WARNING	Any malpractice or any attempt to commit any kind of malpractice in the Examination will DISQUALIFY THE CANDIDATE.

PAPER – I PHYSICS & CHEMISTRY - 2021

Version Code	A3	Question Booklet Serial Number :	6323745
Time: 150 Minutes		Number of Questions : 120	Maximum Marks : 480
Name of the Candidate			
Roll Number			
Signature of the Candidate			

INSTRUCTIONS TO CANDIDATES

1. **Please ensure that the VERSION CODE shown at the top of this Question Booklet is same as that shown in the OMR Answer Sheet issued to you.** If you have received a Question Booklet with a different Version code, please get it replaced with a Question Booklet with the same Version Code as that of OMR Answer Sheet from the Invigilator. **THIS IS VERY IMPORTANT.**
2. Please fill the items such as Name, Roll Number and Signature in the columns given above. Please also write Question Booklet Serial Number given at the top of this page against item 3 in the OMR Answer Sheet.
3. This Question Booklet contains 120 questions. For each question five answers are suggested and given against (A), (B), (C), (D) and (E) of which only one will be the **'Most Appropriate Answer'**. Mark the bubble containing the letter corresponding to the 'Most Appropriate Answer' in the OMR Answer Sheet, by using either **Blue or Black Ball Point Pen only.**
4. **Negative Marking**: In order to discourage wild guessing the score will be subjected to penalization formula based on the number of right answers actually marked and the number of wrong answer marked. Each correct answer will be awarded FOUR marks. ONE mark will be deducted for each incorrect answer. More than one answer marked against a question will be deemed as incorrect answer and will be negatively marked.
5. Please read the instructions in the OMR Answer Sheet for marking the answers. Candidates are advised to strictly follow the instruction contained in the OMR Answer Sheet.

IMMEDIATELY AFTER OPENING THE QUESTION BOOKLET, THE CANDIDATE SHOULD VERIFY WHETHER THE QUESTION BOOKLET CONTAINS ALL THE 120 QUESTIONS IN SERIAL ORDER. IF NOT, REQUEST FOR REPLACEMENT.

DO NOT OPEN THE SEAL UNTIL THE INVIGILATOR ASKS YOU TO DO SO.

SEAL

PLEASE ENSURE THAT THIS QUESTION BOOKLET CONTAINS 120 QUESTIONS SERIALLY NUMBERED FROM 1 TO 120 PRINTED PAGES 32

1. When two sound waves of slightly different frequencies f_1 and f_2 are sounded together, then the time interval between successive maxima is

(A) $\frac{1}{f_1+f_2}$ (B) $\frac{1}{f_1}+\frac{1}{f_2}$ (C) $\frac{1}{f_1-f_2}$ (D) $\frac{1}{f_1 f_2}$ (E) $\frac{1}{f_1}-\frac{1}{f_2}$

2. The electric potential at a point at a distance r due to an electric dipole is proportional to

(A) r^2 (B) r (C) r^{-1} (D) r^{-2} (E) r^{-3}

3. An air capacitor and identical capacitor filled with dielectric medium of dielectric constant 5 are connected in series to a voltage source of 12V. The fall of potential across C_1 and C_2 are respectively

(A) 2 V and 10 V (B) 10 V and 2 V (C) 6 V and 6 V
(D) 4 V and 8 V (E) 8 V and 4 V

Space for rough work

4. The ratio of the magnitudes of electrostatic force between two protons at a distance r apart to that between two electrons at the same distance of separation is

(A) 1:1 (B) 2:1 (C) 1:2 (D) 4:1 (E) 1:4

5. When two charges are kept in air medium, at certain distance d apart, the force between them is F. When they are kept in a dielectric medium at the same distance of separation, the force between them becomes $F/2$. Then the dielectric constant of the medium is

(A) 5 (B) 2 (C) 4 (D) 3 (E) 8

6. The magnitude of the drift velocity per unit electric field is defined as

(A) mobility (B) resistivity (C) conductivity
(D) current density (E) impedance

Space for rough work

7. A Wheatstone network is balanced with respective resistors 5 Ω, 10 Ω, 20 Ω and 40 Ω in the P, Q, R and S arms. If a 40 Ω resistor is connected across S arm, then the bridge is again balanced by connecting

(A) 10Ω across R (B) 10Ω across P (C) 20Ω across Q

(D) 20Ω across P (E) 10Ω across Q

8. If one cell is connected wrongly in a series combination of four cells each of *e.m.f.* 1.5 V and internal resistance of 0.5 Ω, then the equivalent internal resistance of the combination is

(A) 0.5 Ω (B) 1 Ω (C) 1.5 Ω (D) 2 Ω (E) 2.5 Ω

9. A carbon resistor is marked with the rings coloured blue, black, red and silver. Its resistance in ohm is

(A) $60\times10^2 \pm 10\%$ (B) $1\times10^5 \pm 10\%$ (C) $1\times10^6 \pm 5\%$

(D) $3.2\times10^4 \pm 5\%$ (E) $45\times10^2 \pm 5\%$

10. A conductor of length 20 cm carrying a current of 5A is placed at an angle of 30° to the external magnetic field of 0.5 T. The force acting on it is

(A) 0.5 N (B) 5 N (C) 0.25 N (D) 2.5 N (E) 0.125 N

Space for rough work

11. A current carrying coil placed in a magnetic field B experiences a torque τ. If θ is the angle between the normal to the plane of the coil and field B and φ is the flux linked with the coil, then

(A) τ is minimum for $\theta = 90°$
(B) τ and φ are maximum for $\theta = 0°$
(C) φ is maximum for $\theta = 90°$
(D) τ and φ are zero for $\theta = 90°$
(E) τ is zero and φ is maximum for $\theta = 0°$

12. In Cyclotron, the frequency of revolution of the charged particle in a magnetic field is independent of

(A) its mass
(B) its energy
(C) oscillatory frequency
(D) magnetic field
(E) its charge

13. The hard ferromagnetic material among the following is

(A) gadolinium
(B) iron
(C) cobalt
(D) Alnico
(E) nickel

Space for rough work

14. If B_c is the magnetic induction at the centre of a circular coil carrying current, then the magnetic induction at a point on the axis of the coil at a distance equal to the radius of the coil is

(A) $\frac{B_c}{2\sqrt{2}}$ (B) $\frac{B_c}{2}$ (C) $\frac{B_c}{4}$ (D) $\frac{B_c}{\sqrt{2}}$ (E) $\frac{B_c}{8}$

15. If air core is replaced by an iron core in an inductor, its self-inductance is increased from 0.02 mH to 40 mH. The relative permeability of iron is

(A) 5000 (B) 2000 (C) 200 (D) 500 (E) 400

16. Among various circuits constructed with resistor R, inductor L and capacitor C, the circuit that gives maximum power dissipation is

(A) purely inductive circuit
(B) purely capacitive circuit
(C) purely resistive circuit
(D) L-C series circuit
(E) C-R series circuit

17. Eddy currents are not used in the application of

(A) induction furnace
(B) thermal generators
(C) electromagnetic damping
(D) electric power meters
(E) magnetic braking in trains

18. The total intensity of earth's magnetic field at the poles is 7 units. Its value at the equator is

(A) $7\sqrt{2}$ units (B) 3.5 units (C) 7 units (D) $\frac{7}{\sqrt{2}}$ units (E) 14 units

Space for rough work

19. Electromagnetic waves against their detection devices are matched below. The mismatch is

(A) Gamma rays : Ionization chamber

(B) Microwaves : Point contact diode

(C) X – rays : Photographic film

(D) Ultraviolet rays : Thermopiles

(E) Infrared rays : Bolometer

20. In an electromagnetic wave, the oscillating electric and magnetic field vectors are oriented in

(A) mutually perpendicular directions with a phase difference of $\pi/2$

(B) the same direction and in the same phase

(C) mutually perpendicular directions with a phase difference of π

(D) the same direction with a phase difference of $\pi/2$

(E) mutually perpendicular directions and are in phase

21. Fresnel distance for an aperture of size a illuminated by a parallel beam of light of wavelength λ, deciding the validity of ray optics is

(A) $\frac{\lambda}{a^2}$ (B) λa (C) $a^2\lambda$ (D) $\frac{a^2}{\lambda}$ (E) $a^2\lambda^2$

22. The apparent depth of a needle lying in a water beaker is found to be 9 cm. If water is replaced by a liquid of refractive index 1.5, then the apparent depth of needle will be (μ of water is 4/3)

(A) 10 cm (B) 9 cm (C) 12 cm (D) 7 cm (E) 8 cm

Space for rough work

23. An object is placed at 10 cm in front of a concave mirror. If the image is at 20 cm from the mirror on the same side of the object, then the magnification produced by the mirror is

(A) 3 (B) –0.5 (C) –2 (D) 0.33 (E) –1

24. In Young's double–slit experiment, two different light beams of wavelengths λ_1 and λ_2 produce interference pattern with band widths β_1 and β_2 respectively. If the ratio between β_1 and β_2 is 3 : 2, then the ratio between λ_1 and λ_2 is

(A) 3 : 1 (B) 1 : 3 (C) 2 : 3 (D) 3 : 2 (E) 4 : 5

25. If θ_p is the polarizing angle for a glass plate of refractive index μ and critical angle θ_c, then

(A) $\theta_p = \theta_c$ (B) $\tan\theta_p \cdot \sin\theta_c = 1$ (C) $\theta_p\,\theta_c = 1$

(D) $\tan\theta_p = \sin\theta_c$ (E) $\tan\theta_p\ \sin\theta_c = \mu$

26. Two materials A and B having respective work functions 3 eV and 4 eV are emitting photoelectrons of same maximum kinetic energy of 1eV. If the wavelength of incident light on A is 500 nm, then that of light incident on B is

(A) 400 nm (B) 300 nm (C) 350 nm (D) 600 nm (E) 250 nm

Space for rough work

27. If the momentum of an α-particle is half that of a proton, then the ratio between the wavelengths of their de-Broglie waves is

(A) 1 : 2 (B) 4 : 1 (C) 1 : 4 (D) 1 : 1 (E) 2 : 1

28. During β^- decay of a radioactive element there is an increase in its

(A) mass number (B) neutron number (C) electron number
(D) proton number (E) atomic weight

29. 10^{18} fissions per second is required for producing power of 300 MW in a nuclear power station. To increase the power output to 360 MW the additional number of fissions required per second is

(A) 2×10^{18} (B) 5×10^{18} (C) 5×10^{17} (D) 6×10^{17} (E) 2×10^{17}

30. The ratio of the total energy E of the electron to its kinetic energy K in hydrogen atom is

(A) 1 (B) $\frac{1}{2}$ (C) 2 (D) -1 (E) $-\frac{1}{2}$

Space for rough work

31. If the mass numbers of two nuclei are in the ratio 3 : 2, then the ratio of their nuclear densities is :

(A) $3^{1/3} : 2^{1/3}$ (B) $2^{1/3} : 3^{1/3}$ (C) 2 : 3 (D) 1 : 1 (E) 3 : 2

32. In p-type semiconductors

(A) holes are minority carriers

(B) the vacancy of electron is a hole with negative charge

(C) the impurity element added is donor type

(D) for every pentavalent impurity atom added an extra hole is created

(E) the electron will move from one hole to another hole constituting a flow of current

33. In a CB mode of a transistor the current through the emitter is 6 mA. If the current gain of the transistor is 0.95 then its base current is

(A) 0.2 mA (B) 0.3 mA (C) 0.5 mA (D) 0.4 mA (E) 0.8 mA

34. The compound semiconductor used for making LEDs of different colours is

(A) Gallium Arsenide – Phosphide (B) Indium Arsenide – Phosphide

(C) Indium Arsenide – Selenide (D) Gallium Arsenide – Selenide

(E) Scandium Arsenide – Phosphide

Space for rough work

33

35. A transistor amplifier along with a tank circuit with positive feedback will act as

(A) power amplifier (B) voltage amplifier (C) full wave rectifier
(D) half-wave rectifier (E) oscillator

36. In a transmitter the audio signal of frequency ω_m is modulated by the carrier signal ω_c and the band pass filter in it rejects the frequencies

(A) ω_c and ω_m (B) $\omega_c - \omega_m$ and $\omega_c + \omega_m$ (C) ω_m and $2\omega_c$
(D) $\omega_c - \omega_m$ and ω_c (E) $\omega_c + \omega_m$ and ω_c

37. Pick out the INCORRECT statement from the following

(A) Speech signal requires a bandwidth of 2800 Hz
(B) The approximate bandwidth to transmit music is 20 kHz
(C) The bandwidth of video signals required to transmit pictures is 4.2 MHz
(D) The bandwidth usually allocated to transmit TV signals is 6 MHz
(E) Digital signals are usually in the form of sine waves

Space for rough work

38. A physical quantity A on multiplication with velocity results in another quantity B. If the quantity B is energy, then the quantity A is

(A) mass (B) momentum (C) force (D) acceleration (E) power

39. If the percentage errors in the measurements of mass, length and time are 1%, 2% and 3% respectively, then the maximum permissible error in the measurement of the acceleration of a particle is

(A) 8% (B) 9% (C) 6% (D) 10% (E) 2%

40. The radius of a circular plate is 1.05 m. Its area (in m^2) up to correct significant figures is

(A) 3.47 (B) 3.475 (C) 3.467 (D) 3.82 (E) 3.825

41. The velocity of a moving particle at any instant is $\hat{i}+\hat{j}$. The magnitude and direction of the velocity of the particle are

(A) 2 units and 45° with the x-axis

(B) 2 units and 30° with the z-axis

(C) $\sqrt{2}$ units and 45° with the x-axis

(D) $\sqrt{2}$ units and 60° with the y-axis

(E) 2 units and 60° with the x-axis

Space for rough work

42. A hammer is dropped into a mine. Its velocities at depths d, $2d$ and $3d$ are in the ratio

(A) $1:2:3$ (B) $1:\sqrt{2}:\sqrt{3}$ (C) $1:4:9$ (D) $6:3:2$ (E) $1:1:1$

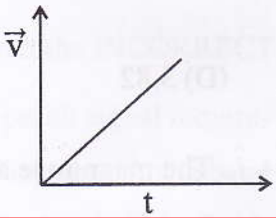
43. The stopping distance of a moving vehicle is proportional to the

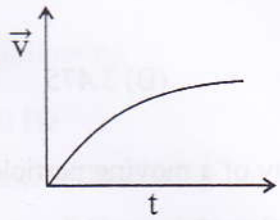
(A) initial velocity (B) cube of the initial velocity

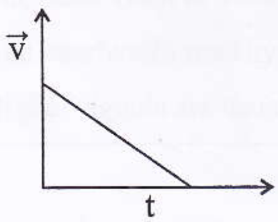
(C) square of the initial velocity (D) cube root of the initial velocity

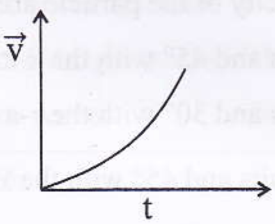
(E) square root of the initial velocity

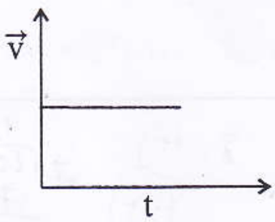
44. When a body starts from rest and moves with a constant acceleration, the velocity-time graph for its motion is

(A) 

(B) 

(C) 

(D) 

(E) 

45. A wooden block of mass 10 kg is moving with an acceleration of $3\,ms^{-2}$ on a rough floor. If the coefficient of friction is 0.3, then the applied force on it is $(g=10\,ms^{-2})$

(A) 10 N (B) 30 N (C) 80 N (D) 60 N (E) 65 N

Space for rough work

46. Which one of the following statement is INCORRECT?

(A) The state of rest or uniform linear motion both imply zero acceleration.

(B) A net force is needed to keep a body in uniform motion.

(C) Inertia means resistance to change.

(D) The rate of change of momentum is proportional to the applied force.

(E) Momentum is a vector quantity.

47. On a conveyor belt moving with a speed u, sand falls at a constant rate $\left(\frac{dm}{dt}\right)$, where m is the mass of sand. The extra force required to maintain the speed of the belt is

(A) $m\left(\frac{du}{dt}\right)$ (B) mu (C) $\left(\frac{dm}{dt}\right)\Big/u$ (D) $u\left(\frac{dm}{dt}\right)$ (E) $\frac{1}{m}\left(\frac{du}{dt}\right)$

48. Area under the force-time graph gives the change in

(A) velocity (B) acceleration

(C) linear momentum (D) angular momentum

(E) impulsive force

49. When a metal spring is elongated within its elastic limit

(A) work is done by the spring (B) potential energy is stored in it

(C) its potential energy is lost (D) its total energy remains constant

(E) its kinetic energy is increased

50. The instantaneous power in terms of force F and instantaneous velocity v is

(A) $P = F \cdot t$ (B) $P = F \cdot v$ (C) $P = F \cdot v^{-1}$ (D) $P = F \cdot v^{-2}$ (E) $P = F \cdot v \cdot t^{-1}$

Space for rough work

51. A ball with 10^3J of kinetic energy collides with a horizontally mounted spring. If the maximum compression of the spring is 50 cm, then the spring constant of the spring is

(A) 2×10^3 Nm^{-1} (B) 6×10^3 Nm^{-1} (C) 8×10^3 Nm^{-1}
(D) 5×10^3 Nm^{-1} (E) 3×10^3 Nm^{-1}

52. An object released from certain height h from the ground rebounds to a height $\frac{h}{4}$ after striking the ground. The fraction of the energy lost by it is

(A) $\frac{1}{4}$ (B) $\frac{3}{4}$ (C) $\frac{1}{2}$ (D) $\frac{1}{8}$ (E) $\frac{3}{8}$

53. A solid metal ring and a disc of same radius and mass are rotating about their diameters with same angular frequency. The ratio of their respective rotational kinetic energy values is

(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 1 : 4 (E) 4 : 1

54. The X and Y coordinates of the three particles of masses m, $2m$ and $3m$ are respectively $(0,0)$, $(1,0)$ and $(-2,0)$. The X-coordinate of the centre of mass of the system is

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$ (C) $-\frac{1}{3}$ (D) $-\frac{2}{3}$ (E) $\frac{1}{6}$

55. Radius of gyration of a solid cylinder of radius R and length L about its long axis of symmetry is

(A) R (B) $\frac{R}{\sqrt{2}}$ (C) $\sqrt{2}R$ (D) $\frac{R}{2}$ (E) $2R$

Space for rough work

56. When no external torque acts on a rotating system,

(A) angular momentum of the system is not conserved

(B) its rotational kinetic energy is conserved

(C) its rotational kinetic energy is independent of moment of inertia

(D) its rotational kinetic energy is directly proportional to moment of inertia

(E) its rotational kinetic energy is inversely proportional to moment of inertia

57. If T be the time period of a planet around the Sun and d is its mean distance from the Sun, then according to Kepler's third law

(A) $T \propto d$ (B) $T \propto d^2$ (C) $T^2 \propto d^3$ (D) $T^2 \propto d$ (E) $T^2 \propto d^{-3}$

58. If the earth shrinks to half of its present size and its mass reduces to half of its actual mass, then the acceleration due to gravity(g) on its surface will be

(A) $4g$ (B) g (C) $2g$ (D) $\frac{g}{2}$ (E) $3g$

59. When two identical spheres each of radius r are kept in contact with each other, then the force of attraction between the two spheres is proportional to

(A) r^2 (B) r^4 (C) r^6 (D) r^{-2} (E) r^{-4}

60. With the increase of temperature

(A) surface tension of liquid increases

(B) viscosity of gases decreases

(C) viscosity of liquids increases

(D) both the surface tension and viscosity of liquids increase

(E) both the surface tension and viscosity of liquid decrease

Space for rough work

61. The TRUE statement is

(A) Young's modulus of a wire depends on its length

(B) The unit of Young's modulus is Nm^{-1}

(C) Dimensional formula of stress is same as that of force

(D) The unit of strain is kgm^{-2}

(E) Compressibility is the reciprocal of bulk modulus

62. When a body is strained, energy stored per unit volume is (Y = Young's modulus)

(A) $\frac{(stress)}{Y}$ (B) $\frac{Y \times strain}{2}$ (C) $\frac{(stress)^2}{2Y}$

(D) $Y \times (strain)^2$ (E) $\frac{1}{2}\left(\frac{stress}{Y}\right)$

63. According to equation of continuity when a liquid flows through a tube of variable cross section a with variable velocity v, the quantity that remains constant is

(A) av^2 (B) a^2v (C) av (D) $\frac{a}{v}$ (E) $\frac{a^2}{v}$

64. Two thermally insulated identical vessels A and B are connected through a stopcock. A contains a gas at STP and B is completely evacuated. If the stopcock is suddenly opened then

(A) temperature is halved

(B) internal energy of the gas is halved

(C) internal energy of the gas and pressure are halved

(D) temperature and internal energy of the gas remain the same

(E) pressure and internal energy of the gas remain the same

Space for rough work

65. A process in which there is no flow of heat between the system and surroundings is a/an

(A) adiabatic process (B) cyclic process
(C) isobaric process (D) isochoric process
(E) isothermal process

66. When the temperature of the source of a Carnot engine is at 400 K, its efficiency is 25%. The required increase in temperature of the source to increase the efficiency to 50% is

(A) 800 K (B) 600 K (C) 100 K (D) 400 K (E) 200 K

67. When an ideal diatomic gas is heated at constant pressure, fraction of heat energy supplied that increases the internal energy of the gas is

(A) $\frac{5}{7}$ (B) $\frac{7}{5}$ (C) $\frac{3}{5}$ (D) $\frac{5}{3}$ (E) $\frac{2}{3}$

68. The ratio of the kinetic energy values of 4g of hydrogen (H_2) to 7g of nitrogen (N_2) at room temperature is

(A) 4 : 1 (B) 1 : 4 (C) 4 : 7 (D) 7 : 4 (E) 1 : 1

Space for rough work

69. A planet with radius R and acceleration due to gravity g, will have atmosphere only if *r.m.s.* speed of air molecules is less than

(A) $1.414\sqrt{gR}$ (B) $1.732\sqrt{gR}$ (C) $2\sqrt{gR}$ (D) $3.14\sqrt{gR}$ (E) $2.75\sqrt{gR}$

70. If the ratio of the acceleration due to gravity on the surface of earth to that on the surface of the moon is 6:1, then the ratio of the periods of a simple pendulum on their surfaces is

(A) 1 : 1 (B) 1 : 6 (C) 1 : 3 (D) $1:\sqrt{6}$ (E) $1:\sqrt{3}$

71. The velocity of a transverse wave propagating on a stretched string represented by the equation, $y = 0.5\sin\left(\frac{\pi}{2}t + \frac{\pi}{3}x\right)$ is (where x and y are in metres and t in seconds)

(A) $0.5\,\text{ms}^{-1}$ (B) $1.0\,\text{ms}^{-1}$ (C) $2\,\text{ms}^{-1}$ (D) $3\,\text{ms}^{-1}$ (E) $1.5\,\text{ms}^{-1}$

72. The kinetic energy of a particle of mass m executing linear simple harmonic motion with angular velocity ω and amplitude a is $\frac{1}{4}ma^2\omega^2$ at a distance of ________ from the mean position.

(A) $\frac{a}{\sqrt{2}}$ (B) $\frac{a}{2}$ (C) $\frac{a}{4}$ (D) a (E) $\frac{a}{8}$

Space for rough work

21/60

73. The reagent that is used to convert but–2–yne to trans–but–2–ene is

(A) $H_2/Pd/C$ (B) $NaBH_4$ (C) Sn/HCl

(D) Na/liquid NH_3 (E) Zn-Hg/HCl

74. Compound '*A*' is obtained by the reaction of benzyl chloride with magnesium metal in dry ether followed by treatment with water. What is the compound '*A*'?

(A) Toluene (B) Benzyl alcohol (C) Phenol

(D) Benzene (E) Benzaldehyde

75. The correct increasing order of boiling points of the following compounds is

(A) $CH_2Br_2 < CH_3Br < CHBr_3 < CH_3Cl$

(B) $CH_2Br_2 < CHBr_3 < CH_3Br < CH_3Cl$

(C) $CH_3Cl < CH_3Br < CH_2Br_2 < CHBr_3$

(D) $CH_3Cl < CHBr_3 < CH_3Br < CH_2Br_2$

(E) $CHBr_3 < CH_2Br_2 < CH_3Br < CH_3Cl$

76. Compounds '*A*', '*B*' and '*C*' have the same molecular formula C_7H_8O. Compound '*A*' and '*B*' liberate hydrogen gas with sodium metal. When treated with sodium hydroxide, compound '*B*' alone dissolves. Compound '*C*' is inert towards both sodium metal and sodium hydroxide. Compounds '*A*', '*B*' and '*C*' are respectively

(A) Cresol, benzyl alcohol and anisole

(B) Benzyl alcohol, cresol and anisole

(C) Benzyl alcohol, anisole and cresol

(D) Cresol, anisole and benzyl alcohol

(E) Anisole, cresol and benzyl alcohol

77. The suitable Grignard reagent used for the preparation of 2-methylpropan-1-ol using methanal is

(A) CH_3-CH_2-CH_2MgBr (B) CH_3-CH_2-CH_2-CH_2MgBr

(C) CH_3-$CH(CH_3)$-CH_2MgBr (D) $(CH_3)_3C$-$MgBr$

(E) CH_3-$CH(CH_3)$-$MgBr$

78. Isopropylbenzene (cumene) is oxidized in the presence of air to give compound '*X*' which on hydrolysis in the presence of acids gives compounds '*Y*' and '*Z*'. Compounds '*X*', '*Y*' and '*Z*' are respectively

(A) benzyl alcohol, benzaldehyde, ethanol

(B) cumene hydroperoxide, phenol, acetaldehyde

(C) cumene hydroperoxide, benzaldehyde, acetone

(D) cumene hydroperoxide, phenol, acetone

(E) cumene hydroperoxide, benzaldehyde, acetaldehyde

Space for rough work

79. A research scholar returned to the laboratory after the lock down due to Covid-19. He kept acetone, benzaldehyde, acetaldehyde and diethyl ketone in four different bottles. The bottles contained only the label as *P*, *Q*, *R* and *S*. He forgot which bottle contained which compound. Compounds *P* and *R* only underwent iodoform test. Compound *R* alone gave reddish brown precipitate with Fehling's reagent. Compounds *Q* and *R* alone underwent Tollen's test. Compound *S* did not answer any of the above tests.

Identify the compounds *P*, *Q*, *R* and *S*.

(A) *P*-diethyl ketone; *Q*-benzaldehyde; *R*-acetaldehyde; *S*-acetone

(B) *P*-acetone; *Q*-benzaldehyde; *R*-acetaldehyde; *S*-diethyl ketone

(C) *P*-acetone; *Q*-acetaldehyde; *R*-benzaldehyde; *S*-diethyl ketone

(D) *P*-acetaldehyde; *Q*-acetone; *R*-diethyl ketone; *S*-benzaldehyde

(E) *P*-benzaldehyde; *Q*-diethyl ketone; *R*-acetone; *S*-acetaldehyde

80. The increasing order of acid strength of the following carboxylic acids is

(A) $ClCH_2\text{-}CH_2\text{-}COOH < ClCH_2COOH < NC\text{-}CH_2COOH < CHCl_2COOH$

(B) $ClCH_2\text{-}COOH < NC\text{-}CH_2COOH < ClCH_2CH_2COOH < CHCl_2COOH$

(C) $ClCH_2\text{-}CH_2\text{-}COOH < CHCl_2\text{-}COOH < ClCH_2\text{-}COOH < NC\text{-}CH_2\text{-}COOH$

(D) $NC\text{-}CH_2\text{-}COOH < Cl\text{-}CH_2COOH < CH\text{-}Cl_2COOH < Cl\text{-}CH_2CH_2COOH$

(E) $ClCH_2CH_2\text{-}COOH < CHCl_2COOH < ClCH_2COOH < NC\text{-}CH_2COOH$

81. Which one of the following is not correct with respect to properties of amines?

(A) pK_b of aniline is more than that of methylamine.

(B) Ethylamine is soluble in water whereas aniline is not.

(C) Ethanamide on reaction with Br_2 and NaOH gives ethylamine.

(D) Ethylamine reacts with nitrous acid to give ethanol.

(E) Aniline does not undergo Friedel-Crafts reaction.

Space for rough work

82. The increasing order of extent of H-bonding of the alkyl ammonium ions, RNH_3^+, $R_2NH_2^+$, R_3NH^+ in water is

(A) $R_3NH^+ < R_2NH_2^+ < RNH_3^+$ (B) $R_3NH^+ < RNH_3^+ < R_2NH_2^+$

(C) $R_2NH_2^+ < RNH_3^+ < R_3NH^+$ (D) $RNH_3^+ < R_2NH_2^+ < R_3NH^+$

(E) $RNH_3^+ < R_3NH^+ < R_2NH_2^+$

83. The conversion of benzene diazonium chloride to bromobenzene by treating with HBr in the presence of copper powder is called

(A) Sandmeyer reaction (B) Gattermann reaction

(C) Wurtz reaction (D) Hoffmann reaction

(E) Gabriel synthesis

84. Which one of the following statements is TRUE with regard to glucose?

(A) It gives Schiff's test

(B) It forms addition product with $NaHSO_3$

(C) Its pentaacetate does not react with NH_2OH

(D) It does not undergo mutarotation

(E) β- form of glucose is obtained by crystallisation from conc. solution of glucose at 303K

85. Fibrous protein present in muscles is

(A) keratin (B) albumin (C) insulin (D) myosin (E) histidine

86. The drug used to inhibit the enzymes which catalyse the degradation of noradrenaline is

(A) phenelzine (B) prontosil (C) cimetidine

(D) terfenadine (E) chloramphenicol

87. The gas which is the major contributor to global warming is

(A) NO_2 (B) CO_2 (C) SO_2 (D) O_2 (E) N_2O

Space for rough work

88. A cooking gas contains carbon and hydrogen only. A volume of 11.2 L of this gas is found to weigh 22 g at STP. Then the molecular formula of the gas is

(A) C_3H_8 (B) C_2H_2 (C) C_2H_4 (D) C_2H_6 (E) C_3H_4

89. The number of electrons in an atom that may have the quantum numbers $n=3$ and $m_s=+\frac{1}{2}$ is

(A) 32 (B) 9 (C) 18 (D) 16 (E) 8

90. "No two electrons in an atom can have the same set of four quantum numbers." This is known as

(A) Hund's rule (B) Pauli's exclusion principle (C) Aufbau principle
(D) Heisenberg's principle (E) Fajan's rule

91. The first ionisation enthalpy is the least in

(A) Germanium (B) Antimony (C) Tellurium
(D) Arsenic (E) Bismuth

92. Predict in which of the following, entropy decreases:

(A) A liquid crystallizes into a solid.
(B) Temperature of a crystalline solid is raised from 0K to 115K.
(C) $2NaHCO_3(s) \rightarrow Na_2CO_3(s)+CO_2(g)+H_2O(g)$
(D) $H_2(g) \rightarrow 2H(g)$
(E) $2SO_3(g) \rightarrow 2SO_2(g)+O_2(g)$

93. In which one of the following, sp^2 hybridisation is involved in the central atom?

(A) NH_3 (B) BCl_3 (C) ClF_3 (D) PCl_3 (E) PH_3

Space for rough work

94. In which one of the following molecules, the central atom has expanded octet?

(A) Sulphur dichloride (B) Boron trichloride (C) Nitrogen dioxide
(D) Ozone (E) Sulphuric acid

95. A cycle tube will burst if the volume of air inside exceeds 1L at the room temperature. If at 1 bar pressure the air occupies 500 mL, then up to what pressure can the tube be expanded at the same temperature?

(A) 2 bar (B) 1.5 bar (C) 0.5 bar (D) 0.002 bar (E) 1.2 bar

96. The ratio of the actual molar volume of a gas to the ideal molar volume is ______ of the gas.

(A) co-volume
(B) van der Waals factor 'a'
(C) critical volume
(D) molar gas constant
(E) compressibility factor

97. Enthalpy change is always negative for which one of the following processes?

(A) Enthalpy of ionisation
(B) Enthalpy of sublimation
(C) Enthalpy of vapourisation
(D) Enthalpy of fusion
(E) Enthalpy of combustion

98. The enthalpy change for the evaporation of a liquid at its boiling point 127°C is +40.32 $kJmol^{-1}$. What is the value of internal energy change for the above process at 127°C? ($R = 8.3\ JK^{-1}mol^{-1}$)

(A) −37.0 $kJmol^{-1}$
(B) +43.0 $kJmol^{-1}$
(C) +37.0 $kJmol^{-1}$
(D) −43.0 $kJmol^{-1}$
(E) +43.64 $kJmol^{-1}$

99. In which one of the following equilibria Δn_g value is zero?

(A) $2NOCl(g) \leftrightharpoons 2NO(g) + Cl_2(g)$
(B) $Ni(s) + 4CO(g) \leftrightharpoons Ni(CO)_4(g)$
(C) $CO_2(g) + C(s) \leftrightharpoons 2CO(g)$
(D) $H_2(g) + Br_2(g) \leftrightharpoons 2HBr(g)$
(E) $N_2O_4(g) \leftrightharpoons 2NO_2(g)$

Space for rough work

100. The following concentrations were obtained for the formation of $NH_3(g)$ from $N_2(g)$ and $H_2(g)$ at equilibrium and at 500K: $[N_2]= 1\times10^{-2}$M, $[H_2] = 2\times10^{-2}$M and $[NH_3]=2\times10^{-2}$M. The equilibrium constant, K_c, for the reaction

$N_2(g)+3H_2(g) \rightleftarrows 2NH_3(g)$ at 500K is

(A) $5 \times 10^3 mol^{-2}dm^6$ (B) $1 \times 10^3 mol^{-2}dm^6$ (C) $5 \times 10^{-3} mol^{-2}dm^6$
(D) $2 \times 10^3 mol^{-2}dm^6$ (E) $2 \times 10^{-3} mol^{-2}dm^6$

101. The SI unit of molar conductivity is

(A) $S\ m^3\ mol^{-1}$ (B) $S\ m\ mol^{-1}$ (C) $S\ m\ mol^{-2}$ (D) $S\ m^2\ mol^{-1}$ (E) $S\ m^2\ mol^{-2}$

102. Which of the following is an example of disproportionation redox reaction?

(A) $N_2(g) + O_2(g) \rightarrow 2NO(g)$
(B) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
(C) $2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$
(D) $NaH(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$
(E) $2NO_2(g) + 2OH^- \rightarrow NO_2^-(aq) + NO_3^-(aq) + H_2O(l)$

103. A scientist wants to perform an experiment in aqueous solution in a hill station where the boiling point of water is 98.98°C. How much urea (mol.wt 60 g mol^{-1}) is to be added by him to 2 kg of water to get the boiling point 100°C at the same place? (K_b of water = 0.51K kg mol^{-1})

(A) 60 g (B) 120 g (C) 180 g (D) 240 g (E) 1.02 g

104. The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 1.0 g when added to 39.0 g of benzene (molar mass 78 g mol^{-1}), vapour pressure of the solution is reduced to 0.845 bar. What is the molar mass of the solid substance?

(A) 340 g mol^{-1} (B) 170 g mol^{-1} (C) 240 g mol^{-1}
(D) 270 g mol^{-1} (E) 370 g mol^{-1}

105. For the reaction $2P + Q \rightleftarrows P_2Q$, the rate of formation of P_2Q is $0.24\ mol\ dm^{-3}s^{-1}$. Then the rates of disappearance of P and Q respectively are

(A) $-0.48\ mol\ dm^{-3}s^{-1}$ and $-0.48\ mol\ dm^{-3}s^{-1}$

(B) $-0.24\ mol\ dm^{-3}s^{-1}$ and $-0.48\ mol\ dm^{-3}s^{-1}$

(C) $-0.48\ mol\ dm^{-3}s^{-1}$ and $-0.24\ mol\ dm^{-3}s^{-1}$

(D) $-0.12\ mol\ dm^{-3}s^{-1}$ and $-0.24\ mol\ dm^{-3}s^{-1}$

(E) $-0.24\ mol\ dm^{-3}s^{-1}$ and $-0.12\ mol\ dm^{-3}s^{-1}$

106. Choose the correct set of reactions which follow first order kinetics:

(i) Thermal decomposition of HI on gold surface.

(ii) Thermal decomposition of $N_2O_5(g)$ at constant volume.

(iii) Hydrogenation of ethene.

(iv) Decomposition of NH_3 on a hot Pt surface.

(v) Thermal decomposition of $SO_2Cl_2(g)$ at constant volume.

(A) i, ii, iii (B) i, iii, iv (C) i, iv, v (D) ii, iv, v (E) ii, iii, v

107. Which one of the following is true?

(A) Chemisorption is not specific in nature

(B) Physisorption is irreversible

(C) Both physisorption and chemisorption depend on the nature of the gas

(D) Enthalpy of adsorption is high in physisorption

(E) Chemisorption increases with surface area of adsorbent while in physisorption it is not

Space for rough work

108. When zinc metal is reacted with aqueous sodium hydroxide, the products formed are

(A) zinc hydroxide and oxygen only

(B) sodium zincate and oxygen only

(C) sodium zincate, hydrogen and oxygen

(D) sodium zincate and hydrogen only

(E) sodium zincate and hydrogen oxide only

109. 'Syngas' produced from sewage is a gaseous mixture of

(A) CH_4 and C_2H_6 (B) CO and H_2 (C) CO and CH_4
(D) CS_2 and CO (E) CS_2 and CH_4

110. Choose the correct choice containing true statements regarding PCl_5.

(i) PCl_5 is prepared by the reaction of white phosphorus with excess of dry chlorine.
(ii) The complete hydrolysis of PCl_5 gives phosphoric acid.
(iii) PCl_5 has square pyramidal structure in gaseous phase.
(iv) All the five bonds in PCl_5 molecule are equivalent.

(A) ii and iii (B) i and iii (C) iii and iv (D) ii and iv (E) i and ii

111. Match the substances and their uses.

a)	Silicones	(i) Cracking of hydrocarbons
b)	Zeolites	(ii) Light composite material for aircraft
c)	Quartz	(iii) Flux for soldering metals
d)	Borax	(iv) Waterproofing of fabrics
e)	Boron fibres	(v) Piezoelectric material

(A) a)-(iv); b)-(ii); c)-(i); d)-(v); e)-(iii)
(B) a)-(i); b)-(ii); c)-(iv); d)-(iii); e)-(v)
(C) a)-(iv); b)-(i); c)-(iii); d)-(ii); e)-(v)
(D) a)-(iii); b)-(ii); c)-(i); d)-(iv); e)-(v)
(E) a)-(iv); b)-(i); c)-(v); d)-(iii); e)-(ii)

Space for rough work

112. Choose the wrong statement in the following with regard to orthoboric acid:

(A) It can be prepared by the hydrolysis of boron trihalide
(B) It is not a protonic acid but acts as a Lewis acid
(C) It has a layer structure
(D) It is freely soluble in cold water
(E) On heating above 370K it forms first metaboric acid which on further heating yields B_2O_3

113. The magnetic moment of a trivalent ion of a metal with $Z = 24$ in aqueous solution is

(A) 3.87 BM (B) 2.84 BM (C) 1.73 BM (D) 4.90 BM (E) 5.92 BM

114. In the first row transition metals, the element that exhibits only +3 oxidation state is

(A) zinc (B) scandium (C) nickel (D) titanium (E) iron

115. The metal that has the highest melting point in the first series of transition elements is

(A) titanium (B) vanadium (C) chromium (D) iron (E) manganese

116. In which one of the following complexes, the conductivity corresponds to 1:2 electrolyte in aqueous solution?

(A) Hexaamminecobalt(III) chloride
(B) Tetraamminedichlorocobalt(III) chloride
(C) Pentaamminechlorocobalt(III) chloride
(D) Triamminetriaquachromium(III) chloride
(E) Diamminesilver(I) dicyanoargentate(I)

Space for rough work

117. The complex ion formed when the film developed in black and white photography is washed with hypo solution is

(A) $[Ag_2(S_2O_3)_2]^{3-}$ (B) $[Ag(S_2O_3)_2]^{3-}$ (C) $[Ag(S_2O_3)_2]^{3+}$
(D) $[Ag_2(S_2O_3)_2]^{3+}$ (E) $[Ag(S_2O_3)_3]^{3-}$.

118. Which one of the following is an ore of aluminium?

(A) Kaolinite (B) Siderite (C) Malachite (D) Calamine (E) Haematite

119. In the estimation of nitrogen present in an organic compound, Kjeldahl's method cannot be applied to

(A) aniline (B) toluidine (C) urea (D) pyridine (E) benzylamine

120. Among the following, the alkene that exhibits optical isomerism is

(A) 3–methyl–2–pentene (B) 4–methyl–1–pentene (C) 3–methyl–1–pentene
(D) 2–methyl–2–pentene (E) 2, 3–dimethyl–2–butene

Space for rough work