

08/04/2023

Morning



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Memory Based Answers & Solutions

Time : 3 hrs.

for

M.M. : 300

JEE (Main)-2023 (Online) Phase-2

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

- (1) The test is of **3 hours** duration.
- (2) The Test Booklet consists of 90 questions. The maximum marks are 300.
- (3) There are **three** parts in the question paper consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each part (subject) has two sections.
 - (i) **Section-A:** This section contains 20 multiple choice questions which have only one correct answer. Each question carries **4 marks** for correct answer and **-1 mark** for wrong answer.
 - (ii) **Section-B:** This section contains 10 questions. In Section-B, attempt any **five questions out of 10**. The answer to each of the questions is a numerical value. Each question carries **4 marks** for correct answer and **-1 mark** for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. For an electron and a proton ($m_p = 1847 m_e$) with same de-Broglie wavelength, the ratio of linear momentum is equal to

- (1) 1 : 2 (2) 2 : 1847
(3) 1 : 1 (4) $\sqrt{1847} : 1$

Answer (3)

Sol. $\lambda = \frac{h}{p}$

As $p_1 = p_2 \Rightarrow \lambda_1 = \lambda_2$

2. If the weight of an object on earth's surface is 400 N, then weight of the same object at a depth

$\frac{R}{2}$ from surface would be (R is radius of earth)

- (1) 100 N (2) 300 N
(3) 200 N (4) 250 N

Answer (3)

Sol. $W' = W \left(1 - \frac{R/2}{R}\right)$
 $= 400 \left(1 - \frac{1}{2}\right) = 200 \text{ N}$

3. If two particles A and B are projected with speed of 40 m/s and 60 m/s at an angle of 30° and 60° with the horizontal respectively. The ratio of the range of A to B will be

- (1) $\sqrt{2} : 3$ (2) $\sqrt{3} : 2$
(3) 4 : 9 (4) 2 : 1

Answer (3)

Sol. $\frac{u_1^2 \sin 2\theta_1}{g} = \frac{u_2^2 \sin 2\theta_2}{g}$
 $\frac{u_1^2 \sin 2\theta_1}{u_2^2 \sin 2\theta_2} = \frac{u_1^2}{u_2^2} \times \frac{\sin 2\theta_1}{\sin 2\theta_2}$
 $= \frac{4}{9} \times \frac{\frac{\sqrt{3}}{2}}{\left(\frac{\sqrt{3}}{2}\right)} = \frac{4}{9}$

4. Two forces of magnitude A and $\frac{A}{2}$ act perpendicular to each other. The magnitude of the resultant force is equal to

- (1) $\frac{A}{2}$ (2) $\frac{\sqrt{5}A}{2}$
(3) $\frac{3A}{2}$ (4) $\frac{5A}{2}$

Answer (2)

Sol. $A_{\text{net}} = \sqrt{A^2 + \frac{A^2}{4}}$
 $= \frac{\sqrt{5}A}{2}$

5. An air bubble having volume 1 cm^3 at depth 40 m inside water comes to surface. What will be the volume of the bubble at the surface?

- (1) 5 cm^3 (2) 2 cm^3
(3) 4 cm^3 (4) 3 cm^3

Answer (1)

Sol. Initial pressure = $P_0 + \rho gh$
 $= 10^5 + 1000 \times 10 \times 40$
 $= 5 \times 10^5$

Final pressure = 10^5

$PV = \text{constant}$

$\Rightarrow 5 \times 10^5 \times V_i = 10^5 \times V_f$

$\Rightarrow V_f = 5 \text{ cm}^3$

6. The height of antenna is 98 m. The radius of earth is 6400 km. The area upto which it will transmit signal, is

- (1) 3642 km^2 (2) 3942 km^2
(3) 11200 km^2 (4) 22400 km^2

Answer (2)

Sol. $r = \sqrt{2Rh}$

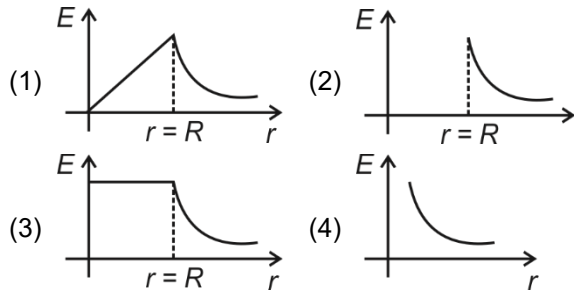
Area = $\pi r^2 = 2\pi Rh$

$= 2 \times \frac{22}{7} \times 6400 \times 10^3 \times 98$

$= 3942.4 \times 10^6 \text{ m}^2$

$= 3942.4 \text{ km}^2$

7. The graph showing the variation of electric field (E) with the distance (r) from the centre of a conducting spherical shell is



Answer (2)

Sol. $E_{\text{inside shell}} = 0$

$$E_{\text{outside shell}} = \frac{KQ}{r^2}$$

8. If mass, radius of cross-section and height of a cylinder are $(0.4 + 0.01)$ g, $(6 + 0.03)$ m and height $(8 + 0.04)$ m. The maximum percentage error in the measurement of density of cylinder is

- (1) 1% (2) 4%
 (3) 8% (4) 7%

Answer (2)

Sol. $\rho = \frac{m}{\pi r^2 h}$

$$\frac{\Delta \rho}{\rho} = \pm \left(\frac{\Delta m}{m} + \frac{2\Delta r}{r} + \frac{\Delta h}{h} \right) = 0.04$$

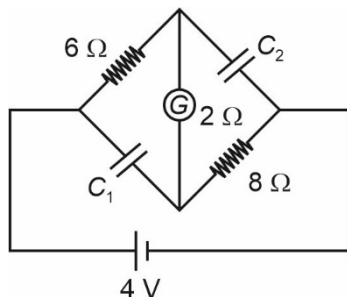
9. An atom of atomic mass 242, having binding energy per nucleon 8.4 MeV, breaks into two atoms of atomic mass 121 each (with binding energy per nucleon 7.1 MeV). Find the absolute Q-value of the reaction

- (1) 150 MeV (2) 314.6 MeV
 (3) 208.4 MeV (4) 290.8 MeV

Answer (2)

Sol. Q-value = $242 [8.4 - 7.1]$ MeV
 = 314.6 MeV

10. What is the ratio of potential difference across C_1 and C_2 at steady state for the given circuit?



- (1) 4 : 5 (2) 2 : 5
 (3) 1 : 4 (4) 3 : 1

Answer (1)

Sol. At steady state $R_{\text{eq}} = 6 + 2 + 8 = 16 \Omega$

$$i_{\text{battery}} = \frac{4}{16} = \frac{1}{4} \text{ A}$$

$$\Delta V_{C_1} = \frac{1}{4} \times 8 = 2 \text{ V}$$

$$\Delta V_{C_2} = \frac{1}{4} \times 10 = \frac{5}{2} \text{ V}$$

11. If velocity of charged particle has the component both in and perpendicular to the direction of magnetic field then the path traced by the charged particle will be

- (1) Circular (2) Straight line
 (3) Cycloid (4) Helical

Answer (4)

Sol. Velocity perpendicular to \vec{B} will cause circular motion which parallel to \vec{B} will cause pitch so helical motion is the correct answer.

12. The dimension of $\frac{1}{\mu_0 \epsilon_0}$ is

- (1) MLT^{-1} (2) M^0LT^{-2}
 (3) ML^2T^{-1} (4) $M^0L^2T^{-2}$

Answer (4)

Sol. $\frac{1}{\mu_0 \epsilon_0} = (LT^{-1})$

$$\frac{1}{\mu_0 \epsilon_0} = (L^2T^{-2})$$

13. In an LC oscillating circuit with $L = 75$ mH and $C = 30 \mu\text{F}$. The maximum charge of capacitor is $2.7 \times 10^{-4}\text{C}$. Maximum current through the circuit will be

- (1) 0.18 Amp (2) 0.24 Amp
 (3) 0.72 Amp (4) 0.92 Amp

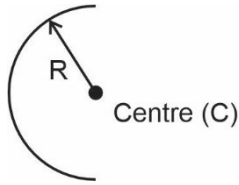
Answer (1)

Sol. $\frac{1}{2} \times 75 \times 10^{-3} \times I^2 = \frac{1}{2} \times \frac{2.7 \times 2.7 \times 10^{-9}}{3 \times 10^{-6}}$

$$I^2 = \frac{27 \times 9}{75} \times 10^{-2} = \frac{81}{25} \times 10^{-2}$$

$$\Rightarrow I = \frac{0.9}{5} \text{ Amp} = 0.18 \text{ Amp}$$

14. The moment of inertia of a semi-circular ring of mass M and radius R about an axis passing through centre and perpendicular to the plane of ring is



- (1) MR^2 (2) $\frac{1}{2}MR^2$
 (3) $2MR^2$ (4) $\frac{3}{4}MR^2$

Answer (1)

Sol. Distance of mass from centre is same so,

$$I = \int dmR^2 = R^2 \int dm = MR^2$$

15. **Statement (1):** If total energy of a satellite revolving around earth in circular path is E , then potential energy of satellite is $2E$

Statement (2): Kinetic energy is also twice of total energy

- (1) (1) & (2), both are true
 (2) (1) is true, but (2) is false
 (3) Both (1) & (2) are false
 (4) (1) is false, but (2) is true

Answer (2)

Sol. Total energy = $-\frac{Gm_1m_2}{2r}$

$$P \cdot E = -\frac{Gm_1m_2}{r}$$

$$K \cdot E = \frac{Gm_1m_2}{2r}$$

16. Consider the following Assertion (A) and Reason (R):

(A): When heat is supplied to a system, temperature increase.

(R): Positive work done by the system increases volume of thermodynamic system.

- (1) Assertion is true, reason is false
 (2) Assertion is false, reason is true
 (3) Both are true and reason is correct explanation of assertion
 (4) Both are true and reason is incorrect explanation of assertion

Answer (2)

Sol. When heat is supplied, if work done exceeds increase in internal energy, then $\Delta T < 0$.

Also, if volume increases \rightarrow work done is positive

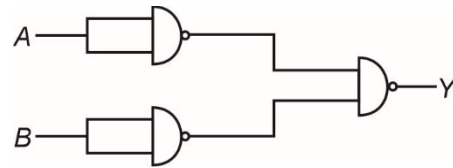
17. Two different lenses are used in telescope because

- (1) Magnification is increased
 (2) Focal length is increased
 (3) More light is captured
 (4) Spherical aberration is increased

Answer (1)

Sol. Theoretical.

18. The truth table of the given circuit is



(1)

A	B	Y
1	0	1
0	0	0
1	1	1
0	1	1

(2)

A	B	Y
1	0	1
0	0	0
1	1	0
0	1	1

(3)

A	B	Y
1	0	1
0	0	1
1	1	1
0	1	1

(4)

A	B	Y
1	0	0
0	0	0
1	1	0
0	1	0

Answer (1)

Sol.

A	B	\bar{A}	\bar{B}	Y
1	0	0	1	1
0	0	1	1	0
1	1	0	0	1
0	1	1	0	1

19. In a lake of depth 40 m a bubble is at bottom. Assuming temperature and density of lake water to be uniform find density of air in bubble. (Assume temperature $T = 12^\circ\text{C}$ and density water = 10^3 kg/m^3)

- (1) 16.76 kg/m^3 (2) 15.32 kg/m^3
 (3) 6.33 kg/m^3 (4) 45.94 kg/m^3

Answer (3)

Sol. $PV = \frac{m}{M}RT$

$$\Rightarrow PM = \rho RT$$

$$\Rightarrow \rho = \frac{5 \times 10^5 \times 30 \times 10^{-3}}{8.314 \times 285}$$

$$= 6.33 \text{ kg/m}^3$$

20. A train is moving with a speed of 10 m/s towards a platform and blows a horn with frequency 400 Hz. Find the frequency heard by a passenger standing on the platform. Take speed of sound = 310 m/s.
- (1) 405 Hz (2) 425 Hz
 (3) 380 Hz (4) 413 Hz

Answer (4)

Sol. $f' = f \left[\frac{v - v_0}{v - v_s} \right]$

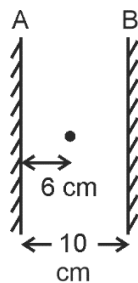
$$= 400 \left[\frac{310 - 0}{310 - 10} \right]$$

$$= \frac{4}{3}(310) \text{ Hz} \simeq 413 \text{ Hz}$$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. In the given diagram, find the distance (in cm) between 2nd and 3rd image formed left of mirror A.



Answer (12.00)

Sol.

	A		B
	6	10	4
2 nd	14	10	16
3 rd	26	10	24

Distance = 26 - 14
 = 12 cm

22. In a long solenoid the magnetic field intensity inside the solenoid is equal to $1.6 \times 10^{-3} \text{ T}$. If number of turns per unit length on the solenoid is equal to $\frac{8}{\pi}$ per cm then current flowing in the solenoid is equal to _____ Amperes.

Answer (5)

Sol. $B = \mu_0 n I$

$$I = \frac{1.6 \times 10^{-3} \times 10^7 \times \pi}{800 \times 4 \pi}$$

$$= \frac{160}{32} = 5 \text{ Amperes}$$

23. A particle of mass 500 grams is moving with velocity $\vec{v} = 2t\hat{i} + 3t^2\hat{j}$ m/s. Then the force on the particle at $t = 1$ s is $\hat{i} + x\hat{j}$ N. Find x.

Answer (3)

Sol. $\vec{a} = 2\hat{i} + 6t\hat{j}$

$$\Rightarrow \vec{F} = m\vec{a} = \hat{i} + 3t\hat{j}$$

$$= \hat{i} + 3\hat{j} \text{ N at } t = 1.$$

24. Momentum of a particle is increased by 50% by keeping its mass constant. Percentage increase in kinetic energy of particle is

Answer (125)

Sol. K.E. = $\frac{p^2}{2m}$

$$\text{K.E.}_i = \frac{p_i^2}{2m}$$

$$\text{K.E.}_f = \frac{p_f^2}{2m} = \frac{2.25p_i^2}{2m}$$

$$= 2.25 \text{ K.E.}_i$$

25. An electric dipole with dipole moment $5 \mu\text{cm}$ is placed in a region with uniform electric field 600 N/C at angle 90° with the direction of field. The torque experienced by the dipole (in milli Newton-meters) is equal to _____.

Answer (3)

Sol. $\tau = |\vec{p} \times \vec{E}| = 5 \times 10^{-6} \times 600 \text{ Nm} = 3 \times 10^{-3} \text{ Nm}$

26.

Answer ()

- Sol.**
 27.
 28.
 29.
 30.

CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

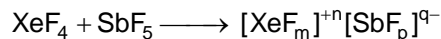
Choose the correct answer:

1. Which of the following elements is most reactive?
 (1) Ca (2) Mg
 (3) Sr (4) K

Answer (4)

Sol. (K) potassium is most reactive out of the given elements.

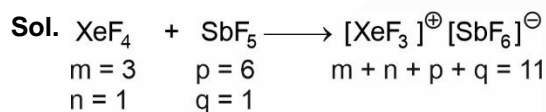
2. Consider the following reaction



The value of $m + n + p + q$ is

- (1) 10 (2) 8
 (3) 6 (4) 11

Answer (4)



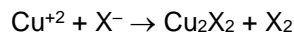
3. The extraction of which one of the following metals involves concentration of the ore by leaching.

- (1) Copper (2) Magnesium
 (3) Aluminium (4) Potassium

Answer (3)

Sol. Bauxite, $(\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O})$, the ore of aluminium is concentrated by leaching by using aq. NaOH solution at high temperature and high pressure.

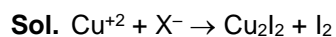
4. Consider the reaction



Final product X_2 will be predominantly.

- (1) Cl_2
 (2) Br_2
 (3) I_2
 (4) All halogens are possible

Answer (3)



X_2 is therefore I_2

5. Read the following two statements

Statement-I : Ionic radius of Li^+ is greater than Mg^{++} .

Statement-II : Lithium and Magnesium can't form superoxide.

- (1) **Statement-I** and **Statement-II** both are correct
 (2) **Statement-I** and **Statement-II** both are incorrect
 (3) **Statement-I** is correct and **Statement-II** is incorrect
 (4) **Statement-I** is incorrect and **Statement-II** is correct

Answer (1)

Sol. Radius of $\text{Li}^+ = 76$ pm and that of Mg^{++} is 72 pm. Both Li and Mg are not able to form peroxide due to their small size.

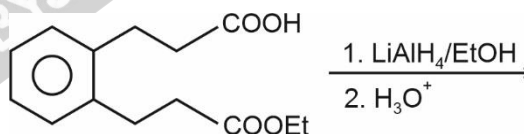
6. Why gypsum is used in cement?

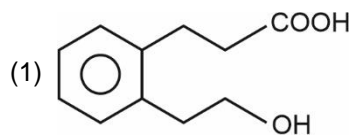
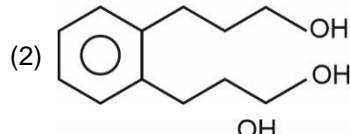
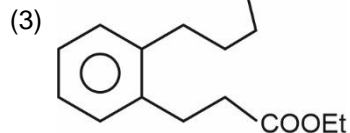
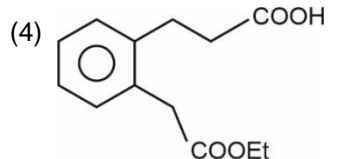
- (1) To increase the hydration of the constituents
 (2) To give a hard mass
 (3) To slow down the process of setting of the cement
 (4) To increase the rate of setting of the cement.

Answer (3)

Sol. Gypsum is added to the cement to slow down the process of setting of the cement.

7. Choose the correct product—

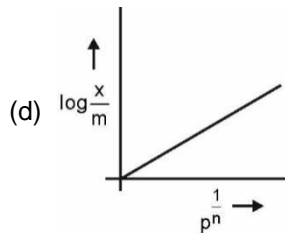
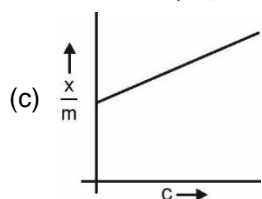
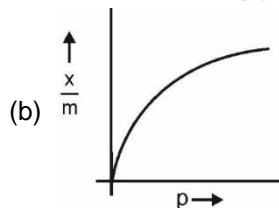
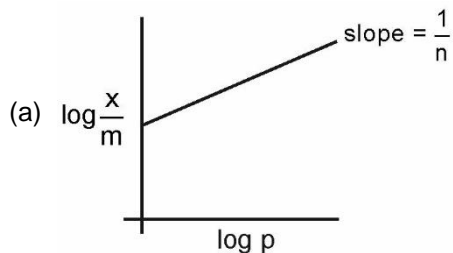


- (1) 
 (2) 
 (3) 
 (4) 

Answer (2)

Sol. LiAlH_4 will reduce both carboxylic acid and ester to Alcohol.

8. Which of the following plots correctly represents Freundlich adsorption isotherm?



(1) a, b

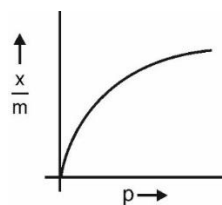
(2) a, b, c

(3) a, b, d

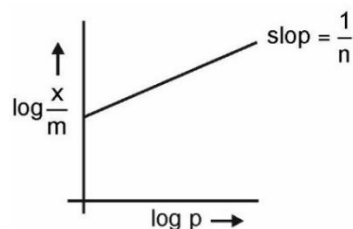
(4) b, d

Answer (1)

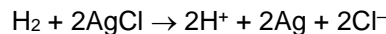
Sol. $\frac{x}{m} = kp^n$



and $\log \frac{x}{m} = \log k + \frac{1}{n} \log p$



9. Which cell representation is correct for the reaction given below



(1) $\text{Pt}|\text{H}_2|\text{HCl}||\text{AgCl}|\text{Ag}$

(2) $\text{Pt}|\text{H}_2|\text{HCl}||\text{AgCl}|\text{Pt}$

(3) $\text{Ag}|\text{AgCl}|\text{HCl}|\text{H}_2|\text{Pt}$

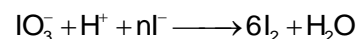
(4) $\text{Pt}|\text{AgCl}|\text{HCl}|\text{H}_2|\text{Pt}$

Answer (1)

Sol. Anode : $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$

Cathode : $\text{e}^- + \text{AgCl} \rightarrow \text{Ag} + \text{Cl}^-$

10. Find the value of 'n' in the following redox reaction



(1) 10

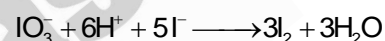
(2) 12

(3) 9

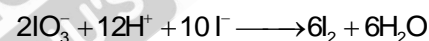
(4) 5

Answer (1)

Sol. n-factor of IO_3^- and I^- in the given redox reaction are 5 and 1 respectively. Therefore, IO_3^- and I^- will always react in the molar ratio 1 : 5 to get I_2



To get 6 molar of I_2 , multiply through out by 2.



$\therefore n = 10$

11. For an electron and proton with same de-Broglie wavelength, the ratio of linear momentum is equal to

(1) 1 : 2

(2) 2 : 1847

(3) 1 : 1

(4) $\sqrt{1847} : 1$

Answer (3)

Sol. $\lambda = \frac{h}{p}$

As λ is same, p is same. \therefore Ratio is 1 : 1

12. Which of the following is most stable, diamagnetic and octahedral shaped?

(1) $\text{K}_3[\text{Co}(\text{CN})_6]$

(2) $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}$

(3) $\text{Na}_3[\text{CoF}_6]$

(4) All have exact equal stability

Answer (1)

Sol. $[\text{Co}(\text{CN})_6]^{3-}$ and $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ are diamagnetic but first one is more stable as Δ_0 is high for first complex.

13. Select the correct order of electronegativity of the elements : B, C, At, S

- (1) $\text{B} > \text{C} > \text{S} > \text{At}$
- (2) $\text{S} > \text{C} > \text{B} > \text{At}$
- (3) $\text{C} > \text{B} > \text{S} > \text{At}$
- (4) $\text{S} > \text{C} > \text{At} > \text{B}$

Answer (4)

Sol. The electronegativity of B (2), C (2.5), At (2.2) & S (2.58). Hence the order will be $\text{S} > \text{C} > \text{At} > \text{B}$

14. Which of the following has same d-electrons as chromium in chromyl chloride?

- (1) Fe(III)
- (2) Ni(III)
- (3) Mn(VII)
- (4) Co(II)

Answer (3)

Sol. Mn^{7+} as d^0 configuration which is same as Cr^{6+} in CrO_2Cl_2 .

15. Syn gas with Cu as catalyst produces :

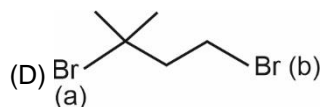
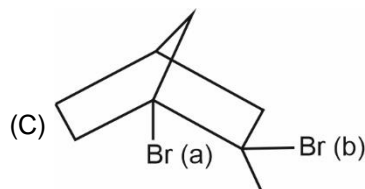
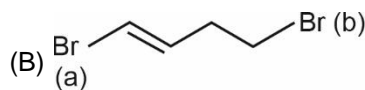
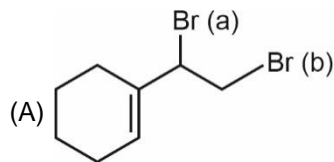
- (1) Ethanol
- (2) Methanal
- (3) Methane
- (4) Methanoic acid

Answer (2)

Sol. $\text{CO} + \text{H}_2 \xrightarrow{\text{Cu}} \text{HCHO}$

Ref: NCERT (Catalysis – Surface chemistry)

16. Consider the following compounds



Which of the following options represent correctly the Br atoms which are more reactive in $\text{S}_{\text{N}}1$ mechanism?

(1) (A) Br – (a)

(B) Br – (a)

(C) Br – (a)

(D) Br – (a)

(2) (A) Br – (a)

(B) Br – (b)

(C) Br – (b)

(D) Br – (a)

(3) (A) Br – (b)

(B) Br – (b)

(C) Br – (b)

(D) Br – (a)

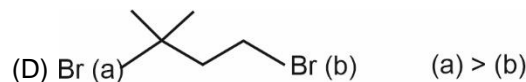
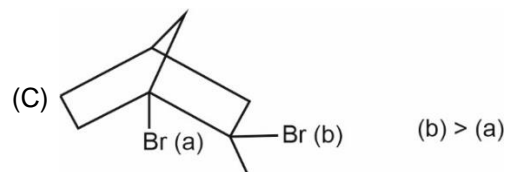
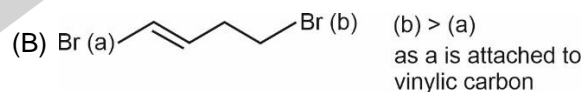
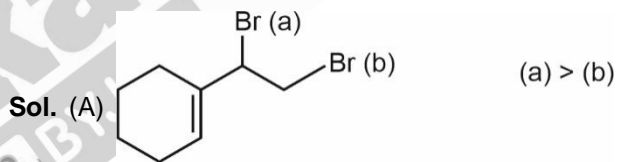
(4) (A) Br – (a)

(B) Br – (b)

(C) Br – (b)

(D) Br – (b)

Answer (2)



Hence (2) is correct

17. For the ions: $[\text{MnF}_6]^{4-}$, $[\text{Fe}(\text{CN})_6]^{3-}$ & $[\text{Co}(\text{NH}_3)_6]^{3+}$. The order of the spin magnetic moment is correct in which of the following option

(1) $[\text{MnF}_6]^{4-} > [\text{Co}(\text{NH}_3)_6]^{3+} > [\text{Fe}(\text{CN})_6]^{3-}$

(2) $[\text{Fe}(\text{CN})_6]^{3-} > [\text{MnF}_6]^{4-} > [\text{Co}(\text{NH}_3)_6]^{3+}$

(3) $[\text{MnF}_6]^{4-} > [\text{Fe}(\text{CN})_6]^{3-} > [\text{Co}(\text{NH}_3)_6]^{3+}$

(4) $[\text{Co}(\text{NH}_3)_6]^{3+} > [\text{Fe}(\text{CN})_6]^{3-} > [\text{MnF}_6]^{4-}$

Answer (3)

Sol. The unpaired electrons present in the given ions are 5 for $[\text{MnF}_6]^{4-}$, 1 for $[\text{Fe}(\text{CN})_6]^{3-}$ & 0 for $[\text{Co}(\text{NH}_3)_6]^{+3}$ hence the option 3 is correct

18. Match the column.

Column-I

(A) Neutral FeCl_3

(B) Iodoform

(C) Carbylamine test

(D) CuSO_4 + Sodium

potassium tartarate
(Rochelle's salt)

(1) A(Q); B(R); C(P); D(S)

(2) A(P); B(R); C(Q); D(S)

(3) A(Q); B(P); C(R); D(S)

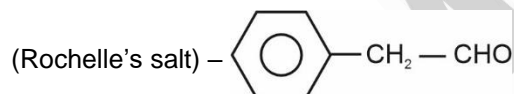
(4) A(Q); B(P); C(S); D(Q)

Answer (3)

Sol. Neutral FeCl_3 – Phenol



CuSO_4 + Sodium Potassium tartrate



19. Match the Column I and II.

	Column I		Column II
A.	Saccharin	1.	Sweetest Sugar
B.	Alitame	2.	Unstable at cooking temperature
C.	Aspartame	3.	Stable at Cooking temperature
D.	Sucralose	4.	First Popular artificial sugar used

(1) A →4; B→1; C→2; D→3

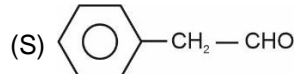
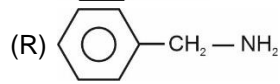
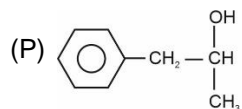
(2) A →1; B→2; C→3; D→4

(3) A →2; B→1; C→4; D→3

(4) A →3; B→2; C→4; D→1

Answer (1)

Column-II



Sol. Option (1) is correct based on the information.

20. Which of the following reagents are used to react with diazonium salt ($\text{Ph}-\text{N}_2^+\text{X}^-$) to get the product given against each reagent.

(a) HBF_4 $\text{Ph}-\text{F}$

(b) CuCN/KCN $\text{Ph}-\text{CN}$

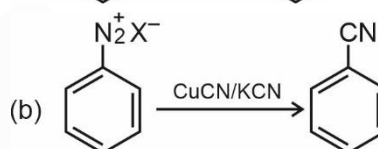
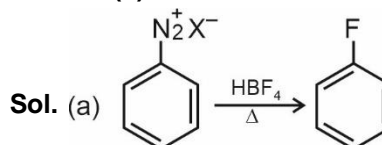
(c) CuCl_2/HCl $\text{Ph}-\text{Cl}$

(d) $\text{Ph}-\text{NH}_2$ $\text{Ph}-\text{N}=\text{N}-\text{Ph}$

(1) (a) and (b) (2) (a), (b) and (c)

(3) (a), (b), (c) and (d) (4) (a), (b) and (d)

Answer (1)



SECTION - B

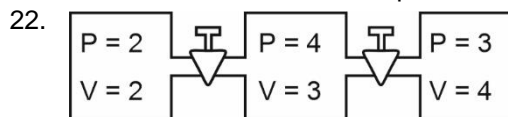
Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. How many factors will contribute to major role in covalent character of a compound.

- (A) Polarising power of Cation
- (B) Polarisability of the anion
- (C) Distortion caused by Cation
- (D) Polarisability of cation

Answer (03.00)

Sol. Polarisability of cation doesn't play a major role in covalent character of a compound.



Calculate final pressure once values are released?
(Round off to the nearest integer)

Answer (03)

Sol. $P_1V_1 + P_2V_2 + P_3V_3 = PV$

$$2 \times 2 + 4 \times 3 + 3 \times 4 = P \times 9$$

$$\therefore P = \frac{28}{9} = 3.11 \approx 3$$

23. How many statements are correct:

- (1) If there is no relation between rate constant and temperature, then activation energy is negative.
- (2) If the activation energy is zero, rate constant is temperature independent.
- (3) If rate constant increases with increase of temperature, activation energy is positive
- (4) If rate constant decreases with increase in temperature, activation energy is negative.

Answer (3)

Sol. $k = Ae^{-E_a/RT}$

$$\ln k = \ln A - \frac{E_a}{RT}$$

Clearly, if $E_a = 0$, k is temperature independent

if $E_a > 0$, k increases with increase in temperature

if $E_a < 0$, k decreases with increase in temperature

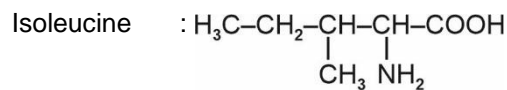
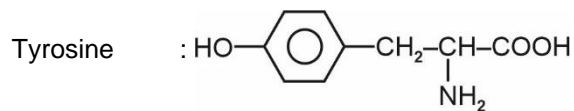
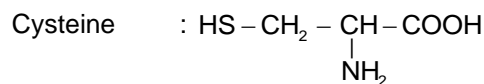
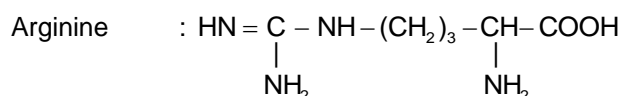
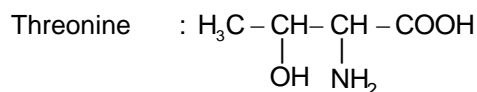
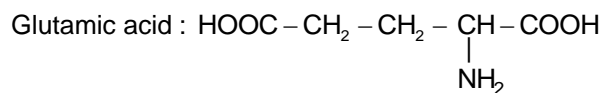
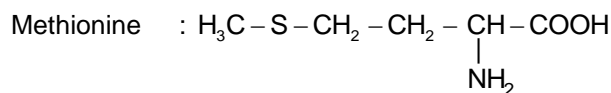
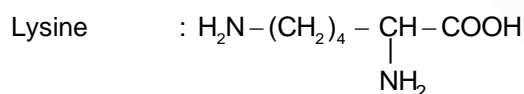
Hence, 2, 3, 4 are correct statements.

24. How many of the following α -amino acids contain sulphur?

Lysine ; Methionine; Glutamic acid; Threonine
Arginine; Cysteine; Tyrosine; Isoleucine

Answer (2)

Sol. The structures of the given α -amino acids are



Methionine and Cysteine contain sulphur

25. 0.5 gm of an organic compound with 60% Carbon will produce _____ gm of CO_2 upon complete combustion

Answer (01.10)

Sol. Moles of Carbon = $\frac{0.5 \times 0.6}{12}$

$$\text{Moles of CO}_2 = \frac{0.5 \times 0.6}{12}$$

$$\text{Mass of CO}_2 = \frac{0.5 \times 0.6}{12} \times 44 = 1.1 \text{ gm}$$

26. How many of the following are not correctly matched?

	Metals or Ions		Maximum prescribed concentration in drinking water (ppm)
A.	Zn	1.	5
B.	F^-	2.	10
C.	NO_3^-	3.	50
D.	SO_4^{2-}	4.	> 500
E.	Mn	5.	0.05

Answer (04.00)

Sol. Maximum prescribed concentration of F^- ion in drinking water is 1 ppm. Rest all are correct matches.

- 27.
- 28.
- 29.
- 30.

MATHEMATICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Shortest distance between lines

$$\frac{x-5}{4} = \frac{y-3}{6} = \frac{z-2}{4} \text{ and } \frac{x-3}{7} = \frac{y-2}{5} = \frac{z-9}{6} \text{ is}$$

- (1) $\frac{190}{37}$ (2) $\frac{190}{\sqrt{756}}$
 (3) $\frac{37}{190}$ (4) $\frac{756}{\sqrt{190}}$

Answer (2)

Sol. $\vec{n}_1 \times \vec{n}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & 6 & 4 \\ 7 & 5 & 6 \end{vmatrix}$

$$= 16\hat{i} + 4\hat{j} - 22\hat{k}$$

$$d = \frac{|(\vec{a} - \vec{b}) \cdot (\vec{n}_1 \times \vec{n}_2)|}{|\vec{n}_1 \times \vec{n}_2|}$$

$$= \frac{|(2\hat{i} + \hat{j} - 7\hat{k}) \cdot (16\hat{i} + 4\hat{j} - 22\hat{k})|}{\sqrt{16^2 + 4^2 + (22)^2}}$$

$$= \frac{|32 + 4 + 154|}{\sqrt{256 + 16 + 484}}$$

$$= \frac{190}{\sqrt{756}}$$

2. Consider the word "INDEPENDENCE". The number of words such that all the vowels are together, is

- (1) 16800 (2) 15800
 (3) 17900 (4) 14800

Answer (1)

Sol. Vowels: I E E E E

Consonants: N N N D D P C

I E E E E 3N, 2D, P, C

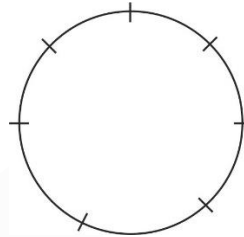
Number of required words = $\frac{8!}{3!2!} \times \frac{5!}{4!}$
 = 16800

3. 7 boys and 5 girls are to be seated around a circular table such that no two girls sits together is

- (1) $126(5!)^2$ (2) $720(5!)$
 (3) $720(6!)$ (4) 720

Answer (1)

Sol. $B_1, B_2, B_3, B_4, B_5, B_6, B_7$



Boys can be seated in $(7 - 1)!$ ways = $6!$

Now ways in which no two girls can be seated together is

$$6! \times {}^7C_5 \times 5!$$

$$6! \times \frac{7!}{5!2!} \times 5!$$

$$= 126(5!)^2$$

4. Consider the data : x, y, 10, 12, 4, 6, 8, 12. If mean is 9 and variance is 9.25, then the value of $3x - 2y$ is ($x > y$)

- (1) 25 (2) 1
 (3) 24 (4) 13

Answer (1)

Sol. $9 = \frac{52 + x + y}{8}$

$\Rightarrow x + y = 20$

$9.25 = \frac{x^2 + y^2 + 100 + 144 + 16 + 36 + 64 + 144}{8} - 81$

$\Rightarrow 722 = x^2 + y^2 + 504$

$\Rightarrow x^2 + y^2 = 218$

$(x + y)^2 - 2xy = 218$

$\Rightarrow xy = 91$

$\therefore x = 13, y = 7$

$3x - 2y = 39 - 14$

= 25

5. Coefficient independent of x in the expansion of

$$\left(3x^2 - \frac{1}{2x^5}\right)^7 \text{ is}$$

(1) $\frac{5103}{4}$

(2) $\frac{5293}{6}$

(3) $\frac{6715}{3}$

(4) $\frac{7193}{4}$

Answer (1)

Sol. $T_{r+1} = {}^7C_r (3x^2)^{7-r} \left(\frac{-1}{2x^5}\right)^r$

$$= {}^7C_r 3^{7-r} \left(\frac{-1}{2}\right)^r x^{14-7r}$$

$$\Rightarrow 14 - 7r = 0$$

$$\Rightarrow r = 2$$

\therefore Coefficient of x^0 is

$${}^7C_2 3^5 \times \frac{1}{4}$$

$$\frac{7 \times 6 \times 3^5}{2 \times 1 \times 4}$$

$$= \frac{5103}{4}$$

6. Dot product of two vectors is 12 and cross product is $4\hat{i} + 6\hat{j} + 8\hat{k}$ find product of modulus of vectors

(1) $4\sqrt{35}$

(2) $2\sqrt{65}$

(3) $5\sqrt{37}$

(4) $6\sqrt{37}$

Answer (2)

Sol. Let the vectors be \vec{a} and \vec{b}

$$|(\vec{a} \times \vec{b})|^2 = |\vec{a}|^2 |\vec{b}|^2 - (\vec{a} \cdot \vec{b})^2$$

$$116 + 144 = (|\vec{a}| |\vec{b}|)^2$$

$$\Rightarrow |\vec{a}| |\vec{b}| = \sqrt{260}$$

7. If the coefficients of three consecutive terms in the expansion of $(1+x)^n$ are in the ratio 1 : 5 : 20, then the coefficient of the fourth term of the expansion is

(1) 3654

(2) 3658

(3) 3600

(4) 1000

Answer (1)

Sol. Given ${}^nC_{r-1} : {}^nC_r : {}^nC_{r+1} = 1 : 5 : 20$

$$\therefore \frac{n!}{(r-1)!(n-r+1)!} \times \frac{r!(n-r)!}{n!} = \frac{1}{5}$$

$$\frac{r}{n-r+1} = \frac{1}{5}$$

$$\Rightarrow n - r + 1 = 5r$$

$$n = 6r - 1 \quad \dots(i)$$

Now,

$$\frac{n!}{r!(n-r)!} \times \frac{(r+1)!(n-r-1)!}{n!} = \frac{5}{20}$$

$$\Rightarrow \frac{r+1}{n-r} = \frac{1}{4}$$

$$\Rightarrow 4r + 4 = n - r$$

$$n = 5r + 4 \quad \dots(ii)$$

By (i) and (ii)

$$5r + 4 = 6r - 1$$

$$\Rightarrow r = 5$$

$$\text{and } n = 29$$

Now coefficient of fourth term

$$= {}^nC_3 = {}^{29}C_3 = 3654$$

8. The area under the curve of equations: $x^2 \leq y$, $y \leq 8 - x^2$ and $y \leq 7$, is

(1) $\frac{16}{3}$

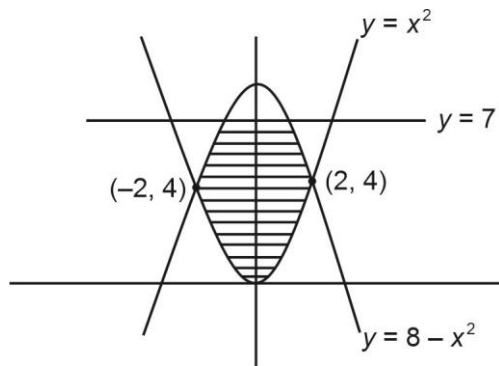
(2) 18

(3) 20

(4) $\frac{22}{3}$

Answer (3)

Sol :



$$\text{Required area} = 2 \left[\int_0^4 \sqrt{y} \, dy + \int_4^7 (\sqrt{8-y}) \, dy \right]$$

$$= 2 \left[\frac{y^{\frac{3}{2}}}{\frac{3}{2}} \Big|_0^4 - \frac{(8-y)^{\frac{3}{2}}}{\frac{3}{2}} \Big|_4^7 \right]$$

$$= \frac{4}{3} (8 - (1 - 8))$$

$$= \frac{4}{3} (15) = 20 \text{ sq. units}$$

9. $P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}, Q = PAP^T$

$A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$, then $P^T Q^{2007} P = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$. Find $2a + b +$

$3c - 4d$.

(1) 2005

(2) 2007

(3) 2006

(4) 2008

Answer (1)

Sol. $P \times P^T = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

Similarly $P^T P = I$

Now, $Q^{2007} = (PAP^T)(PAP^T) \dots 2007 \text{ times}$
 $= PA^{2007}P^T$

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$$

$$A^3 = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$$

$$A^{2007} = \begin{bmatrix} 1 & 2007 \\ 0 & 1 \end{bmatrix}$$

$$P^T Q^{2007} P = P^T P A^{2007} P^T P = A^{2007} = \begin{bmatrix} 1 & 2007 \\ 0 & 1 \end{bmatrix}$$

$$\Rightarrow a = 1, b = 2007, c = 0, d = 1$$

$$2a + b + 3c - 4d = 2 \times 1 + 2007 + 3 \times 0 - 4 \times 1 = 2005$$

10. A bolt manufacturing factory has three products A, B and C. 50% and 30% of the products are A and B type respectively and remaining are C type. Then probability that the product A is defective is 4%, that of B is 3% and that of C is 2%. A product is picked randomly and found to be defective, then the probability that it is type C.

(1) $\frac{4}{33}$

(2) $\frac{1}{33}$

(3) $\frac{2}{33}$

(4) $\frac{9}{33}$

Answer (1)

Sol. Product A is 50%, B is 30% and C is 20%

Let A_1 is the event that product A is selected

B_1 is the event that product B is selected

C_1 is the event that product C is selected

and D is the event that product is defective then,

$$P\left(\frac{D}{C_1}\right) = \frac{P(C_1)P\left(\frac{D}{C_1}\right)}{P(A_1)P\left(\frac{D}{A_1}\right) + P(B_1)P\left(\frac{D}{B_1}\right) + P(C_1)P\left(\frac{D}{C_1}\right)}$$

$$= \frac{\frac{20}{100} \times \frac{2}{100}}{\frac{50}{100} \times \frac{4}{100} + \frac{30}{100} \times \frac{3}{100} + \frac{20}{100} \times \frac{2}{100}}$$

$$= \frac{40}{200 + 90 + 40} = \frac{4}{33}$$

11. A has 5 elements and B has 2 elements. The number of subsets of $A \times B$ such that the number of elements in subset is more than or equal to 3 and less than 6, is

(1) 602

(2) 484

(3) 582

(4) 704

Answer (3)

Sol. $n(A) = 5, n(B) = 2$

$$\Rightarrow n(A \times B) = 10$$

$$\text{Number of subsets having 3 elements} = {}^{10}C_3$$

$$\text{Number of subsets having 4 elements} = {}^{10}C_4$$

$$\text{Number of subsets having 5 elements} = {}^{10}C_5$$

$$\begin{aligned} \therefore & {}^{10}C_3 + {}^{10}C_4 + {}^{10}C_5 \\ & = 120 + 210 + 252 \\ & = 582 \end{aligned}$$

12. Check whether the function $f(x) = \frac{(1+2^x)^7}{2^x}$ is

- (1) Even
- (2) Odd
- (3) Neither even nor odd
- (4) None of these

Answer (3)

Sol. $f(x) = \frac{(1+2^x)^7}{2^x}$

$$f(-x) = \frac{(1+2^{-x})^7}{2^{-x}} = \frac{(2^x+1)^7}{2^{6x}}$$

$\therefore f(x)$ is neither even nor odd.

13. Let $I(x) = \int \frac{(x+1) dx}{x(1+xe^x)^2}$, then $\lim_{x \rightarrow \infty} I(x) = 1$. The value of $I(1)$ is

- (1) $\frac{1}{e+1} - \ln(e+1) + 1$
- (2) $\frac{1}{e+1} - \ln(e+1)$
- (3) $\frac{1}{e+1} - \ln(e+1) + 2$
- (4) $\frac{1}{e+1} + 2$

Answer (3)

Sol. $I(x) = \int \frac{(x+1) dx}{x(1+xe^x)^2}$

$$= \int \frac{e^x(x+1)}{xe^x(1+xe^x)^2} dx$$

Let $1 + xe^x = t$

$$\Rightarrow e^x(1+x) dx = dt$$

$$= \int \frac{dt}{(t-1)t^2} = -\ln t + \frac{1}{t} + \ln(t-1) + c$$

$$= -\ln(1+xe^x) + \frac{1}{x \cdot e^x + 1} + \ln(x \cdot e^x) + c$$

$$= \ln\left(\frac{xe^x}{1+xe^x}\right) + \frac{1}{xe^x+1} + c$$

$$\lim_{x \rightarrow \infty} (I(x)) = c = 1$$

$$\therefore I(x) = \ln\left(\frac{xe^x}{1+xe^x}\right) + \frac{1}{xe^x+1} + 1$$

$$I(1) = \ln\left(\frac{e}{1+e}\right) + \frac{1}{e+1} + 1$$

$$= 2 + \frac{1}{e+1} - \ln(1+e)$$

- 14.
- 15.
- 16.
- 17.
- 18.
- 19.
- 20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. If a_α is the maximum value of $a_n = \frac{n^3}{n^4 + 147}$.

Then find α

Answer (5)

Sol. $f(n) = \frac{n^3}{n^4 + 147}$

$$f'(n) = \frac{(3n^2)(n^4 + 147) - (n^3)(4n^3)}{(n^4 + 147)^2} = 0$$

$f'(n) = 0$

$\Rightarrow n = \sqrt{21}$

$4 < \sqrt{21} < 5$

$a_5 > a_4$

\therefore for $n = 5$ the value is maximum

$\alpha = 5$

22. Maximum value n such that $(66)!$ is divisible by 3^n

Answer (31)

Sol. $\therefore 3$ is a prime number

$$\left[\frac{66}{3} \right] + \left[\frac{66}{3^2} \right] + \left[\frac{66}{3^3} \right] + \left[\frac{66}{3^4} \right] + \dots$$

$22 + 7 + 2 + 0 + \dots$

$= 31$

$(66)! = (3)^{31} \dots$

Maximum value of $n = 31$

23. If $A = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & -1 \\ 0 & 1 & 2 \end{bmatrix}$ and $|\text{adj}(\text{adj}(\text{adj}(A)))| = 16^n$ then

the value of n is

Answer (06)

Sol. $|A| = 2(5) - 1(2) = 8$

\therefore Now $|\text{adj}(\text{adj}(\text{adj}(A)))| = |A|^{(n-1)^3}$
 $= 8^8 = 16^6$

$\therefore n = 6$

24. The value of $\frac{8}{\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} (8[\text{cosec}x] - 5[\cot x]) dx$ is

([.] represents greatest integer function) _____.

Answer (56)

Sol. $\frac{8}{\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} 8[\text{cosec}x] dx - \frac{8}{\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} 5[\cot x] dx$

$$= \frac{8}{\pi} \times 8 \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} 1 \cdot dx - \frac{8}{\pi} \times 5 \left(\int_{\frac{\pi}{6}}^{\frac{\pi}{4}} 1 dx + \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} 0 \cdot dx + \int_{\frac{\pi}{2}}^{\frac{3\pi}{4}} (-1) dx + \int_{\frac{3\pi}{4}}^{\frac{5\pi}{6}} (-2) dx \right)$$

$$= \frac{64}{\pi} \left(\frac{2\pi}{3} \right) - \frac{40}{\pi} \left(\left(\frac{\pi}{4} - \frac{\pi}{6} \right) + 0 - \left(\frac{3\pi}{4} - \frac{\pi}{2} \right) - 2 \left(\frac{5\pi}{6} - \frac{3\pi}{4} \right) \right)$$

$$= \frac{128}{3} - \frac{40}{\pi} \left(\frac{\pi}{12} - \frac{\pi}{4} - \frac{2\pi}{12} \right)$$

$$= \frac{128}{3} - 40 \left(\frac{1}{12} - \frac{1}{4} - \frac{1}{6} \right)$$

$$= \frac{128}{3} - 40 \left(\frac{1-3-2}{12} \right) = \frac{128}{3} - 40 \left(-\frac{1}{3} \right)$$

$$= \frac{168}{3}$$

$$= 56$$

25. If $\lim_{x \rightarrow 0} \frac{1 - \cos^2 3x}{\cos^3 4x} \times \frac{\sin^3 4x}{(\log(1+2x))^5} = t$ then $[t]$ is

(where [.] represents greatest integer fraction)

Answer (18)

Sol. $\lim_{x \rightarrow 0} \frac{1 - \cos^2 3x}{\cos^3 4x} \times \frac{\sin^3 4x}{(\log(1+2x))^5}$

$$\lim_{x \rightarrow 0} \frac{\sin^2 3x \sin^3 4x}{\cos^3(4x)(\log(1+2x))^5}$$

$$\frac{\sin^2 3x}{(3x)^2} \cdot \frac{\sin^3 4x}{(4x)^3} \cdot (3x)^2 \cdot (4x)^3$$

$$\lim_{x \rightarrow 0} \frac{\sin^2 3x \cdot \sin^3 4x \cdot (3x)^2 \cdot (4x)^3}{\cos^3 4x \cdot \left(\frac{\log(1+2x)}{2x} \right)^5 (2x)^5}$$

$$= \frac{9 \times 64}{32} = 18$$

- 26.
- 27.
- 28.
- 29.
- 30.

