SC... 2014 C.S.K.M.-2014

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

T.B.C. : B-QAPY-N-DMF

Test Booklet Series

Serial No.	**TEST BOOKLET**	**A**
277701	**PHYSICAL SCIENCES** **Paper II**	

Time Allowed : Two Hours ***Maximum Marks : 200***

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. **Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.**
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write ***anything else*** on the Test Booklet.
4. This Test Booklet contains **120** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose ***ONLY ONE*** response for each item.
5. You have to mark all your responses ***ONLY*** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator ***only*** the ***Answer Sheet***. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**
    THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.
    (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0·33)** of the marks assigned to that question will be deducted as penalty.
    (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
    (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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1. A particle in uniform circular motion can possess

   (a) radial acceleration only

   (b) tangential acceleration only

   (c) both radial and tangential acceleration

   (d) neither radial nor tangential acceleration

2. A particle motion on a space curve is governed by $x = 2 \sin t$, $y = 3 \cos t$ and $z = \sqrt{5} \sin t$. The speed of the particle at any instant is

   (a) $3\sqrt{2} \sin t$

   (b) $3\sqrt{\cos 2t}$

   (c) $3\sqrt{\sin 2t}$

   (d) independent of time

3. The frictional force on a rolling cylinder is proportional to

   (a) the tangential force and directed perpendicular to the surfaces in contact

   (b) the tangential force and directed parallel to the surfaces in contact

   (c) the normal force and directed parallel to the surfaces in contact

   (d) the normal force and directed perpendicular to the surfaces in contact

4. The kinetic energy (T) of a particle moving along a circle of radius R depends on the distance covered (s) as $T = cs^2$ where c is a constant. The force acting on the particle as a function of s is

   (a) $ks\sqrt{1+\frac{s}{R}}$

   (b) $ks\sqrt{1+\left(\frac{s}{R}\right)^2}$

   (c) $ks\sqrt{1+\left(\frac{s}{R}\right)^3}$

   (d) $ks\sqrt{1+\left(\frac{s}{R}\right)^4}$

   where k is a constant.

5. A point mass moves along x-axis according to the law $x = A\cos^2\left(\omega t - \frac{\pi}{4}\right)$. The amplitude of the oscillation is

   (a) A

   (b) $\frac{A}{2}$

   (c) $2A$

   (d) $\frac{A}{3}$

6. A pendulum consisting of a small sphere of mass m, suspended by an inextensible and massless string of length L is made to swing in a vertical plane. If the breaking strength of the string is $2\,mg$ where g is the acceleration due to gravity, then the maximum angular amplitude of the displacement from the vertical can be

(a) 15°

(b) 30°

(c) 60°

(d) 75°

For the next 02 (two) items that follow :

A body of mass m is thrown up with velocity v_0. The air drag is equal to kv^2 where v is the velocity at any instant and k is a positive constant (proportionally constant).

7. The maximum height to which the body can go is

(a) $\frac{m}{2k}\left(1+\frac{kv_0^2}{mg}\right)$

(b) $\frac{m}{k}ln\left(1+\frac{kv_0^2}{mg}\right)$

(c) $\frac{m}{2k}ln\left(1+\frac{kv_0^2}{mg}\right)$

(d) None of the above

8. What is the velocity with which the body comes down ?

(a) $\frac{v_0}{\left(1+\frac{kv_0^2}{mg}\right)}$

(b) $\frac{v_0}{\left(1+\frac{kv_0^2}{mg}\right)^{1/2}}$

(c) $\frac{v_0}{\left(1+\frac{kv_0^2}{mg}\right)^{1/3}}$

(d) None of the above

9. The velocity of a particle moving in the positive direction of x-axis is given by $v=\alpha\sqrt{x}$ where α is a positive constant. The acceleration of the particle will be

(a) α^2

(b) $\frac{\alpha^2}{2}$

(c) $2\alpha^2$

(d) $\alpha^{3/2}$

10. A planet moves round the Sun in a circular orbit. The angular velocity of planet will be proportional to

(a) velocity of planet

(b) square of velocity of planet

(c) cube of velocity of planet

(d) None of the above

11. A wave is represented by $y(x, t) = y_m \sin(kx - \omega t - \varphi)$. The phase of the wave is

(a) φ

(b) $kx - \omega t$

(c) $\omega t + \varphi$

(d) $kx - \omega t - \varphi$

12. Consider the following statements in respect of a plane progressive wave :

1. All the particles of the medium vibrate in same phase at any instant of time.
2. All the particles of the medium execute simple harmonic motion.
3. The wave velocity depends upon the nature of the medium.

Which of the above statements are correct ?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

13. Electric charges A and B attract each other. Electric charges B and C also attract each other. But electric charges C and D repel each other. If A and D are held close together then which one of the following is correct ?

(a) They cannot affect each other

(b) They attract each other

(c) They repel each other

(d) Cannot be predicted due to insufficient data

14. Two small charged spheres, contain charges $+q$ and $+Q$. Some charge is removed from the sphere carrying charge q and is transferred to the other. The charge on each sphere which will result in maximum force between them is

(a) $\sqrt{qQ}$

(b) $\frac{(q+Q)}{2}$

(c) $\frac{(q-Q)}{2}$

(d) None of the above

15. Permanent magnets are those substances that

(a) retain their ferromagnetic property for a long time at room temperature

(b) retain their ferromagnetic property for a long time at all temperatures

(c) have high permeability and low retentivity at room temperature

(d) high coercivity and low retentivity at room temperature

16. A particle with a positive charge travelling in the x-direction enters a region with a uniform magnetic field $\vec{B} = B\hat{j}$

1. The particle will move in circular path.
2. The kinetic energy of the particle will increase.
3. The particle path will be confined to $x =$ constant plane.

Which of the above statements is/are correct ?

(a) 1 and 3

(b) 2 and 3

(c) 1 only

(d) 2 only

17. To increase the range of an ammeter of resistance (r) n times, a shunt of resistance (s) is connected in parallel with the ammeter coil. What would be the appropriate value of s ?

(a) nr

(b) $\frac{r}{(n-1)}$

(c) $\frac{r}{n}$

(d) $\frac{r}{(n+1)}$

18. Consider the following statements :

When no current flows through a conductor,

1. the average velocity of free electrons over a large period of time is zero.
2. the average of the velocities of all the free electrons at any instant is zero.

Which of the above statements is/are correct ?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

19. Given that the ground state energy ($n = 1$) of the hydrogen atom is $-13{\cdot}6$ eV. The energy difference between $n = 1$ and $n = 2$ states of He^+ is

(a) 13·6 eV

(b) 27·2 eV

(c) 40·8 eV

(d) 54·4 eV

20. Consider the following statements in respect of stationary waves :

1. The energy flux per unit area is zero.
2. The energy density is same throughout.

Which of the above statements is/are correct ?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

21. On the pole of the earth of radius R, a body is imparted velocity v directly vertically up. The height to which the body will ascend is

(a) $\frac{vR}{2gR-v^2}$

(b) $\frac{2v^2R}{gR-v^2}$

(c) $\frac{v^2R}{2gR-v^2}$

(d) $\frac{v^2R}{gR-v^2}$

22. A block takes n times as much time to slide down a rough incline of 45° as it takes to slide down a perfectly smooth 45° incline. The coefficient of kinetic friction is

(a) $1-\frac{1}{n^2}$

(b) $\frac{1}{1-n^2}$

(c) $\frac{1}{\sqrt{1-n^2}}$

(d) $\sqrt{1-\frac{1}{n^2}}$

23. The earth's magnetic field varies with

(a) position

(b) time

(c) both position and time

(d) neither position nor time

24. A particle is projected vertically upward from the surface of earth of radius R with kinetic energy equal to one-third of the minimum value needed for it to escape. The height to which it rises above the surface of earth is

(a) R

(b) $\frac{R}{2}$

(c) $2R$

(d) $\frac{R}{3}$

25. A piece of cork floats in a vessel filled with kerosene. What part of its volume is submerged in kerosene ?

[density of cork = 200 kg/m^3 and density of kerosene = 800 kg/m^3]

(a) $\frac{1}{5}$

(b) $\frac{1}{4}$

(c) $\frac{1}{3}$

(d) $\frac{3}{4}$

26. Two particles of masses m and M initially at rest at infinite distance apart approach each other under inverse square law of force given by $F = kr^{-2}$. Their relative speed of approach at the instant when they are at a distance d apart is

(a) $\sqrt{\frac{2k}{d}\left(\frac{mM}{m+M}\right)}$

(b) $\sqrt{\frac{2k}{d}\left(\frac{m+M}{mM}\right)}$

(c) $\sqrt{\frac{k}{2d}\left(\frac{m+M}{mM}\right)}$

(d) None of the above

27. A pan pizza cools from 91°C to 79°C in 2 minutes, on a summer day, when the room temperature is 25°C. How long will the pan pizza take to cool (from 91°C to 79°C), on a winter day, when the room temperature is 5°C ?

(a) $\frac{3}{2}$ minutes

(b) 1 minute

(c) $\frac{1}{2}$ minute

(d) $\frac{1}{4}$ minute

28. A proton, a neutron, a β-particle and an α-particle are moving with equal velocity. Which one of the following is correct ?

1. β-particle has greatest de Broglie wavelength
2. α-particle has the smallest de Broglie wavelength

Select the correct answer using the code given below :

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

29. Hydrostatic paradox states that the pressure exerted by a liquid

(a) depends on the shape of the containing vessel and independent of height of liquid column

(b) depends on both shape of the containing vessel and height of liquid column

(c) independent of both shape of the containing vessel and height of liquid column

(d) depends on height only and independent of the shape of the containing vessel

30. A sphere of relative density ρ and diameter D has concentric cavity of diameter d. When the sphere just floats on water in a tank, then which one of the following is correct ?

(a) $\frac{D}{d}=\left(\frac{\rho+1}{\rho}\right)^{1/3}$

(b) $\frac{D}{d}=\left(\frac{\rho-1}{\rho}\right)^{1/3}$

(c) $\frac{D}{d}=\left(\frac{\rho}{\rho-1}\right)^{1/3}$

(d) $\frac{D}{d}=\left(\frac{\rho}{\rho+1}\right)^{1/3}$

31. What is the ratio of minimum wavelength of radiation emitted in Balmer series of hydrogen atom to maximum wavelength of the series ?

(a) 5 : 9

(b) 9 : 5

(c) 1 : 4

(d) 4 : 1

32. An object X of mass m moving forward with velocity v along x-axis collides elastically with a stationary object Y of mass $2\,m$ at the origin. After collision, the object X moves backward along x-axis. Given that the kinetic energy of the system is conserved, the speed of the object Y after collision is

(a) $\frac{2v}{3}$

(b) $\frac{v}{3}$

(c) $\frac{v}{2}$

(d) $\frac{3v}{4}$

33. There is a linear current I going around a circular wire of radius (a) with centre at origin in the xy-plane. The magnetic field B at (0, 0, z) in Cartesian coordinates is given by

(a) $B = \frac{\mu_0 I a^2}{2\left(z^2 + a^2\right)^{3/2}}$

(b) $B = \frac{\mu_0 I z a}{2\left(z^2 + a^2\right)^{3/2}}$

(c) $B = \frac{\mu_0 I z^2}{2\left(z^2 + a^2\right)^{3/2}}$

(d) $B = \frac{\mu_0 I a^2}{2\left(z^2 + a^2\right)^{1/2}}$

34. There are two long wires each parallel to z-axis, each carrying current I, are at (0, 0) and the other at (a, b). The force on unit length of each wire is

(a) $\frac{\mu_0 I^2}{2\pi\left(a^2 + b^2\right)}$

(b) $\frac{\mu_0 I^2 (a+b)}{2\pi\left(a^2 + b^2\right)}$

(c) $\frac{\mu_0 I^2}{2\pi\left(a^2 + b^2\right)^{3/2}}$

(d) $\frac{\mu_0 I^2}{2\pi\left(a^2 + b^2\right)^{1/2}}$

35. In a fusion process, effectively 4 protons each of mass m_p each combine to form an alpha particle of mass M, two positrons each of mass m_e, some gamma rays and neutrinos. With c being speed of light, the energy released in the formation of one alpha particle is

(a) $(4m_p - M + 2m_e)c^2$

(b) $(M - 4m_p + 2m_e)c^2$

(c) $(M - 4m_p - 2m_e)c^2$

(d) $(4m_p - M - 2m_e)c^2$

36. A piece of bar magnet of length L having pole strength m is held at an angle θ with a uniform magnetic field of strength H. The piece is then transversely cut into two equal pieces; one of the pieces is held in the same field in similar manner. The ratio of torque of the former to the latter piece of the bar magnet is

(a) 1 : 2

(b) 2 : 1

(c) 1 : 4

(d) 4 : 1

37. The critical angle of incidence of a ray of light going from a medium A to another medium B is 30°. If the velocity of light in the medium A is half the velocity of light in vacuum, then velocity of light in B is

(a) $\frac{c}{4}$

(b) c

(c) $\frac{\sqrt{3}c}{2}$

(d) $\frac{c}{2\sqrt{3}}$

where c is the speed of light in vacuum.

38. A particle of mass m and charge q is thrown at velocity u in the x-direction against uniform electric field E in the negative x-direction. The distance it will travel before coming to momentary rest is

(a) $\frac{mu^2}{qE}$

(b) $\frac{2mu^2}{qE}$

(c) $\frac{mu^2}{2qE}$

(d) $\frac{mu^2}{4qE}$

39. The optical path of a monochromatic light is the same if it passes through 0·665 cm of glass or 0·750 cm of a liquid of refractive index 1·5. The refractive index of glass is

(a) 1·5

(b) 1·7

(c) 1·2

(d) 1·6

40. The lateral displacement of light passing through a parallel plate of glass of thickness t with angle of incidence 60° and angle of refraction 45° is

(a) $\left(\sqrt{3}-1\right)t$

(b) $\frac{\left(\sqrt{3}-1\right)t}{2}$

(c) $\frac{\left(\sqrt{3}+1\right)t}{2}$

(d) None of the above

41. A small bar starts sliding down on inclined plane making an angle α with the horizontal. The cooefficient of friction μ depends on the distance x as $\mu = ax$ where a is a constant. The distance covered by the bar till it stops is

(a) $\frac{(\tan \alpha)}{a}$

(b) $\frac{2(\tan \alpha)}{a}$

(c) $2a \tan \alpha$

(d) $\frac{\tan \alpha}{(2a)}$

42. Which one of the following waves does not involve oscillations of particles of a medium ?

(a) Waves in a hanging spring

(b) Ripples on a water surface

(c) A light wave

(d) Ultrasonic waves

43. A certain mass of a given gas of specific heat ratio 1·5 is compressed such that its volume becomes one-fourth of original volume, first adiabatically and then isothermally. In both the cases the initial state of gas is the same. The ratio of the respective works in each compression respectively is approximately
($ln\ 2 = 0{\cdot}3$)

(a) 4

(b) 3

(c) 2

(d) 1

44. Two plane mirrors form an angle of 120°. The distance between the two images of a point source formed in them is 20 cm and the point source lies on the bisector of the angle formed by the mirrors. What would be the least distance of the point source from the line along which the mirrors would touch each other ?

(a) 10 cm

(b) $\frac{20}{\sqrt{3}}$ cm

(c) $10\sqrt{2}$ cm

(d) None of the above

45. An astronomical telescope consists of an objective lens that forms at or very near to its principal focus an image of the object which is

(a) real, inverted and reduced

(b) real, inverted and magnified

(c) virtual, erect and reduced

(d) real, erect and reduced

For the next 03 (three) items that follow :
A non-conducting disc of radius r and uniform positive surface charge density σ is placed on the ground, with its axis vertical. A particle of mass m and charge q is dropped along the axis of the disc from a height h with zero initial velocity. The ratio of charge to mass of the particle is given by $\frac{q}{m} = \frac{4 \in_0 g}{\sigma}$.

46. What is the value of h if the particle just reaches the disc ?

(a) $\frac{4r}{3}$

(b) $2r$

(c) $\frac{3r}{2}$

(d) None of the above

47. At what position z (from the ground) will the particle attain equilibrium position ?

(a) $z = \frac{r}{2}$

(b) $z = \frac{r}{\sqrt{3}}$

(c) $z = \frac{r}{\sqrt{2}}$

(d) None of the above

48. What is the minimum potential energy of the particle ?

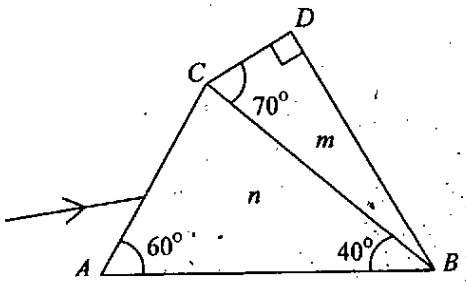
(a) $-mgr$

(b) $\sqrt{2}\ mgr$

(c) $\sqrt{3}\ mgr$

(d) None of the above

For the next 02 (two) items that follow :



A prism of refractive index n and another prism of refractive index m are stuck together without a gap as shown in the figure. The angles of the prisms are as shown. Refractive indices n and m depend on wavelength λ as follows :

$$n = 1{\cdot}20 + \frac{10{\cdot}8 \times 10^4}{\lambda^2} \text{ and}$$

$$m = 1{\cdot}45 + \frac{1{\cdot}80 \times 10^4}{\lambda^2}$$

where λ is in nanometer.

49. What is the wavelength λ_0 for which rays incident at an angle on the interface BC pass through without bending at the interface ?

(a) 500 nm

(b) 600 nm

(c) 650 nm

(d) None of the above

50. For light of wavelength λ_0 what is the angle of incidence on the face AC such that the deviation produced by the combination of the prisms is minimum ?

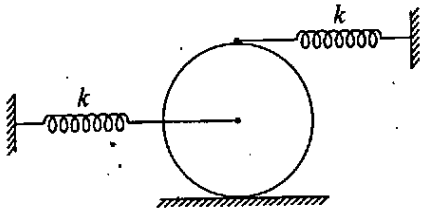
(a) 30°

(b) 45°

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

(d) None of the above

For the next 02 (two) items that follow :



A disc of mass m and radius R is connected to springs each with spring constant k as shown in the figure. The disc is rolling on a rough surface.

51. If v is the velocity at any instant, then what is the kinetic energy of disk at that instant ?

(a) $\frac{mv^2}{2}$

(b) $\frac{2mv^2}{3}$

(c) $\frac{3mv^2}{4}$

(d) None of the above

52. What is the time period of oscillation of disc ?

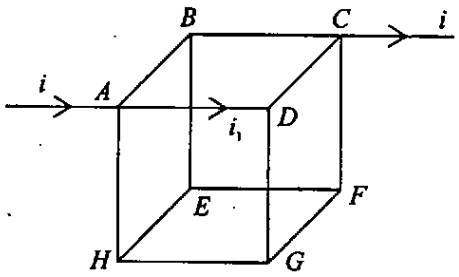
(a) $T = 2\pi\sqrt{\frac{m}{k}}$

(b) $T = 2\pi\sqrt{\frac{3m}{10k}}$

(c) $T = 2\pi\sqrt{\frac{7m}{10k}}$

(d) None of the above

For the next 02 (two) items that follow :



12 wires, each having resistance R are joined to form a skeleton cube as shown in the figure.

53. What is the current through wire BE ?

(a) 0

(b) $\frac{i}{3}$

(c) $i - i_1$

(d) None of the above

54. What is the equivalent resistance between A and C ?

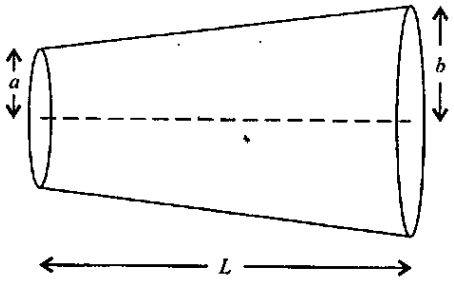
(a) $\frac{R}{6}$

(b) $\frac{2R}{3}$

(c) $\frac{3R}{4}$

(d) None of the above

55.



A resistor is in the shape of a truncated right circular cone as shown in the figure. The end radii are a and b, and the length is L. The specific resistance of the material is ρ. What is the resistance of the object ? [Assume that the taper is small, so that the current density is uniform across any cross-section]

(a) $\frac{\rho L}{ab}$

(b) $\frac{\rho L}{\pi ab}$

(c) $\frac{\rho L}{\pi\left(b^2 - a^2\right)}$

(d) $\frac{\rho L}{2\pi\left(b^2 - a^2\right)}$

56. A battery of emf 3 V and internal resistance 0·2 Ω is being charged with a current of 5 A. What is the potential difference between the terminals of the battery ?

(a) 2 V

(b) 3 V

(c) 3·5 V

(d) 4 V

57. An equilateral triangle is made of wires each having a resistance of 1 Ω. Any two corners are connected to a cell of emf 2 V. The current drawn from the cell is equal to

(a) 0·66 A

(b) 2 A

(c) 3 A

(d) 3·5 A

58. A ray of light incident at an angle θ on the first refracting surface of a prism having small angle A gets refracted out normally from the second surface. If n is the refractive index of the material of the prism, then

(a) $\theta = \frac{A}{n}$

(b) $\theta = nA$

(c) $\theta = \frac{A}{(2n)}$

(d) $\theta = (n-1)A$

59. Light travels from air to water, from water to glass and then again from glass to air. If x represents refractive index of water with respect to air, y represents refractive index of glass with respect to water and z represents refractive index of air with respect to glass, then which one of the following is correct ?

(a) $xy = z$

(b) $yz = x$

(c) $zx = y$

(d) $xyz = 1$

60. A fusion reactor when achieved will have which of the following advantages over fission reactor ?

1. Elimination of nuclear waste disposal and nuclear pollution problems
2. Relative ease of procurement of nuclear fuel

Select the correct answer using the code given below :

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

61. If light of energy 5 eV ejects electrons from copper metal with kinetic energy 0·2 eV, what is the approximate wavelength of light that will eject electrons with kinetic energy 1·8 eV ? [Planck's constant = $6{\cdot}6 \times 10^{-34}$ Joule second, charge of electron = $1{\cdot}6 \times 10^{-19}$C]

(a) 200 nm

(b) 400 nm

(c) 100 nm

(d) 500 nm

62. The longest wavelength present in Balmer series lines is

[Given
Rydberg constant = $1{\cdot}097 \times 10^7 m^{-1}$]

(a) 640 nm

(b) 656 nm

(c) 662 nm

(d) 670 nm

63. For the iso-electronic series, which among the following species requires the least energy to remove an outer electron ?

(a) K^+

(b) Ag

(c) Cl^-

(d) S^{2-}

64. The percentage of ionic character in HCl molecule which has dipole moment of $3{\cdot}6 \times 10^{-30}$ Coulomb metre and bond length of 123 pm, is

(a) 100%

(b) 87%

(c) 24·2%

(d) 18·3%

65. Consider the following with regard to water molecule :

1. Non-polar covalent
2. Polar covalent
3. σ bond
4. sp^3 hybridization

Which of the above describe the bonding in water molecule ?

(a) 2 and 4 only

(b) 1 and 4

(c) 2 and 3 only

(d) 2, 3 and 4

66. An electric current of 0·965 A is passed for 2000 seconds through a solution containing $[Cu(CH_3CN)_4]^+$ and metallic copper is deposited at the cathode. The amount of copper deposited is

(a) 0·005 mol

(b) 0·01 mol

(c) 0·02 mol

(d) 0·04 mol

67. When sugar $C_{12}H_{22}O_{11}$ is burned to give carbon dioxide CO_2, the increase in oxidation number of carbon atoms is

(a) +4

(b) +2

(c) +1

(d) 0

68. An ideal gas at initial pressure P_i and volume V_i undergoes reversible expansion to the same volume V_f either isothermally or adiabatically. Consider the following statements :

1. P_f(adiabatic) < P_f(isothermal)
2. $|W(\text{adiabatic})| < |W(\text{isothermal})|$
3. T_f(adiabatic) < T_f(isothermal)
4. $|q(\text{adiabatic})| < |q(\text{isothermal})|$

where the symbols have their usual meaning.

How many statements of the above are correct ?

(a) Only one

(b) Only two

(c) Only three

(d) All

69. Consider the following :

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g) \quad \Delta H = -467 \text{ kJmol}^{-1}$$

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) \quad \Delta H = -151 \text{ kJmol}^{-1}$$

and given that for water,
$\Delta H_f^\circ = -286$ kJmol^{-1}

What is ΔH_f° for MgO(s) ?

(a) –904 kJmol^{-1}

(b) –602 kJmol^{-1}

(c) –334 kJmol^{-1}

(d) –30 kJmol^{-1}

70. The half life of ^{14}C is 5570 years. If it takes t years for 90% of the sample to decompose, then which one of the following is correct ? [$\log_e 10 = 2{\cdot}3$]

(a) t < 17,000 years

(b) 17,000 years < t < 18,000 years

(c) 18,000 years < t < 19,000 years

(d) t > 19,000 years

71. Consider the following equilibria involving $SO_2(g)$ and their corresponding equilibrium constants :

$SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ with equilibrium constant K_1

$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ with equilibrium constant K_2

Which one of the following is correct ?

(a) $K_2 = K_1^2$

(b) $K_2^2 = K_1$

(c) $K_2 = K_1$

(d) $K_2 K_1^2 = 1$

72. When a particular aqueous solution is diluted by a factor of ten with H_2O, the pH increases by one unit. The solution most likely contains a

(a) Weak acid

(b) Strong base

(c) Strong acid

(d) Buffer

73. A solution prepared from 1·25 g of oil of wintergreen in 99·0 g of benzene has a boiling point of 80·31°C. What is the molar mass of the compound, given that the normal boiling point of benzene is 80·10°C and its boiling point elevation constant K_b is 2·53 K kg mol^{-1} ?

(a) 137 gm mol^{-1}

(b) 150 gm mol^{-1}

(c) 560 gm mol^{-1}

(d) 117 gm mol^{-1}

74. By dissolving 68·4 g of a compound whose molecular mass is 342 in 1 kg of water, a solution is prepared. If K_f for water is 1·86 K kg mol^{-1} then freezing point of the solution will be

(a) 272·8 K

(b) 273·5 K

(c) 282·3 K

(d) 263·7 K

75. For the reaction
$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$,
the equilibrium concentrations at a certain temperature are found to be $[NO] = 0·10$ M, $[O_2] = 0·20$ M, $[NO_2] = 0·30$ M. The value of equilibrium constant at this temperature is

(a) 1·5

(b) 15

(c) 45

(d) 150

76. Beta-carotene is the most important of the A vitamins. Its molar mass can be determined by measuring the osmotic pressure generated by a given mass of beta-carotene. If 10 mL of a solution containing 7·68 mg of beta-carotene, has an osmotic pressure of $3·54 \times 10^{-2}$ bar at 25°C ($R = 0·083$ dm^3 bar $mol^{-1}K^{-1}$), the molar mass of beta-carotene is

(a) 109 g/mol

(b) 54 g/mol

(c) 537 g/mol

(d) 768 g/mol

77. In the spontaneous beta particle (β^-) emission, what is the source of the emitted electron ?

(a) the nucleus

(b) the 1*s* orbital

(c) the outermost occupied orbital

(d) a random orbital

78. Which one of the following represents acid-base reaction according to Lewis definition, but not according to Bronsted-Lowry definition ?

(a) $MgCl_2(s) \rightleftharpoons Mg^{2+}(aq) + 2Cl^-(aq)$

(b) $CN^- + H_2O(l) \rightleftharpoons HCN(aq) + OH^-(aq)$

(c) $NH_3(g) + HBr(g) \rightleftharpoons NH_4Br(s)$

(d) $Fe(H_2O)_6^{3+}(aq) + H_2O \rightleftharpoons [Fe(H_2O)_5OH]^{2+}(aq) + H_3O^+(aq)$

79. A 0·20 molar solution of a weak monoprotic acid, HA, has a pH of 3·0. The ionization constant of the acid is

(a) $5{\cdot}0 \times 10^{-7}$

(b) $2{\cdot}0 \times 10^{-7}$

(c) $5{\cdot}0 \times 10^{-6}$

(d) $5{\cdot}0 \times 10^{-3}$

80. If the radius of 1*s* electron orbit of a hydrogen atom is 53 pm, then the radius of the 3*p* electron orbit would be

(a) 0·477 nm

(b) 477 nm

(c) 159 pm

(d) 17·66 nm

81. In which one of the following properties of hydrogen, its resemblance with halogens is seen ?

1. It forms oxides
2. It forms a diatomic molecule
3. Its ionization enthalpy is quite high
4. It forms numerous covalent compounds

Select the correct answer using the code given below :

(a) 2, 3 and 4 only

(b) 1, 2 and 3 only

(c) 1 and 4 only

(d) 1, 2, 3 and 4

82. The radioactivity is highest for which one of the following ?

(a) Ortho hydrogen

(b) Tritium

(c) Protium

(d) Deuterium

83. Consider the following reactions :

1. $T_2 + CuO \rightarrow T_2O + Cu$
2. $2T_2 + O_2 \xrightarrow[catalyst]{Pd} 2T_2O$
3. $2T_2 + O_2 \xrightarrow{sunlight} 2T_2O$

Which of the above give good yield of T_2O in laboratory conditions ?

(a) 1, 2 and 3

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1 and 3 only

84. Consider the following compounds :

1. $CaCl_2$
2. $BeCl_2$
3. $BaCl_2$
4. $SrCl_2$
5. $MgCl_2$

What is the correct order of melting point for the above compounds ?

(a) $1 > 2 > 3 > 4 > 5$

(b) $3 > 4 > 1 > 5 > 2$

(c) $2 > 5 > 1 > 4 > 3$

(d) $4 > 2 > 5 > 1 > 3$

85. Which one of the following is used for water softening ?

(a) $Ca_3(PO_4)_2$

(b) Na_3PO_4

(c) $Na_2[Na_4(PO_3)_6]$

(d) Na_2HPO_4

86. Bubbling of CO_2 through lime water results in a turbid solution. This is due to formation of

(a) $Ca(HCO_3)_2$

(b) $CaCO_3$

(c) $Ca(OH)_2$

(d) CaO

87. Partial dehydration of gypsum at around 150°C affords mainly

(a) $CaSO_4$

(b) $CaSO_4 \cdot 2H_2O$

(c) $CaSO_4 \cdot \frac{1}{2}H_2O$

(d) $CaSO_4 \cdot H_2O$

88. Consider the following statements with regard to magnesium sulphate :

1. It is sparingly soluble in water.
2. Its solubility in water is less than calcium sulphate.
3. When heated to 900°C, it gives magnesium oxide.

Which of the above statements is/are correct ?

(a) 1 and 3

(b) 2 only

(c) 3 only

(d) 2 and 3

89. The number and type of bonds between two carbon atoms in CaC_2 are

(a) One σ bond and one π bond

(b) One σ bond and two π bonds

(c) One σ bond only

(d) One σ and one δ bond

90. Among the following allotropic forms of sulphur, which does ***not*** contain S_8 rings ?

(a) Monoclinic sulphur

(b) Engel's sulphur

(c) Rhombic sulphur

(d) γ-monoclinic sulphur

91. Oxalic acid, when heated with conc. H_2SO_4, gives

(a) H_2O and CO_2

(b) H_2O_2 and CO

(c) CO and CO_2

(d) CO_2 and H_2S

92. Which one of the following is ***not*** used as a catalyst in the reaction of SO_2 with O_2 (for the formation of SO_3) ?

(a) V_2O_5 supported on silica

(b) Platinized asbestos

(c) Platinum gauze

(d) Charcoal

93. Which one of the following isotopes of fluorine is commonly used for NMR spectroscopy ?

(a) $^{19}_{9}F$

(b) $^{18}_{9}F$

(c) $^{20}_{9}F$

(d) None of the above

94. Consider the following trends in properties of hydrogen halides :

1. Acidic strength :
   HF < HCl < HBr < HI
2. Thermal stability :
   HF > HCl > HBr > HI
3. Dipole moment :
   HF < HCl < HBr < HI
4. Reducing power :
   HF > HCl > HBr > HI

The number of correct trends is :

(a) One

(b) Two

(c) Three

(d) Four

95. The bond order of He_2^+ is

(a) 1

(b) 0

(c) 0·5

(d) 2

96. Liquefaction of helium gives two phases called helium-I and helium-II. Consider the following statements :

1. Helium-I is formed at 4·2 K.
2. Helium-II is formed at 4·2 K.
3. Helium-II is a superconductor.
4. Viscosity of Helium-II is nearly zero.

Which of the above statements are correct ?

(a) 1 and 2 only

(b) 1, 3 and 4 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

97. In electrolytic refining of copper, the electrodes used are

(a) Anode is impure copper plate and cathode is pure nickel plate

(b) Anode is pure copper plate and cathode is impure copper plate

(c) Anode is impure copper plate and cathode is pure graphite plate

(d) Anode is impure copper plate and cathode is pure copper plate

98. The Cl_2 gas prepared by oxidation of HCl with MnO_2 contains impurities of HCl and H_2O. Chlorine gas is best purified by passing through/over

(a) H_2O and dry CaO

(b) H_2O, concentrated H_2SO_4 and dry CaO

(c) concentrated H_2SO_4 and dry CaO

(d) dry CaO only

99. In the extraction of Pb, ore is roasted in air to get PbO which is reduced to elemental Pb under different conditions :

1. Coke
2. CO
3. PbS

Of the above reducing agents the correct ones for this purpose are :

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

100. In the manufacturing of I_2 from the solution of chile salt petre, left after the crystallization of $NaNO_3$, IO_3^- is generally reduced to I^- with

(a) $NaHSO_3$

(b) adding finely divided zinc

(c) passing SO_2

(d) adding $SnCl_2$

101. What is the hybridization of carbon atom '2' in the following compound ?

$$\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{CH}=\overset{4}{CH_3}$$

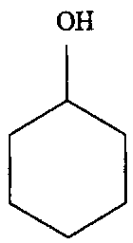
(a) sp^3

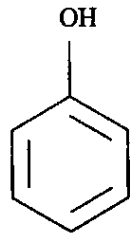
(b) sp^2

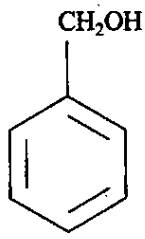
(c) sp

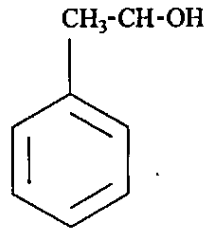
(d) sp^3d

102. Consider the following compounds :

I. 

II. 

III. 

IV. 

Which of the above compounds has/ have phenolic –OH function ?

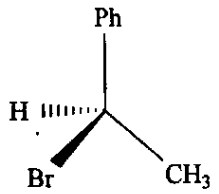
(a) I and III

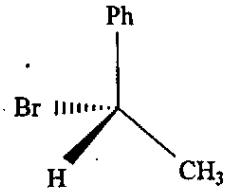
(b) II and IV

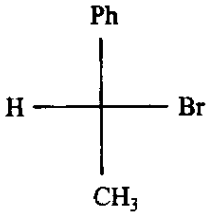
(c) I and II

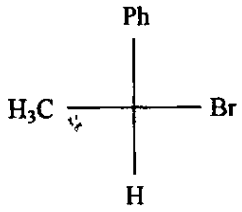
(d) II only

103. Consider the following :

I. 

II. 

III. 

IV. 

Which of the above is/are the correct stereochemical representation of (*S*)-1-bromoethyl benzene ?

(a) I

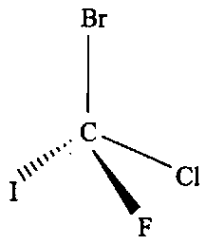
(b) II only

(c) II and IV

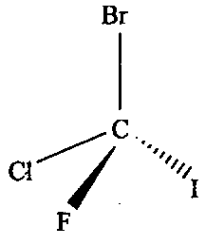
(d) II and III

104. Consider the following molecules :

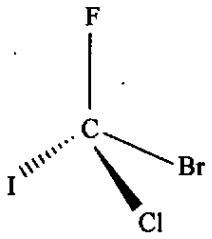
I.



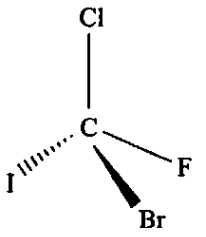
II.



III.



IV.



Which of the above are enantiomers ?

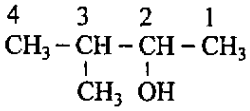
(a) I and II

(b) I and III

(c) I and IV

(d) III and IV

105. Consider the following compound :



Which of the carbon atoms in this compound is/are asymmetric ?

(a) C-1 and C-4

(b) C-2 only

(c) C-3 only

(d) C-2 and C-3

106. What is the number of structural isomers for a compound with molecular formula C_5H_{12} ?

(a) 2

(b) 3

(c) 4

(d) 5

107. Which of the following on ozonolysis yields propanal and acetone ?

(a) 2-hexane

(b) 3-hexane

(c) 2-methylpent-2-ene

(d) None of the above

108. Consider the following compounds :

I. CH_3Br

II. CH_3CH_2Br

III. $CH_3-\overset{CH_3}{\underset{|}{C}}HBr$

What is the correct order of reactivity of a nucleophile toward the above compounds ?

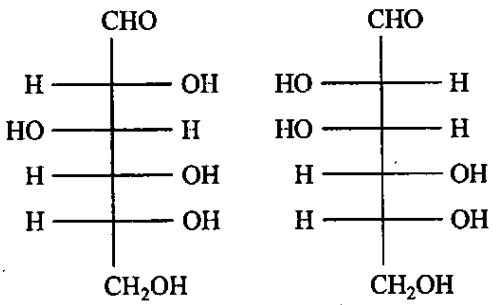
(a) I < II < III

(b) II < III < I

(c) III < II < I

(d) III < I < II

109. Consider the following structures :



Which one of the following is correct in respect of above structures ?

(a) Anomers

(b) Epimers

(c) Enantiomers

(d) Aldopentose

110. Consider the following compounds :

I. Cl_3CCO_2H

II. $O_2NCH_2CO_2H$

III. $NCCH_2CO_2H$

What is the correct order of acidity of the above compounds ?

(a) I < III < II

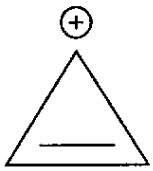
(b) III < II < I

(c) II < III < I

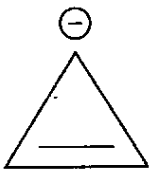
(d) III < I < II

111. Consider the following compounds :

I.

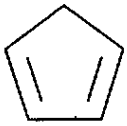


II.

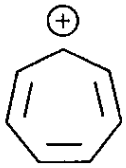


III.

IV.



V.



Which of the above compounds is/are aromatic ?

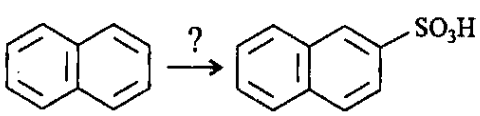
(a) I only

(b) I and IV

(c) I and V

(d) II and III

112. Which of the following conditions can bring about the following transformation ?



(a) conc. H_2SO_4, 80°C

(b) conc. H_2SO_4, 160°C

(c) dil. H_2SO_4, 160°C

(d) None of the above

113. Which one of the following polysaccharides is soluble in water ?

(a) Amylopectin

(b) Amylose

(c) Cellulose

(d) Glycogen

114. Reactant and product are given in the following reaction :

$$CH_3 - CH = CH_2 \rightarrow CH_3 - CH_2 - CH_2OH$$

Which of the following reagents can one use for this reaction ?

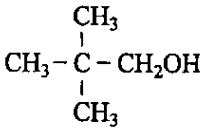
(a) Dilute H_2SO_4 solution

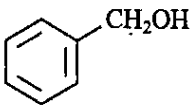
(b) $(H\text{-}BH_2)_2$ $|H_2O_2|$ NaOH(aq)

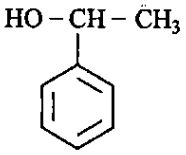
(c) Dilute NaOH solution

(d) Grignard reagent

115. Consider the following compounds :

I. 

II. 

III. 

IV. $CH_2 = CH - \underset{\displaystyle CH_3}{\underset{|}{C}}HOH$

In which of the above compounds –OH group is attached to secondary carbon atom ?

(a) I and II

(b) I, III and IV

(c) III and IV only

(d) II and III

116. The *ortho* and *para* nitrophenols can be separated by

(a) Steam distillation

(b) Crystallization

(c) Sublimation

(d) Condensation

117. Consider the following :

I. $SH^{\ominus}$

II. $\dot{F}^{\ominus}$

III. $\ddot{N}H_3$

IV. $\overset{\ominus}{O}H$

V. $\overset{\ominus}{O}R$

What is the correct order of decreasing nucleophilicity in water ?

(a) I > III > II > IV > V

(b) II > V > IV > I > III

(c) III > I > IV > V > II

(d) III > I > V > IV > II

118. Consider the following with regard to enzymes :

1. Enzymes are biocatalysts.

2. Enzymes are proteins in nature.

Which of the above statements is/are correct ?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

119. In the direct nitration of aniline by using $HNO_3|H_2SO_4$ at 288 K, a mixture of products is formed in which

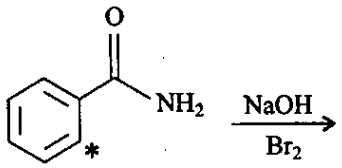
(a) *p*-nitroaniline and *o*-nitroaniline are major products and *m*-nitroaniline is not formed

(b) *p*-nitroaniline and *m*-nitroaniline are major products and *o*-nitroaniline is minor product

(c) *p*-nitroaniline and *o*-nitroaniline are major products and *m*-nitroaniline is minor product

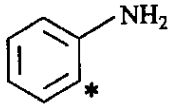
(d) *o*-nitroaniline and *m*-nitroaniline are major products and *p*-nitroaniline is minor product

120. Consider the following reaction :

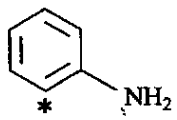


What is the major product in the above reaction ?

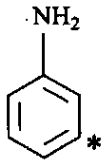
(a)



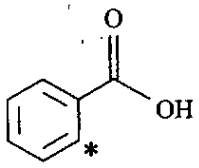
(b)



(c)



(d)



SPACE FOR ROUGH WORK

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