,(a>0)$ and between the lines $x=-\frac{a}{2}$ and $x=\frac{a}{2}$ is

(A) $a^2\left(\frac{\pi}{3}-\frac{\sqrt{3}}{2}\right)$

(B) $a^2\left(\frac{\pi}{3}+\frac{\sqrt{3}}{2}\right)$

(C) $\frac{a^2}{2}\left(\frac{\pi}{3}-\frac{\sqrt{3}}{2}\right)$

(D) $\frac{a^2}{2}\left(\frac{\pi}{3}+\frac{\sqrt{3}}{2}\right)$

90. If $S=\sum_{n=1}^{\infty}\left(\frac{r}{a}\right)^n \cos^n\theta$, which of the following statements is TRUE

(A) $S=\frac{r}{a\cos\theta+r}$, if (r, θ) are the polar coordinates such that $r<a$

(B) $S=\frac{r}{a\cos\theta+r}$, if (r, θ) are the polar coordinates such that $r>a$

(C) $S=\frac{r}{a\sec\theta-r}$, if (r, θ) are the polar coordinates such that $r<a$

(D) $S=\frac{r}{a\sec\theta-r}$, if (r, θ) are the polar coordinates such that $r>a$

91. Let α and β be two real numbers satisfying $a\cos\theta + b\sin\theta = c$, where a, b and c are three real constants. Also $\alpha - \beta \neq 2n\pi$, (n is an integer). The value of $\sin(\alpha+\beta)$ is:

(A) $\dfrac{2ab}{a^2+b^2}$

(B) $\dfrac{ab}{a^2+b^2}$

(C) $\dfrac{2ab}{a^2-b^2}$

(D) $\dfrac{a^2-b^2}{a^2+b^2}$

92. If the point $(x, y) = (2, 4)$ minimizes $Z = 6x + 10y$ subject to the constraints $2x + y \geq 4$, $x + 2y \geq 10$, $x + y \geq 6$, then which of the given constraints does NOT effect the minimization point (2, 4) in minimizing $Z = 6x + 10y$.

(A) no constraint can be omitted

(B) $x + 2y \geq 10$

(C) $x + y \geq 6$

(D) $2x + y \geq 4$

93. $\alpha = \dfrac{i-1}{\cos\dfrac{\pi}{3} + i\sin\dfrac{\pi}{3}}$ is one of the roots of the quadratic equation $x^2 + bx + c = 0$, where b and c are real constants. The value of b is:

(A) $1-\sqrt{3}$

(B) $\sqrt{3}-1$

(C) $\dfrac{1-\sqrt{3}}{2}$

(D) $\dfrac{\sqrt{3}-1}{2}$

94. Let f be a function given by $f(x) = x - [x]$, where $x \in \Re$ and $[x]$ is the greatest integer defined as $[x] = n$ for all $n \leq x < n+1$. Then which of the following statements is TRUE:

(A) f is discontinuous at all integer values

(B) f is continuous everywhere

(C) f is discontinuous at all integer values except at '0'

(D) f is discontinuous only at positive integer values

95. Let *a, b, c, d* and *e* be real and non-zero. For the given matrix $A = \begin{pmatrix} a & 0 & b \\ 0 & c & 0 \\ d & 0 & e \end{pmatrix}$ which of the following statements is TRUE:

(A) Matrix A is non-singular for all distinct *a, b, c, d* and *e*

(B) The minor of every element of A is equal to the cofactor of the corresponding element

(C) The number of non-zero elements of the matrix $\frac{1}{2}\left(A - A^T\right)$ is 5

(D) The matrix $\frac{1}{2}\left(A - A^T\right)$ is symmetric

96. Given $x\ln(x)\frac{dy}{dx} - y = 0, (x > 0),\ y(e) = e$, then y(4) is

(A) $\ln(4)$

(B) $e\ln(4)$

(C) $e^2\ln(4)$

(D) $e^4\ln(4)$

97. Let $f(x) = \begin{cases} \dfrac{e^{\cos x}\sin x}{1+x^2} & \text{for} \quad |\,x\,| < 2 \\ xe^{x-2} & \text{otherwise} \end{cases}$. The value of the integral $\int_{-2}^{4} f(x)\,dx$ is:

(A) $1 - 3e^2$

(B) $3e^2 + 1$

(C) $3e^2 - 1$

(D) $3e^2$

98. If *y* is a function of *x* defined as $y = a^x + \dfrac{1}{a^x + \dfrac{1}{a^x + \cdots}}$. The derivative of *y* with respect to *x* is:

(A) $\dfrac{ya^x \ln a}{2y + a^x}$

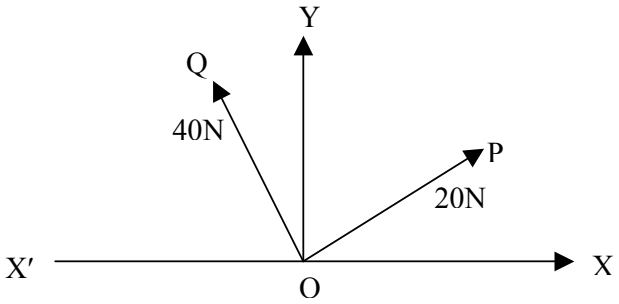
(B) $\dfrac{ya^x \ln a}{2y - a^x}$

(C) $\dfrac{ya^x \ln a}{2(y - a^x)}$

(D) $\dfrac{ya^x \ln a}{2(y + a^x)}$

99. Let A, B, C and D be four points in a vertical line such that $AB = \frac{1}{3}BC = \frac{1}{5}CD$. If a body falls from rest from A, the ratio of the times of descending AB, BC and CD is:
(A) 1 : 4 : 9
(B) 1 : 3 : 5
(C) 1 : 2 : 3
(D) 1 : 1 : 1

100. The resultant of two forces of 20N and 40N is acting vertically at 'O' as shown in the following figure. If the angle XOP is 30^0, then the angle X′OQ is:



(A) $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(B) $\cos^{-1}\left(\frac{\sqrt{3}}{4}\right)$

(C) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(D) $\sin^{-1}\left(\frac{\sqrt{3}}{4}\right)$