

Entrance Examination – 2016
M.Sc. (5 - Year Integrated) Sciences
(Chemistry, Mathematics, Physics, Systems Biology and Earth Sciences)

Hall Ticket Number

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Time : 2 hours

Max. Marks. 100

Instructions

1. Please enter your Hall Ticket Number on this page and on the OMR Answer Sheet without fail.
2. Please read the following instructions carefully
 - (a) There are 100 questions in this paper. Questions 1- 25 are in Biology, 26-50 are in Chemistry, 51-75 are in Mathematics and 76 - 100 are in Physics.
 - (b) **There is a negative marking. Each correct answer carries 1 mark and each wrong answer carries -0.33 mark. Each question has only one correct option.**
 - (c) The appropriate answer(s) should be coloured with either a blue or a black ball point or a sketch pen. **DO NOT USE A PENCIL.**
 - (d) Answers are to be marked on the OMR sheet following the instructions given there.
 - (e) Hand over the OMR answer sheet at the end of the examination to the invigilator.
 - (f) No additional sheets will be provided. Rough work can be done in the question paper itself/space provided at the end of the booklet.
 - (g) Non programmable Calculators can be used.
 - (h) Mobile phones are not allowed.
 - (i) This book contains 22 pages including this page and excluding page for the rough work, Please check that your paper has all the pages.

Biology

1. Of the following, what structures are found in both prokaryotic and eukaryotic cells?
 - (a) Plasma membrane and nucleus
 - (b) Plasma membrane and ribosomes
 - (c) Cytoplasm and mitochondria
 - (d) Ribosomes and mitochondria

2. Metagenesis or alteration of generation is a term primarily used to describe the life cycle of flowering plants. Which generation in a flowering plant is diploid, but can produce haploid spores?
 - (a) Sporophyte
 - (b) Spermatocyte
 - (c) Gametophyte
 - (d) Oocyte

3. The multicellular plants that are also called the amphibians of plant kingdom, have thallus level organization, are haploid, have rhizoids and needs water to complete their life cycles. To which of the following groups they belong to?
 - (a) Pteridophytes
 - (b) Angiosperms
 - (c) Gymnosperms
 - (d) Bryophytes

4. A flowering plant has diploid number of chromosomes equal to 34. How many chromosomes will be there in its endosperm tissue?
 - (a) 17
 - (b) 34
 - (c) 51
 - (d) 68

5. Which of the following components is found only in ribonucleic acid (RNA) and not in deoxyribonucleic acid (DNA)?
 - (a) Uracil
 - (b) Deoxyribose sugar
 - (c) Cytosine
 - (d) Thymine

6. Nucleic acids like RNA and DNA are polymers of Nucleotide. A nucleotide is made up of:

- (a) Nitrogenous base and a sugar
- (b) Nitrogenous base, sugar and one or more phosphate groups
- (c) Nitrogenous base and phosphates
- (d) A sugar and a phosphate

7. What is common between a mature mammalian red blood cell and a mature plant sieve tube cells?

- (a) Absence of mitochondria
- (b) Absence of nucleus
- (c) Presence of perforated cell membrane
- (d) Presence of tonoplast

8. Match the plant tissue with their function and pick up the correct option from below

- | | |
|-----------------|-------------------------------------|
| (A) Meristem | (i) Transport of water and minerals |
| (B) Tracheids | (ii) Mechanical support |
| (C) Parenchyma | (iii) Dividing cells for growth |
| (D) Collenchyma | (iv) Storage, photosynthesis |

Options:

- (a) A-ii, B-i, C-iv, D-iii
- (b) A-iii, B-iv, C-i, D-ii
- (c) A-iii, B-ii, C-iv, D-i
- (d) A-iii, B-i, C-iv, D-ii

9. The glands that secrete their products directly into the blood stream and lack duct system are called

- (a) Endocrine glands
- (b) Exocrine glands
- (c) Merocrine glands
- (d) Columnar glands

10. Most biochemical reactions inside a cell are carried out with the help of enzymes that act as bio-catalysts. Enzymes function by reducing the activation energy of reactions. Which of the following will not require an enzyme to carry out the reaction in a cell?

- (a) Movement of water molecules through semipermeable membrane
- (b) Unwinding of the two strands of DNA double helix
- (c) Breakdown of glucose into carbondioxide and water
- (d) Formation of peptide bonds between amino acids

11. Which of these organs in human body is engaged in removing cellular wastes, toxins like drugs and alcohol and also stores excess of glucose in the form of glycogen?

- (a) Lungs
- (b) Kidneys
- (c) Skin
- (d) Liver

12. Which of the following plant hormones causes fruits to ripe and act as a stress hormone?

- (a) Auxin
- (b) Gibberellin
- (c) Cytokinin
- (d) Ethylene

13. Lymph is the fluid that circulates throughout the lymphatic system. It differs from blood in the absence of which of the following component?

- (a) White blood cells
- (b) Serum albumin
- (c) Red blood cells
- (d) Immunoglobulins

14. Attached earlobes are a recessive trait in human. If one out of four children of two carrier parents has attached earlobes, what is the chance that their next child will have attached earlobes?

- (a) 0%
- (b) 25%
- (c) 75%
- (d) 100%

15. Which Mendel's law of inheritance states that two alleles of a gene separate during gamete formation so that half the gametes carry one allele and the other half carry the other?

- (a) Particulate inheritance
- (b) Dominance
- (c) Segregation
- (d) Independent assortment

16. Gases like carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); sulphur dioxide (SO_2); carbon monoxide (CO); ozone (O_3) etc in the atmosphere are called Greenhouse gases because _____.

- (a) they are produced by large amounts in plants
- (b) they generate heat by chemical reactions
- (c) they absorb infrared radiations, trap and hold heat
- (d) they are present at higher concentrations in the atmosphere

17. The term 'Bio-magnification' means

- (a) increasing accumulation of toxic chemicals in the organisms at successively higher levels in a food chain.
- (b) increasing population of organisms at successively higher levels in a food chain.
- (c) increasing size of the organisms at successively higher levels in a food chain.
- (d) increasing concentration of decomposers at successively higher levels in a food chain.

18. Microscopic organisms that float in the water and serve as a crucial source of food to many large aquatic organisms, including whales are called _____.

- (a) Coral reef
- (b) Pisces
- (c) Seaweeds
- (d) Planktons

19. Which of the following flows through an ecosystem but does not cycle?

- (a) Carbon
- (b) Nitrogen
- (c) Energy
- (d) Water

20. Viruses that infect bacteria are called _____.

- (a) Oncoviruses
- (b) Retroviruses
- (c) Phytoviruses
- (d) Bacteriophages

21. What are the bacteria that cannot grow in the presence of oxygen called?

- (a) Facultative anaerobes
- (b) Obligate anaerobes
- (c) Obligate aerobes
- (d) Saprotrophs

22. During which phase of mitotic cell division is the DNA of the dividing cell replicated?

- (a) Interphase
- (b) Prophase
- (c) Anaphase
- (d) Telophase

23. An allele is the alternate form of the same genes or genes locus. Diploid organisms have two alleles for each gene. The allele that suppresses the trait of the other is called _____, while the one which is suppressed is called _____, respectively.

- (a) recessive, dominant
- (b) recessive, homozygous
- (c) dominant, heterozygous
- (d) dominant, recessive

24. Which of the following enzymes will function optimally at an acidic pH?

- (a) Maltase
- (b) Trypsin
- (c) Amylase
- (d) Pepsin

25. A diploid cell with 36 chromosomes undergoes meiosis. What will be the chromosome number in each daughter cell?

- (a) 9
- (b) 18
- (c) 27
- (d) 36

Chemistry

26. The vapor pressure of water at 20 °C is 17.5 torr. The change in the vapor pressure of an aqueous solution prepared by adding 36.0 grams of glucose ($C_6H_{12}O_6$) to 14.4 grams of water is

- (a) 15.0 torr
- (b) 17.5 torr
- (c) 16.4 torr
- (d) 14.0 torr

27. van't Hoff factor (i) is associated with the degree of dissociation or association of the solute in solvent. The i value for MgCl_2 is

- (a) 1
- (b) 2
- (c) 3
- (d) 4

28. The osmotic pressure of a solution containing 4 grams of solute per litre of solution is 0.4 atm at 27°C . The molar mass of the solute is $(R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1})$

- (a) 246 gram/mol
- (b) 0.246 gram/mol
- (c) 984 gram/mol
- (d) 543 gram/mol

29. According to Freundlich adsorption isotherm...

- (a) at a fixed pressure, there is a decrease in physical adsorption with increase in temperature
- (b) at a fixed pressure, there is a decrease in physical adsorption with decrease in temperature
- (c) at a fixed pressure, there is no change in physical adsorption with increase in temperature
- (d) at a fixed pressure, there is no change in physical adsorption with decrease in temperature

30. The process of removing dissolved impurities from a colloidal system, by means of diffusion through a suitable membrane under the influence of an electric field is

- (a) Electrosmosis
- (b) Electrodialysis
- (c) Electrophoresis
- (d) Peptization

31. Corrosion of iron metal produces "rust" with composition

- (a) FeO
- (b) Fe_2O_3
- (c) $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- (d) $\text{Fe}(\text{OH})_3$

32. Molar ionic conductance of $\lambda_+^0(\text{Al}^{3+}) = 189 \text{ S cm}^2 \text{ mol}^{-1}$ and $\lambda_-^0(\text{SO}_4^{2-}) = 160 \text{ S cm}^2 \text{ mol}^{-1}$. The molar conductance (Λ_m^0) of $\text{Al}_2(\text{SO}_4)_3$ is

- (a) $349 \text{ S cm}^2 \text{ mol}^{-1}$
- (b) $30240 \text{ S cm}^2 \text{ mol}^{-1}$
- (c) $858 \text{ S cm}^2 \text{ mol}^{-1}$
- (d) $746 \text{ S cm}^2 \text{ mol}^{-1}$

33. The rate expression of a reaction is, $\text{Rate} = k [\text{A}]^{3/2} [\text{B}]^{-1}$
The overall order of the reaction is

- (a) 1
- (b) 2
- (c) $\frac{1}{2}$
- (d) $\frac{3}{2}$

34. The name given to ABC, ABC, ABC type arrangements is

- (a) Cubic close packed arrangements
- (b) Hexagonal packed arrangements
- (c) Tetrahedral arrangements
- (d) Octahedral arrangements

35. When electrons are trapped into the crystal in anion vacancy the defect in the crystal is known as

- (a) Schottky defects
- (b) Frenkel Defects
- (c) Stoichiometric defects
- (d) F-Centres

36. In the solid state MnO shows

- (a) Ferromagnetism
- (b) Ferrimagnetism
- (c) Antiferromagnetism
- (d) Paramagnetism

37. The metallurgical technique used for producing very high purity germanium suitable for semiconductor industry is

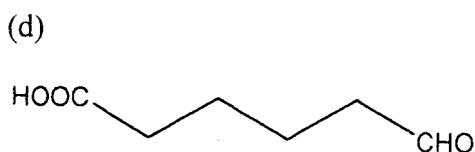
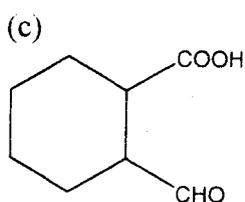
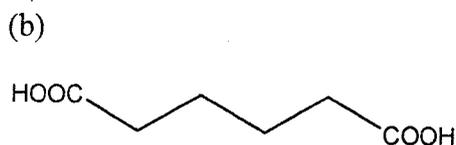
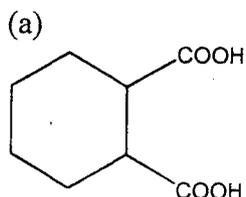
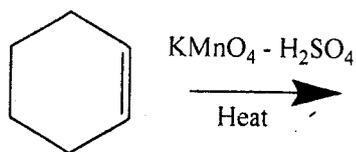
- (a) Zone Refining
- (b) Vapour phase refining
- (c) Liquation
- (d) Chromatography

38. The spin only magnetic moment of Ti^{3+} is

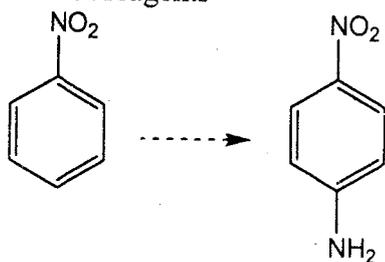
- (a) 1.73 BM
- (b) 2.76 BM
- (c) 3.75 BM
- (d) 0 BM

39. In the "spectrochemical series" the ligand producing strong field strength is
- (a) Cl^-
 - (b) CN^-
 - (c) I^-
 - (d) EDTA^{4-}
40. The following metal complex is a Wilkinson catalyst (Ph = Phenyl)
- (a) $[(\text{Ph}_3\text{P})_3\text{RhCl}]$
 - (b) $[(\text{Ph}_3\text{P})_3\text{RuCl}]$
 - (c) $[(\text{Ph}_3\text{P})_3\text{IrCl}]$
 - (d) $[(\text{Ph}_3\text{P})_3\text{CoCl}]$
41. If the principle quantum number $n=4$, the quantum number l can have the values
- (a) 1, 2, 3 and 4
 - (b) 1, 2, 3 only
 - (c) 0, 1, 2, and 3
 - (d) 0, ± 1 , ± 2 , and ± 3
42. Bohr radius of hydrogen atom is
- (a) 52.9 nm
 - (b) 52.9 pm
 - (c) 52.9 Å
 - (d) 52.9 fm
43. Suppose you compress an ideal gas to half of its original volume, while also halving its absolute temperature. During this process, the pressure of the gas
- (a) Halves
 - (b) Remains constants
 - (c) Doubles
 - (d) Quadruples

44. The following chemical transformation gives



45. The following multi-step transformation can be carried out by using the following sequence of reagents

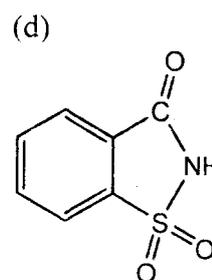
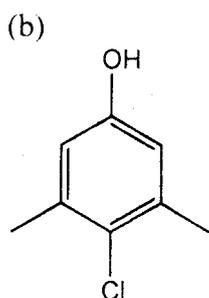
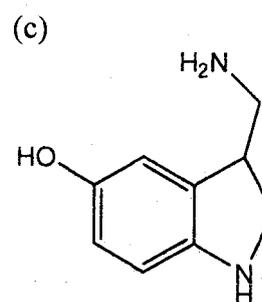
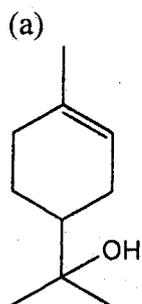


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|-----|------------|---------------------------|--|----------------------|
| (a) | (i) Sn/HCl | (ii) CH ₃ COCl | (iii) HNO ₃ / H ₂ SO ₄ / heat | (iv) H ⁺ |
| (b) | (i) Sn/HCl | (ii) CH ₃ COCl | (iii) HCl / H ₂ SO ₄ / heat | (iv) OH ⁻ |
| (c) | (i) Fe/HCl | (ii) CH ₃ COCl | (iii) HCl / H ₂ SO ₄ / heat | (iv) OH ⁻ |
| (d) | (i) Fe/HCl | (ii) CH ₃ COOH | (iii) HNO ₃ / H ₂ SO ₄ / heat | (iv) OH ⁻ |

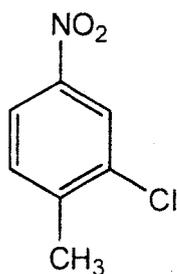
46. Buna-N is prepared from

- (a) 1,3-Butadiene and Acrylonitrile
 (b) Chloroprene and Styrene
 (c) 1,3-Butadiene and Styrene
 (d) 3-Hydroxybutanoic acid and 3-Hydroxypentanoic acid

47. Which one of the following is the structure of *Saccharin*

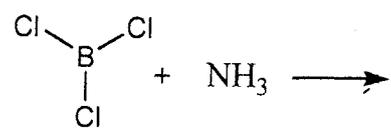


48. The IUPAC name of the following compound is



- (a) 2-Chloro-1-methyl-4-nitrobenzene
- (b) 1-Nitro-3-chloro-4-methylbenzene
- (c) 2-Chloro-3-Nitro-6-methylbenzene
- (d) 1-Methyl-2-chloro-4-nitrobenzene

49. In the following reaction the geometry of the product is



- (a) Pyramid
- (b) Square planar
- (c) Tetrahedral
- (d) Trigonal planar

50. The following is the composition of "*producer gas*"

- (a) CO + N₂
- (b) CO + H₂
- (c) CO + H₂O
- (d) C + H₂

Mathematics

51. If the number of all subsets of A is between 50 and 100, the number of elements in A is equal to
- (a.) 5
 - (b.) 6
 - (c.) 7
 - (d.) 10
52. The point on the line $4x - y - 2 = 0$ and is equidistant from the points $(-5, 6)$ and $(3, 2)$ is
- (a.) $(1, 2)$
 - (b.) $(3, 10)$
 - (c.) $(2, 6)$
 - (d.) $(4, 14)$
53. If A and B are two independent events with $P(B) = 2/7$ and $P(A \cup B^c) = 4/5$, then $P(A)$ is
- (a.) $18/35$
 - (b.) $1/2$
 - (c.) $1/10$
 - (d.) $3/10$
54. The coefficient of middle term of $(1 + x)^{20}$ is
- (a.) $20!$
 - (b.) 2^{10}
 - (c.) $20!/(10!)^2$
 - (d.) $10!$
55. For any integer $n \geq 1$, let $d(n)$ be the number of divisors of n , denoted by $d(n)$. The number $d(d(d(2187)))$ is
- (a.) 2
 - (b.) 3
 - (c.) 4
 - (d.) 1
56. Define an order in $N \times N$ as $(a, b) \leq (c, d)$ if either $a \leq c$ or $a = c$ and $b \leq d$. Which of the following is false?

- (a.) $(3, 7) \leq (4, 5)$
 (b.) $(3, 5) \leq (3, 7)$
 (c.) $(4, 5) \leq (7, 3)$
 (d.) $(5, 4) \leq (3, 7)$
57. Let \bar{a} , \bar{b} and \bar{c} be noncoplanar vectors. If $7\bar{a} + 6\bar{c} = x(\bar{a} + \bar{b} + \bar{c}) + y(2\bar{a} - \bar{b} + \bar{c}) + z(\bar{a} - \bar{b} - \bar{c})$, then (x, y, z) is equal to
- (a.) $(2, 3, 1)$
 (b.) $(2, 3, -1)$
 (c.) $(2, -3, -1)$
 (d.) $(2, -3, 1)$
58. The volume of the parallelepiped with cotermious edges $i + j$, $i + 2j$ and $i + j + \pi k$ is
- (a.) $\pi/2$
 (b.) $\pi/3$
 (c.) π
 (d.) $2\pi/3$
59. If m and n are two natural numbers with $m < 99 < 101 < n$, which of the following is always true ?
- (a.) $(m + n)/2 \geq m + 2$
 (b.) $(m + n)/2 \geq 99$
 (c.) $(m + n)/2 \leq 101$
 (d.) $(m + n)/2 = 100$
60. Let $f : [-1, 1] \rightarrow [-1, 1]$ be defined by $f(x) = x|x| \forall x \in [-1, 1]$. Then f is
- (a.) injective, not surjective
 (b.) surjective, not injective
 (c.) bijective
 (d.) None of the above
61. Which of the following is an infinite set ?
- (a.) $\{n \in N : n^3 \leq 1000n^2\}$
 (b.) $\{n \in N : n^4 \leq n^3 + 1000\}$
 (c.) $\{n \in N : \text{both } n^3 + 1000 \text{ and } n^3 - 1000 \text{ are divisible by } 3\}$.
 (d.) $\{n \in N : n^3 \text{ is divisible by } 1000 \text{ and } 3\}$
62. Let $A = \begin{pmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{pmatrix}$. The inverse of $(A/2)$ is

- (a.) $2A$
(b.) A^2
(c.) $A^{-1}/2$
(d.) $A/2$.
63. If $A, B, A + B$ are idempotent matrices, then $AB =$
(a.) 0
(b.) Identity
(c.) BA
(d.) $-BA$
64. The product of all 7th roots of unity is
(a.) 0
(b.) 1
(c.) -1
(d.) None of the above
65. The multiplicative inverse of $(i - 2)$ is
(a.) $(i - 2)/5$
(b.) $(i + 2)/5$
(c.) $(2 - i)/5$
(d.) $(-2 - i)/5$
66. If $f(x) = x/(1 + x)$ and $g(x) = f(f(x))$, then $g'(x)$ is equal to
(a.) $1/x^2$
(b.) $1/(2x + 1)^2$
(c.) $1/(x + 2)^2$
(d.) $1/(2x + 3)^2$
67. The value of c in Lagrange's mean value theorem for $f(x) = (x - 2)^{1/2}$ in the interval $[2, 6]$ is
(a.) 3
(b.) 4
(c.) 5
(d.) $9/2$
68. $\int (x^5/(x^2 + 1))dx$ is equal to
(a.) $x^4/4 + x^2/2 + \tan^{-1}(x) + C$
(b.) $x^4/4 - x^3/3 + (\log(x^2 + 1))/2 + C$
(c.) $x^4 + x^3/3 + \tan^{-1}(x) + C$
(d.) $x^4/4 - x^2/2 + (\log(x^2 + 1))/2 + C$

69. $\int \sin^2(2x)dx$ is equal to
- (a.) $x/2 - \sin(4x)/4 + C$
 - (b.) $x/4 - \sin(4x)/2 + C$
 - (c.) $x/2 - \sin(4x)/8 + C$
 - (d.) $x/4 - \sin(4x)/8 + C$
70. The minimum value of $\sin(x)^{\sin(x)}$ in $(0, \pi)$ is
- (a.) $e^{-1/e}$
 - (b.) $e^{1/e}$
 - (c.) e^e
 - (d.) 1
71. The point P is equidistant from $(1, 3)$, $(-3, 5)$ and $(5, -1)$. The point P is
- (a.) $(-4, -8)$
 - (b.) $(3, 10)$
 - (c.) $(8, 8)$
 - (d.) $(-8, -10)$
72. If the lines $2x - 3y = 5$ and $3x - 4y = 7$ are diameters of a circle with radius 7, the equation of the circle is
- (a.) $x^2 + y^2 - 2x + 2y - 47 = 0$
 - (b.) $x^2 + y^2 = 49$
 - (c.) $x^2 + y^2 + 2x + 2y - 47 = 0$
 - (d.) $x^2 + y^2 + 4x + 2y + 47 = 0$
73. The eccentricity of the ellipse $9x^2 + 5y^2 - 18x - 20y - 16 = 0$ is
- (a.) $1/2$
 - (b.) $2/3$
 - (c.) $3/2$
 - (d.) 2
74. Six boys and six girls are to sit in a row at random. The probability that boys and girls sit alternately is
- (a.) $1/154$
 - (b.) $1/462$
 - (c.) $3/154$
 - (d.) $5/462$
75. In a triangle, if $a = 20$, $b = 21$ and $\sin C = 3/5$, c is
- (a.) 13
 - (b.) 14
 - (c.) 15
 - (d.) 16

Physics

76. The Yield strength of a structural steel is $2.5 \times 10^8 \text{ N/m}^2$. A steel rod of length 80cm and radius $R = 9.5 \text{ mm}$ is fixed in a vise and a force of magnitude 90 kN is applied perpendicular to its end face, the rod undergoes

- (a) Permanent deformation
- (b) Elongates in the elastic limit
- (c) No change
- (d) Diameter reduces to half.

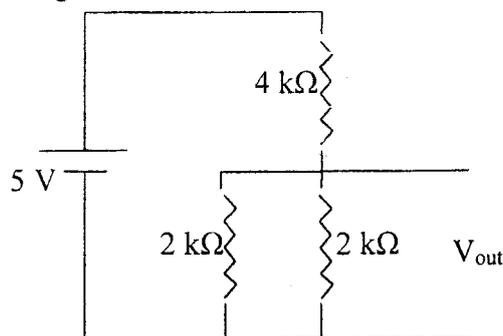
77. A spring stretches to 2.5 cm when 20 N is hanged to it. If a 40 N is hanged it has moved to 5 cm. The spring constant of the spring in N/m is

- (a) 850
- (b) 950
- (c) 700
- (d) 800

78. The bulk modulus of water is $2.2 \times 10^9 \text{ N/m}^2$. Find the pressure necessary to change the volume of water by 1.0 %. [1bar = 10^5 N/m^2]

- (a) 2.2 bar
- (b) 110 bar
- (c) 220 bar
- (d) 220 mbar

79. The voltage across the $2 \text{ k}\Omega$ resistance in the following circuit is



- (a) 2 V
- (b) 4 V
- (c) 1 V
- (d) 2.5 V

80. In the photoelectric effect experiment by changing the frequency of the incident light the energy of the emitted electrons

- (a) reaches a maximum value
- (b) increases with increase in frequency
- (c) decreases with increase in frequency
- (d) remains constant

81. Hydrogen atom emits a photon of energy $13.6 \times 8/9$ eV. What is the corresponding principle quantum number of higher energy state if the principle quantum number for the lower energy state is $n_1 = 1$?

- (a) $n_2 = 2$
- (b) $n_2 = 3$
- (c) $n_2 = 3$
- (d) $n_2 = 4$

82. The electron is one Bohr radius away from the nucleus on a Hydrogen atom. Find its coulomb potential energy. 1 Bohr radius = $a = 5.292 \times 10^{-11}$ m

- (a) -22 eV
- (b) -13.6 eV
- (c) -27.2 eV
- (d) -44 eV

83. A meteorite rock was found to have ^{40}K atoms and ^{40}Ar atoms. Assume that all the argon atoms have been created by decay of ^{40}K with a half-life of T , the age t of the rock is given by

- (a) $t = \frac{T}{\ln(2)} \ln \left(1 + \frac{N_{\text{Ar}}}{N_{\text{K}}} \right)$
- (b) $t = \frac{T}{\ln(2)} \ln \left(1 - \frac{N_{\text{Ar}}}{N_{\text{K}}} \right)$
- (c) $t = \frac{T}{\ln(2)} \ln \left(\frac{N_{\text{Ar}}}{N_{\text{K}}} \right)$
- (d) $t = \frac{2T}{\ln(2)} \ln \left(\frac{N_{\text{Ar}}}{N_{\text{K}}} \right)$

84. A particle of mass m moving with velocity v_1 leaves a region in which its potential energy is a constant U_1 and enters another in which its potential energy is another constant U_2 . If θ_1 and θ_2 are the angles between the normal to the plane and the velocities v_1 & v_2 of the particle before and after passing the plane of separation of the two regions, then

- (a) $v_2/v_1 = \sin \theta_1 / \sin \theta_2$
- (b) $v_2/v_1 = \cos \theta_1 / \cos \theta_2$
- (c) $v_2/v_1 = \tan \theta_1 / \tan \theta_2$
- (d) $v_2/v_1 = (1 - \cos \theta_1) / (1 - \cos \theta_2)$

85. A solid spherical object (of radius r and mass m) is rolling down (without slip) with an acceleration $a = (5g \sin \theta)/7$ along an inclined plane which makes an angle θ with the horizontal line where g is the gravitational acceleration. If object starts journey with zero velocity from the upper end of the inclined plane of length L , then what would be the total (translational and rotational) kinetic energy of the object at the lower end of the inclined plane?

- (a) $[5mgL \sin(\theta)]/7$
- (b) $[2mgL \sin(\theta)]/5$
- (c) $[5mgL \sin(\theta)]/2$
- (d) $mgL \sin(\theta)$

86. Maximum how many independent displacements and rotations a rigid body can have in 2-dimension?

- (a) 2
- (b) 3
- (c) 4
- (d) 5

87. A particle slides down a smooth inclined plane of inclination θ , fixed in an elevator going up with an acceleration a . The inclined plane has length L . The particle starts at zero velocity from the top. Find the time taken by the particle to reach the bottom if g is the acceleration due to gravity.

- (a) $\left[\frac{2L}{(g-a)\sin(\theta)} \right]^{1/2}$
- (b) $\left[\frac{2L}{(g+a)\sin(\theta)\cos(\theta)} \right]^{1/2}$
- (c) $\left[\frac{2L}{(g+a)\sin(\theta)} \right]^{1/2}$
- (d) $\left[\frac{2L}{(g-a)\sin(\theta)\cos(\theta)} \right]^{1/2}$

88. What minimum horizontal speed should be given to the bob of a simple pendulum of length l so that it describes a complete circle if g is the acceleration due to gravity?

- (a) $\sqrt{2gl}$
- (b) $\sqrt{3gl}$
- (c) $\sqrt{4gl}$
- (d) $\sqrt{5gl}$

89. A uniform rectangular stick of length l and mass m is suspended through a small pinhole at a distance d ($d < l/2$) from the top. What is the moment of inertia of the stick with respect to the pinhole?

(a) $m \left(\frac{l}{2} - d \right)^2 + \frac{ml^2}{12}$

(b) $md^2 + \frac{ml^2}{12}$

(c) $m \left(\frac{l}{2} - d \right)^2 + \frac{ml^2}{3}$

(d) $md^2 + \frac{ml^2}{3}$

90. If speed of light be the escape velocity of a particle from the surface of a planet of $GM/c^2 = 743$ m, where G is the gravitational constant, M is the mass of the planet and c is the speed of light, then what would be the radius of the planet?

(a) 0.743 km

(b) 1.486 km

(c) 2.229 km

(d) 6000 km

91. Magnitude of the attractive force per unit area between the two large plates of a parallel plate capacitor of surface charge density σ and $-\sigma$ on them in the free space (of permittivity ϵ_0) is given by

(a) $\frac{\sigma^2}{\epsilon_0}$

(b) $\frac{2\sigma^2}{\epsilon_0}$

(c) $\frac{\sigma^2}{2\epsilon_0}$

(d) $\frac{\sigma^3}{\epsilon_0}$

92. Magnetic field due to a bar magnet of length $2l$ and magnetic dipole moment \vec{M} at a distance \vec{d} from the middle of the magnet towards the south to north pole in free space of permeability μ_0 is given by

(a) $\frac{\mu_0}{4\pi} \frac{2Md}{(d^2 - l^2)^2} \hat{d}$

(b) $\frac{\mu_0}{2\pi} \frac{2Md}{(d^2 - l^2)^2} \hat{d}$

(c) $\frac{\mu_0}{\pi} \frac{2Md}{(d^2 - l^2)^2} \hat{d}$

(d) $-\frac{\mu_0}{4\pi} \frac{2Md}{(d^2 - l^2)^2} \hat{d}$

93. How many real roots are there for volume of a van-der Waals gas below the critical temperature?

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

94. For an adiabatic process undergone on two moles of ideal gas, the equation of state of the system is given (in conventional notation) by

- (a) $pV^{2\gamma} = \text{constant}$
- (b) $pV^\gamma = \text{constant}$
- (c) $pV^\gamma = RT$
- (d) $pV^{2\gamma} = RT$

95. The angle between vectors $\vec{A} = 2\hat{i} + 2\hat{j}$ and $\vec{B} = 2\hat{j} + 2\hat{k}$ is

- (a) 30°
- (b) 45°
- (c) 90°
- (d) 60°

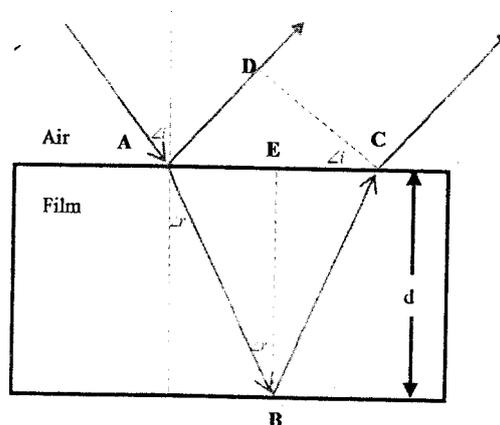
96. The area of the parallelogram with edges represented by the vectors $\vec{L} = 2\hat{i} + \hat{j} - 3\hat{k}$ and $\vec{W} = \hat{i} + 3\hat{j} + 2\hat{k}$

- (a) $2\hat{i} + \hat{j} - 3\hat{k}$
- (b) $11\hat{i} + \hat{j} - 3\hat{k}$
- (c) $11\hat{i} - 7\hat{j} + 5\hat{k}$
- (d) $11\hat{i} + \hat{j} + 5\hat{k}$

97. Light is travelling from medium 1 to medium 2 with refractive index μ_1 and μ_2 , respectively. On reflection at the interface it suffers a phase change of π . The relation between μ_1 and μ_2 is given as

- (a) $\mu_1 = \mu_2$
- (b) $\mu_1 > \mu_2$
- (c) $\mu_1 < \mu_2$
- (d) $\mu_1 = 1.5\mu_2$, and $\mu_2 > \mu_1$

98. The condition for interference of reflected light from a film with uniform thickness d and the refractive index μ is given by _____, where r is the angle of refraction, and λ is the



$$AD = 2\mu d \sin^2(r) / \cos(r)$$

wavelength of incident light and m is an integer ($m=1, 2, 3, \dots$).

- (a) $2\mu d \cos(r) = (2m - 1)\lambda/2$
- (b) $2\mu d \cos(r) = m\lambda/2$
- (c) $2\mu d \cos(r) = (2m + 1)\lambda/2$
- (d) $2\mu d \cos(r) = m\lambda$

99. You want to make a classical flute from 4 cm diameter pipe. If the frequency of lowest desired note is 646 Hz, what length should it be cut? Velocity of sound at room temperature is 343 m/s.

- (a) 0.75 m
- (b) 1.0 m
- (c) 0.25 m
- (d) 0.5 m

100. Which of the following statement is not true?

- (a) All periodic motions are simple harmonic motion
- (b) In simple harmonic motion the restoring force is proportional to the displacement
- (c) In simple harmonic motion the acceleration is proportional to the displacement
- (d) The total energy in a simple harmonic motion is proportional to square of the amplitude of oscillation.