Joint Entrance Exam | Mains-2019

Paper Code -

10th April 2019 | Evening

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 elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400 N load without exceeding its elastic limit ?

(1) 1.00 mm **(2)** 0.90 mm **(3)** 1.36 mm **(4)** 1.16 mm

2. A square loop is carrying a steady current I and the magnitude of its magnetic dipole moment is m. If this square loop is changed to a circular loop and it carries the same current, the magnitude of the magnetic dipole moment of circular loop will be:

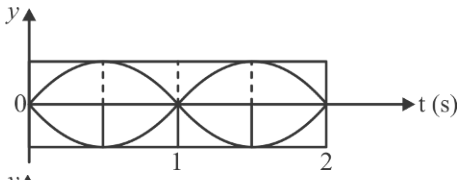
(1) $\frac{4m}{\pi}$ **(2)** $\frac{2m}{\pi}$ **(3)** $\frac{3m}{\pi}$ **(4)** $\frac{m}{\pi}$

3. In free space, a particle A of charge $1\,\mu C$ is held fixed at a point P. Another particle B of the same charge and mass $4\,\mu g$ is kept at a distance of 1 mm from P. If B is released, then its velocity at a distance of 9 mm from P is: $\left[\text{Take } \frac{1}{4\pi\in_0} = 9\times10^9 \text{ Nm}^2\text{ C}^{-2}\right]$

(1) 2.0×10^3 m/s **(2)** 1.5×10^2 m/s **(3)** 3.0×10^4 m/s **(4)** 1.0 m/s

4. The correct figure that shows, schematically, the wave pattern produced by superposition of two waves of frequencies 9 Hz and 11 Hz, is :

(1)



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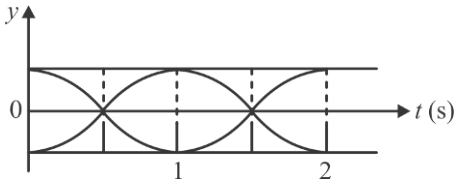

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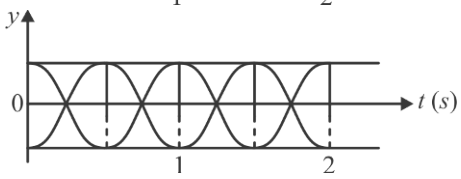

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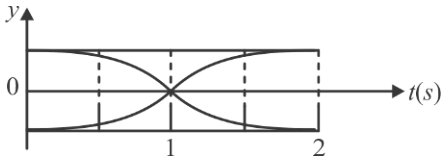


5. When heat Q is supplied to a diatomic gas of rigid molecules, at constant volume its temperature increases by ΔT. The heat required to produce the same change in temperature, at a constant pressure is:

(1) $\frac{2}{3}Q$ **(2)** $\frac{5}{3}Q$ **(3)** $\frac{3}{2}Q$ **(4)** $\frac{7}{5}Q$

6. The time dependence of the position of a particle of mass $m = 2$ is given by $\vec{r}(t) = 2t\hat{i} - 3t^2\hat{j}$. Its angular momentum, with respect to the origin, at time $t = 2$ is :

(1) $-34(\hat{k}-\hat{i})$ **(2)** $-48\hat{k}$ **(3)** $36\hat{k}$ **(4)** $48(\hat{i}+\hat{j})$

7. A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to:

(1) 0.7 ms^{-1} **(2)** 0.4 ms^{-1} **(3)** 0.1 ms^{-1} **(4)** 0.3 ms^{-1}

8. In a Young's double slit experiment, the ratio of the slit's width is 4 : 1. The ratio of the intensity of maxima to minima, close to the central fringe on the screen, will be:

(1) $(\sqrt{3}+1)^4 : 16$ **(2)** 25 : 9 **(3)** 4 : 1 **(4)** 9 : 1

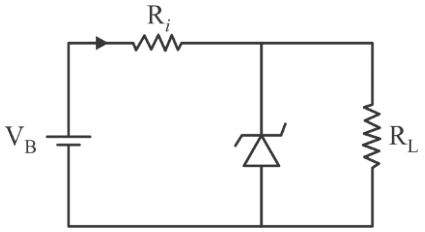
9. A solid sphere of mass M and radius R is divided into two unequal parts. The first part has a mass of $\frac{7M}{8}$ and is converted into a uniform disc of radius $2R$. The second part is converted into a uniform solid sphere. Let I_1 be the moment of inertia of the disc about its axis and I_2 be the moment of inertia of the new sphere about its axis. The ratio $\frac{I_1}{I_2}$ is given by:

(1) 285 **(2)** 185 **(3)** 140 **(4)** 65

10. Space between two concentric conducting spheres of radii a and b ($b > a$) is filled with a medium of resistivity ρ. The resistance between the two spheres will be:

(1) $\frac{\rho}{4\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$ **(2)** $\frac{\rho}{2\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$ **(3)** $\frac{\rho}{4\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$ **(4)** $\frac{\rho}{2\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$

11. The figure represents a voltage regulator circuit using a Zener diode. The breakdown voltage of the Zener diode is 6 V and the load resistance is, $R_L = 4\,k\Omega$. The series resistance of the circuit is $R_i = 1\,k\Omega$. If the battery voltage V_B varies from 8 V to 16 V, what are the minimum and maximum values of the current through Zener diode?



(1) 1 mA; 8.5 mA **(2)** 0.5 mA; 8.5 mA
(3) 1.5 mA; 8.5 mA **(4)** 0.5 mA; 6 mA

12. Water from a tap emerges vertically downwards with an initial speed of 1.0 ms^{-1}. The cross-sectional area of the tap is 10^{-4} m^2. Assume that the pressure is constant throughout the stream of water and that the flow is streamlined. The cross-sectional area of the stream, 0.15 m below the tap would be :
(Take g = 10 ms^{-2})

(1) 5×10^{-4} m^2 **(2)** 1×10^{-5} m^2 **(3)** 2×10^{-5} m^2 **(4)** 5×10^{-5} m^2

13. Two radioactive substances A and B have decay constants 5λ and λ respectively. At $t = 0$, a sample has the same number of the two nuclei. The time taken for the ratio of the number of nuclei to become $\left(\frac{1}{e}\right)^2$ will be:

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

14. A submarine experiences a pressure of 5.05×10^6 Pa at a depth of d_1 in a sea. When it goes further to a depth of d_2, it experiences a pressure of 8.08×10^6 Pa. Then $d_2 - d_1$ is approximately (density of water $=10^3$ kg/m^3 and acceleration due to gravity = 10 ms^{-2}):

(1) 500 m **(2)** 400 m **(3)** 300 m **(4)** 600 m

15. In Li^{++}, electron in first Bohr orbit is excited to a level by a radiation of wavelength λ. When the ion gets deexcited to the ground state in all possible ways (including intermediate emissions), a total of six spectral lines are observed. What is the value of λ? (Given : $h = 6.63\times10^{-34}$ Js; $c = 3\times10^8$ ms^{-1})

(1) 9.4 nm **(2)** 12.3 nm **(3)** 11.4 nm **(4)** 10.8 nm

16. A 2 mW laser operates at a wavelength of 500 nm. The member of photons that will be emitted per second is: [Given Planck's constant $h = 6.6\times10^{-34}$ Js, speed of light $c = 3.0\times10^8$ m/s]

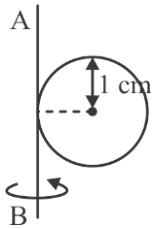
(1) 5×10^{15} **(2)** 1×10^{16} **(3)** 2×10^{16} **(4)** 1.5×10^{16}

17. A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water?

[Take, density of water = 10^3 kg/m^3]

(1) 87.5 kg **(2)** 30.1 kg **(3)** 46.3 kg **(4)** 65.4 kg

18. A metal coin of mass 5 g and radius 1 cm is fixed to a think stick AB of negligible mass as shown in the figure. The system is initially at rest. The constant torque, that will make the system rotate about AB at 25 rotations per second in 5 s, is close to:



(1) 1.6×10^{-5} Nm **(2)** 7.9×10^{-6} Nm

(3) 2.0×10^{-5} Nm **(4)** 4.0×10^{-6} Nm

19. The magnitude of the magnetic field at the center of an equilateral triangular loop of side 1 m which is carrying a current of 10 A is :

[Take $\mu_0 = 4\pi\times10^{-7}$ NA^{-2}]

(1) $3\,\mu T$ **(2)** $9\,\mu T$ **(3)** $1\,\mu T$ **(4)** $18\,\mu T$

20. A spaceship orbits around a planet at a height of 20 km from its surface. Assuming that only gravitational field of the planet acts on the spaceship, what will be the number of complete revolutions made by the spaceship in 24 hours around the planet? [Given : Mass of planet = 8×10^{22} kg, Radius of planet = 2×10^{6} m, Gravitational constant G = 6.67×10^{-11} Nm^2/kg^2]

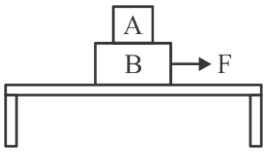
(1) 9 **(2)** 11 **(3)** 13 **(4)** 27

21. In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units?

(1) $[M^{-2}L^{-2}T^{6}A^{3}]$ **(2)** $[M^{-2}L^{0}T^{-4}A^{-2}]$

(3) $[M^{-3}L^{-2}T^{8}A^{4}]$ **(4)** $[M^{-1}L^{-2}T^{4}A^{2}]$

22. Two blocks A and B of masses $m_A = 1$ kg and $m_B = 3$ kg are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on B horizontally, so that the block A does not slide over the block B is: [Take $g = 10$ m/s^2]

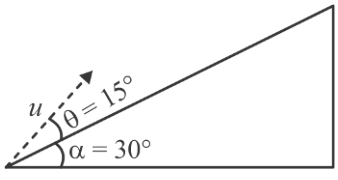


(1) 12 N **(2)** 8 N **(3)** 16 N **(4)** 40 N

23. Light is incident normally on a completely absorbing surface with an energy flux of 25 Wcm^{-2}. If the surface has an area of 25 cm^2, the momentum transferred to the surface in 40 min time duration will be:

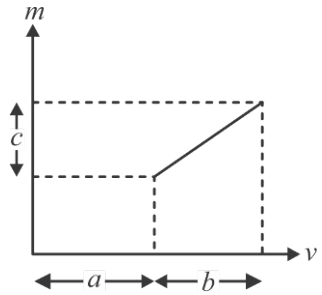
(1) 6.3×10^{-4} Ns **(2)** 5.0×10^{-3} Ns **(3)** 1.4×10^{-6} Ns **(4)** 3.5×10^{-6} Ns

24. A planet is inclined at an angle $\alpha = 30°$ with respect to the horizontal. A particle is projected with a speed $u = 2$ ms^{-1} from the base of the plane, making an angle $\theta = 15°$ with respect to the plane as shown in the figure. The distance from the base, at which the particle hits the plane is close to: [Take $g = 10$ ms^{-2}]



(1) 18 cm **(2)** 14 cm **(3)** 26 cm **(4)** 20 cm

25. The graph shows how the magnification m produced by a thin lens varies with image distance *v*. What is the focal length of the lens used?



(1) $\frac{b}{c}$ **(2)** $\frac{b^2c}{a}$

(3) $\frac{a}{c}$ **(4)** $\frac{b^2}{ac}$

26. A coil of self inductance 10 mH and resistance $0.1\,\Omega$ is connected through a switch to a battery of internal resistance $0.9\,\Omega$. After the switch is closed, the time taken for the current to attain 80% of the saturation value is: [take *l*n 5 = 1.6]

(1) 0.016 s **(2)** 0.324 s **(3)** 0.002 s **(4)** 0.103 s

27. In an experiment, brass and steel wires of length 1 m each with areas of cross section 1 mm^2 are used. The wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is,

[Given, the Young's Modulus for steel and brass are, respectively, 120×10^9 N/m^2 and 60×10^9 N/m^2]

(1) 1.8×10^6 N/m^2 **(2)** 1.2×10^6 N/m^2 **(3)** 4.0×10^6 N/m^2 **(4)** 0.2×10^6 N/m^2

28. One mole of an ideal gas passes through a process where pressure and volume obey the relation $P=P_0\left[1-\frac{1}{2}\left(\frac{V_0}{V}\right)^2\right]$. Here P_0 and V_0 are constants. Calculate the change in the temperature of the gas if its volume changes from V_0 to $2V_0$.

(1) $\frac{3}{4}\frac{P_0V_0}{R}$ **(2)** $\frac{1}{2}\frac{P_0V_0}{R}$ **(3)** $\frac{1}{4}\frac{P_0V_0}{R}$ **(4)** $\frac{5}{4}\frac{P_0V_0}{R}$

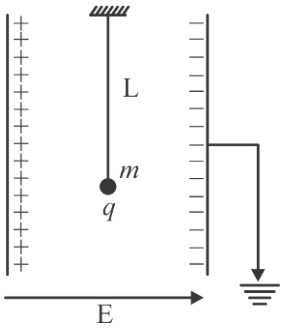
29. A source of sound *S* is moving with a velocity of 50 m/s towards a stationary observer. The observer measures the frequency of the source as 1000 Hz. What will be the apparent frequency of the source when it is moving away from the observer after crossing him? (Take velocity of sound in air is 350 m/s)

(1) 1143 Hz **(2)** 857 Hz **(3)** 750 Hz **(4)** 897 Hz

30. A simple pendulum of length *L* is placed between the plates of a parallel plate capacitor having electric field *E*, as shown in figure. Its bob has mass *m* and charge *q*. The time period of the pendulum is given by:

(1) $2\pi\sqrt{\frac{L}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$ **(2)** $2\pi\sqrt{\frac{L}{\sqrt{g^2-\left(\frac{qE}{m}\right)^2}}}$

(3) $2\pi\sqrt{\frac{L}{\left(g-\frac{qE}{m}\right)}}$ **(4)** $2\pi\sqrt{\frac{L}{\left(g+\frac{qE}{m}\right)}}$



PART-B	CHEMISTRY

1. The pH of $0.02\,M\,NH_4Cl$ solution will be [given $K_b(NH_4OH) = 10^{-5}$ and $\log 2 = 0.301$]

(1) 4.65 **(2)** 5.35 **(3)** 2.65 **(4)** 4.35

2. Number of stereo centers present in linear and cyclic structures of glucose are respectively:

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

3. The correct statements among (a) to (d) are:

(a) Saline hydrides produce H_2 gas when reacted with H_2O

(b) Reaction of $LiAlH_4$ with BF_3 leads to B_2H_6

(c) PH_3 and CH_4 are electron – rich and electron – precise hydrides, respectively.

(d) HF and CH_4 are called as molecular hydrides

(1) c and d only **(2)** a, c and d only **(3)** a, b, and c only **(4)** a, b, c and d only

4. A hydrated solid X on heating initially gives a monohydrated compound Y. Y upon heating above 373 K leads to an anhydrous white powder Z. X and Z, respectively, are:

(1) Baking soda and soda ash **(2)** Washing soda and dead burnt plaster

(3) Baking soda and dead burnt plaster **(4)** Washing soda and soda ash

5. For the reaction of H_2 with I_2, the constant is $2.5\times10^{-4}\,dm^3\,mol^{-1}s^{-1}$ at 327 °C and $1.0\,dm^3\,mol^{-1}s^{-1}$ at $527\,°C$. The activation energy for the reaction, in $kJ\,mol^{-1}$ is:

$(R = 8.314\,J\,K^{-1}\,mol^{-1})$

(1) 150 **(2)** 72 **(3)** 166 **(4)** 59

6. The crystal field stabilization energy (CFSE) of $[Fe(H_2O)_6]Cl_2$ and $K_2[NiCl_4]$ respectively, are:

(1) $-0.4\Delta_0$ and $-1.2\Delta_t$ **(2)** $-0.4\Delta_0$ and $-0.8\Delta_t$

(3) $-2.4\Delta_0$ and $-1.2\Delta_t$ **(4)** $-0.6\Delta_0$ and $-0.8\Delta_t$

7. The difference between ΔH and ΔU $(\Delta H - \Delta U)$, when the combustion of one mole of heptane (l) is carried out at a temperature T, is equal to:

(1) $-4RT$ **(2)** $4RT$ **(3)** $-3RT$ **(4)** $3RT$

8. The correct option among the following is:

(1) Colloidal particles in lyophobic sols can be precipitated by electrophoresis.

(2) Colloidal medicines are more effective because they have small surface area.

(3) Brownian motion in colloidal solution is faster if the viscosity of the solution is very high.

(4) Addition of alum to water makes it unfit for drinking

9. The highest possible oxidation states of uranium and plutonium, respectively, are:

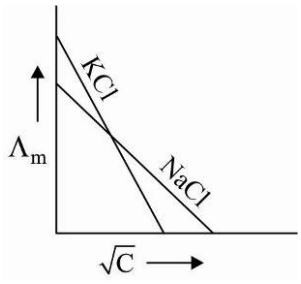
(1) 4 and 6 **(2)** 6 and 4 **(3)** 7 and 6 **(4)** 6 and 7

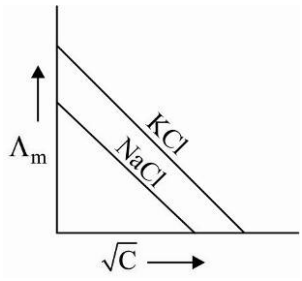
10. Which of these factors does not govern the stability of a conformation in acyclic compounds?

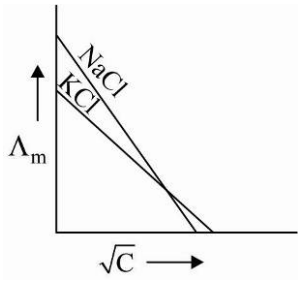
(1) Torsional strain **(2)** Angle strain

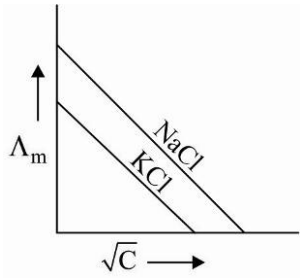
(3) Electrostatic forces of interaction **(4)** Steric interactions

11. Which one of the following graphs between molar conductivity (Λ_m) versus $\sqrt{C}$ is correct?

(1) 

(2) 

(3) 

(4) 

12. The number of pentagons in C_{60} and trigons (triangles) in while phosphorus, respectively, are:

(1) 12 and 4 **(2)** 20 and 3 **(3)** 12 and 3 **(4)** 20 and 4

13. The noble gas that does NOT occur in the atmosphere is:

(1) Kr **(2)** Ne **(3)** He **(4)** Ra

14. For the reaction,

$2SO_2(g) + O_2(g) \quad 2SO_3(g)$,

$\Delta H = -57.2 kJ\,mol^{-1}$ and $K_c = 1.7 \times 10^{16}$.

Which of the following statement is INCORRECT?

(1) The equilibrium constant decreases as the temperature increases

(2) The addition of inert gas at constant volume will not affect the equilibrium constant

(3) The equilibrium constant is large suggestive of reaction going to completion and so no catalyst is required.

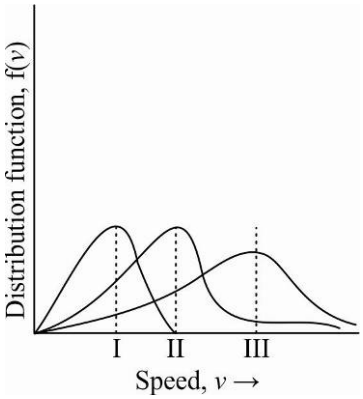
(4) The equilibrium will shift in forward direction as the pressure increases.

15. The correct order of the first ionization enthalpies is:

(1) Mn < Ti < Zn < Ni **(2)** Ti < Mn < Ni < Zn

(3) Zn < Ni < Mn < Ti **(4)** Ti < Mn < Zn < Ni

16. Points I, II and III in the following plot respectively correspond to (V_{mp} : most probable velocity)



(1) V_{mp} of $N_2(300K)$; V_{mp} of $H_2(300K)$; V_{mp} of $O_2(400K)$

(2) V_{mp} of $N_2(300K)$; V_{mp} of $O_2(400K)$; V_{mp} of $H_2(300K)$

(3) V_{mp} of $H_2(300K)$; V_{mp} of $N_2(300K)$; V_{mp} of $O_2(400K)$

(4) V_{mp} of $O_2(400K)$; V_{mp} of $N_2(300K)$; V_{mp} of $H_2(300K)$

17. The correct statement is

(1) Aniline is a froth stabilizer

(2) Zincite is a carbonate ore

(3) Zone refining process is used for the refining of titanium

(4) Sodium cyanide cannot be used in the metallurgy of silver

18. The INCORRECT statement is:

(1) The spin-only magnetic moment of $\left[Ni(NH_3)_4(H_2O)_2\right]^{2+}$ is 2.83 BM.

(2) The color of $\left[CoCl(NH_3)_5\right]^{2+}$ is violet as it absorbs the yellow light

(3) The spin-only magnetic moments of $\left[Fe\left(H_2O\right)_6\right]^{2+}$ and $\left[Cr(H_2O)_6\right]^{2+}$ are nearly similar.

(4) The gemstone, ruby, has Cr^{3+} ions occupying the octahedral sites of beryl

19. The increasing order of nucleophilicity of the following nucleophiles is:

(a) $CH_3CO_2^-$ (b) H_2O (c) $CH_3SO_3^-$ (d) $\bar{O}H$

(1) (b) < (c) < (d) < (a) **(2)** (d) < (a) < (c) < (b)

(3) (b) < (c) < (a) < (d) **(4)** (a) < (d) < (c) < (b)

20. The correct match between Item-I and Item-II is:

Column I		Column II	
(a)	High density polythene	**(I)**	Peroxide catalyst
(b)	Polyacrylonitrile	**(II)**	Condensation at high temperature & Pressure
(c)	Novolac	**(III)**	Ziegler-Natta Catalyst
(d)	Nylon 6	**(IV)**	Acid or base catalyst

(1) (a) $\rightarrow$ (III), (b) $\rightarrow$ (I), (c) $\rightarrow$ (IV), (d) $\rightarrow$ (II)

(2) (a) $\rightarrow$ (III), (b) $\rightarrow$ (I), (c) $\rightarrow$ (II), (d) $\rightarrow$ (IV)

(3) (a) $\rightarrow$ (IV), (b) $\rightarrow$ (II), (c) $\rightarrow$ (I), (d) $\rightarrow$ (III)

(4) (a) $\rightarrow$ (II), (b) $\rightarrow$ (IV), (c) $\rightarrow$ (I), (d) $\rightarrow$ (III)

21. The minimum amount of $O_2(g)$ consumed per gram of reactant is for the reaction:

(Given atomic mass : Fe = 56, O = 16, Mg = 24, P = 31, C = 12, H = 1)

(1) $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ **(2)** $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

(3) $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$ **(4)** $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$

22. The ratio of the shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are:

(1) Balmer and Barckett **(2)** Paschen and Pfund

(3) Brackett and Pfund **(4)** Lyman and Paschen

23. Which of the following is NOT a Correct method of the preparation of benzylamine from cyanobenzene?

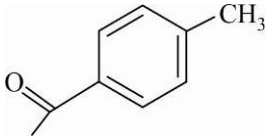
(1) (i) HCl / H_2O (ii) $NaBH_4$

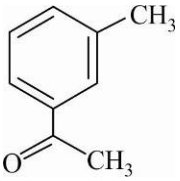
(2) (i) $SnCl_2 + HCl(gas)$ (ii) $NaBH_4$

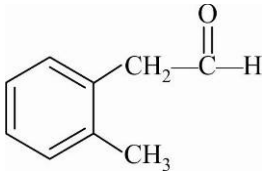
(3) H_2 / Ni

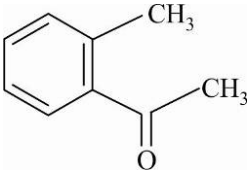
(4) (i) $LiAlH_4$ (ii) H_3O^+

24. Compound $A(C_9H_{10}O)$ shows positive iodoform test. Oxidation of A with $KMnO_4$ / KOH gives acid $B(C_8H_6O_4)$. Anhydride of B is used for the preparation of phenolphthalein. Compound A is:

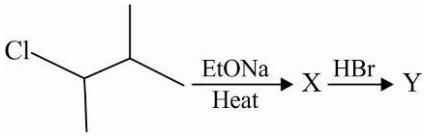
(1) 

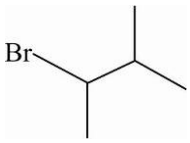
(2) 

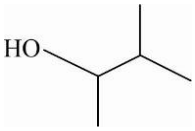
(3) 

(4) 

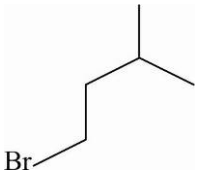
25. The major product 'Y' in the following reaction is:



(1) 

(2) 

(3) 

(4) 

26. In chromatography, which of the following statements is INCORRECT for R_f?

(1) R_f value depends on the type of chromatography

(2) Higher R_f value means higher adsorption

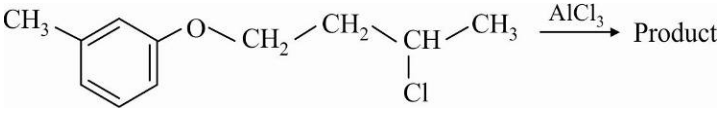
(3) The value of R_f can not be more than one

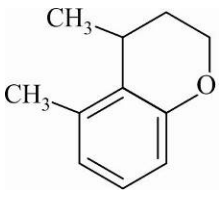
(4) R_f value dependent on the mobile phase

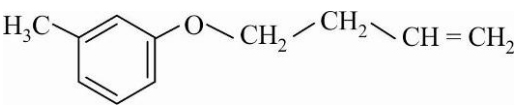
27. 1g of a non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is:

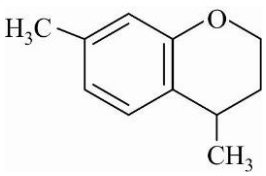
(1) 1 : 0.2 **(2)** 1 : 5 **(3)** 5 : 1 **(4)** 10 : 1

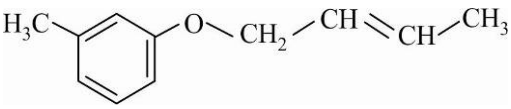
28. The major product obtained in the given reaction is:



(1) 

(2) 

(3) 

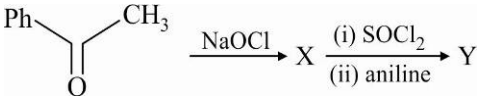
(4) 

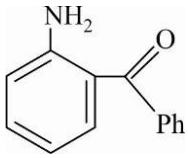
29. Air pollution that occurs in sunlight is:

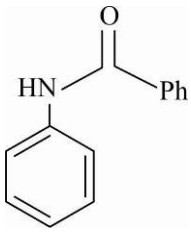
(1) Oxidising smog **(2)** Acid rain

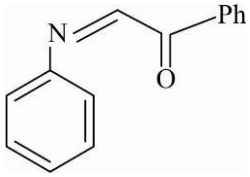
(3) Fog **(4)** Reducing smog

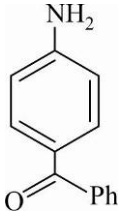
30. The major product 'Y' in the following reaction is:



(1) 

(2) 

(3) 

(4) 

PART-C	MATHEMATICS

1. If both the mean and the standard deviation of 50 observations $x_1, x_2, ..., x_{50}$ are equal to 16, then the mean of $(x_1-4)^2, (x_2-4)^2, ..., (x_{50}-4)^2$ is:

(1) 400 **(2)** 380 **(3)** 480 **(4)** 525

2. The number of real roots of the equation $5+|2^x-1|=2^x(2^x-2)$ is:

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

3. If the plane $2x-y+2z+3=0$ has the distance $\frac{1}{3}$ and $\frac{2}{3}$ units from the planes $4x-2y+4z+\lambda=0$ and $2x-y+2z+\mu=0$, respectively, then the maximum value of $\lambda+\mu$ is equal to:

(1) 15 **(2)** 5 **(3)** 9 **(4)** 13

4. Lines are drawn parallel to the line $4x-3y+2=0,$ at a distance $\frac{3}{5}$ from the origin. Then which one of the following points lies on any of these lines?

(1) $\left(-\frac{1}{4},\frac{2}{3}\right)$ **(2)** $\left(-\frac{1}{4},-\frac{2}{3}\right)$ **(3)** $\left(\frac{1}{4},-\frac{1}{3}\right)$ **(4)** $\left(\frac{1}{4},\frac{1}{3}\right)$

5. If $\cos^{-1}x-\cos^{-1}\frac{y}{2}=\alpha,$ where $-1\le x\le 1, -2\le y\le 2, x\le\frac{y}{2},$ then for all $x, y, 4x^2-4xy\cos\alpha+y^2$ is equal to:

(1) $2\sin^2\alpha$ **(2)** $4\cos^2\alpha+2x^2y^2$

(3) $4\sin^2\alpha-2x^2y^2$ **(4)** $4\sin^2\alpha$

6. If the tangent to the curve $y=\frac{x}{x^2-3}, x\in R, (x\neq\pm\sqrt{3}),$ at a point $(\alpha,\beta)\neq(0,0)$ on it is parallel to the line $2x+6y-11=0,$ then:

(1) $|2\alpha+6\beta|=11$ **(2)** $|6\alpha+2\beta|=19$ **(3)** $|6\alpha+2\beta|=9$ **(4)** $|2\alpha+6\beta|=19$

7. If the line $ax + y = c,$ touches both the curves $x^2 + y^2 = 1$ and $y^2 = 4\sqrt{2}x,$ then $|c|$ is equal to:

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

8. Let $y = y(x)$ be the solution of the differential equation, $\frac{dy}{dx} + y\tan x = 2x + x^2\tan x, x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right),$ such that $y(0) = 1.$ Then:

(1) $y'\left(\frac{\pi}{4}\right) - y'\left(-\frac{\pi}{4}\right) = \pi - \sqrt{2}$ **(2)** $y\left(\frac{\pi}{4}\right) - y\left(-\frac{\pi}{4}\right) = \sqrt{2}$

(3) $y\left(\frac{\pi}{4}\right) + y\left(-\frac{\pi}{4}\right) = \frac{\pi^2}{2} + 2$ **(4)** $y'\left(\frac{\pi}{4}\right) + y'\left(-\frac{\pi}{4}\right) = -\sqrt{2}$

9. If z and w are two complex numbers such that $|zw| = 1$ and $\arg(z) - \arg(w) = \frac{\pi}{2},$ then:

(1) $\bar{z}w = -i$ **(2)** $\bar{z}w = i$ **(3)** $z\bar{w} = \frac{-1+i}{\sqrt{2}}$ **(4)** $z\bar{w} = \frac{1-i}{\sqrt{2}}$

10. A spherical iron ball of radius 10 cm is coated with a layer of ice of uniform thickness that melts at a rate of 50 cm^3/min. When the thickness of the ice is 5 cm, then the rate at which the thickness (in cm/min) of the ice decreases, is:

(1) $\frac{5}{6\pi}$ **(2)** $\frac{1}{9\pi}$ **(3)** $\frac{1}{18\pi}$ **(4)** $\frac{1}{36\pi}$

11. Let $a_1, a_2, a_3, \ldots.$ be an A.P. with $a_6 = 2.$ Then the common difference of this A.P., which maximizes the product $a_1\, a_4\, a_5,$ is:

(1) $\frac{6}{5}$ **(2)** $\frac{2}{3}$ **(3)** $\frac{8}{5}$ **(4)** $\frac{3}{2}$

12. The sum $1 + \frac{1^3+2^3}{1+2} + \frac{1^3+2^3+3^3}{1+2+3} + \ldots + \frac{1^3+2^3+3^3+\ldots+15^3}{1+2+3+\ldots+15} - \frac{1}{2}(1+2+3+\ldots+15)$ is equal to:

(1) 660 **(2)** 620 **(3)** 1860 **(4)** 1240

13. The sum of the real roots of the equation $\begin{vmatrix} x & -6 & -1 \\ 2 & -3x & x-3 \\ -3 & 2x & x+2 \end{vmatrix} = 0,$ is equal to:

(1) 6 **(2)** 1 **(3)** 0 **(4)** –4

14. If $\int x^5 e^{-x^2}\, dx = g(x)e^{-x^2} + c,$ where c is a constant of integration, then $g(-1)$ is equal to:

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

15. The angles A, B and C of a triangle ABC are in A.P. and $a : b = 1 : \sqrt{3}.$ If c = 4 cm, then the area (in sq. cm) of this triangle is :

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

16. The tangent and normal to the ellipse $3x^2+5y^2=32$ at the point $P(2, 2)$ meet the x-axis at Q and R, respectively. Then the area (in sq. units) of the triangle PQR is:

(1) $\frac{34}{15}$ **(2)** $\frac{16}{3}$ **(3)** $\frac{68}{15}$ **(4)** $\frac{14}{3}$

17. The smallest natural number n, such that the coefficient of x in the expansion of $\left(x^2+\frac{1}{x^3}\right)^n$ is ${}^nC_{23}$, is:

(1) 58 **(2)** 38 **(3)** 23 **(4)** 35

18. The distance of the point having position vector $-\hat{i}+2\hat{j}+6\hat{k}$ from the straight line passing through the point (2, 3, –4) and parallel to the vector, $6\hat{i}+3\hat{j}-4\hat{k}$ is:

(1) 6 **(2)** $4\sqrt{3}$ **(3)** $2\sqrt{13}$ **(4)** 7

19. If $5x+9=0$ is the directrix of the hyperbola $16x^2-9y^2=144,$ then its corresponding focus is:

(1) (5, 0) **(2)** $\left(-\frac{5}{3}, 0\right)$ **(3)** (–5, 0) **(4)** $\left(\frac{5}{3}, 0\right)$

20. Let λ be a real number for which the system of linear equations

$$x+y+z=6$$
$$4x+\lambda y-\lambda z=\lambda-2$$
$$3x+2y-4z=-5$$

has infinitely many solutions. Then λ is a root of the quadratic equation:

(1) $\lambda^2+3\lambda-4=0$ **(2)** $\lambda^2-\lambda-6=0$

(3) $\lambda^2+\lambda-6=0$ **(4)** $\lambda^2-3\lambda-4=0$

21. Minimum number of times a fair coin must be tossed so that the probability of getting at least one head is more than 99% is:

(1) 5 **(2)** 6 **(3)** 7 **(4)** 8

22. The negation of the Boolean expression $\sim s\vee(\sim r\wedge s)$ is equivalent to:

(1) $s\wedge r$ **(2)** $s\vee r$ **(3)** $\sim s\wedge\sim r$ **(4)** r

23. Suppose that 20 pillars of the same height have been erected along the boundary of a circular stadium. If the top of each pillar has been connected by beams with the top of all its non-adjacent pillars, then the total number of beams is:

(1) 180 **(2)** 170 **(3)** 190 **(4)** 210

24. Let $f(x)=\log_e(\sin x), (0<x<\pi)$ and $g(x)=\sin^{-1}(e^{-x}), (x\geq 0)$. If α is a positive real number such that $a=(fog)'(\alpha)$ and $b=(fog)(\alpha),$ then:

(1) $a\alpha^2+b\alpha-a=-2\alpha^2$ **(2)** $a\alpha^2+b\alpha+a=0$

(3) $a\alpha^2-b\alpha-a=1$ **(4)** $a\alpha^2-b\alpha-a=0$

25. If $\lim\limits_{x\to 1}\frac{x^2-ax+b}{x-1}=5,$ then $a+b$ is equal to:

(1) –4 **(2)** 1 **(3)** –7 **(4)** 5

26. The integral $\int_{\pi/6}^{\pi/3}\sec^{2/3}\operatorname{cosec}^{4/3}x\,dx$ is equal to:

(1) $3^{\frac{5}{3}} - 3^{\frac{1}{3}}$ **(2)** $3^{\frac{7}{6}} - 3^{\frac{5}{6}}$ **(3)** $3^{\frac{4}{3}} - 3^{\frac{1}{3}}$ **(4)** $3^{\frac{5}{6}} - 3^{\frac{2}{3}}$

27. The locus of the centres of the circles, which touch the circle, $x^2 + y^2 = 1$ externally, also touch the *y*-axis and lie in the first quadrant, is:

(1) $y = \sqrt{1 + 4x}, x \geq 0$ **(2)** $x = \sqrt{1 + 2y}, y \geq 0$

(3) $x = \sqrt{1 + 4y}, y \geq 0$ **(4)** $y = \sqrt{1 + 2x}, x \geq 0$

28. A perpendicular is drawn from a point on the line $\frac{x-1}{2} = \frac{y+1}{-1} = \frac{z}{1}$ to the plane $x + y + z = 3$ such that the foot of the perpendicular *Q* also lies on the plane $x - y + z = 3$. Then the co-ordinates of *Q* are:

(1) (1, 0, 2) **(2)** (2, 0, 1) **(3)** (4, 0, –1) **(4)** (–1, 0, 4)

29. Let *a, b* and *c* be in G.P. with common ratio *r*, where $a \neq 0$ and $0 < r \leq \frac{1}{2}$. If 3*a*, 7*b* and 15*c* are the first three terms of an A.P., then the 4^{th} term of this A.P. is:

(1) $\frac{2}{3}a$ **(2)** a **(3)** $5a$ **(4)** $\frac{7}{3}a$

30. The area (in sq. units) of the region bounded by the curves $y = 2^x$ and $y = |x + 1|$, in the first quadrant is:

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