

25/07/2022

Evening



Corporate Office : Aakash Tower, 8, Pusa Road, New Delhi-110005 | Ph.: 011-47623456

Memory Based Answers & Solutions

Time : 3 hrs.

for

M.M. : 300

JEE (Main)-2022 (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. The length of a seconds pendulum when it is at height $2R$ from the earth's surface

- (1) $\frac{2}{9}$ (2) $\frac{1}{9}$
 (3) $\frac{4}{9}$ (4) $\frac{5}{9}$

Answer (2)

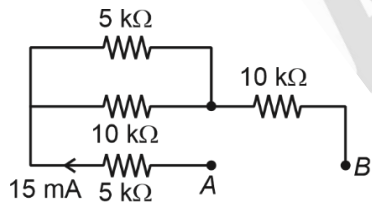
Sol. At height $2R$

$$g' = \frac{GM}{(3R)^3} = \frac{g_s}{9}$$

$$T' = 2\pi\sqrt{\frac{l'}{g'}} = 2\pi\sqrt{\frac{l'}{g}} = 2\text{ s}$$

$$\Rightarrow l' = \frac{g'}{\pi^2} = \frac{1}{9}\text{ m}$$

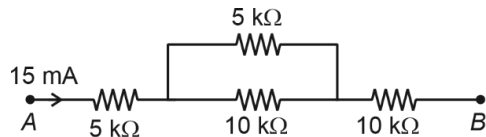
2. In the circuit shown find potential difference across point A and B



- (1) 275 V (2) 27.5 V
 (3) 40 V (4) 30 V

Answer (1)

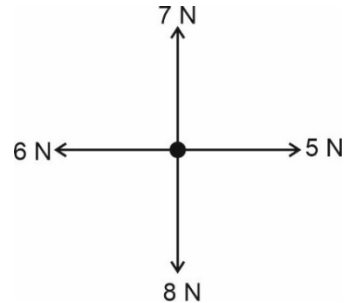
Sol. The circuit can be redrawn as



$$R_{AB} = \frac{55}{3}\text{ k}\Omega$$

$$V_{AB} = \frac{55}{3} \times 15\text{ V} = 275\text{ V}$$

3. Find the force required so as to make net force zero



- (1) $\sqrt{2}$ N, 45° with x-axis
 (2) $\sqrt{3}$ N, 45° with x-axis
 (3) 2 N, 60° with x-axis
 (4) 4 N, 30° with x-axis

Answer (1)

Sol. Vector sum of the forces shown $= (-\hat{i} - \hat{j})\text{ N}$

\Rightarrow Force required to make net force zero.

$$= (\hat{i} + \hat{j})\text{ N} = \sqrt{2}\text{ N at } 45^\circ \text{ with x-axis}$$

4. An electron moving with kinetic energy 0.1 KeV enters perpendicularly to field, 10^{-4} T. Find frequency of revolution

- (1) 2.8×10^6 Hz (2) 4.1×10^6 Hz
 (3) 6.0×10^6 Hz (4) 7.0×10^6 Hz

Answer (1)

$$\begin{aligned} \text{Sol. } f &= \frac{qB}{2\pi m} \\ &= \frac{1.6 \times 10^{-19} \times 10^{-4}}{2 \times 3.14 \times 9.1 \times 10^{-31}}\text{ Hz} \\ &= 2.799 \times 10^6\text{ Hz} \\ &\cong 2.8 \times 10^6\text{ Hz} \end{aligned}$$

5. Find the amplitude of magnetic field (B_0) if amplitude of electric field (E_0) = 540 N/C

- (Speed of light (c) = 3×10^8 m/s)
 (1) 18×10^{-7} T (2) 36×10^{-8} T
 (3) 18×10^{-8} T (4) 36×10^{-7} T

Answer (1)

$$\begin{aligned} \text{Sol. } B_0 &= \frac{E_0}{C} = \frac{540}{3 \times 10^8} \\ &= 18 \times 10^{-7}\text{ T} \end{aligned}$$

6. Find % error in heat if % error in resistance is 1%, time is 3% and current is 2%
- (1) 4 (2) 6
(3) 2 (4) 8

Answer (4)

Sol. $H = i^2 R t$

$$\Rightarrow \frac{\Delta H}{H} \times 100 = 2 \frac{\Delta i}{i} \times 100 + \frac{\Delta R}{R} \times 100 + \frac{\Delta t}{t} \times 100$$

$$= 4\% + 1\% + 3\%$$

$$= 8\%$$

7. Find percentage change in weight of object when it is taken from surface of earth to $\frac{R}{4}$ height above the surface of earth.
- (1) 16% (2) 36%
(3) 25% (4) 20%

Answer (2)

Sol. At height $\frac{R}{4}$

$$g' = \frac{g}{\left(1 + \frac{1}{4}\right)^2} = \frac{16g}{25}$$

$$\text{Change in weight} = mg \left(1 - \frac{16}{25}\right) = \frac{9mg}{25}$$

$$\Rightarrow \text{Percentage change} = \frac{9}{25} \times 100\%$$

$$= 36\%$$

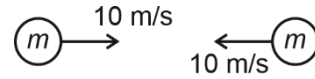
8. Two coils having 5 turns and 2 turns respectively carry equal current. Magnetic field at their respective centre is B_1 and B_2 respectively value of $\frac{B_1}{B_2}$ is (Both coils have equal radii)
- (1) $\frac{5}{2}$ (2) $\frac{2}{5}$
(3) $\frac{1}{1}$ (4) $\frac{1}{5}$

Answer (1)

Sol. $B = \frac{N\mu_0 i}{2r}$

$$\Rightarrow \frac{B_1}{B_2} = \frac{N_1}{N_2} = \frac{5}{2}$$

9. Two identical particles each of mass, $m = 1$ kg collide with each other elastically.



If collisions lasts for 0.05 s then average force of collision is

- (1) 200 N (2) 400 N
(3) 100 N (4) 300 N

Answer (2)

Sol. Total final momentum = Total initial momentum
= Zero

\Rightarrow Impulse on one ball = $2 \times mv$
(as the balls will bounce back with same speed)

$$\Rightarrow F_{avg} = \frac{2mv}{0.05} = \frac{2 \times 1 \times 10}{0.05}$$

$$= 400 \text{ N}$$

10. If wavelength of photon emitted when electron de excites from n to ground state, then value of n , is

- (1) $\sqrt{\frac{\lambda R}{\lambda R - 1}}$ (2) $\sqrt{\frac{\lambda}{\lambda R - 1}}$
(3) $\sqrt{\frac{\lambda R^2}{\lambda R - 1}}$ (4) $\sqrt{\frac{R}{\lambda - 1}}$

Answer (1)

Sol. $\lambda R c \left(1 - \frac{1}{n^2}\right) = \frac{hc}{\lambda}$

$$\Rightarrow 1 - \frac{1}{\lambda R n^2} = \frac{1}{n^2}$$

$$\text{or } n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

11. A bullet of mass 0.2 kg is fired on sand bag of mass 9.8 kg. The final kinetic energy is ___ percentage of initial kinetic energy if bullet stops in sand bag.
- (1) 2% (2) 4%
(3) 8% (4) 0.2%

Answer (1)

Sol. $0.2 v_b = (9.8 + 0.2)v_{total}$

$$\Rightarrow v_{total} = \frac{0.2 \times v_b}{10} = \frac{2v_b}{100}$$

$$K.E_i = \frac{1}{2}(0.2)(v_b)^2 = \frac{v_b^2}{10}$$

$$K.E_f = \frac{1}{2}(10)(v_{total})^2 = \frac{2v_b^2}{1000} = \frac{2}{100} \left(\frac{v_b^2}{10}\right)$$

$$K.E_f = 2\% \text{ of } K.E_i$$

12. A body projected from ground has equal maximum height and range. If θ is the angle of projection, find the value of $\tan\theta$

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

Answer (4)

Sol. $\frac{2u^2 \sin\theta \cos\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$

$$\Rightarrow \frac{\sin\theta}{\cos\theta} = 4$$

$$\Rightarrow \tan\theta = 4$$

13. If magnetic flux associated with loop is $\phi = 6t^2 - 2t + 10$. At resistance of loop is 20Ω then induced current in the loop at $t = 0.25$ is

- (1) 0.05 A
- (2) 0.04 A
- (3) 0.02 A
- (4) 0.01 A

Answer (1)

Sol. $\phi = 6t^2 - 2t + 10$

$$\left| \frac{d\phi}{dt} \right|_{at\ t=\frac{1}{4}s} = (3-2)V = 1V$$

$$I = \frac{V}{R} = \frac{1}{20} = 0.05 A$$

14. Why does the metal detector beep when a metal passes through it?

- (1) EMI (Electromagnetic Induction)
- (2) Thermal conductance
- (3) Potential Difference
- (4) Charge

Answer (1)

Sol. The metal detector works on the basis of electromagnetic induction as the metal opposes the change in external magnetic field to which it is exposed.

15. A proton and deuteron are passed through their respective potential differences such that finally the ratio of their de-Broglie wavelengths i.e. $\lambda_p : \lambda_D$ is $1 : \sqrt{2}$. If V represent the acceleration potential difference then value of $V_P : V_D$ is equal to

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

Answer (2)

Sol. $\frac{h}{\lambda} = mv = \sqrt{mqV}$

$$\Rightarrow \frac{\lambda_P}{\lambda_D} = \frac{\sqrt{m_D q_D V_D}}{\sqrt{m_P q_P V_P}}$$

$$\Rightarrow \frac{V_P}{V_D} = \frac{\lambda_D^2}{\lambda_P^2} \times \frac{m_D}{m_P}$$

$$= 2 \times \frac{2}{1}$$

$$= 4 : 1$$

16. In case of amplitude modulated wave, the maximum and minimum amplitude of wave is 6 V and 2 V respectively then modulation index is

- (1) 0.5
- (2) 0.25
- (3) 0.75
- (4) 0.33

Answer (1)

Sol. Amplitude modulation

$$= \frac{A_m}{A_c}$$

$$= \frac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}}$$

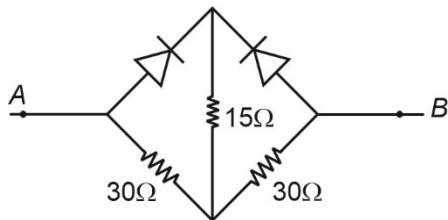
$$= \frac{6 - 2}{6 + 2} = 0.5$$

- 17.
- 18.
- 19.
- 20.

SECTION - B

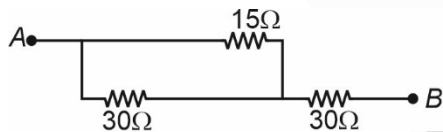
Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 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 is at higher potential than B, then equivalent resistance (in Ω) across AB is



Answer (40)

Sol. As A is at higher potential than B so left diode is forward bias while right diode is reverse bias, so equivalent circuit would be



$$R_{eq} = \frac{15 \times 30}{15 + 30} + 30$$

$$= 40\Omega$$

22. One cell (12V) is balanced in a potentiometer against a length of 72 cm another cell of (1.8 V) is balanced at some other length. Find the different in length (in cm)

Answer (36)

Sol. $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ and $l_1 = 72$ cm

$$\Rightarrow \frac{1.8}{1.2} \times 72$$

$$= 108 \text{ cm}$$

$$\Delta l = l_1 - l_2 = 108 - 72$$

$$= 36 \text{ cm}$$

23. A mixture of 2 moles of He and n moles of hydrogen has $V_{rms} = \sqrt{2}$ velocity of sound in the mixture. Find value of n .

Answer (2)

Sol. $v = \sqrt{\frac{\gamma RT}{M}}$, $v_{rms} = \sqrt{\frac{3RT}{M}}$

$$\Rightarrow 3 = 2\gamma$$

$$\text{Or } \gamma = \frac{3}{2}$$

$$\Rightarrow \frac{2 \times \left(\frac{3}{2} + 1\right) + n \left(\frac{5}{2} + 1\right)}{3 + \frac{5n}{2}} = \frac{3}{2}$$

$$\text{Or } n = 2$$

24. Ratio of efficiencies of 2 Carnot engines A and B operating at temperature, is

$$A : T_1 = 447^\circ\text{C} \quad T_2 = 147^\circ\text{C}$$

$$B : T_1 = 947^\circ\text{C} \quad T_2 = 47^\circ\text{C}$$

Answer (0.56)

Sol. $\eta_A = \frac{1 - \frac{147 + 273}{447 + 273}}{1 - \frac{47 + 273}{947 + 273}}$

$$= \frac{300 \times 1220}{900 \times 720}$$

$$= 0.56$$

25. A body is moving in straight line with speed increasing at 5 m/s per metre distance travelled acceleration of body (in m/s^2) when speed of body is 20 m/s.

Answer (100)

Sol. $\frac{dv}{dx} = 5$

$$a = v \frac{dv}{dx}$$

$$= 20 \times 5 = 100$$

26.

27.

28.

29.

30.

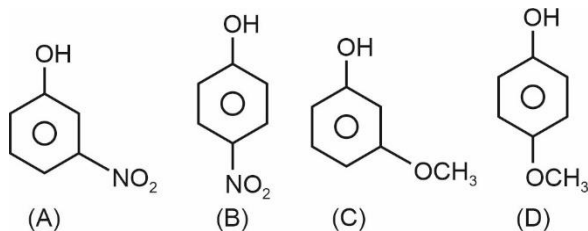
CHEMISTRY

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 :

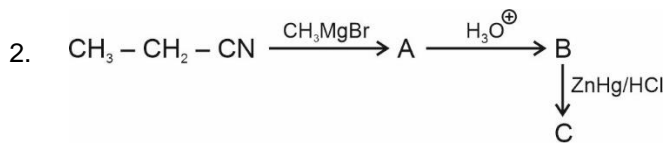
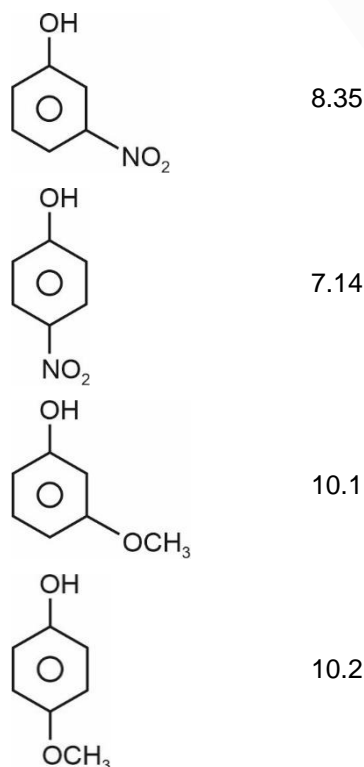
1. Which of the following is correct decreasing order of acidity?



- (1) $A > B > C > D$
 (2) $B > A > C > D$
 (3) $C > A > B > D$
 (4) $D > A > B > C$

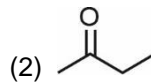
Answer (2)

Sol.



From the given scheme identify C.

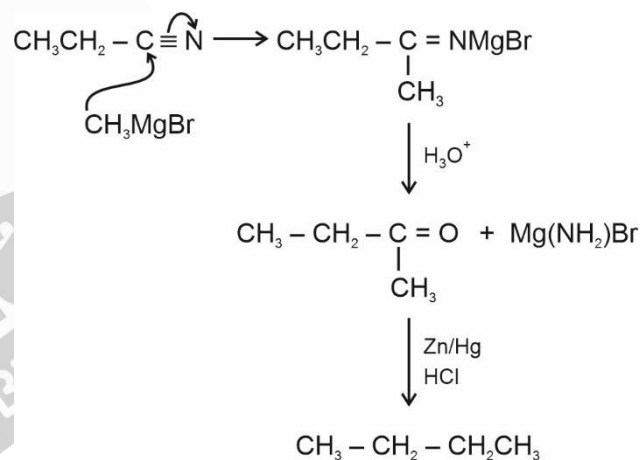
- (1) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$



- (4) $\text{CH}_3 - \text{CH}_2 - \text{C}(=\text{O}) - \text{OH}$

Answer (1)

Sol.



3. Which of the following is the correct order of first IE for the below given elements?

B, Be, O, N

- (1) $B > O > \text{Be} > N$ (2) $\text{Be} > B > O > N$
 (3) $O > N > B > \text{Be}$ (4) $N > O > \text{Be} > B$

Answer (4)

Sol. The first ionisation energy increases from left to right along 2nd period with the following exceptions

$$\text{IE}_1 : \text{Be} > \text{B} \text{ and } \text{IE}_1 : \text{N} > \text{O}$$

This is due to stable configuration of Be in comparison to B and that of N in comparison to O.

The correct order of first ionisation energy is

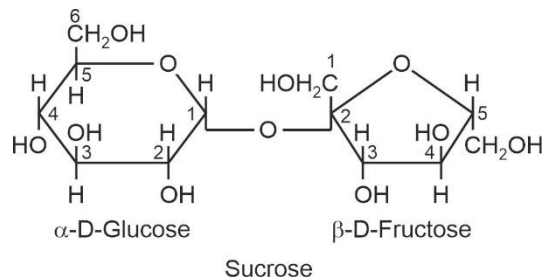
$$N > O > \text{Be} > B$$

4. 1,2-Glycosidic linkage is present in which biomolecule?

- (1) Sucrose (2) Mannose
 (3) Fructose (4) Lactose

Answer (1)

Sol. 1,2-Glycosidic linkage is present in sucrose



5. The site occupied by inhibitor which changes the shape of the active site is called

- (1) Allosteric site (2) Non-Active site
 (3) Competitive site (4) Active site

Answer (1)

Sol. Binding of inhibitors at allosteric site changes the shape of the active site in such a way that the substrate is not able to recognise it

6. The correct order of density of the following elements Be, Mg, Ca, Sr

- (1) Ca < Mg < Be < Sr (2) Be < Mg < Ca < Sr
 (3) Mg < Be < Ca < Sr (4) Be < Ca < Mg < Sr

Answer (1)

Sol. The correct increasing order of density of the given alkaline earth metals is,

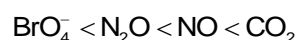
- Ca < Mg < Be < Sr
 Ca = 1.55 g/cm³
 Mg = 1.74 g/cm³
 Be = 1.84 g/cm³
 Sr = 2.63 g/cm³

7. Which of the following is correct order of acidic strength

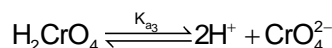
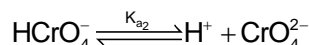
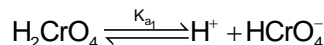
- (1) BrO₄⁻ > CO₂ > NO > N₂O
 (2) BrO₄⁻ > NO > CO₂ > N₂O
 (3) BrO₄⁻ < CO₂ < NO < N₂O
 (4) BrO₄⁻ < N₂O < NO < CO₂

Answer (4)

Sol. Of the given species CO₂ is most acidic as it is the anhydride of H₂CO₃ and BrO₄⁻ is least acidic as it is the conjugate base of HBrO₄. NO is more acidic than N₂O based on the electron deficiency of N-atom. Correct order of their acidic strength is



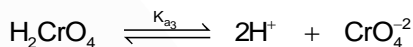
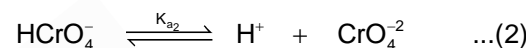
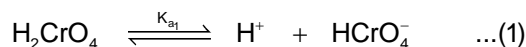
8. Find the relation between K_{a1}, K_{a2} and K_{a3} for,



- (1) K_{a3} = K_{a1} + K_{a2} (2) K_{a3} = $\frac{K_{a1}}{K_{a2}}$
 (3) K_{a3} = K_{a1} - K_{a2} (4) K_{a3} = K_{a1} × K_{a2}

Answer (4)

Sol.



[After adding (1) and (2)]

Clearly, K_{a3} = K_{a1} × K_{a2}

9. Match the following

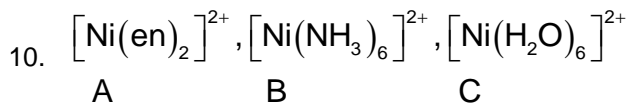
- | | |
|----------------------------|------------------------|
| (A) Nylon 6, 6 | (P) Buckets |
| (B) Low density polythene | (Q) Toys |
| (C) High density polythene | (R) Bristles of Brush |
| (D) Teflon | (S) Non stick utensils |

- (1) A-R, B-Q, C-P, D-S (2) A-P, B-Q, C-R, D-S
 (3) A-P, B-S, C-Q, D-R (4) A-S, B-Q, C-P, D-R

Answer (1)

Sol. Nylon 6, 6 is used in making bristles of brushes. Low density polythene is used in making toys. High density polythene is used in making buckets Teflon is used in making non-stick utensils. Correct match is

A-R; B-Q; C-P; D-S



CFSE order is

- (1) B > A > C
 (2) C > A > B
 (3) B > C > A
 (4) A > B > C

Answer (4)

Sol. CFSE of the given complexes is decided by their stability

$[\text{Ni}(\text{en})_3]^{2+}$: Most stable due to 3 cyclic rings

(A)

$[\text{Ni}(\text{NH}_3)_6]^{2+}$: Less stable as it is an open chain

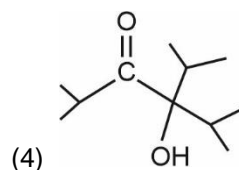
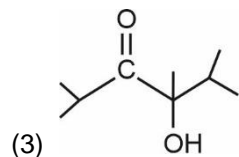
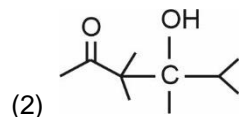
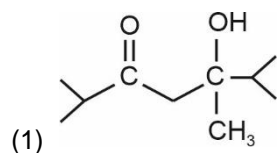
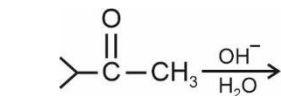
(B) complex

$[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$: Least stable as H_2O is a weak field ligand.

∴ The correct order of CFSE

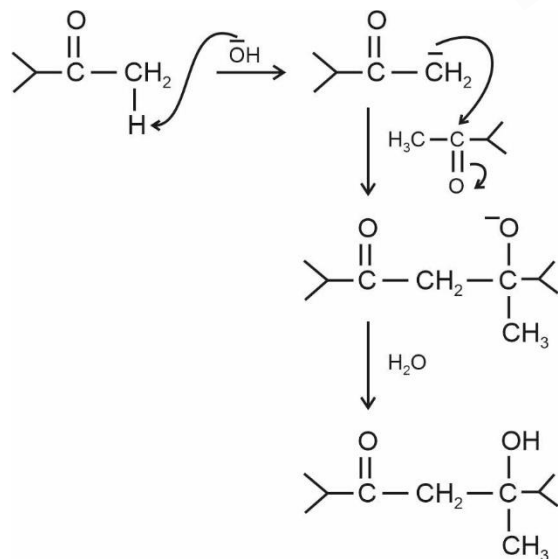
$A > B > C$

11. Which of the following option represents the correct aldol product (major) of the following reaction?

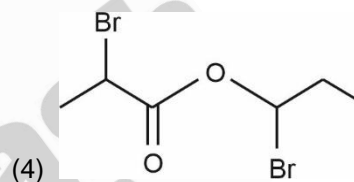
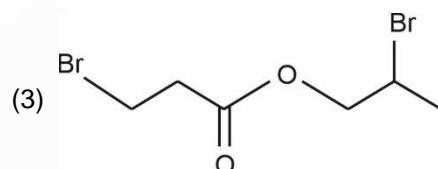
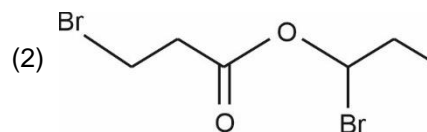
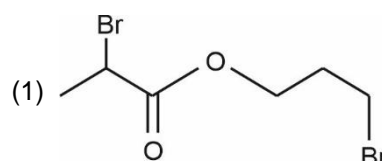
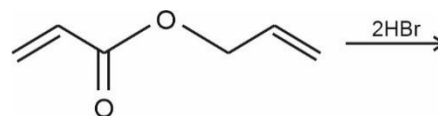


Answer (1)

Sol.

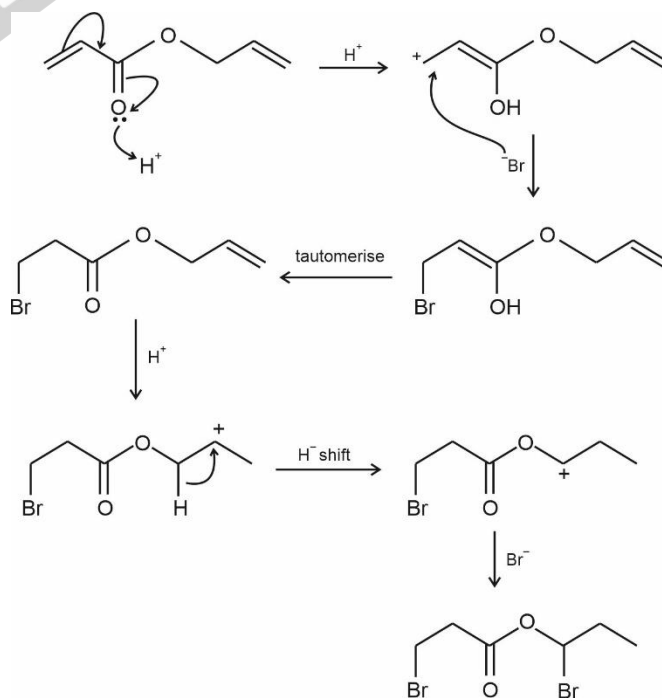


12. Which of the following option represents the correct product of the following reaction.



Answer (2)

Sol.



13. Match the following :

- | | |
|--------------------|-----------------------|
| 1. Nicotine | A. Harmful for bones |
| 2. Sulphates | B. Laxative effective |
| 3. Fluoride | C. Pesticides |
| 4. Sodium Arsenite | D. Herbicide |
- (1) 1-C, 2-A, 3-B, 4-D (2) 1-C, 2-B, 3-A, 4-D
 (3) 1-A, 2-C, 3-B, 4-D (4) 1-A, 2-D, 3-B, 4-C

Answer (2)

Sol. Nicotine is an example of pesticide.

Presence of sulphates in drinking water causes laxative effect.

Sodium Arsenite is an example of Herbicide.

Presence of excess fluorides in drinking water is harmful for bones.

14. High purity H₂ can be produced by

- (1) Natural gas reforming
 (2) Electrolysis of warm solution of barium hydroxide
 (3) Electrolysis of acidified water
 (4) Treatment of alkali with Zn

Answer (2)

Sol. High purity (>99.95%) dihydrogen is obtained by electrolysis of warm aqueous barium hydroxide solution between nickel electrodes.

15. Which of the following contain all the correct match of compounds and hybridisation of their central atoms?

- (i) XeOF₄ → sp³
 (ii) XeO₃ → sp³
 (iii) XeF₆ → sp³d²
 (iv) XeO₂F₂ → sp³d
- (1) (i), (ii) and (iv) (2) (i), (iii) and (iv)
 (3) (ii), (iii) and (iv) (4) (i) and (ii) only

Answer (3)

Sol. **Compound** **Hybridisation of Central atom**

- (i) XeOF₄ → sp³d²
 (ii) XeO₃ → sp³
 (iii) XeF₆ → sp³d²
 (iv) XeO₂F₂ → sp³d

Hence, (ii), (iii) and (iv) are correct.

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.

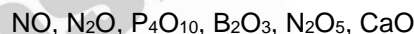
21. Find the sum of the total lone pair in the following compounds.



Answer (41.00)

Sol.	Lone pairs
XeF ₆	19
XeOF ₄	15
XeO ₃	7
Total 41 lone pairs.	

22. How many of the following oxides are acidic oxides?



Answer (3)

Sol. NO, N₂O → Neutral oxides
 CaO → Basic oxide
 B₂O₃, N₂O₅, P₄O₁₀ → Acidic oxides

23. An electron is present in the 4th excited state in H-atom. When it jumps to ground state, then find the maximum number of wavelength emitted?

Answer (10)

Sol. Maximum number of wavelength emitted

$$= \frac{\Delta n(\Delta n + 1)}{2}$$

$$= \frac{4(4 + 1)}{2} \quad [\Delta n = 5 - 1 = 4]$$

$$= 10$$

24. Find the molar ratio of gas present in two different container having same volume.

- Container-1 at 47°C
 Container-2 at 447°C

having same pressure.

[Calculate the ratio of moles present in container-1 and container-2]

Answer (02.25)

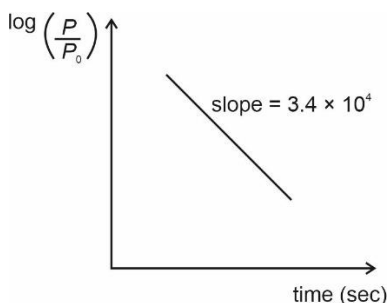
Sol. As pressure and volume are same,

$$n_1 T_1 = n_2 T_2$$

$$n_1(320) = n_2(720)$$

$$\frac{n_1}{n_2} = \frac{72}{32} = \frac{9}{4} = 2.25$$

25. For a first order reaction, the following graph is given



The half life of the reaction is $k \times 10^{-5}$ sec. Find the value of 'k'

Answer (0.88)

Sol. $\log\left(\frac{P}{P_0}\right) = \frac{-kt}{2.303}$

$$\text{Slope} = \frac{-k}{2.303} = -3.4 \times 10^4$$

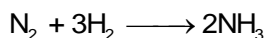
$$\therefore k = 3.4 \times 2.303 \times 10^4 \text{ [where k is rate constant]}$$

$$\therefore \text{Half life, } t_{1/2} = \frac{0.693}{3.4 \times 2.303} \times 10^{-4}$$

$$= 0.088 \times 10^{-4}$$

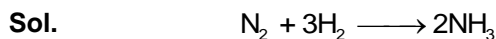
$$\approx 0.88 \times 10^{-5}$$

26. 56 lit of N_2 reacts with H_2 gas according to the following reaction.



20 lit of NH_3 gas is produced at same temperature and pressure. Find the Residual volume of Nitrogen gas. (in litres)

Answer (46)



$$t = 0 \quad \quad \quad 56 \quad \quad \quad - \quad \quad -$$

$$t = t \quad \quad \quad 56 - v \quad \quad \quad \quad \quad 2v$$

Given $2v = 20$

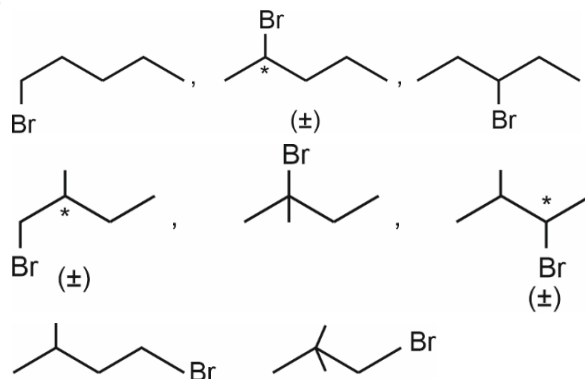
$$\therefore v = 10$$

Hence, Residual volume of $N_2 = 56 - 10 = 46$ L

27. How many isomers (including stereoisomers) are there of monobrominated products of C_5H_{12}

Answer (11.00)

Sol.



28. If molar conductivity of 10 molar 20 ml NaCl solution is Λm_1 and Λm_2 is the molar conductivity of 20 molar, 80 ml NaCl solution. Find $\frac{\Lambda m_2}{\Lambda m_1}$

Answer (01.00)

Sol. $\Lambda_{m_1} = \frac{k_1 \times 1000}{10}$

$$\Lambda_{m_2} = \frac{k_2 \times 1000}{20}$$

$$\frac{\Lambda_{m_2}}{\Lambda_{m_1}} = \frac{k_2}{k_1} \times \frac{1}{2} \quad \left[\text{Also, } \frac{k_1}{k_2} = \frac{10}{20} = \frac{1}{2} \right]$$

$$= 2 \times \frac{1}{2} = 1$$

29. In sample of H atom, electron makes a transition from 3rd excited state to 2nd energy level.

If $\frac{x}{x+4}$ is equal to the number of spectral lines emitted, find the value of x^2 .

Answer (36.00)

Sol. The transition as per the question should be from (4 \rightarrow 2)

$$\therefore \text{Number of spectral lines} = \frac{2 \times 3}{2} = 3$$

$$\frac{x}{x+4} = 3$$

$$x = 3x + 12$$

$$x = -6$$

$$\therefore x^2 = (-6)^2 = 36$$

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. The number of bijective function $f(1, 3, 5, 7, \dots, 99) \rightarrow (2, 4, 6, 8, \dots, 100)$ if $f(3) \geq f(5) \geq f(7) \dots \geq f(99)$
- (1) ${}^{50}C_1$ (2) ${}^{50}C_2$
 (3) $\frac{50!}{2}$ (4) ${}^{50}C_3 \cdot 3!$

Answer (1)

Sol. As $f(3) \geq f(5) \dots \geq f(99)$

$\therefore f(1)$ can take any value i.e., ${}^{50}C_1$ ways

Rest all will be fixed

\therefore Required number of ways = $50C_1$

2. The value of $2 \sin \frac{\pi}{22} \sin \frac{3\pi}{22} \sin \frac{5\pi}{22} \sin \frac{7\pi}{22} \sin \frac{9\pi}{22}$ is equal to
- (1) $\frac{1}{16}$ (2) $\frac{5}{16}$
 (3) $\frac{7}{16}$ (4) $\frac{3}{16}$

Answer (1)

Sol. $2 \sin \frac{\pi}{22} \cdot \sin \frac{3\pi}{22} \cdot \sin \frac{5\pi}{22} \cdot \sin \frac{7\pi}{22} \cdot \sin \frac{9\pi}{22}$
 $= 2 \cos \frac{5\pi}{11} \cdot \cos \frac{4\pi}{11} \cdot \cos \frac{3\pi}{11} \cdot \cos \frac{2\pi}{11} \cdot \cos \frac{\pi}{11}$
 $= 2 \cos \frac{\pi}{11} \cdot \cos \frac{2\pi}{11} \cdot \cos \frac{4\pi}{11} \cdot \cos \frac{8\pi}{11} \cdot \cos \frac{16\pi}{11}$
 { because $\cos \frac{3\pi}{11} = -\cos \frac{8\pi}{11}$ and $\cos \frac{5\pi}{11} = -\cos \frac{16\pi}{11}$ }
 $= \frac{2 \sin \frac{32\pi}{11}}{2^5 \cdot \sin \frac{\pi}{11}} = \frac{1}{16} \frac{\sin \left(3\pi - \frac{\pi}{11} \right)}{\sin \frac{\pi}{11}}$
 $= \frac{1}{16}$

3. $\lim_{x \rightarrow \frac{\pi}{4}} \frac{8\sqrt{2} - 8(\sin x + \cos x)}{\sqrt{2} - \sqrt{2} \sin 2x}$ is equal to
- (1) 2 (2) 4
 (3) 6 (4) 8

Answer (1)

Sol. $\lim_{x \rightarrow \frac{\pi}{4}} \frac{8\sqrt{2} - 8(\sin x + \cos x)}{\sqrt{2} - \sqrt{2} \sin 2x} \left(\frac{0}{0} \right)$ form
 $= \lim_{x \rightarrow \frac{\pi}{4}} \frac{-8(\cos x + \sin x)}{-\sqrt{2} \cdot 2 \cos 2x} \left(\frac{0}{0} \right)$ form
 (Using L-H Rule)
 $= \lim_{x \rightarrow \frac{\pi}{4}} \frac{8(\sin x + \cos x)}{4\sqrt{2} \sin 2x} = \frac{8\sqrt{2}}{4\sqrt{2}} = 2$

(Again, using L-H Rule)

4. If $P(A) = \frac{1}{3}$, $P(B) = \frac{1}{5}$ and $P(A \cup B) = \frac{1}{2}$ then $P(A/B') + P(A'/B) =$
- (1) $\frac{5}{8}$ (2) $\frac{4}{9}$
 (3) $\frac{29}{24}$ (4) 3

Answer (3)

Sol. $P(A) = \frac{1}{3}$

$P(B) = \frac{1}{5}$

And $P(A \cup B) = \frac{1}{2}$

So, $P(A \cap B) = \frac{1}{30}$

Now, $P\left(\frac{A}{B'}\right) = \frac{P(A \cap B')}{P(B')} = \frac{1 - \frac{1}{30}}{\frac{4}{5}} = \frac{3}{8}$

And $P\left(\frac{A'}{B}\right) + \frac{P(A' \cap B)}{P(B)} = \frac{1 - \frac{1}{30}}{\frac{1}{5}} = \frac{5}{6}$

So, $P\left(\frac{A}{B'}\right) + P\left(\frac{A'}{B}\right) = \frac{3}{8} + \frac{5}{6} = \frac{29}{24}$

5. Let $f(x) = [x^2 - 2x] + |5x - 7|$, and let m be min. value of $f(x)$ and M be max. value of $f(x)$ in $[\frac{5}{4}, 2]$, then

- (1) $m = -1, M = 2$ (2) $m = 0, M = 3$
 (3) $m = -1, M = 4$ (4) $m = -2, M = 2$

Answer (1)

Sol. For $x \in [\frac{5}{4}, 2]$, $[x^2 - 2x] = -1$

So, $f(x) = -1 + |5x - 7|$ is least at $x = \frac{7}{5}$ and

greatest at $x = 2$

$$m = f\left(\frac{7}{5}\right) = -1$$

$$\text{and } M = f(2) = 2$$

6. If the equation $x^3 + px^2 + qx + 1 = 0$ ($p < q$) has only one root α , then α belongs to

- (1) $(-2, -1)$
 (2) $(-1, 0)$
 (3) $(0, 1)$
 (4) $(1, 2)$

Answer (2)

Sol. $f(0) = 1$

$$\& f(-1) = -1 + p - q + 1 = p - q < 0$$

$$\therefore f(0) > 0 \& f(-1) < 0$$

$$\therefore f(x) \text{ must have root between } (-1, 0)$$

7. Statement $P \rightarrow$ Ramu is innocent

$q \rightarrow$ Ramu is not honest

$r \rightarrow$ Ramu is rich

then statement "Ramu is innocent and not honest if and only if he is rich" is represented by

- (1) $(P \vee q) \rightarrow r$ (2) $(P \wedge q) \rightarrow r$
 (3) $(P \wedge q) \leftrightarrow r$ (4) $(P \vee q) \leftrightarrow r$

Answer (3)

Sol. $P \rightarrow$ Ramu is innocent

$q \rightarrow$ Ramu is not honest

$r \rightarrow$ Ramu is rich

$$\therefore \text{Ramu is innocent and not honest} \rightarrow P \wedge q$$

$$\therefore \text{Ramu is innocent and not honest if and only if he is rich represented by } (P \wedge q) \leftrightarrow r$$

8. If $A = \begin{bmatrix} 1 & a & a \\ 0 & 1 & b \\ 0 & 0 & 1 \end{bmatrix}$ and $A^n = \begin{bmatrix} 1 & 48 & 2064 \\ 0 & 1 & 96 \\ 0 & 0 & 1 \end{bmatrix}$ then

$n + a + b$ is equal to

- (1) 24 (2) 25
 (3) 26 (4) 2736

Answer (3)

Sol. Let $\begin{bmatrix} 0 & a & a \\ 0 & 0 & b \\ 0 & 0 & 0 \end{bmatrix} = B$

$$\text{So, } A = I + B \text{ where } B^2 = \begin{bmatrix} 0 & 0 & ab \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \text{ and } B^3 = 0$$

$$\Rightarrow A^n = (I + B)^n$$

$$= I + {}^n C_1 B + {}^n C_2 B^2 + {}^n C_3 B^3 + \dots$$

$$= I + nB + \frac{n(n-1)}{2} B^2$$

$$= \begin{bmatrix} 1 & na & na + \frac{(n-1)n}{2} ab \\ 0 & 1 & nb \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{Clearly } na = 48, nb = 96 \text{ and } \frac{na(nb-b)}{2} = 2064 - na$$

$$\Rightarrow b = 12, a = 6 \text{ and } n = 8$$

9. Focus of ellipse $\frac{x^2}{9} + \frac{y^2}{7} = 1$ and hyperbola

$$\frac{x^2}{1} - \frac{y^2}{\alpha^2} = 1 \text{ coincide then latus rectum of}$$

hyperbola is

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

Answer (3)

Sol. $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and $\frac{x^2}{l^2} - \frac{y^2}{m^2} = 1$ have same foci, so

$$a^2 - b^2 = l^2 + m^2$$

$$\Rightarrow 9 - 7 = \frac{1}{4} + \alpha^2 \quad \Rightarrow \alpha^2 = \frac{7}{4}$$

$$\text{Length of latus rectum} = \frac{2m^2}{l} = \frac{2\alpha^2}{\frac{1}{2}} = 4\left(\frac{7}{4}\right) = 7$$

10. The shortest distance between the lines

$$\frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{1} \text{ and } \frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1} \text{ is}$$

- (1) $\frac{\sqrt{29}}{2}$ (2) $3\sqrt{29}$
 (3) $\sqrt{29}$ (4) $2\sqrt{29}$

Answer (4)

Sol. $\vec{b}_1 \times \vec{b}_2$ for given lines

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & -6 & 1 \\ 1 & -2 & 1 \end{vmatrix} = \hat{i}(-4) - \hat{j}(6) + \hat{k}(-8)$$

$$= -4\hat{i} - 6\hat{j} - 8\hat{k}$$

$$\therefore (\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 - \vec{b}_2) = (4\hat{i} + 6\hat{j} + 8\hat{k}) \cdot (-4\hat{i} - 6\hat{j} - 8\hat{k})$$

$$= -16 - 36 - 64 = -116$$

\therefore

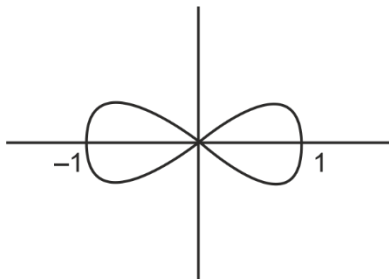
$$S.D = \frac{116}{|\vec{b}_1 \times \vec{b}_2|} = \frac{116}{\sqrt{116}} = \sqrt{116} = 2\sqrt{29}$$

11. Area enclosed by the curve $y^2 + x^4 = x^2$ is

- (1) $\frac{2}{3}$ (2) $\frac{4}{3}$
 (3) $\frac{8}{3}$ (4) $\frac{10}{3}$

Answer (2)

Sol.



$$y = |x|\sqrt{1-x^2}$$

$$\text{Required area} = 4 \int_0^1 x\sqrt{1-x^2} dx$$

$$= -\frac{4(1-x^2)^{3/2}}{3} \Big|_0^1$$

$$= \frac{4}{3}$$

12. The value of $\int_{-3}^{101} ([\sin \pi x] + e^{[\cos 2\pi x]}) dx$ is

- (1) $\frac{52}{e}$ (2) $-52 + \frac{50}{e}$
 (3) $-48 + \frac{48}{e}$ (4) $-30 + \frac{30}{e}$

Answer (1)

Sol. $\int_{-3}^{101} ([\sin \pi x] + e^{[\cos 2\pi x]}) dx$

$$= 52 \int_0^2 [\sin \pi x] dx + 104 \int_0^1 e^{[\cos 2\pi x]} dx$$

$$= 52 \int_1^2 -dx + 104 \left[\int_0^{1/4} e^0 dx + \int_{1/4}^{3/4} e^{-1} dx + \int_{3/4}^1 e^0 dx \right]$$

$$= -52 + 104 \left(\frac{1}{2} + \frac{1}{2e} \right)$$

$$= \frac{52}{e}$$

13. Solution of differential equation

$$\frac{dy}{dx} = \frac{4y^3 + 2x^2y}{3y^2x + x^3}, y(1) = 1 \text{ is}$$

- (1) $y^3 + x^2y = 2x^4$ (2) $y^3 + xy = x^3$
 (3) $xy^3 + y = 2x^4$ (4) $y^3 + x^3y = 2x^3$

Answer (1)

Sol. $\frac{dy}{dx} = \frac{4y^3 + 2x^2y}{3y^2x + x^3}$

$$\text{Let } y = vx, \text{ then } \frac{dy}{dx} = v + x \frac{dv}{dx}$$

$$\therefore v + x \frac{dv}{dx} = \frac{4v^3 + 2v}{3v^2 + 1}$$

$$\Rightarrow x \frac{dv}{dx} = \frac{v^3 + v}{3v^2 + 1}$$

$$\Rightarrow \int \frac{3v^2 + 1}{v^3 + v} dv = \int \frac{1}{x} dx$$

$$\Rightarrow \ln|v^3 + v| = \ln(x) + \ln c$$

$$\left(\frac{y}{x} \right)^3 + \left(\frac{y}{x} \right) = cx, y(1) = 1$$

$$\therefore c = 2$$

$$\therefore y^3 + x^2y = 2x^4$$

14. The value of $\sum_{n=1}^{21} \frac{3}{(4n-1)(4n+3)}$ is

- (1) $\frac{5}{29}$ (2) $\frac{7}{29}$
 (3) $\frac{9}{29}$ (4) $\frac{11}{29}$

Answer (2)

Sol.
$$\sum_{n=1}^{21} \frac{1}{(4n-1)(4n+3)}$$

$$= \frac{3}{4} \sum_{n=1}^{21} \frac{(4n+3) - (4n-1)}{(4n-1)(4n+3)}$$

$$= \frac{3}{4} \sum_{n=1}^{21} \left(\frac{1}{4n-1} - \frac{1}{4n+3} \right)$$

$$= \frac{3}{4} \left(\frac{1}{3} - \frac{1}{87} \right)$$

$$= \frac{1}{4} \left(1 - \frac{1}{29} \right) = \frac{7}{29}$$

15. The tangent at the point $A(1, 3)$ and $B(1, -1)$ on the parabola $y^2 - 2x - 2y = 1$ meet at point P , then area of ΔPAB is

- (1) 4 (2) 6
 (3) 7 (4) 8

Answer (4)

Sol. $y^2 - 2x - 2y - 1 = 0$

Equation of tangent at $A(1, 3)$:

$$3y - (x + 1) - (y + 3) - 1 = 0 \Rightarrow 2y - x = 5$$

Equation of tangent at $B(1, -1)$:

$$-y - (x + 1) - (y - 1) - 1 = 0 \Rightarrow 2y + x = -1$$

So, $P(-3, 1)$

$$\text{Area of } \Delta PAB = \frac{1}{2} \begin{vmatrix} 1 & 3 & 1 \\ -3 & 1 & 1 \\ 1 & -1 & 1 \end{vmatrix}$$

$$= 8$$

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. Find the remainder when $(11)^{1011} + (1011)^{11}$ is divided by 9

Answer (8)

Sol. $\because 11 \equiv 2 \pmod{9}$

$$11^3 \equiv 8 \equiv -1 \pmod{9}$$

$$(11^3)^{337} \equiv (-1)^{337} \pmod{9}$$

$$11^{1011} \equiv -1 \pmod{9} \quad \dots(i)$$

$$\therefore 1011 \equiv 3 \pmod{9}$$

$$(1011)^2 \equiv 0 \pmod{9}$$

$$\Rightarrow (1011)^{11} \equiv 0 \pmod{9} \quad \dots(ii)$$

Clearly $11^{1011} + 1011^{11} \equiv -1 \equiv 8 \pmod{9}$

22. Eight numbers 3, 5, 7, $2K$, 12, 15, 21, 27 are in increasing order and if mean deviation about median is 6, then median of data is

Answer (12)

Sol. Median of given data = $\frac{2K+12}{2} = K+6$

$$(K+3) + (K+1) + (K-1) + (6-k) + (6-k) + (9-k) + (15-k) + (21-k)$$

$$M.D.(M) = \frac{\quad}{8}$$

$$= \frac{60-2K}{8} = 6$$

$$\Rightarrow K = 6$$

Hence median = $K + 6 = 12$

23.
 24.
 25.
 26.
 27.
 28.
 29.
 30.

