

104

QUESTION PAPER
SERIES CODE
A

Registration No. :

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Centre of Exam. : _____

Name of Candidate : _____

Signature of Invigilator

ENTRANCE EXAMINATION, 2017
M.Sc. COMPUTATIONAL AND INTEGRATIVE SCIENCE
[Field of Study Code : CISM (232)]

Time Allowed : 3 hours

Maximum Marks : 70

INSTRUCTIONS FOR CANDIDATES

- Candidates must read carefully the following instructions before attempting the Question Paper :
- (i) Write your Name and Registration Number in the space provided for the purpose on the top of this Question Paper and in the Answer Sheet.
 - (ii) **Please darken the appropriate Circle of Question Paper Series Code on the Answer Sheet.**
 - (iii) The Question Paper consists of two Parts : **Part—A** and **Part—B**.
 - (iv) **Part—A** contains twenty (20) questions. Answer **all** questions. Each correct answer carries 1 mark and **0.25 mark will be deducted for every wrong answer.**
 - (v) **Part—B** has **four** sections of twenty-five (25) questions each. Candidates may choose any **one** section and answer twenty-five (25) questions. Each question carries 2 marks and **0.5 mark will be deducted for every wrong answer.**
 - (vi) Answer all the questions in the Answer Sheet provided for the purpose by darkening the correct choice, i.e., (a) or (b) or (c) or (d) with BLUE/BLACK BALLPOINT PEN only against each question in the corresponding circle.
 - (vii) In case you think none of the possible answers are correct, mark the correct answer which you think is closest to the correct one.
 - (viii) Answer written by the candidates inside the Question Paper will not be evaluated.
 - (ix) Simple Calculators and Log Tables may be used.
 - (x) Pages at the end have been provided for Rough Work.
 - (xi) Return the Question Paper and Answer Sheet to the Invigilator at the end of the Entrance Examination. **DO NOT FOLD THE ANSWER SHEET.**

INSTRUCTIONS FOR MARKING ANSWERS

1. Use only Blue/Black Ballpoint Pen (do not use pencil) to darken the appropriate Circle.
2. Please darken the whole Circle.
3. Darken ONLY ONE CIRCLE for each question as shown in example below :

Wrong	Wrong	Wrong	Wrong	Correct
<input type="radio"/> (a) <input type="radio"/> (b) <input type="radio"/> (c) <input type="radio"/> (d)	<input checked="" type="radio"/> (a) <input type="radio"/> (b) <input type="radio"/> (c) <input type="radio"/> (d)	<input checked="" type="radio"/> (a) <input type="radio"/> (b) <input type="radio"/> (c) <input checked="" type="radio"/> (d)	<input checked="" type="radio"/> (a) <input type="radio"/> (b) <input type="radio"/> (c) <input type="radio"/> (d)	<input type="radio"/> (a) <input type="radio"/> (b) <input type="radio"/> (c) <input checked="" type="radio"/> (d)

4. Once marked, no change in the answer is allowed.
5. Please do not make any stray marks on the Answer Sheet.
6. Please do not do any rough work on the Answer Sheet.
7. Mark your answer only in the appropriate space against the number corresponding to the question.
8. **Ensure that you have darkened the appropriate Circle of Question Paper Series Code on the Answer Sheet.**

PART—A

Answer all questions

1. If ten objects are distributed at random among ten persons, the probability that at least one of them will not get any object is
 - (a) $(10^{10} - 10) / 10^{10}$
 - (b) $(10^{10} - 10!) / 10^{10}$
 - (c) $(10^{10} - 1) / 10^{10}$
 - (d) None of the above

2. A die is thrown twice and the sum of the numbers appearing is observed to be 6. What is the conditional probability that the number 4 has appeared at least once?
 - (a) $2/5$
 - (b) $4/12$
 - (c) $2/36$
 - (d) None of the above

3. The mean and variance of a binomial distribution are 4 and 2 respectively. Then the probability of 2 successes is
 - (a) $37/256$
 - (b) $219/256$
 - (c) $7/64$
 - (d) $128/256$

4. There are 5 imitations and 10 original items in an automobile shop and 3 items are bought at random by a customer. The probability that none of the items is an imitation, is
 - (a) $20/91$
 - (b) $22/91$
 - (c) $24/91$
 - (d) $89/91$

5. Evaluating $\lim_{x \rightarrow 5} \left(\frac{x^4 - 625}{x^3 - 125} \right)$ yields
- (a) $31/5$
 - (b) $20/5$
 - (c) $5/3$
 - (d) $40/3$
6. If $A = \begin{bmatrix} \alpha & 2 \\ 2 & \alpha \end{bmatrix}$ and $|A^3| = 125$, then the value of α is
- (a) ± 1
 - (b) ± 2
 - (c) ± 3
 - (d) ± 5
7. The arithmetic mean of the numbers $1^2, 2^2, \dots, n^2$ is
- (a) $\frac{n+1}{2}$
 - (b) $\frac{n}{2}$
 - (c) $\frac{n^2(n+1)}{4}$
 - (d) $\frac{(n+1)(2n+1)}{6}$
8. Trials of a random experiment are called Bernoulli trials. Which one of the options below does not satisfy the necessary condition?
- (a) There should be a finite number of trials
 - (b) The trials should be dependent
 - (c) Each trial has exactly two outcomes : success or failure
 - (d) The probability of success (or failure) remains the same in each trial

9. Let A and B be two events. If $P(A) = 0.2$, $P(B) = 0.4$, $P(A \cup B) = 0.6$, then $P(A|B)$ is equal to

- (a) 0.8
- (b) 0.5
- (c) 0.3
- (d) 0

10. A die is thrown and a card is selected at random from a deck of 52 playing cards. The probability of getting an even number on the die and a spade from the deck is

- (a) $1/2$
- (b) $1/4$
- (c) $1/8$
- (d) $3/4$

11. Let X be a discrete random variable. The probability distribution $P(X)$ for X is given below :

X	30	10	-10
$P(X)$	$1/5$	$3/10$	$1/2$

Then $E(X)$ is equal to

- (a) 6
- (b) 4
- (c) 3
- (d) -5

12. If $|\vec{a}| = 8$, $|\vec{b}| = 3$ and $|\vec{a} \times \vec{b}| = 12$, then the value of $\vec{a} \cdot \vec{b}$ is

- (a) $6\sqrt{3}$
- (b) $8\sqrt{3}$
- (c) $12\sqrt{3}$
- (d) None of the above

13. The value of λ for which the two vectors $2\hat{i} - \hat{j} + 2\hat{k}$ and $3\hat{i} + \lambda\hat{j} + \hat{k}$ are perpendicular is
- (a) 2
 - (b) 4
 - (c) 6
 - (d) 8
14. If A and B are two matrices of the order $3 \times m$ and $3 \times n$ respectively and $m = n$, then the order of matrix $(5A - 2B)$ is
- (a) $m \times 3$
 - (b) 3×3
 - (c) $m \times n$
 - (d) $3 \times n$
15. If $\begin{vmatrix} 2x & 5 \\ 8 & x \end{vmatrix} = \begin{vmatrix} 6 & -2 \\ 7 & 3 \end{vmatrix}$, then the value of x is
- (a) 3
 - (b) ± 3
 - (c) ± 6
 - (d) 6
16. The differential coefficient of $\sec(\tan^{-1} x)$ w.r.t. x is
- (a) $\frac{x}{\sqrt{1+x^2}}$
 - (b) $\frac{x}{1+x^2}$
 - (c) $x\sqrt{1+x^2}$
 - (d) $\frac{1}{\sqrt{1+x^2}}$

17. If $y = \sqrt{\sin x + y}$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{\cos x}{2y-1}$

(b) $\frac{\cos x}{1-2y}$

(c) $\frac{\sin x}{1-2y}$

(d) $\frac{\sin x}{2y-1}$

18. $\int e^x \left(\frac{1-x}{1+x^2} \right)^2 dx$ is equal to

(a) $\frac{e^x}{1+x^2} + C$

(b) $\frac{-e^x}{1+x^2} + C$

(c) $\frac{e^x}{(1+x^2)^2} + C$

(d) $\frac{-e^x}{(1+x^2)^2} + C$

19. The degree of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx} \right)^3 + 6y^5 = 0$ is

(a) 1

(b) 2

(c) 3

(d) 5

20. Which of the following is **not** true for a normal distribution?

(a) Mean, median and mode are the same

(b) All the observed values are less than 3 times the standard deviation away from mean

(c) The probability distribution is symmetric about the mean

(d) Total area under the probability distribution curve is 1

PART—B

Answer all questions from any ONE Section

Section—I

(Mathematics / Statistics)

21. $L^{-1} \left\{ \frac{1}{(s-3)^4} \right\}$ is

(a) $\frac{1}{6} t^3 e^{3t}$

(b) $-\frac{1}{6} t^3 e^{3t}$

(c) $\frac{1}{6} t^3 e^{-3t}$

(d) $\frac{1}{6} t^{-3} e^{3t}$

22. If $\int_0^t N(t) dt = 0$, for all $t > 0$, then $N(t)$ is called

(a) delta function

(b) Heaviside step function

(c) null function

(d) constant function

23. If $\oint f(z) dz = 0$ over C , where C is simple closed curve, then

(a) $f(z)$ is analytic

(b) $f'(z)$ is continuous

(c) Both (a) and (b)

(d) $f(z)$ is not analytic

24. The poles of the function $f(z) = \frac{z^2}{(z-1)(z-2)^2}$ are

(a) 1, 2

(b) 1, 0

(c) 2, 3

(d) 1, 3

25. If a function $f(z)$ is analytic except at finite number of poles, the sum of the residues at these poles is

- (a) 1
- (b) 0
- (c) ∞
- (d) $2\pi i$

26. The value of $\int_0^{\infty} \frac{dx}{(x^2 + a^2)^3}$ is

- (a) $\frac{\pi}{4a^3}$
- (b) $\frac{\pi}{a+b}$
- (c) $\frac{\pi}{2}$
- (d) 0

27. Evaluate $\lim_{\substack{x \rightarrow \infty \\ y \rightarrow 3}} \frac{2x-3}{x^3+4y^3}$.

- (a) 0
- (b) 1
- (c) 2
- (d) 3

28. If $u = xyz$, $v = x^2 + y^2 + z^2$, $w = x + y + z$, then $J = \frac{\partial(x, y, z)}{\partial(u, v, w)}$ is

- (a) $-2(x-y)(y-z)(z-x)$
- (b) $(x-y)(y-z)(z-x)$
- (c) $(x-y)^2(y-z)(z-x)$
- (d) $(x+y+z)(y-z)(z-x)$

29. The solution of the equation $\frac{dy}{dx} = \frac{y}{x} + x \sin \frac{y}{x}$ is

(a) $\log \cot \left(\frac{y}{2x} \right) = x + C$

(b) $\log \tan \left(\frac{y}{2x} \right) = x + C$

(c) $\log \tan^{-1} \left(\frac{y}{2x} \right) = x + C$

(d) $\log \cot^{-1} \left(\frac{y}{2x} \right) = x + C$

30. The solution of the differential equation $[D^2 + 5D + 6]y = e^x$ is

(a) $c_1 e^{-2x} + c_2 e^{-3x} + \frac{e^x}{12}$

(b) $c_1 e^{-2x} + c_2 e^{-2x} + \frac{e^{2x}}{12}$

(c) $c_1 e^{2x} + c_2 e^{-3x} + \frac{e^{3x}}{12}$

(d) $c_1 e^{3x} + c_2 e^{-3x} + \frac{e^{3x}}{12}$

31. The integrating factor of $\cos^2 x \frac{dy}{dx} + y = \tan x$ is

(a) $e^{\cos x}$

(b) $e^{\tan x}$

(c) $e^{\sin x}$

(d) $e^{\cot x}$

32. $Mdx + Ndy = 0$ is an exact differential equation, if

(a) $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$

(b) $\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$

(c) $\frac{\partial M}{\partial y} = 0$

(d) $\frac{\partial N}{\partial x} \neq 0$

33. The value of $\oint \frac{dz}{z-a}$ over C , where C is the circle $|z-a|=r$ is
- (a) πi
 - (b) $2\pi i$
 - (c) 1
 - (d) 0
34. If $\Delta f(x) = f(x+h) - f(x)$, then a constant k , Δk equals
- (a) 1
 - (b) 0
 - (c) $f(k) - f(0)$
 - (d) $f(x+k) - f(x)$
35. In the Gauss elimination method for solving a system of linear algebraic equations, triangularization leads to
- (a) diagonal matrix
 - (b) lower triangular matrix
 - (c) upper triangular matrix
 - (d) singular matrix
36. What is the maximum number of edges possible in a simple graph G with 10 vertices?
- (a) 40
 - (b) 30
 - (c) 45
 - (d) 10
37. For a given linear congruences $12x = 9 \pmod{15}$, how many non-congruent modulo 15 are there?
- (a) 3
 - (b) 4
 - (c) 5
 - (d) 6

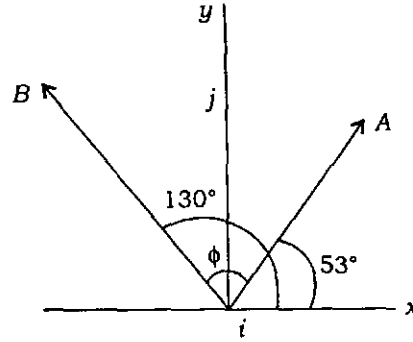
38. Find the radius and centre of the circle $z\bar{z} - (2 + 3i)z - (2 - 3i)\bar{z} + 9 = 0$.
- (a) 2, $2 + 3i$
 - (b) 3, $2 + 3i$
 - (c) -2 , $-2 - 3i$
 - (d) 2, $2 - 3i$
39. The diagonal elements of a skew-Hermitian matrix are
- (a) pure imaginary numbers or zero
 - (b) pure imaginary numbers and zero
 - (c) real numbers excluding zero
 - (d) divisor of order of matrix
40. The image of a point $(1, 3)$ in the line $x + y - 6 = 0$ is
- (a) $(3, 5)$
 - (b) $(5, 3)$
 - (c) $(1, -3)$
 - (d) $(-1, 3)$
41. What is the probability that the sum of two numbers x and y randomly chosen on the interval $(0, 1)$ is greater than 1 while the sum of squares is less than 1?
- (a) $\frac{\pi}{4} - \frac{1}{2}$
 - (b) $\frac{\pi}{12}$
 - (c) $\frac{1}{18}$
 - (d) $\frac{\pi}{24}$

42. The m.g.f. of a continuous random variate is $M_x(t) = \exp[\mu t + \sigma^2 t^2 / 2]$. Find $E[e^x]$.
- (a) $e^{\mu + \sigma^2 / 2}$
 - (b) $e^{\sigma^2 / 2}$
 - (c) 1
 - (d) None of the above
43. In a bivariate distribution (X, Y) , the random variables X and Y are connected by the equation $y = 7x - 8$. The correlation coefficient between them is
- (a) 1
 - (b) -1
 - (c) $-8/7$
 - (d) $-7/8$
44. If X and Y are independent variables, then $\text{Cov}(X, Y)$ is
- (a) 0
 - (b) 1
 - (c) -1
 - (d) undefined
45. Ten couples (5 males and 5 females) are to sit around a round table with 10 seats. How many arrangements are possible?
- (a) ${}^{10}C_5$
 - (b) $10!$
 - (c) $9!$
 - (d) ${}^{10}P_5$

Section—II

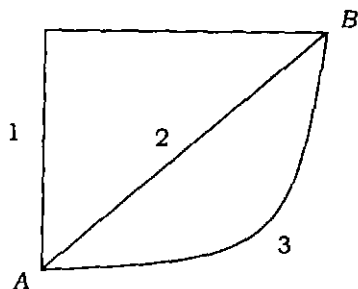
(Physics)

46. Find the scalar product $\vec{A} \cdot \vec{B}$ of the two vectors shown in the figure below (the magnitudes of the vectors are $A = 4.00$ and $B = 5.00$) :



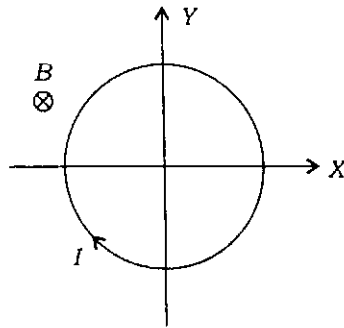
- (a) 4.50
(b) 20.00
(c) 5.50
(d) 10.00
47. A train 600 m long is travelling at 80 kmph. In what time it will cross a cyclist moving at 8 kmph (cycling in a road parallel and adjacent to the railway track) in the same direction?
- (a) 10 sec
(b) 30 sec
(c) 20 sec
(d) 5 sec
48. Two particles are thrown up simultaneously with a velocity of 30 m/s, one vertically and another at 45 degrees with respect to the horizon. Find out the distance between them at $t = 1.5$ s.
- (a) 36 m
(b) 34.44 m
(c) 32 m
(d) 30.5 m

49. W_1 , W_2 and W_3 represent the works done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown in the figure below) in the gravitational field of a point mass m :



- The correct relation between W_1 , W_2 and W_3 is
- (a) $W_1 > W_2 > W_3$
 - (b) $W_1 = W_2 = W_3$
 - (c) $W_1 < W_2 < W_3$
 - (d) $W_2 > W_1 > W_3$
50. A particle executes simple harmonic motion with a frequency f . The frequency with which its kinetic energy oscillates, is
- (a) $f/2$
 - (b) f
 - (c) $2f$
 - (d) $4f$
51. In which of the following processes, convection does not take place primarily?
- (a) Sea and land breeze
 - (b) Boiling of water
 - (c) Warming of glass of bulb due to filament
 - (d) Heating air around a furnace
52. In a compound microscope, the intermediate image is
- (a) virtual, erect and magnified
 - (b) real, erect and magnified
 - (c) real, inverted and magnified
 - (d) virtual, erect and reduced

53. A conducting loop carrying a current I is placed in a uniform magnetic field pointing into the plane of the paper as shown in the figure below :



The loop will have a tendency to

- (a) contract
 - (b) expand
 - (c) move towards +ve X axis
 - (d) move towards -ve Y axis
54. Half-life of a radioactive substance A is 4 days. The probability that a nucleus will decay in two half-lives is
- (a) $1/4$
 - (b) $3/4$
 - (c) $1/2$
 - (d) 1
55. The maximum number of electrons in each shell of an atom is (note that n is the number of shell)
- (a) $2n$
 - (b) $2n^2$
 - (c) $4n$
 - (d) 8
56. For normal operations of a PNP BJT, the base must be ___ with respect to the emitter and ___ with respect to the collector.
- (a) positive, positive
 - (b) positive, negative
 - (c) negative, positive
 - (d) negative, negative

57. When a transistor is used as a switch, it is stable in which two distinct regions?
- (a) Saturation and active
 - (b) Active and cutoff
 - (c) Saturation and cutoff
 - (d) None of the above
58. Which of the following is true for an NPN or a PNP transistor?
- (a) $I_E = I_B + I_C$
 - (b) $I_B = I_C + I_E$
 - (c) $I_C = I_B + I_E$
 - (d) None of the above
59. Magnetic properties of ferrites result mainly from
- (a) polarization of electromagnetic waves
 - (b) dielectric behaviour of ferrite
 - (c) magnetic dipole moment associated with the electron spin
 - (d) external magnetic fields
60. Transistor-Transistor Logic (TTL) operates from a
- (a) 9-volt supply
 - (b) 3-volt supply
 - (c) 5-volt supply
 - (d) 12-volt supply
61. In a digital logic circuit, a typical flip-flop has
- (a) one stable state
 - (b) no stable state
 - (c) two stable states
 - (d) None of the above

62. A radioactive material decays by simultaneous emission of two particles with respective half-lives 1620 and 810 years. The time, in years, after which one-fourth of the material remains, is
- (a) 1080
 - (b) 2430
 - (c) 3240
 - (d) 4860
63. A proton has kinetic energy $E = 100$ keV which is equal to that of a photon. The wavelength of photon is λ_1 and that of proton is λ_2 . The ratio of λ_1 / λ_2 is proportional to
- (a) E^2
 - (b) $E^{1/2}$
 - (c) E^{-1}
 - (d) $E^{-1/2}$
64. The specific heat per mole of a diatomic gas at constant volume C_V is given by
- (a) $C_V = \frac{1}{2}R$
 - (b) $C_V = 2R$
 - (c) $C_V = \frac{3}{2}R$
 - (d) $C_V = \frac{5}{2}R$
- (R is gas constant)
65. Average velocity of a particle moving in a straight line with constant acceleration a and initial velocity u in first t second is
- (a) $u + 1/2at$
 - (b) $u + at$
 - (c) $(u + at) / 2$
 - (d) $u / 2$

66. What gives rise to the doublet structure of the optical spectra from sodium?
- (a) Due to orbital angular momentum of the valence electron
 - (b) Due to coupling between orbital and spin angular momenta of the valence electron
 - (c) Due to spin angular momentum of the valence electron
 - (d) Due to coupling between spin angular momentum of valence electron and nuclear spin angular momentum
67. Resistivity of a cylindrical metallic wire depends on its
- (a) length
 - (b) diameter
 - (c) both length and diameter
 - (d) neither length, nor diameter
68. Which of the following is **not** a Bravais lattice in three dimensions?
- (a) Monoclinic
 - (b) Biclinic
 - (c) Triclinic
 - (d) Hexagonal
69. Miller indices notation $\langle 010 \rangle$ refers to
- (a) a family of equivalent directions
 - (b) a family of equivalent planes
 - (c) XZ-plane
 - (d) a diagonal axis in a cube
70. Michelson-Morley experiment proved
- (a) invariance of velocity of light in all reference frames
 - (b) that no medium is needed for light to travel
 - (c) transverse nature of electromagnetic waves
 - (d) All of the above

Section—III

(Chemistry)

71. Which of the following equations was suggested by de Broglie?

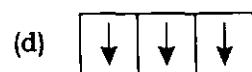
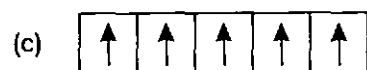
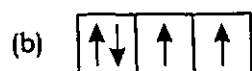
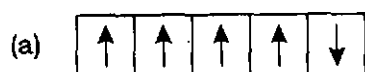
(a) $2\pi r = n\lambda$

(b) $\lambda = \frac{p}{h}$

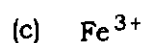
(c) $\pi r^2 = n\lambda$

(d) $2\pi r = \frac{nh}{\lambda}$

72. In the given electronic configurations, which one violates Hund's rule?



73. Which of the following ions has the maximum magnetic moment?



74. The mathematical expression that is true for the uncertainty principle is

(a) $(\Delta x)(\Delta v) \geq \frac{h}{4\pi}$

(b) $(\Delta E)(\Delta x) \geq \frac{h}{4\pi}$

(c) $(\Delta \theta)(\Delta \phi) \geq \frac{h}{4\pi}$

(d) $(\Delta x)(\Delta m) \geq \frac{h}{4\pi}$

75. Which of the following compounds is non-polar?
- (a) CCl_4
 - (b) CH_2Cl_2
 - (c) CHCl_3
 - (d) CH_3Cl
76. The average kinetic energy associated with one mole of a gas is
- (a) $\frac{3}{2}RT$
 - (b) $\frac{3}{2}KT$
 - (c) $\frac{1}{2}RT$
 - (d) $\frac{1}{2}KT$
77. Five molecules of a gas are moving with speeds 1 km/s, 2 km/s, 3 km/s, 4 km/s, 5 km/s. What is their root-mean-square speed?
- (a) $\sqrt{55}$ km/s
 - (b) $\sqrt{44}$ km/s
 - (c) $\sqrt{11}$ km/s
 - (d) $\sqrt{6}$ km/s
78. Two samples of gases *A* and *B* are at the same temperature. The molecules of *A* are travelling four times faster than the molecules of *B*. The ratio of $\frac{m_A}{m_B}$ of their masses will be
- (a) 16
 - (b) 4
 - (c) 1/4
 - (d) 1/16
79. Bond energy of H—H bond is 80 kJ/mol, I—I bond is 100 kJ/mol and for H—I bond is 200 kJ/mol. The enthalpy of the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI}(\text{g})$ is
- (a) - 120 kJ
 - (b) - 220 kJ
 - (c) + 100 kJ
 - (d) + 120 kJ

80. For the reaction $2\text{HgO (s)} \rightarrow 2\text{Hg (l)} + \text{O}_2 \text{ (g)}$
- (a) $\Delta H > 0$ and $\Delta S < 0$
 - (b) $\Delta H > 0$ and $\Delta S > 0$
 - (c) $\Delta H < 0$ and $\Delta S < 0$
 - (d) $\Delta H < 0$ and $\Delta S > 0$
81. For the process $\text{H}_2\text{O (l)} \text{ (1 bar, 373 K)} \rightarrow \text{H}_2\text{O (g)} \text{ (1 bar, 373 K)}$, the correct set of thermodynamic parameters is
- (a) $\Delta G = 0$, $\Delta S = +\text{ve}$
 - (b) $\Delta G = 0$, $\Delta S = -\text{ve}$
 - (c) $\Delta G = +\text{ve}$, $\Delta S = 0$
 - (d) $\Delta G = -\text{ve}$, $\Delta S = +\text{ve}$
82. Conjugate acid for PO_4^{-3} is
- (a) H_3PO_4
 - (b) H_3PO_4^-
 - (c) HPO_4^{-2}
 - (d) HPO_3^-
83. Oxidation number of Cr in K_3CrO_8 is
- (a) + 6
 - (b) + 5
 - (c) + 3
 - (d) + 2
84. The stoichiometric of S in the following reaction
- $$\text{H}_2\text{S} + \text{HNO}_3 \rightarrow \text{NO} + \text{S} + \text{H}_2\text{O}$$
- is balanced (in acidic medium). What is the oxidation state of nitrogen in reactants?
- (a) 2
 - (b) 3
 - (c) 4
 - (d) 5

85. In the reaction $4\text{Al} + 3\text{O}_2 \rightarrow 4\text{Al}^{3+} + 6\text{O}^{2-}$, which of the following statements is **incorrect**?
- (a) It is a redox reaction
 - (b) Metallic aluminium is a reducing agent
 - (c) Metallic aluminium is oxidized to Al^{3+}
 - (d) Metallic aluminium is reduced to Al^{3+}
86. Which of the following molecules belongs to the same symmetry group as NH_3 ?
- (a) BF_3
 - (b) CH_4
 - (c) CH_3OH
 - (d) CHCl_3
87. Which of the following has the largest radius?
- (a) Cl^-
 - (b) K^+
 - (c) Na^+
 - (d) S^{2-}
88. The migration of the colloidal particles under the influence of an electric field is known as
- (a) electrophoresis
 - (b) electroosmosis
 - (c) electrodialysis
 - (d) electrodispersion
89. Which step in a multi-step reaction is the rate-determining step?
- (a) The first step
 - (b) The last step
 - (c) The step with the lowest activation energy
 - (d) The step with the highest activation energy
90. For the hydrogen atom, which of the following orbitals has the lowest energy?
- (a) $4s$
 - (b) $4p$
 - (c) $4d$
 - (d) They all have the same energy

91. Given that $dU = TdS - PdV$ and $H = U + PV$. Which of the following is true?
- (a) $dH = TdS + VdP$
 - (b) $dH = SdT - VdP$
 - (c) $dH = -SdT - PdV$
 - (d) $dH = dU + PdV$
92. Which is the electron configuration for an atom with $Z = 22$?
- (a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$
 - (b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^2$
 - (c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4p^2$
 - (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
93. Benzene undergoes substitution reactions more easily than addition reactions because
- (a) it has a cyclic structure
 - (b) it has three double bonds
 - (c) it has six hydrogen atoms
 - (d) there is a delocalization of electrons
94. If ψ is a normalized solution of the Schrödinger equation and Q is an operator corresponding to a physical observable x , the quantity $\psi \cdot Q\psi$ may be integrated to obtain
- (a) normalization constant of ψ
 - (b) mean value of x
 - (c) uncertainty in x
 - (d) spatial overlap of Q with ψ
95. Particle in a box model in quantum mechanics can be used as an approximate model for
- (a) conjugated molecules
 - (b) aromatic molecules
 - (c) proteins
 - (d) nucleic acids

Section—IV

(Biology)

96. An exon is a
- (a) part of gene that is transcribed but not translated into protein
 - (b) part of gene that is neither transcribed nor translated into protein
 - (c) part of gene that is transcribed as well as translated into protein
 - (d) part of gene that is not transcribed but is important for alternative splicing
97. Shine-Dalgarno sequence is related to ____ binding site.
- (a) mitochondrial
 - (b) ribosome
 - (c) splice
 - (d) CpG island
98. In transgenic animals, which of the following carries the transgene?
- (a) Only gametes
 - (b) Only somatic cells
 - (c) All cells
 - (d) The cells that were originally transformed
99. After digesting a circular DNA with EcoRI, you get two bands of 6Kb and 4Kb on agarose gel. By cutting the same DNA with BamHI, you get two fragments of 9Kb and 1Kb. In double digestion, you get only three bands, because
- (a) the double digestion will interfere with digestion pattern
 - (b) one of EcoRI and one of BamHI sites are close to each other
 - (c) two fragments of same length will be obtained thus running on same position in gel
 - (d) one of the EcoRI sites get methylated in presence of BamHI

100. If a series of six alleles are known to exist for a locus in human beings, how many alleles would be present in one individual?
- (a) 6
 - (b) 2
 - (c) 4
 - (d) 12
101. The length of circular DNA in a prokaryotic cell is about 55000 bp. If the DNA polymerase replicates the DNA at a rate of 1000 nucleotides per second, how many origins of replications would be formed to complete the replication in less than 20 minutes?
- (a) 1
 - (b) 2
 - (c) 55
 - (d) 1000
102. Given the sequence of a DNA segment 5'-ATGCATGCATGCATGCATGC-3'. How many different types of amino acid can be found in corresponding protein?
- (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
103. An enzyme which is homodimer of a protein encoded by 438 bp long gene sequence including start and stop codon. Considering the average mass of each amino acid is 100 daltons, what would be molecular mass of the enzyme?
- (a) 29200 daltons
 - (b) 14600 daltons
 - (c) 14500 daltons
 - (d) 29000 daltons

- 104.** Which of the following is **not** correct about mass spectrometry (MS)?
- (a) MS can be used to investigate post-translational modifications
 - (b) MS can be used to determine sequence of peptides
 - (c) MS can be used to in metabolite identification
 - (d) MS can be used to distinguish between optical isomers
- 105.** *Cis*-regulatory elements play the important role in regulation of gene expression. What is true about them?
- (a) *Cis*-regulatory elements can be present in promoter region, introns or untranslated regions
 - (b) *Cis*-regulatory elements can only be present in promoter region
 - (c) *Cis*-regulatory elements can only be present in promoter region and introns
 - (d) *Cis*-regulatory elements can only be present in promoter region and untranslated regions
- 106.** Metabolic pathways can be categorized into anabolic, catabolic and amphibolic reactions. Which of the following is true?
- (a) Citric acid cycle is amphibolic, glycolysis is catabolic and gluconeogenesis is an anabolic pathway
 - (b) TCA cycle is anabolic, glycolysis is amphibolic and beta oxidation is a catabolic pathway
 - (c) Krebs' cycle is amphibolic, beta oxidation is anabolic and gluconeogenesis is a catabolic pathway
 - (d) TCA cycle is anabolic, gluconeogenesis is catabolic and beta oxidation is amphibolic pathway
- 107.** Ion exclusion in plants is critical for acclimation to
- (a) drought stress
 - (b) heat stress
 - (c) salt stress
 - (d) metal toxicity

- 108.** A researcher is putting up a PCR reaction. You saw him adding reverse transcriptase. What should be his template?
- (a) Genomic DNA
 - (b) RNA
 - (c) cDNA
 - (d) Plasmid DNA
- 109.** Which of the following statements are true about C4 and CAM plants?
- (a) Both C4 and CAM plants use RUBISCO in Calvin cycle
 - (b) C4 plants use RUBISCO, whereas CAM plants use PEP carboxylase in Calvin cycle
 - (c) C4 plants have PEP carboxylase, whereas CAM plants use RUBISCO in Calvin cycle
 - (d) Both C4 and CAM plants use PEP carboxylase in Calvin cycle
- 110.** Which of the following is true for an operon?
- (a) Only present in prokaryotes
 - (b) Only present in eukaryotes
 - (c) Contain multiple genes
 - (d) Contain multiple promoters
- 111.** RT-PCR is used to
- (a) determine gene sequence
 - (b) amplify RNA sequence
 - (c) amplify DNA sequence
 - (d) determine gene expression

- 112.** A nucleoside is formed of
- (a) phosphate and nitrogen base
 - (b) pentose sugar and phosphate
 - (c) pentose sugar and nitrogen base
 - (d) pentose sugar, phosphate and nitrogen base
- 113.** Which of the following amino acids is major neurotransmitter in the brain?
- (a) Tyrosine
 - (b) Tryptophan
 - (c) Glutamate
 - (d) Serine
- 114.** Which of the following allows the primary transcript to process into two or more different mRNAs?
- (a) Frameshift mutation
 - (b) Alternative splicing
 - (c) Alternative binding
 - (d) Multiple enzyme binding sites
- 115.** Which of the following RNA species is least stable in a cell?
- (a) tRNA
 - (b) mRNA
 - (c) snoRNA
 - (d) rRNA

116. Proper folding of proteins is assisted by
- (a) nucleosomes
 - (b) chaperones
 - (c) polysomes
 - (d) acyl carrier proteins
117. A gene with more than one allele is termed as
- (a) heterologous
 - (b) hybrid
 - (c) pleiotropic
 - (d) polymorphic
118. Which of the following is **not** a DNA binding domain?
- (a) MADS-box
 - (b) Zinc finger
 - (c) Homeodomain
 - (d) Glycoside hydrolase
119. Homologous genes within the same species having similar but non-identical functions are known as
- (a) orthologues
 - (b) paralogues
 - (c) isozymes
 - (d) biochemical variants
120. Which of the following is odd one?
- (a) Enhancer
 - (b) Copia elements
 - (c) Retrotransposons
 - (d) FB elements

SPACE FOR ROUGH WORK

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