JEE Advanced
Sample Question Paper - 1

PAPER 1

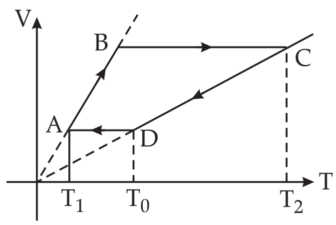
PHYSICS

SECTION-I

General Instructions :

- This section contains **SIX (06)** Questions.
- Each question has four options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

1. The work done by one mole of a gas in the cyclic process shown in the graph is W. Then



(R is the universal gas constant.)

(A) $T_0 = \frac{T_1 + T_2}{2}$ **(B)** $T_0 = \frac{W}{2R} + \frac{T_1 + T_2}{2}$

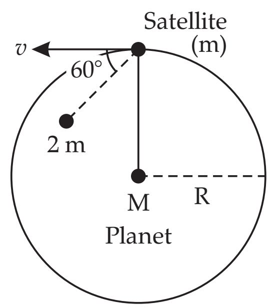
(C) $T_0 = \frac{W}{2R}$ **(D)** $T_0 = \frac{W}{2R} + \frac{T_1 - T_2}{2}$

2. A particle of charge Q and mass m moves in a circular path of radius R in a uniform magnetic field B. The same particle now moves with same speed in a circle of radius R in the space between cylindrical electrodes of a cylindrical capacitor. The radius of inner electrode is $\frac{R}{2}$ and that of outer is $\frac{3R}{2}$. The potential difference between electrodes must be

(A) $\frac{QBR(\ln 3)}{m}$ **(B)** $\frac{QB^2R^2(\ln 3)}{2m}$

(C) $\frac{QB^2R^2(\ln 3)}{m}$ **(D)** $\frac{QB^2R^2(\ln 3)}{4m}$

3. A satellite of mass m is moving in a circular orbit of radius R around a planet of mass M. A particle of mass 2m moving with the same speed as that of the satellite, collides with the satellite as shown, and sticks to it. The maximum separation between the planet and satellite, after collision would be (M >m)



(A) $\frac{6R}{5}$ **(B)** $\frac{9R}{5}$

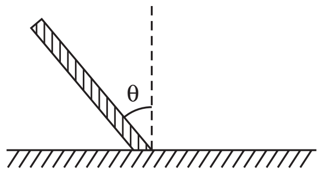
(C) $\frac{6R}{4}$ **(D)** 2R

4. In an experiment to measure the focal length of an equiconvex lens, following measurements were made : $|u| = 0.30$ cm, $|v| = 0.60$ cm. The image formed is real. The focal length of the lens within error limits is

(A) (0.20 ± 0.01) cm **(B)** (0.20 ± 0.02) cm

(C) (0.20 ± 0.0055) cm **(D)** (0.20 ± 0.005) cm

5. A thin rod (mass m and length l) is released from rest in the position shown. Frictional force initially acting on the rod, if it does not slip over the surface, is



(A) $\frac{3}{8} mg \sin 2\theta$ **(B)** $\frac{3}{8} mg \sin \theta$

(C) $\frac{3}{8} mg \sin^2\theta$ **(D)** $\frac{3}{8} mg \cos^2\theta$

6. A thin ring of radius R is made of a material of density ρ and Young's modulus Y. If the ring is rotated about its centre in its own plane with angular velocity ω, fractional change in radius is proportional to

(A) R^2 **(B)** R^3

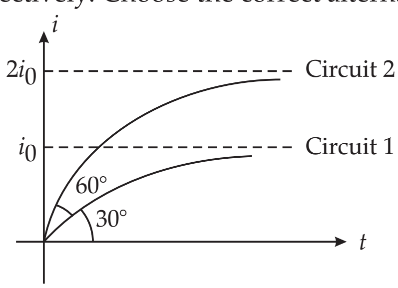
(C) R **(D)** $R^{1/2}$

SECTION-II

General Instructions :

- This section contains **SIX (06)** Question
- Each question has **FOUR** option **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).

7. Growth of current in two different L-R circuits are depicted by *i-t* graphs shown below. Angle subtended by the curves with time axis at time $t = 0$ are also shown in the graphs. τ_1 and τ_2 are the time constants for the circuits 1 and 2 respectively. Choose the correct alternative (*s*)

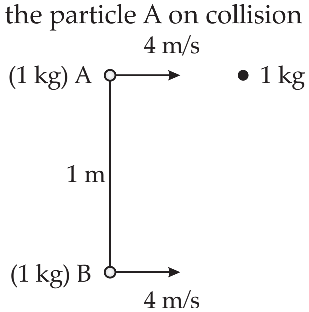


(A) $\frac{\tau_1}{\tau_2} = \frac{2}{3}$ **(B)** $\frac{\tau_1}{\tau_2} = \frac{3}{2}$

(C) Initial rate of growth of current for circuit 1 is 3 times that of circuit 2

(D) Initial rate of growth of current for circuit 2 is 3 times that of circuit 1

8. Two point masses A and B each of mass 1 kg are joined by a meter rod. The system translates on the horizontal surface as shown. A particle of mass 1 kg at rest on the horizontal surface, sticks to the particle A on collision



(A) Linear speed of particle A just after collision is 2 m/s

(B) Linear speed of particle B just after collision is 4 m/s

(C) Velocity of centre of mass of the system is $\frac{8}{3}$ m/s

(D) Angular speed of the system about the centre of mass, after collision is 2 rad/s

9. For a proton and an α-particle, λ_1 and λ_2 represent De-Broglie wavelengths respectively, then

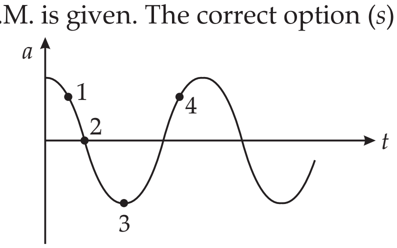
(A) If they have same momenta, $\lambda_1 = \lambda_2$

(B) If they have same kinetic energies, $\lambda_1 = 2\lambda_2$

(C) If they are accelerated through same potential difference, $\lambda_1 = 2\sqrt{2}\lambda_2$

(D) λ_1 can never be lesser than λ_2

10. Acceleration-time graph of a particle excuting S.H.M. is given. The correct option (*s*) is/are



(A) displacement of particle is negative at 1

(B) velocity of particle is positive at 2

(C) potential energy of particle is maximum at 3

(D) speed of particle is decreasing at 4

11. The r.m.s. velocity of an ideal gas having adiabatic exponent $r = 1.5$ is increased to 2 times then

(A) The ratio of initial to final volume is 16 : 1, if it is carried out by adiabetic process

(B) The ratio of initial to final volume is 1 : 4, if it is carried out by isochoric process

(C) The ratio of work done in adiabetic to that in isobaric processes in the given case is – 2

(D) The ratio of work done in adiabetic to that in isobaric processes in the given case is + 1

12. Consider a Y.D.S.E. arrangement with slit separation d, distance between slits and screen is D and intensity of each slit is I. If wavelength of light used is λ, then (Angular position θ of any point on the screen is measured w.r.t. centre point between the slits)

(A) Intensity at a point with angular position $\theta = \frac{\lambda}{4d}$ is 2I

(B) If the screen is shifted away from the slits, angular position of first maxima remains unchanged

(C) If a glass slab is placed in front of one of the slits, and the incident wavefront on the slits is planar it may happen that the central maxima is symmetrically located on the screen

(D) If the arrangement is immersed in an oil of refractive index μ, fringe width becomes $\frac{1}{\mu}$ times

SECTION-III

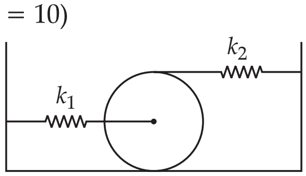
General Instructions :

- This section contains **SIX (06)** question. The answer to each question is **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate**/**round-off** the value to **TWO** decimal places.

13. A battery has an open circuit potential difference of 10 V across its terminals. When two loads 9 Ω and 4 Ω are connected one by one, across the battery, the power in the load resistance is same. How much heat in Joules will be generated in one second in the load, if a load of 5 Ω is connected across battery.

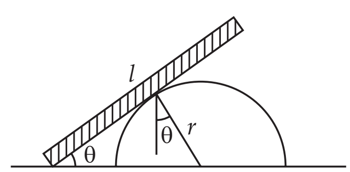
14. A balloon is rising up along the principal axis of a concave mirror of radius of curvature R = 20 cm. A ball is dropped from balloon at a height of 15 m from the mirror, when the balloon has velocity 30 m/s. Find the speed of image in mm/sec, of the ball formed by concave mirror after 4 sec. (Take $g = 10$ m/s^2)

15. A solid sphere of mass 2 kg is kept in equilibrium on a horizontal surface. Two unstretched springs of force constants $k_1 = 10$ N/m and $k_2 = 20$ N/m are attached to the sphere as shown in the figure. Find the time period of small oscillations, assuming pure rolling of sphere. (Take $\pi^2 = 10$)



16. Radium-226 decays to Radon-222 with half life of 1620 years. Radon decays to Polonium-218 with half life of 3.83 days. Starting with initial pure sample of Ra-226, find the number of Rn half lives that have elapsed when radon reaches 90% of its equilibrium concentration.

17. A uniform bar of length l rests with one end on a horizontal floor and the other on a half cylinder of radius r. The coefficients of friction on the ground and on the cylinder are both equal to μ. If $r = \frac{l}{2}$ and $\theta = 30°$, find the value of μ.



18. A pond of water at 0°C is covered with a layer of ice 4 cm thick. If air temperature is – 10°C (constant), find the time (in hours) it takes for ice thickness to increase to 8 cm? $K_{ice} = 2$ W/m°c, $L_f = 80$ cal/gm, $\rho_{ice} = 900$ kg/m^3.

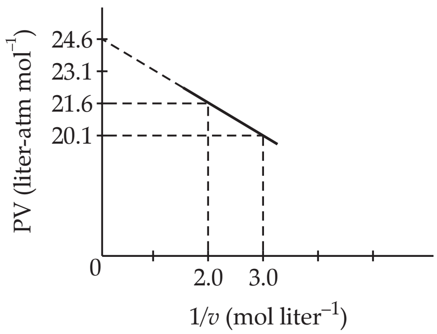
CHEMISTRY

SECTION-I

General Instructions :

- This section contains **SIX (06)** Question.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

1. For one mole of a Vander Waals gas when $b = 0$ and T = 300 K, the PV vs $\frac{1}{V}$ plot is shown below. The value of the Vander Waal's constant a [atm.litre^{2}mol^{-2}] is

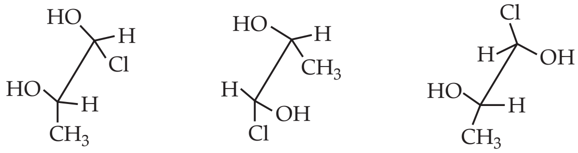


(A) 1.0 **(B)** 4.5
(C) 1.5 **(D)** 3.0

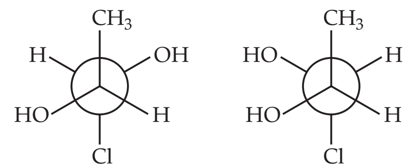
2. Which of the following does not give oxygen on heating?
(A) $K_2Cr_2O_7$ **(B)** $(NH_4)_2Cr_2O_7$
(C) $KClO_3$ **(D)** $Zn(ClO_3)_2$

3. A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt (II) thiocyanate gives rise to a deep-blue crystalline precipitate. The metal ion is:
(A) Pb^{2+} **(B)** Hg^{2+}
(C) Cu^{2+} **(D)** Co^{2+}

4. Which of the given statement (s) about N, O, P and Q with respect to M is (are) wrong ?



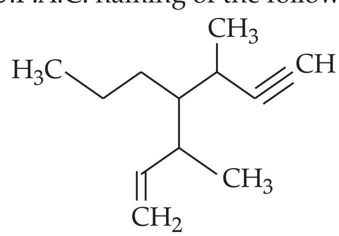
(M) (N) (O)



(P) (Q)

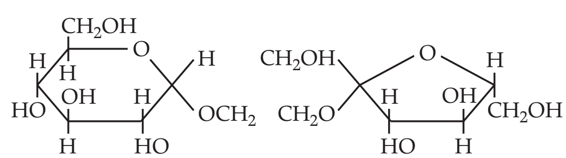
(A) M and N are non-mirror image stereoisomers
(B) M and O are identical
(C) M and P are enantiomers
(D) M and Q are identical

5. The I.U.P.A.C. naming of the following:



(A) 3 methyl-4-(1-methyl prop-2-ynyl)-1-heptene
(B) 3, 5 dimethyl-4-propyl-hept-1-en-6-yne
(C) 3, 5-dimethyl-4-propyl-hept-1-en-6-yne
(D) 3-methyl-4-(3-methylprop-1-enyl)-1-heptyne

6. The correct statement about the following disaccharide is:



(A) (B)

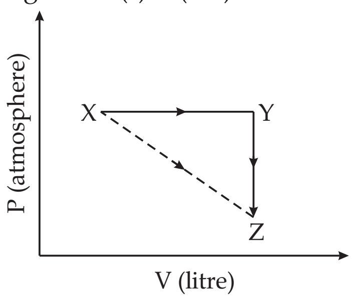
(A) Ring (A) is pyranose with α-glycosidic link
(B) Ring (A) is furanose with α-glycosidic link
(C) Ring (B) is furanose with α-glycosidic link
(D) Ring (B) is pyranose with β-glycosidic link

SECTION-II

General Instructions :

- This section contains **SIX (06)** Question
- Each question has **FOUR** option **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).

7. For an ideal gas, consider only P-V work in going from an initial stats X to the final state Z. The final state Z can be reached by either of two paths shown in the figure. Which of the following choice(s) is (are) correct?



[Take ΔS as change in entropy and w as work done]

(A) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$

(B) $W_{x\to z} = W_{x\to y} + W_{y\to z}$

(C) $W_{x\to y\to z} = W_{x\to y}$

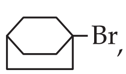
(D) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

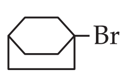
8. Select the correct statement

(A) Neopentyl bromide gives 1° alcohol by S_N2 reaction and 3° alcohol by S_N1 reaction

(B) Intramolecular S_N2 reaction is favoured in 2-bromoethanol

(C) Relative rate of solvolysis of $(CH_3)_3$ C – Br,
I

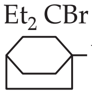


, 

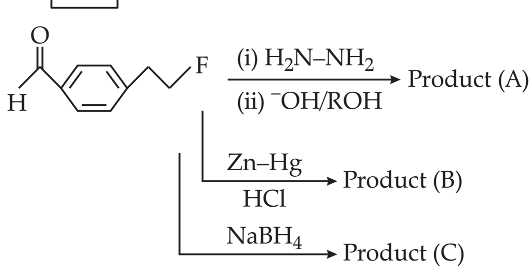
is in order III < II < I

II III

(D) Et_2 CBr and mechanism.

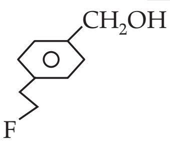


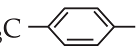
react by SN^1 mechanism

9. 

Correct option is

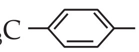
(A) A = B = H_3C  CH_2CH_2F;

C = 

(B) A = H_3C  CH = CH_2;

B = H_3C  CH_2CH_2F

(C) C = $HOCH_2$  CH_2CH_2 F

(D) B = H_3C  CH_2CH_2F;

C = $HOCH_2$  CH_2CH_3

10. For: $[Ni(CN)_4]^{2-}$ and $[Ni(CN)_4]^{4-}$, which of the following statement(s) is/are correct?

(A) Differ in hybridisation but magnetic properties are same

(B) Differ in magnetic property and hybridisation but no one can show optical isomerism

(C) Differ in shape and EAN value but no one can show geometrical isomerism

(D) Different number of atoms are in same plane but same dipole moment.

11. The correct statement(s) regarding
(i) HClO (ii) $HClO_2$ (iii) $HClO_3$ and (iv) $HClO_4$ is(are)

(A) The number of Cl = O bonds in (ii) and (iii) together is two.

(B) The number of lone pairs electrons on Cl in (ii) and (iii) together is three.

(C) The hybridisation of Cl in (iv) is sp^3.

(D) Amongst (i) to (iv), the strongest acid is (i).

12. Which of the following statements is/are correct?

(A) The coordination number of each type of ion in CsCl crystal is 8.

(B) A metal that crystallizes in b.c.c. structure has a coordination number of 12.

(C) A unit cell of an ionic crystal shares some of its ions with other unit cells.

(D) The length of the unit cell in NaCl is 552 pm (r_{Na^+} = 95 pm) (r_{Cl^-} = 181 pm)

SECTION-III

General Instructions :

- This section contains **SIX (06)** question. The answer to each question is **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

13. To measure the quantity of $MnCl_2$ dissolved in an aqueous solution, it was completely converted to $KMnO_4$ using the reaction,

$MnCl_2 + K_2S_2O_8 + H_2O \rightarrow KMnO_4 + H_2SO_4 + HCl$

(equation not balanced). Few drops of conc. HCl were added to this solution and gently warmed. Further, oxalic acid (225 g) was added in portions till the colour of the permaganate ion disappeared. The quantity of $MnCl_2$ (in mg) present in the initial solution is

(Atomic wt. in g mol^{-1}: Mn = 55, Cl = 35.5)

14. In the following equilibrium

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

When 5 moles of each is taken, the temperature is kept at 298 K, the total pressure was bound to be 20 bar.

Given that

$\Delta G_f^o(N_2O_4) = 100$ kJ

$\Delta G_f^o\ NO_2 = 50$ kJ

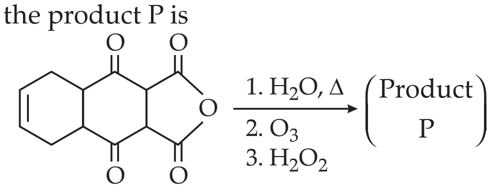
The ΔG of the reaction is L atm.

15. All the energy released from the reaction $X \rightarrow Y$, $\Delta_r G^0 = -193$ kJ mol^{-1} is used for oxidizing M^+ as $M^+ \rightarrow M^{3+} + 2e^-$, $E^0 = -0.25$ V under standard conditions, the number of moles of M^+ oxidized when one mole of X is converted to Y is [F = 96500 mol^{-1}]

16. When 5 ml of 8N nitric acid, 4.8 ml of 5N hydrochloric acid and a certain volume of 17 M sulphuric acid are mixed together and made up to 2L. 30 ml of this acid mixture exactly neutralize 42.9 ml of sodium carbonate solution containing one gram of $Na_2CO_3.10H_2O$ in 100 ml of water. Calculate the amount in gram of the sulphate ions in solutions.

17. On analysis a sample of uranium ore was found to contain 0.2 779 of ${}_{82}Pb^{206}$ and 1.667 g of ${}_{92}U^{238}$. The half life period of U^{238} is 4.51×10^9 years. If all the lead were assumed to have come from decay of ${}_{92}U^{238}$, the age of Earth is ...$\times 10^9$ years ?

18. The total number of carboxylic acid groups in the product P is



MATHEMATICS

SECTION-I

General Instructions :

- This section contains **SIX (06)** Question.
- Each question has four options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

1. Let $\sum_{r=1}^{n}(-1)^{r-1}\frac{C_r}{r} = \sum_{r=1}^{n} f(r)$; where $C_r = {}^nC_r$ then value of $\lim_{n\to\infty}\sum_{r=1}^{n}\{f(r)f(r+1)\}$ is

(A) 0 **(B)** –1

(C) 1 **(D)** e

2. If f be a even function and $I_1 = \int_{1-a}^{a} xf(x(1-x))\,dx, I_2 = \int_{1-a}^{a} f(x(1-x))\,dx$ where $2a-1>0$, then $\frac{I_1}{I_2}$ is

(A) 2 **(B)** a

(C) $\frac{1}{2}$ **(D)** 1

3. Let α, β, γ, δ are four roots of the equation $x^4 + 5x^3 + 4x^2 + 5x + 3 = 0$ then $(1 + \alpha^2)(1 + \beta^2)(1 + \gamma^2)(1 + \delta^2)$ is equal to:

(A) 0 **(B)** 1

(C) 4 **(D)** 16

4. If three normals of parabola $y^2 = 4ax$ at points, A, B, C meet at P and F be the focus, then value of $\frac{\text{FA.FB.FC}}{(\text{FP})^2}$ is

(A) $4a$ **(B)** $2a$

(C) a **(D)** none of these

5. Let $f(x)$ is differentiable on [0, 2]. If $f(0) = 0$ and $|f'(x)| \le \frac{1}{2}$ for all x in [0, 2], then

(A) $f(x) \le 2$

(B) $|f(x)| \le 1$

(C) $f(x) = 2x$

(D) $f(x) = 3$ for at least one x in [0, 2]

6. When $x = \frac{1}{2}$ then $\frac{1-2x}{1-x+x^2} + \frac{2x-4x^3}{1-x^2+x^4} + \frac{4x^3-8x^7}{1-x^4+x^8} + ...\infty$ is equal to:

(A) 1 **(B)** $\frac{8}{7}$

(C) $\frac{4}{7}$ **(D)** $\frac{7}{16}$

SECTION-II

General Instructions :

- This section contains **SIX (06)** Question
- Each question has **FOUR** option **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).

7. Let $f(x-y)$, $f(x).f(y)$ and $f(x+y)$ are in A.P. $\forall\, x, y \in$ R and $f(0) \neq 0$ then

(A) $f'(5) = f(-5)$ **(B)** $f(5) = f(-5)$

(C) $f'(5) - f'(-5) = 0$ **(D)** $f'(5) + f'(-5) = 0$

8. Each term of sequence (T_n) being different and $\text{T}_1 = 2$, $\text{T}_n = \frac{\text{T}_{n-1}^2}{\text{T}_{n-2}}$, $\forall\, n \ge 3$, If T_2 and T_5 are +ve integer and $\text{T}_5 \le 162$ then the possible value of T_5 is

(A) 162 **(B)** 64

(C) 32 **(D)** 2

9. Let $f_n(x) = e^{f_{n-1}(x)}$ for all $n \in$ N and $f_0(x) = x$ then $f_n'(x)$ is equal to

(A) $f_n(x)(f_{n-1}'(x))$

(B) $f_n(x)\, f_{n-1}(x)$

(C) $f_n(x)\, f_{n-1}(x)\, ...\, f_2(x)\, f_1(x)$

(D) None of the above

10. Let ABC, be a triangle with in centre at I. If foot of the perpendicular from A to BI and CI are P and Q respectively, then which of the following results are correct?

(A) $\frac{\text{AP}}{\text{BI}} = \frac{\sin\frac{\text{B}}{2}\cos\frac{\text{C}}{2}}{\sin\frac{\text{A}}{2}}$

(B) $\frac{\text{AQ}}{\text{CI}} = \frac{\sin\frac{\text{C}}{2}\cos\frac{\text{B}}{2}}{\sin\frac{\text{A}}{2}}$

(C) $\frac{\text{AP}}{\text{BI}} = \frac{\sin\frac{\text{C}}{2}\cos\frac{\text{B}}{2}}{\sin\frac{\text{A}}{2}}$

(D) $\frac{\text{AP}}{\text{BI}} + \frac{\text{AQ}}{\text{CI}} = \sqrt{3}$ if $\angle\text{A} = 60°$

11. If $\vec{a}$, $\vec{b}$, $\vec{c}$, be three unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{u}$, $\vec{a}.\vec{u} = \frac{3}{2}$, $\vec{b}.\vec{u} = \frac{7}{4}$ and $|\vec{u}| = 2$, then

(A) $\vec{a}.\vec{b} = \frac{3}{4}$ **(B)** $\vec{a}.\vec{c} = 0$

(C) $\vec{a}.\vec{b} = \frac{1}{2}$ **(D)** $\vec{b}.\vec{c} = \frac{1}{4}$

12. Let $I_1 = \int_1^e (1+x)(x+\ln x)^{100}\,dx$ and

$I_2 = \int_{\sin^{-1}(1/e)}^{\pi/2} (1+e\sin x + \ln \sin x)^{101}\cos x\,dx$

If $I_1 + \frac{e}{101} I_2 = \frac{e(1+e)^{101} - K}{101}$ then value K is greater than

(A) 0 **(B)** 1

(C) 2 **(D)** –1

SECTION-III

General Instructions :

- This section contains **SIX (06)** Question.
- The answer to each question is a **SINGLE DIGIT INTEGER ranging from 0 to 9, BOTH INCLUSIVE.**
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

13. In a game a tosses 2 fair coins and B tosses 3 fair coins. The person who throws greater number of heads win the game. In case of a tie, the game is continued until any one finally wins the game. If the probability that 'A' finally wins the game is $\frac{K}{11}$ then K is ....

14. O (0, 0), P (–3, – 1) and Q (–1, –3) are vertices of a triangle OPQ. If line $ax + by + 2 = 0$ is parallel to PQ and perpendicular distance from the origin is $\frac{1}{\sqrt{2}}$, then the value of $\frac{a^4+b^4}{4}$ is ....

15. In ΔPQR, $\angle$PQR = 45°, point S lies on side BC such that 2QS = SR and $\angle$QPS = 15° and $\angle$PRQ is (25K)° then K is equal to ....

16. If $1 \le l < k \le n$ where n is a positive integer such that $\frac{\sin^2 nx}{\sin^2 x} = a_0 + \sum_{1\le l<k\le n} a_{l,k} \cos 2(k-l)\ \forall\ x \in$ R and $x \ne k\pi$ where $k \in z$, then the value of $a_{l,k}$ is ....

17. If f : R → R be a twice differentiable function such that $t^2 f(x) - 2t f'(x) + f''(x) = 0$ has two equal roots of $t\ \forall\ x$ and $f(0) = 1$ $f'(0) = 2$ then value of $\lim_{x\to 0}\left(\frac{f(x)-1}{x} - \frac{t}{2}\right)$ is ....

18. If a, b, c, d are the roots of the equation $Q(x) = x^4 - x^3 - x^2 - 1 = 0$ and $P(x) = x^6 - x^5 - x^3 - x^2 - x$. Then $P(A) + P(B) + P(C) + P(D) =$ ....

ANSWER KEY

PHYSICS

1.	B	**10.**	A, B, C, D
2.	C	**11.**	A, B, C
3.	A	**12.**	A, B, C, D
4.	A	**13.**	4.13
5.	A	**14.**	0.03
6.	A	**15.**	1.11
7.	B, D	**16.**	3.32
8.	A, B, C, D	**17.**	0.27
9.	A, B, C	**18.**	10.08

MATHEMATICS

1.	C	**10.**	A, B, D
2.	C	**11.**	B, C, D
3.	A	**12.**	A, B, C, D
4.	C	**13.**	3
5.	B	**14.**	8
6.	B	**15.**	3
7.	B, D	**16.**	2
8.	A, C	**17.**	1
9.	A, C	**18.**	6

CHEMISTRY

1.	C	**10.**	A, C, D
2.	B	**11.**	B, C
3.	A	**12.**	A, C, D
4.	D	**13.**	126
5.	B	**14.**	56.28
6.	A	**15.**	4
7.	A, C	**16.**	6.528
8.	A, C, D	**17.**	1.143
9.	B, C	**18.**	2