Joint Entrance Exam | Mains-2019

Paper Code -

8th April 2019 | Morning

PHYSICS , CHMISTRY & MATHEMATICS

Important Instructions:

1. Immediately fill in the particulars on this page of the Test Booklet with only Black Ball Point Pen provided in the examination hall.

2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.

3. The test is of **3 hours** duration.

4. The Test Booklet consists of **90** questions. The maximum marks are **360**.

5. There are three parts in the question paper A, B, C consisting of **Physics, Mathematics** and **Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for correct response.

6. Candidate will be awarded marks as stated above in instruction No. 5 for correct response of each question. $\frac{1}{4}$ (one-fourth) marks of the total marks allotted to the questions (i.e. 1 mark) will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.

8. For writing particulars/marking responses on *Side-1* and *Side-2* of the Answer Sheet use ***only Black Ball Point Pen*** provided in the examination hall.

9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination room/hall.

10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in **four** pages (Page **20-23**) at the end of the booklet.

11. On completion of the test, the candidate must hand over the Answer Sheet to the **Invigilator** on duty in the Room/Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***

12. The CODE for this Booklet is **B.** Make sure that the CODE printed on Side-2 of the Answer Sheet is same as that on this Booklet. Also tally the serial number of the Test Booklet and Answer Sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.

13. **Do not fold or make any stray mark on the Answer Sheet.**

Joint Entrance Exam/IITJEE-2019

PART-A	PHYSICS

1. The wavelength of the carrier waves in a modern optical fiber communication network is close to :

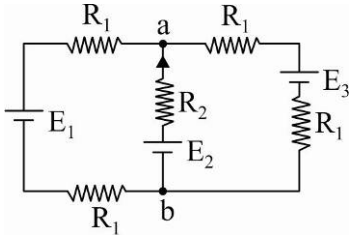
(1) 900 *nm* **(2)** 600 nm **(3)** 1500 *nm* **(4)** 2400 *nm*

2. A thermally insulated vessel contains 150 *g* of water at 0°*C*. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°*C* itself. The mass of evaporated water will be closest to :

(Latent heat of vaporization of water $= 2.10 \times 10^6\, J\, kg^{-1}$ and Latent heat of Fusion of water $= 3.36 \times 10^5\, J\, kg^{-1}$)

(1) 20 *g* **(2)** 150 *g* **(3)** 130 *g* **(4)** 35 *g*

3. For the circuit shown, with $R_1 = 1.0\Omega$, $R_2 = 2.0\Omega$, $E_1 = 2V$ and $E_2 = E_3 = 4V$, the potential difference between the points '*a*' and '*b*' is approximately (in *V*) :



(1) 3.7 **(2)** 2.7

(3) 3.3 **(4)** 2.3

4. A boy's catapult is made of rubber cord which is 42 *cm* long, with 6 *mm* diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02 *kg* on it and stretches the cord by 20 *cm* by applying a constant force. When released, the stone flies off with a velocity of $20\, ms^{-1}$. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to :

(1) $10^6\, Nm^{-2}$ **(2)** $10^3\, Nm^{-2}$ **(3)** $10^8\, Nm^{-2}$ **(4)** $10^4\, Nm^{-2}$

5. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2} = \frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be :

(1) 9 **(2)** 18 **(3)** 4 **(4)** 2

6. Water from a pipe is coming at a rate of 100 liters per minute. If the radius of the pipe is 5 *cm*, the Reynolds number for the flow is of the order of : (density of water $= 1000\, kg/m^3$, coefficient of viscosity of water 1 *mPa s*)

(1) 10^2 **(2)** 10^3 **(3)** 10^6 **(4)** 10^4

7. A steel wire having a radius of 2.0 *mm*, carrying a load of 4 *kg*, is hanging from a ceiling. Given that $g = 3.1\ \pi ms^{-2}$, what will be the tensile stress that would be developed the wire ?

(1) $3.1 \times 10^6\, Nm^{-2}$ **(2)** $4.8 \times 10^6\, Nm^{-2}$ **(3)** $5.2 \times 10^6\, Nm^{-2}$ **(4)** $6.2 \times 10^6\, Nm^{-2}$

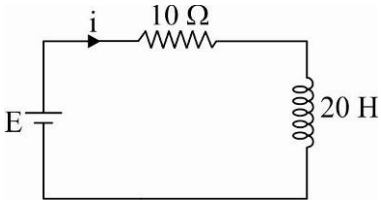
8. A circular coil having *N* turns and radius *r* carries a current *I*. It is held in the *XZ* plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is :

(1) $B\pi r^2 I N$ **(2)** Zero **(3)** $\frac{Br^2 I}{\pi N}$ **(4)** $\frac{B\pi r^2 I}{N}$

9. Two particles move at right angle to each other. Their de Broglie wavelengths are λ_1 and λ_2 respectively. The particles suffer perfectly inelastic collision. The de Broglie wavelength λ, of the final particle is given by :

(1) $\lambda = \sqrt{\lambda_1 \lambda_2}$ **(2)** $\frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$ **(3)** $\frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2}$ **(4)** $\lambda = \frac{\lambda_1 + \lambda_2}{2}$

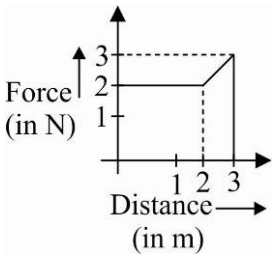
10. A 20 Henry inductor coil is connected to a 10 ohm resistance in series as shown in figure. The time at which rate of dissipation of energy (Joule's heat) across resistance is equal to the rate at which magnetic energy is stored in the inductor, is :



(1) $\frac{1}{2}\ln 2$ **(2)** $2\ln 2$

(3) $\ln 2$ **(4)** $\frac{2}{\ln 2}$

11. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3 *m* is :



(1) 2.5 *J* **(2)** 5 *J*

(3) 6.5 *J* **(4)** 4 *J*

12. An upright object is placed at a distance of 40 *cm* in front of a convergent lens of focal length 20 *cm*. A convergent mirror of focal length 10 *cm* is placed at a distance of 60 *cm* on the other side of the lens. The position and size of the final image will be :

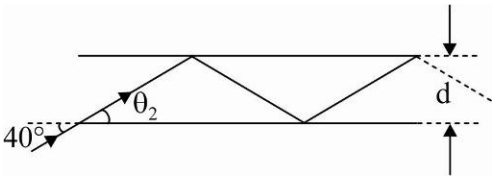
(1) 40 *cm* from the convergent lens, twice the size of the object

(2) 20 *cm* from the convergent mirror, twice the size of the object

(3) 20 *cm* from the convergent mirror, same size as the object

(4) 40 *cm* from the convergent mirror, same size as the object

13. In figure, the optical fiber is $l = 2$ *m* long and has a diameter of $d = 20$ μm. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40^\circ$, the number of reflections it makes before emerging form the other end is close to : (refractive index of fiber is 1.31 and $\sin 40^\circ = 0.64$)



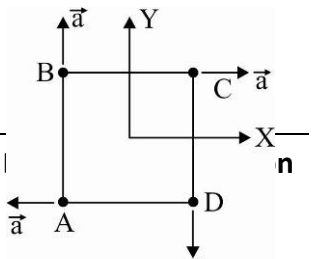
(1) 55000 **(2)** 45000 **(3)** 57000 **(4)** 66000

14. A plane electromagnetic wave travels in free space along the *x*-direction. The electric field component of the wave at a particular point of space and time is $E = 6Vm^{-1}$ along *y*-direction. Its corresponding magnetic field component, *B* would be :

(1) $6\times10^{-8}T$ along *x*-direction **(2)** $2\times10^{-8}T$ along *y*-direction

(3) $2\times10^{-8}T$ along *z*-direction **(4)** $6\times10^{-8}T$ along *z*-direction

15. Four particles *A*, *B*, *C* and *D* with masses $m_A = m$, $m_B = 2m$, $m_C = 3m$ and $m_D = 4m$ are at the corners of a square. They have accelerations of equal

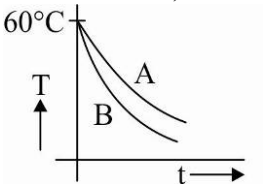


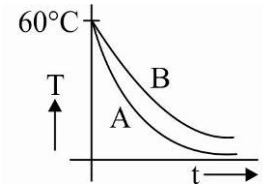
magnitude with directions as shown. The acceleration of the centre of mass of the particles is :

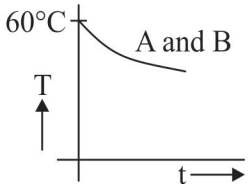
(1) $\frac{a}{5}\left(\hat{i}-\hat{j}\right)$ **(2)** $a\left(\hat{i}+\hat{j}\right)$

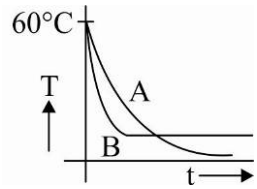
(3) $\frac{a}{5}\left(\hat{i}+\hat{j}\right)$ **(4)** Zero

16. Two identical beakers A and B contain equal volumes of two different liquids at 60°C each and left to cool down. Liquid in A has density of $8\times10^2\,kg/m^3$ and specific heat of $2000\,J\,kg^{-1}K^{-1}$ while liquid in B has density of $10^3\,kg\,m^{-3}$ and specific heat of $4000\,J\,kg^{-1}K^{-1}$. Which of the following best describes their temperature versus time graph schematically ? (assume the emissivity of both the beakers to be the same)

(1) 

(2) 

(3) 

(4) 

17. In *SI* units, the dimensions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is :

(1) $AT^{-3}ML^{3/2}$ **(2)** $A^{-1}TML^3$ **(3)** $AT^2M^{-1}L^{-1}$ **(4)** $A^2T^3M^{-1}L^{-2}$

18. If 10^{22} gas molecules each of mass $10^{-26}\,kg$ collide with a surface (perpendicular to it) elastically per second over an area $1\,m^2$ with a speed $10^4\,m/s$, the pressure exerted by the gas molecules will be of the order of :

(1) $10^{16}\,N/m^2$ **(2)** $10^3\,N/m^2$ **(3)** $10^4\,N/m^2$ **(4)** $10^8\,N/m^2$

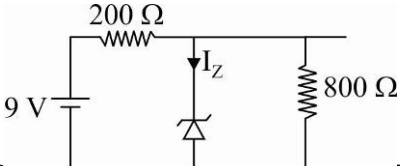
19. Radiation coming from transitions $n = 2$ to $n = 1$ of hydrogen atoms fall on He^+ ions in $n = 1$ and $n = 2$ states. The possible transition of helium ions as they absorb energy from the radiation is :

(1) $n=2\rightarrow n=5$ **(2)** $n=1\rightarrow n=4$ **(3)** $n=2\rightarrow n=4$ **(4)** $n=2\rightarrow n=3$

20. The bob of a simple pendulum has mass $2\,g$ and a charge of $5.0\,\mu C$. It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is : $(take\,g=10\,m/s^2)$

(1) $\tan^{-1}(0.2)$ **(2)** $\tan^{-1}(0.5)$ **(3)** $\tan^{-1}(5.0)$ **(4)** $\tan^{-1}(2.0)$

21. The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit.



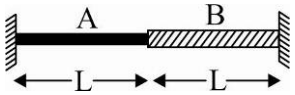
(1) 17 mA **(2)** 7 mA

(3) 15 mA **(4)** 10 mA

22. A 200 Ω resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be :

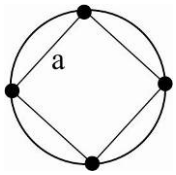
(1) 500 Ω **(2)** 300 Ω **(3)** 400 Ω **(4)** 100 Ω

23. A wire of length $2L$, is made by joining two wires A and B of same length but different radii r and $2r$ and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is p and that in B is q then the ratio $p : q$ is :



(1) 3 : 5 **(2)** 1 : 4 **(3)** 4 : 9 **(4)** 1 : 2

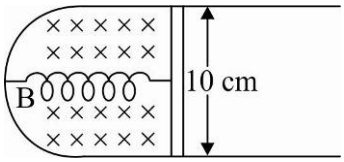
24. Four identical particles of mass M are located at the corners of a square of side 'a'. What should be their speed if each of them revolves under the influence of others' gravitational field in circular orbit circumscribing the square ?



(1) $1.2\sqrt{\frac{GM}{a}}$ **(2)** $1.41\sqrt{\frac{GM}{a}}$

(3) $1.16\sqrt{\frac{GM}{a}}$ **(4)** $1.35\sqrt{\frac{GM}{a}}$

25. A thin strip 10 *cm* long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant $0.5\,Nm^{-1}$. The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillations it performs before its amplitude decreases by a factor of e is N. If the mass of the strip is 50 grams, its resistance 10 Ω and air drag negligible, N will be close to :



(1) 1000 **(2)** 10000 **(3)** 50000 **(4)** 5000

26. A thin circular plate of mass M and radius R has its density varying as $\rho(r) = \rho_0 r$ with ρ_0 as constant and r is the distance from its center. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $I = a\,MR^2$. The value of the coefficient a is :

(1) $\frac{1}{2}$ **(2)** $\frac{3}{2}$ **(3)** $\frac{8}{5}$ **(4)** $\frac{3}{5}$

27. A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of -4 Q, the new potential difference between the same two surfaces is :

(1) 4 V **(2)** 2 V **(3)** -2 V **(4)** V

28. An alternating voltage $v(t)$ = 220 sin 100 πt volt is applied to a purely resistive load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is :

(1) 3.3 *ms* **(2)** 7.2 *ms* **(3)** 2.2 *ms* **(4)** 5 *ms*

29. Ship A is sailing towards north-east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}\,km/hr$ where $\hat{i}$ points east and $\hat{j}$, north. Ship B is at a distance of 80 *km* east and 150 *km* north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in :

(1) 2.2 hrs **(2)** 3.2 hrs **(3)** 4.2 hrs **(4)** 2.6 hrs

30. Voltage rating of a parallel plate capacitor is 500 V. Its dielectric can withstand a maximum electric field of $10^6\,V/m$. The plate area is $10^{-4}\,m^2$. What is the dielectric constant if the capacitance is 15 pF ?

$(given \in_0 = 8.86 \times 10^{-12}\,C^2/Nm^2)$

(1) 6.2 **(2)** 4.5 **(3)** 8.5 **(4)** 3.8

PART-B	CHEMISTRY

1. With respect to an ore, Ellingham diagram helps to predict the feasibility of its

(1) Thermal reduction **(2)** Electrolysis

(3) Zone refining **(4)** Vapour phase refining

2. For the reaction $2A + B \rightarrow C$, the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is :

$[A](mol\,L^{-1})$	$[B](mol\,L^{-1})$	Initial Rate $(mol\,L^{-1}s^{-1})$
0.05	0.05	0.045
0.10	0.05	0.090
0.20	0.10	0.72

(1) $Rate = k[A]^2[B]$ **(2)** $Rate = k[A]^2[B]^2$

(3) $Rate = k[A][B]$ **(4)** $Rate = k[A][B]^2$

3. The correct order of the spin-only magnetic moment of metal ions in the following low-spin complexes, $[V(CN)_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Ru(NH_3)_6]^{3+}$, and $[Cr(NH_3)_6]^{2+}$, is :

(1) $V^2 > Ru^{3+} > Cr^{2+} > Fe^{2+}$ **(2)** $Cr^{2+} > V^{2+} > Ru^{3+} > Fe^{2+}$

(3) $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$ **(4)** $Cr^{2+} > Ru^{3+} > Fe^{2+} > V^{2+}$

4. The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by :

(1) Nuclear charge

(2) Principal quantum number of valence shell

(3) Azimuthal quantum number of valence shell

(4) Electron-electron interaction in the outer orbitals

5. In order to oxidise a mixture of one mole of each of FeC_2O_4, $Fe_2(C_2O_4)_3$, $FeSO_4$ and $Fe_2(SO_4)_3$ in acidic medium, the number of moles of $KMnO_4$ required is :

(1) 3 **(2)** 1 **(3)** 1.5 **(4)** 2

6. 100 mL of a water sample contains 0.81 g of calcium bicarbonate and 0.73 g of magnesium bicarbonate. The hardness of this water sample expressed in terms of equivalents of $CaCO_3$ is: (molar mass of calcium bicarbonate is $162\,g\,mol^{-1}$ and magnesium bicarbonate is $146\,g\,mol^{-1}$)

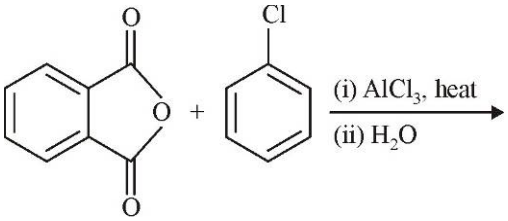
(1) 10,000 ppm **(2)** 100 ppm **(3)** 1,000 ppm **(4)** 5,000 ppm

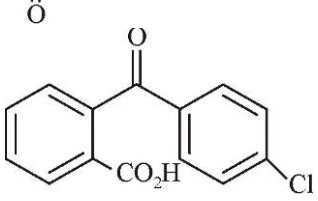
7. The vapour pressures of pure liquids A and B are 400 and 600 mm Hg respectively at 298 K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fractions of components A and B in vapour phase, respectively are :

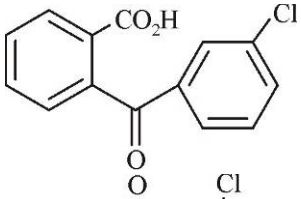
(1) 450 mm Hg, 0.5, 0.5 **(2)** 450 mm Hg, 0.4, 0.6

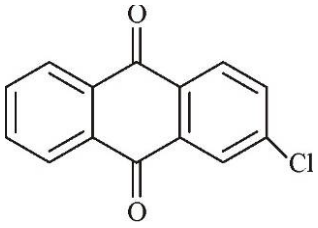
(3) 500 mm Hg, 0.4, 0.6 **(4)** 500 mm Hg, 0.5, 0.5

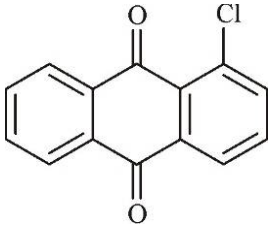
8. The major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

9. If solubility product of $Zr_3(PO_4)_4$ is denotes by K_{sp} and its molar solubility is denoted by S, then which of the following relation between S and K_{sp} is correct?

(1) $S=\left(\frac{K_{sp}}{6912}\right)^{\frac{1}{7}}$ **(2)** $S=\left(\frac{K_{sp}}{929}\right)^{\frac{1}{9}}$ **(3)** $S=\left(\frac{K_{sp}}{216}\right)^{\frac{1}{7}}$ **(4)** $S=\left(\frac{K_{sp}}{144}\right)^{\frac{1}{6}}$

10. The quantum number of four electrons are given below:

I. $n=4,\ \ell=2,\ m_\ell=-2,\ m_s=-\frac{1}{2}$ **II.** $n=3,\ \ell=2,\ m_\ell=1,\ m_s=+\frac{1}{2}$

III. $n=4,\ \ell=1,\ m_\ell=0,\ m_s=+\frac{1}{2}$ **IV.** $n=3,\ \ell=1,\ m_\ell=1,\ m_s=-\frac{1}{2}$

The correct order of their increasing energies will be :

(1) I < II < III < IV **(2)** IV < III < II < I **(3)** IV < II < III < I **(4)** I < III < II < IV

11. In the following compounds, the decreasing order of basic strength will be :

(1) $(C_2H_5)_2NH > NH_3 > C_2H_5NH_2$ **(2)** $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH$

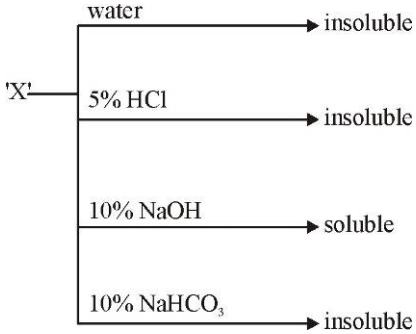
(3) $(C_2H_5)_2NH > C_2H_5NH_2 > NH_3$ **(4)** $C_2H_5NH_2 > NH_3 > (C_2H_5)_2NH$

12. Which of the following amines can be prepared by Gabriel phthalimide reaction?

(1) neo-pentylamine **(2)** t-butylamine

(3) n-butylamine **(4)** triethylamine

13. An organic compound 'X' showing the following solubility profile is :

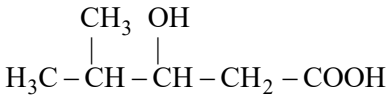


(1) m-Cresol **(2)** o-Toluidine **(3)** Oleic acid **(4)** Benzamide

14. The lanthanide ion that would show colour is:

(1) Lu^{3+} **(2)** La^{3+} **(3)** Gd^{3+} **(4)** Sm^{3+}

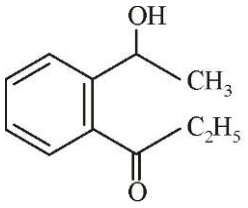
15. The IUPAC name of the following compound is :

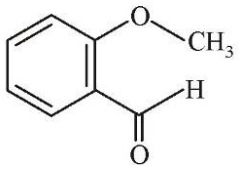


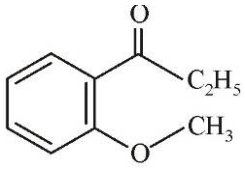
(1) 4-Methyl-3-hydroxypentanoic acid **(2)** 2-Methyl-3-hydroxypentan-5-oic acid

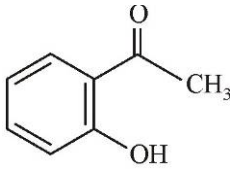
(3) 3-Hydroxy-4-methylpentanoic acid **(4)** 4,4-Dimethyl-3-hydroxybutanoic acid

16. An organic compound neither reacts with neutral ferric chloride solution nor with Fehling solution. It however, reacts with Grignard reagent and gives positive iodoform test. The compound is :

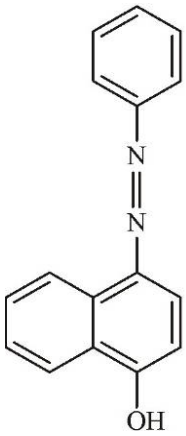
(1) 

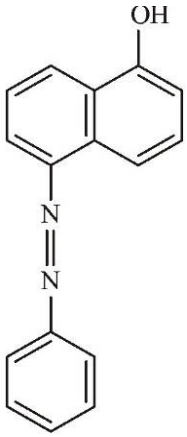
(2) 

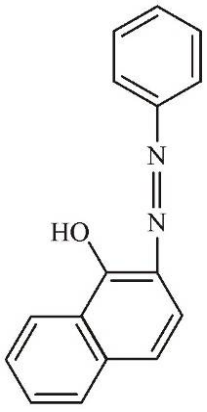
(3) 

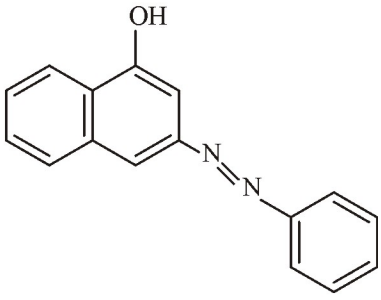
(4) 

17. Coupling of benzene diazonium chloride with 1-naphthol in alkaline medium will give :

(1) 

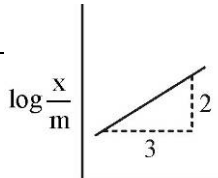
(2) 

(3) 

(4) 

18. Adsorption of gas follows Freundlich adsorption isotherm. x is the mass of the gas adsorbed on mass m of the adsorbent. The plot of $\log\frac{x}{m}$ versus log p is shown in the given graph. $\frac{x}{m}$ is proportional to :

(1) p^3

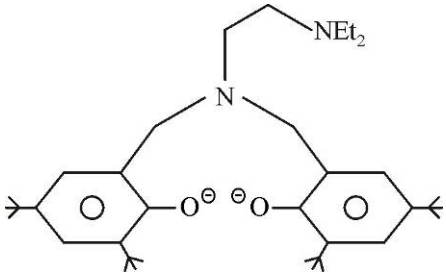


(2) $p^{\frac{2}{3}}$

(3) p^{2}

(4) $p^{\frac{3}{2}}$

19. The following ligand is :



(1) hexadentate **(2)** bidentate **(3)** tetradentate **(4)** tridentate

20. Which one of the following equations does not correctly represent the first law of thermodynamics for the given processes involving an ideal gas? (Assume non-expansion work is zero)

(1) Cyclic process : q = -w **(2)** Adiabatic process : $\Delta U = -w$

(3) Isochoric process : $\Delta U = q$ **(4)** Isothermal process : $q = -w$

21. Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce, respectively:

(1) HBO_2 and H_3BO_3 **(2)** B_2O_3 and H_3BO_3

(3) B_2O_3 and $[BH_4]^-$ **(4)** H_3BO_3 and B_2O_3

22. For silver, $C_p(J\,K^{-1}\,mol^{-1}) = 23 + 0.01T$. If the temperature (T) of 3 moles of silver is raised from 300 K to 1000 K at 1 atm pressure, the value of ΔH will be close to :

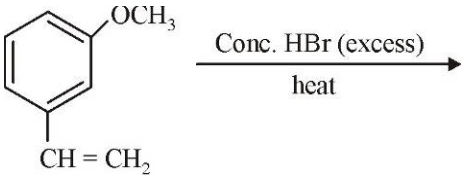
(1) 21 kJ **(2)** 13 kJ **(3)** 16 kJ **(4)** 62 kJ

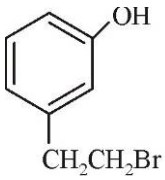
23. Maltose on treatment with dilute HCl gives :

(1) D-Galactose **(2)** D-Fructose

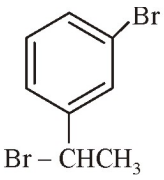
(3) D-Glucose and D-Fructose **(4)** D-Glucose

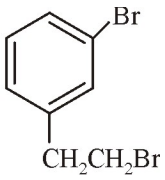
24. The major product of the following reaction is :



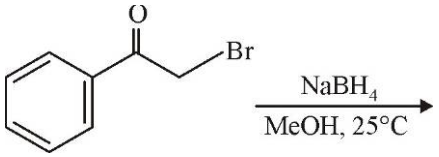
(1) 

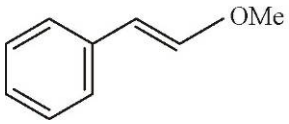
(2) 

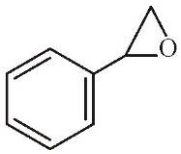
(3) 

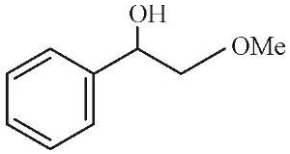
(4) 

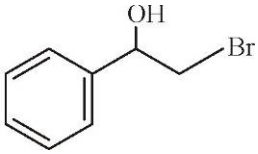
25. The major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

26. Element 'B' forms ccp structure and 'A' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids. The structure of bimetallic oxide is :

(1) A_4B_2O **(2)** A_2BO_4 **(3)** AB_2O_4 **(4)** A_2B_2O

27. Given that $E^{\Theta}_{O_2/H_2O} = +1.23\,V$; $E^{\Theta}_{S_2O_8^{2-}/SO_4^{2-}} = 2.05\,V$;

$E^{\Theta}_{Br_2/Br^-} = +1.09\,V$; $E^{\Theta}_{Au^{3+}/Au} = +1.4\,V$

The strongest oxidizing agent is :

(1) $S_2O_8^{2-}$ **(2)** O_2 **(3)** Br_2 **(4)** Au^{3+}

28. **Assertion :** Ozone is destroyed by CFCs in the upper stratosphere.
Reason : Ozone holes increase the amount of UV radiation reaching the earth

(1) Assertion is false, but the Reason is correct.
(2) Assertion and Reason are correct, but the reason is not the explanation for the Assertion.
(3) Assertion and Reason are incorrect.
(4) Assertion and Reason are both correct and the Reason is the correct explanation for the Assertion.

29. The correct order of hydration enthalpies of alkali metal ions is :

(1) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$ **(2)** $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$

(3) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ **(4)** $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$

30. Which is wrong with respect to our responsibility as a human being to protect our environment?

(1) Avoiding the use of floodlighted facilities
(2) Setting up compost tin in gardens
(3) Using plastic bags
(4) Restricting the use of vehicles

PART-C	MATHEMATICS

1. Let $y = y(x)$ be the solution of the differential equation, $(x^2+1)^2\frac{dy}{dx} + 2x(x^2+1)y = 1$ such that $y(0) = 0$. If $\sqrt{a}\,y(1) = \frac{\pi}{32}$, then the value of '$a$' is :

(1) $\frac{1}{4}$ **(2)** $\frac{1}{16}$ **(3)** $\frac{1}{2}$ **(4)** 1

2. The greatest value of $c \in R$ for which the system of linear equations

$x - cy - cz = 0$

$cx - y + cz = 0$

$cx + cy - z = 0$

Has a non-trivial solution, is :

(1) $\frac{1}{2}$ **(2)** 2 **(3)** -1 **(4)** 0

3. If $f(x) = \log_e\left(\frac{1-x}{1+x}\right), |x|<1,$ then $f\left(\frac{2x}{1+x^2}\right)$ is equal to :

(1) $-2f(x)$ **(2)** $\left(f(x)\right)^2$ **(3)** $2f(x^2)$ **(4)** $2f(x)$

4. The sum of the solutions of the equation $\left|\sqrt{x}-2\right| + \sqrt{x}\left(\sqrt{x}-4\right) + 2 = 0, (x>0)$ is equal to :

(1) 4 **(2)** 10 **(3)** 9 **(4)** 12

5. The sum of the coefficients of all even degree terms in x in the expansion of $\left(x+\sqrt{x^3-1}\right)^6 + \left(x-\sqrt{x^3-1}\right)^6, (x>1)$ is equal to :

(1) 24 **(2)** 26 **(3)** 29 **(4)** 32

6. If $\cos(\alpha+\beta) < \frac{\pi}{4}, \sin(\alpha-\beta) = \frac{5}{13}$ *and* $0<\alpha, \beta < \frac{\pi}{4},$ then tan (2α) is equal to :

(1) $\frac{21}{16}$ **(2)** $\frac{63}{52}$ **(3)** $\frac{33}{52}$ **(4)** $\frac{63}{16}$

7. If α and β be the roots of the equation $x^2 - 2x + 2 = 0,$ then the least value of n for which $\left(\frac{\alpha}{\beta}\right)^n = 1$ *is* :

(1) 5 **(2)** 3 **(3)** 4 **(4)** 2

8. The sum of the series $2\cdot{}^{20}C_0 + 5\cdot{}^{20}C_1 + 8\cdot{}^{20}C_2 + 11\cdot{}^{20}C_3 + ... + 62\cdot{}^{20}C_{20}$ is equal to :

(1) 2^{26} **(2)** 2^{23} **(3)** 2^{24} **(4)** 2^{25}

9. The length of the perpendicular from the point (2, -1, 4) on the straight line, $\frac{x+3}{10} = \frac{y-2}{-7} = \frac{z}{1}$ is :

(1) greater than 4 **(2)** greater than 2 but less than 3

(3) less than 2 **(4)** greater than 3 but less than 4

10. The magnitude of the projection of the vector $2\hat{i} + 3\hat{j} + \hat{k}$ on the vector perpendicular to the plane containing the vectors $\hat{i} + \hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} + 3\hat{k},$ is :

(1) $\sqrt{\frac{3}{2}}$ **(2)** $3\sqrt{6}$ **(3)** $\frac{\sqrt{3}}{2}$ **(4)** $\sqrt{6}$

11. The contrapositive of the statement "if you are born in India, then you are citizen of India", is :

(1) If you are not born in India, then you are not a citizen of India.

(2) If you are a citizen of India, then you are born in India.

(3) If you are born in India, then you are not a citizen of India.

(4) If you are not a citizen of India, then you are not born in India.

12. The shortest distance between the line $y = x$ and the curve $y^2 = x - 2$ is :

(1) $\frac{11}{4\sqrt{2}}$ **(2)** $\frac{7}{8}$ **(3)** $\frac{7}{4\sqrt{2}}$ **(4)** 2

13. $\int \frac{\sin\frac{5x}{2}}{\sin\frac{x}{2}}dx$ is equal to : (where c is a constant of integration.)

(1) $2x + \sin x + \sin 2x + c$ **(2)** $x + 2\sin x + \sin 2x + c$

(3) $2x + \sin x + 2\sin 2x + c$ **(4)** $x + 2\sin x + 2\sin 2x + c$

14. A point on the straight line, $3x + 5y = 15$ which is equidistant from the coordinate axes will lie only in :

(1) 1st and 2nd quadrants **(2)** 1st, 2nd and 4th quadrants

(3) 1st quadrant **(4)** 4th quadrant

15. All possible numbers are formed using the digits 1, 1, 2, 2, 2, 2, 3, 4, 4 taken all at a time. The number of such numbers in which the odd digits occupy even places is :

(1) 160 **(2)** 162 **(3)** 175 **(4)** 180

16. If S_1 *and* S_2 are respectively the sets of local minimum and local maximum points of the function, $f(x) = 9x^4 + 12x^3 - 36x^2 + 25, x \in R,$ then :

(1) $S_1 = \{-2\}; S_2 = \{0, 1\}$ **(2)** $S_1 = \{-2, 1\}; S_2 = \{0\}$

(3) $S_1 = \{-1\}; S_2 = \{0, 2\}$ **(4)** $S_1 = \{-2, 0\}; S_2 = \{1\}$

17. Let $O(0, 0)$ and $A(0, 1)$ be two fixed points. Then the locus of a point P such that the perimeter of ΔAOP is 4, is :

(1) $9x^2 + 8y^2 - 8y = 16$ **(2)** $9x^2 - 8y^2 + 8y = 16$

(3) $8x^2 + 9y^2 - 9y = 18$ **(4)** $8x^2 - 9y^2 + 9y = 18$

18. The mean and variance of seven observations are 8 and 16, respectively. If 5 of the observations are 2, 4, 10, 12, 14, then the product of the remaining two observations is :

(1) 48 **(2)** 40 **(3)** 45 **(4)** 49

19. If the tangents on the ellipse $4x^2 + y^2 = 8$ at the points (1, 2) and (a, b) are perpendicular to each other, then a^2 is equal to :

(1) $\frac{64}{17}$ **(2)** $\frac{4}{17}$ **(3)** $\frac{2}{17}$ **(4)** $\frac{128}{17}$

20. If $\alpha = \cos^{-1}\left(\frac{3}{5}\right), b = \tan^{-1}\left(\frac{1}{3}\right),$ where $0 < \alpha, \beta < \left(\frac{\pi}{2}\right),$ then $\alpha - \beta$ is equal to :

(1) $\cos^{-1}\left(\frac{9}{5\sqrt{10}}\right)$ **(2)** $\sin^{-1}\left(\frac{9}{5\sqrt{10}}\right)$ **(3)** $\tan^{-1}\left(\frac{9}{5\sqrt{10}}\right)$ **(4)** $\tan^{-1}\left(\frac{9}{14}\right)$

21. The sum of all natural numbers 'n' such that $100 < n < 200$ and *H.C.F.* $(91, n) > 1$ is :

(1) 3303 **(2)** 3121 **(3)** 3203 **(4)** 3221

22. If $2y = \left(\cot^{-1}\left(\frac{\sqrt{3}\cos x + \sin x}{\cos x - \sqrt{3}\sin x}\right)\right)^2, x \in \left(0, \frac{\pi}{2}\right)$ then $\frac{dy}{dx}$ is equal to :

(1) $2x-\frac{\pi}{3}$ **(2)** $\frac{\pi}{6}-x$ **(3)** $x-\frac{\pi}{6}$ **(4)** $\frac{\pi}{3}-x$

23. The sum of the squares of the lengths of the chords intercepted on the circle, $x^2+y^2=16,$ by the lines, $x+y=n,\ n\in N,$ where N is the set of all natural numbers, is :

(1) 160 **(2)** 320 **(3)** 105 **(4)** 210

24. Let $A=\begin{pmatrix}\cos\alpha & -\sin\alpha\\ \sin\alpha & \cos\alpha\end{pmatrix},(a\in R)$ such that $A^{32}=\begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}.$ Then a value of α is :

(1) 0 **(2)** $\frac{\pi}{16}$ **(3)** $\frac{\pi}{32}$ **(4)** $\frac{\pi}{64}$

25. Let $f:[0,2]\to R$ be a twice differentiable function such that $f''(x)>0,$ for all $x\in(0,2).$ If $\phi(x)=f(x)+f(2-x),$ then ϕ is :

(1) increasing on (0, 1) and decreasing on (1, 2)
(2) decreasing on (0, 1) and increasing on (1, 2)
(3) decreasing on (0, 2)
(4) increasing on (0, 2)

26. $\lim\limits_{x\to\infty}\frac{\sin^2 x}{\sqrt{2}-\sqrt{1+\cos x}}$ equals :

(1) $\sqrt{2}$ **(2)** 4 **(3)** $4\sqrt{2}$ **(4)** $2\sqrt{2}$

27. The area (in sq. units) of the region $A=\left\{(x,\ y)\in R\times R\,|\,0\le x\le 3,\ 0\le y\le 4,\ y\le x^2+3x\right\}$ is :

(1) $\frac{59}{6}$ **(2)** $\frac{26}{3}$ **(3)** $\frac{53}{6}$ **(4)** 8

28. Let A and B be two non-null events such that $A\subset B.$ Then, which of the following statements is always correct ?

(1) $P(A\,|\,B)\le P(A)$ **(2)** $P(A\,|\,B)=P(B)-P(A)$
(3) $P(A\,|\,B)=1$ **(4)** $P(A\,|\,B)\ge P(A)$

29. The equation of a plane containing the line of intersection of the planes $2x-y-4=0$ and $y+2z-4=0$ and passing through the point (1, 1, 0) is :

(1) $x+3y+z=4$ **(2)** $x-y-z=0$ **(3)** $2x-z=2$ **(4)** $x-3y-2z=-2$

30. If $f(x)=\frac{2-x\cos x}{2+x\cos x}$ and $g(x)=\log_e x,\ (x>0)$ then the value of the integral $\int\limits_{\frac{-\pi}{4}}^{\frac{\pi}{4}} g(f(x))\,dx$ is :

(1) $\log_e 2$ **(2)** $\log_e e$ **(3)** $\log_e 1$ **(4)** $\log_e 3$