



ESTD : 2003

SRI GANESH
IIT - MEDICAL ACADEMY

Recognized by B.I.E. A.P. College Code : 02030

25/01/2023
Evening

Memory Based

Answers & Solutions

for

Time : 3 hrs.

M.M. : 300

JEE (Main)-2023 (Online) Phase-1

(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.

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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. A wire with resistance 5 ohms is redrawn to increase its length 5 times. What is the final resistance of the wire.

- (1) 25 Ω (2) 16 Ω
 (3) 125 Ω (4) 32 Ω

Answer (3)

Sol. $R = \rho \frac{l_0}{A_0} = 5 \Omega$

Volume is constant so

$l_0 A_0 = 5 l A$

So $A = \frac{A_0}{5}$

$R' = \rho \frac{5l_0}{\frac{A_0}{5}} = 25\rho \frac{l_0}{A_0}$
 $= 25R$
 $= 125 \Omega$

2. Find velocity of particle if position of the particle is given by $x = 2t^2$ at $t = 2$ sec.

- (1) 8 m/s (2) 4 m/s
 (3) 16 m/s (4) 32 m/s

Answer (1)

Sol. $x = 2t^2$

$\frac{dx}{dt} = 4t$

$v = 4t$

v at $t = 2$ sec = 8 m/s

3. A particle performing SHM with amplitude A starts from $x = 0$ and reaches $x = \frac{A}{2}$ in 2 s. Find time

required for the particle to go from $x = \frac{A}{2}$ to $x = A$?

- (1) 1.5 s (2) 4 s
 (3) 6 s (4) 1 s

Answer (2)

Sol. $x = A \sin(\omega t)$

For $x = \frac{A}{2}$

$\Rightarrow \frac{A}{2} = A \sin(\omega t)$

$\omega t = \frac{\pi}{6}$

$t = \left(\frac{\pi}{6\omega}\right) = 2 \text{ s} \Rightarrow \frac{\pi}{\omega} = 12 \text{ s}$

When $x = A, = A \sin(\omega t)$

$\omega t = \frac{\pi}{2}$

$t = \left(\frac{\pi}{2\omega}\right) = \frac{1}{2} \times 12 \text{ s} = 6 \text{ s}$

Time taken from $\frac{A}{2}$ to $A = 6 - 2 = 4$ second.

4. An object of mass m is placed at a height R_e from surface of earth. Find the increase in potential energy of the object if the height of the object is increased to $2R_e$ from surface. (R_e : Radius of earth)

- (1) $\frac{1}{3} mgR_e$ (2) $\frac{1}{6} mgR_e$
 (3) $\frac{1}{2} mgR_e$ (4) $\frac{1}{4} mgR_e$

Answer (2)

Sol. $U_i = -\frac{GM_e m}{2R_e}$

$U_f = -\frac{GM_e m}{3R_e}$

$\Delta U = U_f - U_i = \frac{GM_e m}{6R_e}$

$= \frac{mgR_e}{6}$

5. A charge of $10 \mu\text{C}$ is placed at origin. Where should a charge of $40 \mu\text{C}$ be placed on x -axis such that electric field is zero at $x = 2$?

- (1) $x = -2$ (2) $x = 4$
 (3) $x = 6$ (4) $x = 2$

Answer (3)

Sol. $E = 0$

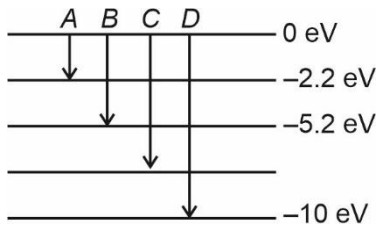
$\Rightarrow \frac{1}{4\pi\epsilon_0} \frac{10}{2^2} = \frac{1}{4\pi\epsilon_0} \frac{40}{(x_0 - 2)^2}$

$\Rightarrow x_0 - 2 = 4$

$\Rightarrow x_0 = 6$

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6. The diagram shown represents different transitions of electron (A, B, C, D) between the energy levels with energies mentioned along. Among the shown transitions which transition will generate photon of wavelength 124.1 nm? ($hc = 1241 \text{ eV-nm}$)



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

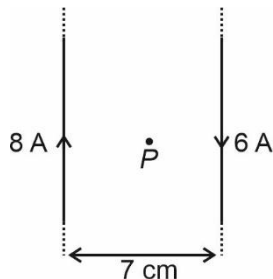
Answer (4)

Sol. So, energy of photon

$$\Delta E = \frac{hc}{\lambda} = \frac{1241}{124.1} = 10 \text{ eV}$$

Only D has energy to produce this wavelength.

7. Two straight infinite wires placed parallel to each other are carrying currents as shown



P is equidistant from the wires find magnetic field at point P. (Point P is in the plane of wire)

- (1) $8 \times 10^{-5} \text{ T}$
(2) $8 \times 10^{-7} \text{ T}$
(3) $16 \times 10^{-5} \text{ T}$
(4) $2 \times 10^{-5} \text{ T}$

Answer 1)

Sol. $B_{\text{net}} = \frac{\mu_0 i_1}{2\pi r_1} + \frac{\mu_0 i_2}{2\pi r_2}$

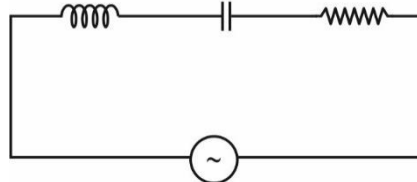
$$= 2 \times 10^{-7} \left[\frac{8}{\frac{3.5}{100}} + \frac{6}{\frac{3.5}{100}} \right] \text{ T}$$

$$= \frac{2 \times 10^{-7} \times 14 \times 100}{3.5} \text{ T}$$

$$= 8 \times 10^{-5} \text{ T}$$

8. For an LCR series circuit $X_L = 130 \Omega$, $X_C = 80 \Omega$ and $R = 80 \Omega$. The value of power factor of the circuit is equal to

$$X_L = 130 \Omega \quad X_C = 80 \Omega \quad R = 80 \Omega$$



- (1) $\frac{\sqrt{54}}{9}$
(2) $\frac{8}{\sqrt{89}}$
(3) $\frac{8}{13}$
(4) $\frac{7}{9}$

Answer (2)

Sol. $\cos \phi = \frac{R}{Z} = \frac{R}{\sqrt{(X_L - X_C)^2 + R^2}}$

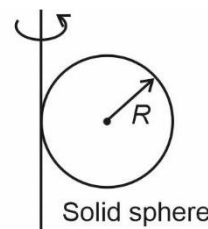
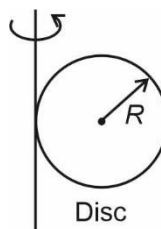
$$= \frac{80}{\sqrt{(130 - 80)^2 + 80^2}}$$

$$= \frac{80}{\sqrt{2500 + 6400}}$$

$$\cos \theta = \frac{8}{\sqrt{89}}$$

9. A disc and a solid sphere of same radius are rotated as shown in the figure. If mass of disc and solid sphere are 4 kg and 5 kg respectively then

$$\frac{I_{\text{disc}}}{I_{\text{solid sphere}}}$$



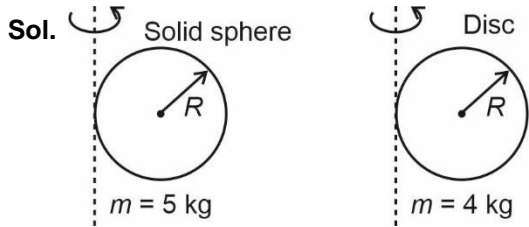
(1) $\frac{7}{5}$

(2) $\frac{25}{28}$

(3) $\frac{5}{7}$

(4) $\frac{28}{25}$

Answer (3)



Using parallel axis theorem,

$$I_{\text{solid sphere}} = \left(\frac{2}{5} mR^2 + mR^2 \right)$$

$$= \left(\frac{7}{5} mR^2 \right) = 7R^2 \text{ (as } m = 5 \text{ kg)}$$

$$I_{\text{disc}} = \left(\frac{1}{4} mR^2 + mR^2 \right) = \left(\frac{5}{4} mR^2 \right) = 5R^2$$

(as $m = 4 \text{ kg}$)

$$\frac{I_{\text{disc}}}{I_{\text{solid sphere}}} = \frac{5R^2}{7R^2} = \frac{5}{7}$$

10. Two projectiles are thrown at angle of projection α and β with the horizontal. If $\alpha + \beta = 90^\circ$ then ratio of range of two projectiles on horizontal plane is equal to

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

Answer (1)

Sol. $R_1 = \frac{u^2 \sin 2\alpha}{g}$

$$R_2 = \frac{u^2 \sin 2(90 - \alpha)}{g} = \frac{u^2 \sin 2\alpha}{g}$$

So $R_1 = R_2$

$$\Rightarrow \frac{R_1}{R_2} = \frac{1}{1}$$

11. What will be molar specific heat capacity of an isochoric process of a diatomic gas if it has additional vibrational mode?

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

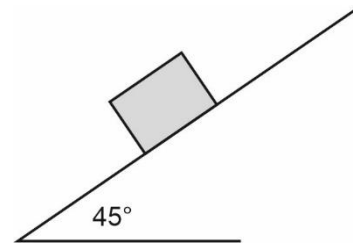
(3) $\frac{7}{2}R$ (4) $\frac{9}{2}R$

Answer (3)

Sol. For each additional vibrational mode degree of freedom is increased by 2 so new degree of freedom $f = 5 + 2 = 7$

$$\text{So, } C_v = \frac{f}{2}R = \frac{7}{2}R$$

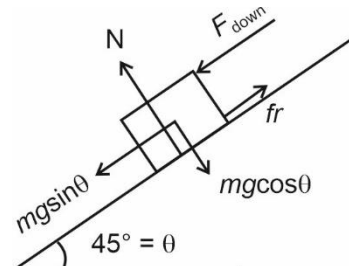
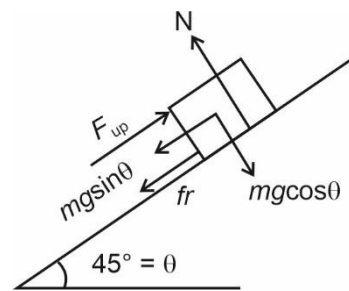
12. A block is placed on a rough inclined plane with 45° inclination. If minimum force required to push the block up the incline is equal to 2 times the minimum force required to slide the block down the inclined plane, then find the value of coefficient of friction between block and incline?



- (1) 0.25 (2) 1
- (3) 2 (4) 3

Answer (4)

Sol.



$$F_{\text{up}} = mg \sin \theta + \mu mg \cos \theta$$

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$$F_{\text{down}} = \mu mg \cos \theta - mg \sin \theta$$

$$F_{\text{up}} = 2F_{\text{down}}$$

$$\Rightarrow mg \sin \theta + \mu mg \cos \theta = 2\mu mg \cos \theta - 2mg \sin \theta$$

$$\Rightarrow 3 \sin \theta = \mu \cos \theta$$

$$\mu = 3 \tan \theta$$

$$\mu = 3 \text{ as } \tan 45^\circ = 1, \theta = 45^\circ$$

13. Correctly match the two lists

	List-I (Physical Quantity)		List-II (Dimensions)
P.	Young's Modulus	A.	$[ML^2T^{-1}]$
Q.	Planck's constant	B.	$[ML^{-1}T^{-2}]$
R.	Work function	C.	$[ML^{-1}T^{-1}]$
S.	Co-efficient of viscosity	D.	$[ML^2T^{-2}]$

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

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

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

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

Answer (2)

$$\text{Sol. } Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L}} \Rightarrow Y = ML^{-1}T^{-2}$$

$$E = hf \Rightarrow h = ML^2T^{-1}$$

$$hf = hf_0 - \phi \Rightarrow \phi = ML^2T^{-2}$$

$$F = \eta A \frac{dv}{dx} \Rightarrow \eta = ML^{-1}T^{-1}$$

14. A big drop is divided into 1000 identical droplets. If the big drop had surface energy U_i and all small droplet together had a surface energy U_f , then $\frac{U_i}{U_f}$

is equal to

(1) $\frac{1}{100}$

(2) 10

(3) $\frac{1}{10}$

(4) 1000

Answer (3)

$$\text{Sol. } \frac{4}{3}\pi R^3 = 1000 \frac{4}{3}\pi r^3$$

$$R = 10r$$

$$U_i = 4\pi R^2 T$$

$$\& U_f = 1000 \times 4\pi r^2 T = 40\pi R^2 T$$

$$\text{So, } \frac{U_i}{U_f} = \frac{4\pi R^2 T}{40\pi R^2 T} = \frac{1}{10}$$

15.

a.	Gauss law (electrostatics)	P.	$\oint \vec{B} \cdot d\vec{A} = 0$
b.	Ampere's circuital law	Q.	$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_{\text{enc}}$
c.	Gauss law (magnetism)	R.	$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{enc}}}{\epsilon_0}$
d.	Faraday's law	S.	$\epsilon = \frac{-d\phi_B}{dt}$

(1) a-R, b-Q, c-S, d-P (2) a-R, b-Q, c-P, d-S

(3) a-R, b-S, c-Q, d-P (4) a-R, b-S, c-P, d-Q

Answer (2)

$$\text{Sol. Gauss law for electrostatic} = \oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

$$\text{Gauss law for magnetism} = \oint \vec{B} \cdot d\vec{A} = 0$$

$$\text{Ampere circuital law} = \oint \vec{B} \cdot d\vec{l} = \mu_0 i_{\text{enclosed}}$$

$$\text{Faraday's law} = \epsilon_{\text{induced}} = \frac{-d\phi_B}{dt}$$

16. A stationary nucleus breaks into 2 daughter nucleus having velocities in ratio 3 : 2. Find the ratio of their nuclear sizes.

(1) $\left(\frac{2}{3}\right)^{1/2}$

(2) $\left(\frac{2}{3}\right)^{1/3}$

(3) $\left(\frac{4}{9}\right)^{1/3}$

(4) $\left(\frac{9}{4}\right)^{1/2}$

Answer (2)

SECTION - B

Sol. Applying momentum conservation

$$m_1 v_1 = m_2 v_2$$

$$\Rightarrow \frac{m_1}{m_2} = \left(\frac{v_2}{v_1} \right) = \frac{2}{3}$$

$$\Rightarrow \frac{A_1}{A_2} = \frac{2}{3}$$

$$\text{also, } \frac{R_1}{R_2} = \left(\frac{A_1}{A_2} \right)^{1/3}$$

$$\text{so, } \frac{R_1}{R_2} = \left(\frac{2}{3} \right)^{1/3}$$

17. Match the two lists :

	List-I		List-II
P.	Adiabatic process	A.	No work done by or on gas
Q.	Isochoric process	B.	Some amount of heat given is converted into internal energy
R.	Isobaric process	C.	No heat exchange
S.	Isothermal process	D.	No change in internal energy

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

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

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

(4) P(B), Q(D), R(C), S(A)

Answer (3)

Sol. Adiabatic $\Rightarrow \Delta Q = 0$

Isochoric $\Rightarrow W = 0$

Isothermal $\Rightarrow \Delta U = 0$

Isobaric $\Rightarrow \Delta Q = \Delta U + W$

(Both ΔU and W are non-zero)

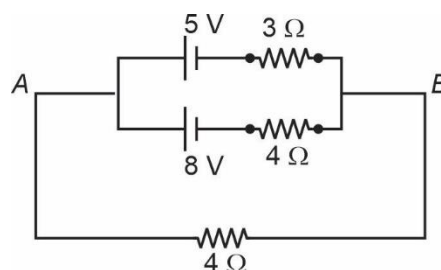
18.

19.

20.

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 circuit shown, the current (in A) through the 4Ω resistor connected across A and B is $\frac{1}{n}$ amperes.



Find n

Answer (10)

$$\text{Sol. } e_{\text{effective}} = \frac{8 \times 3 - 5 \times 4}{3 + 4} \text{ V}$$

$$= \frac{4}{7} \text{ V}$$

$$r_{\text{effective}} = \frac{3 \times 4}{3 + 4} \Omega = \frac{12}{7} \Omega$$

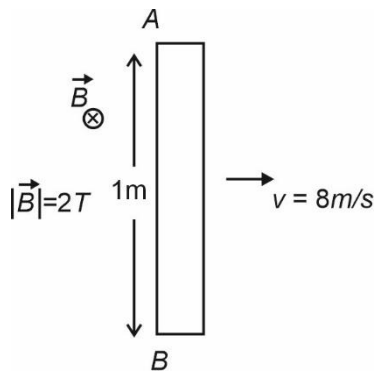
$$\Rightarrow i = \frac{\frac{4}{7}}{\frac{12}{7} + 4} \text{ A}$$

$$= \frac{4}{12 + 28} \text{ A} = \frac{1}{10} \text{ A}$$

22. A metal rod of length 1 m is moving perpendicular to its length with 8 m/s velocity along positive x-axis. If a magnetic field $B = 2 \text{ T}$ perpendicular to the plane of motion. Find the emf involved between the two ends of rod.

Answer (16.00)

Sol.

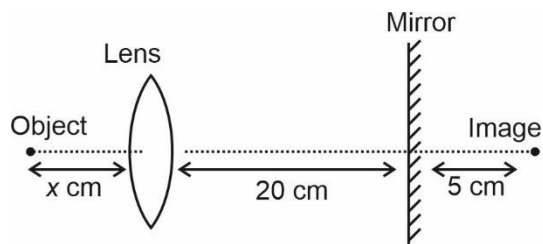


$$|V_A - V_B| = Bvl$$

$$= 2 \times 8 \times 1$$

$$= 16 \text{ v}$$

23. In the arrangement shown:



The image shown is formed after refraction from lens and reflection from mirror. If the length of lens is 10 cm, find x.

Answer (30)

Sol. Writing equation for lens:

$$\frac{1}{+15} - \frac{1}{-x} = \frac{1}{10} \Rightarrow \frac{1}{x} = \frac{1}{10} - \frac{1}{15}$$

$$\Rightarrow x = 30 \text{ cm}$$

24. A capacitor has a capacitance of $5 \mu\text{F}$ when the medium between the plates is air. Now, a material of dielectric constant 1.5 is filled in half the separation between the plates and area same as plates. The new capacitance in μF is _____

Answer (06)

Sol. $C_0 = \frac{\epsilon_0 A}{d}$... (i)

$$C_{\text{new}} = \frac{\frac{1.5 \epsilon_0 A}{\frac{d}{2}} \times \frac{\epsilon_0 A}{\frac{d}{2}}}{\frac{1.5 \epsilon_0 A}{\frac{d}{2}} + \frac{\epsilon_0 A}{\frac{d}{2}}}$$

$$= \frac{1.5 \times \frac{\epsilon_0 A}{d} \times 2}{1.5 + 1}$$

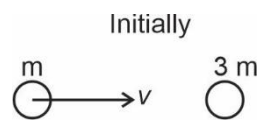
$$= \frac{6 \epsilon_0 A}{5 d}$$

$$= 6 \mu\text{F}$$

25. A particle of mass 1 kg is moving with a velocity towards a stationary particle of mass 3 kg. After collision, the lighter particle returns along same path with speed 2 m/s. If the collision was elastic then speed of 1 kg particle before collision is _____ m/s.

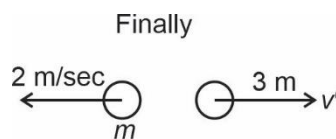
Answer (04.00)

Sol. Linear momentum is conserved.



So $mv = 3mv' - 2m$... (1)

Coefficient of restitution is 1 so



$$e = 1 = \frac{v' + 2}{v}$$

$v' = v - 2$... (2)

on solving

$v = 4 \text{ m/sec}$

26.

27.

28.

29.

30.

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7. Select the correct match.
- A. Hexan-2-one and hexan-3-one – Position isomers
- B. Pentan-3-one and pentan-2-one – Functional isomers
- C. 2-pentene and 1-pentene – Metamers
- D. Pentanoic acid and hexanoic acid – Functional isomers
- (1) A (2) B
(3) C (4) D

Answer (1)

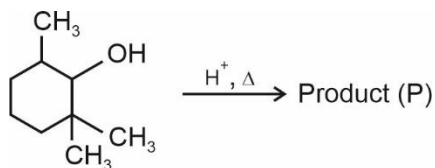
Sol. Hexan-2-one and hexan-3-one are position isomers.

8. Chloride salt of M is treated with excess of AgNO_3 . It forms curdly white precipitate 'A'. When 'A' is treated with NH_4OH , it forms a soluble salt 'B'. The A and B respectively is
- (1) AgCl , $[\text{Ag}(\text{NH}_3)_2]^+$ (2) AgBr , $[\text{Ag}(\text{OH})_2]^-$
(3) AgCl , $[\text{Ag}(\text{OH})_4]^{2-}$ (4) AgBr , $[\text{Ag}(\text{OH})_4]^{2-}$

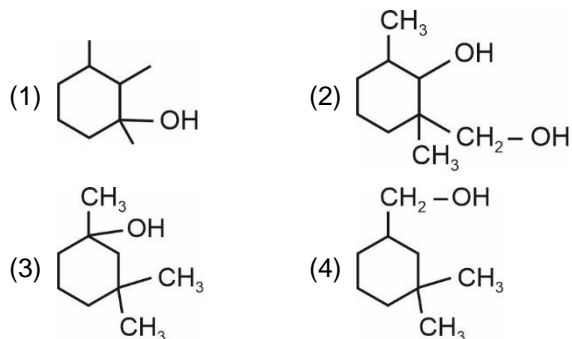
Answer (1)

Sol. AgCl forms white ppt. which is soluble in NH_4OH . The correct answer of this question is (1).

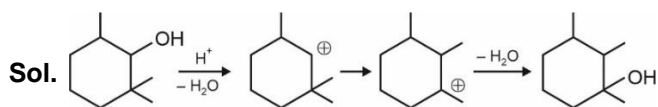
9. Consider the following reaction



The correct product 'P' is



Answer (1)



10. Final oxidation number of Cr when $\text{K}_2\text{Cr}_2\text{O}_7$ is used in acidic medium during titration.
- (1) +6 (2) +2
(3) +3 (4) +4

Answer (3)

Sol. $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$

11. Match the following

(I)	Neoprene	(a)	Synthetic Wool
(II)	Acrolein	(b)	Paint
(III)	LDP	(c)	Flexible Pipes
(IV)	Glyptal	(d)	Gaskets

- (1) II-(d), IV-(b), III-(a), I-(c)
(2) II-(d), IV-(b), III-(c), I-(a)
(3) II-(a), IV-(b), III-(c), I-(d)
(4) II-(b), IV-(c), III-(d), I-(a)

Answer (3)

Sol. Neoprene is a synthetic rubber. It is used for manufacturing of gaskets.

Acrolein is used for making synthetic wool. LDP is used for making flexible pipes. Glyptal is used for making paints.

12. **Assertion** : BHA is added to butter to increase shelf life.

Reason : BHA reacts with oxygen more than butter.

- (1) Assertion is correct Reason is correct
(2) Assertion is correct Reason is incorrect
(3) Assertion is incorrect Reason is correct
(4) Assertion is incorrect Reason is incorrect

Answer (1)

Sol. Butylated hydroxy anisole (BHA) is an antioxidant. It is added to butter to increase its shelf life from months to years. BHA reacts with O_2 present in air in preference to butter. So, both the assertion and reason are correct.

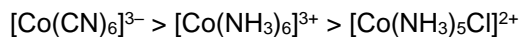
13. A hydrocarbon is having molar mass 84 g mol^{-1} and 85.8% C by mass. Calculate the number of H atoms in the molecule?

- (1) 8 (2) 10
(3) 12 (4) 14

Answer (3)

Answer (3)

Sol. The CFSE value order of the given complexes are:



$\therefore \lambda$, absorbed will be in the reverse order.

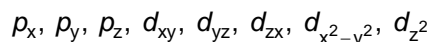
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SECTION - B

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.

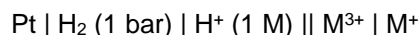
21. How many of the following orbitals is/are considered as axial orbital(s).



Answer (5)

Sol. $p_x, p_y, p_z, d_{x^2-y^2}$ and d_{z^2} orbitals are called axial orbitals.

22. Consider the following cell :



If the value of $\frac{[\text{M}^{3+}]}{[\text{M}^+]}$ is 10^x , then find the value of

'x'. [Given : $E_{\text{M}^{3+}/\text{M}^+}^0 = 2 \text{ V}$ and $E_{\text{cell}} = 1.1 \text{ V}$]

Answer (30)

$$\text{Sol. } 1.1 = 2 - \frac{0.06}{2} \log \frac{[\text{M}^{3+}]}{[\text{M}^+]}$$

$$0.9 = 0.03 \log \frac{[\text{M}^{3+}]}{[\text{M}^+]}$$

$$\therefore \frac{[\text{M}^{3+}]}{[\text{M}^+]} = 10^{30}$$

$$\therefore x = 30$$

23. For a reaction $\text{A} \longrightarrow \text{B}$

$$k = 2 \times 10^{-3} \text{ s}^{-1}$$

Consider the following statements for the above reaction.

SI : The reaction is complete in 1000 sec.

SII : Half life of the reaction is 500 sec.

SIII : Units of rate constant is same as that of rate

SIV : Degree of dissociation is $(1 - e^{-kt})$

SV : It is a zero order reaction.

How many statements are incorrect?

Answer (4)

Sol. Except (4), all statements are incorrect

$$\text{As } [\text{B}] = a(1 - e^{-kt})$$

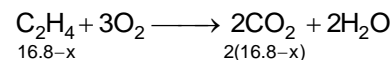
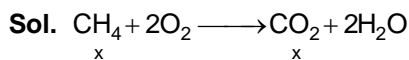
$$\therefore, \left[\alpha = \frac{[\text{B}]}{a} = 1 - e^{-kt} \right]$$

24. Consider a mixture of CH_4 and C_2H_4 having volume 16.8 L at 273 K and 1 atm.

It undergoes combustion to form CO_2 with total volume 28 L at the same temperature and pressure.

If the enthalpy of combustion of CH_4 is -900 kJ/mol and enthalpy of combustion of C_2H_4 is -1400 kJ/mol then find the magnitude of heat released on combustion of given mixture in kJ

Answer (925)



$$x + 2(16.8 - x) = 28$$

$$x = 5.6 \text{ L}$$

$$\begin{aligned} \therefore \text{Heat released} &= \frac{1}{4} \times 900 + \frac{1}{2} \times 1400 \\ &= 225 + 700 \\ &= 925 \text{ kJ} \end{aligned}$$

- 25.
- 26.
- 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. The value of $\sum_{k=0}^6 {}^{51-k}C_3$ is
- (1) ${}^{52}C_4 - {}^{46}C_4$ (2) ${}^{52}C_4 - {}^{45}C_4$
 (3) ${}^{51}C_4 - {}^{45}C_4$ (4) ${}^{51}C_4 - {}^{46}C_4$

Answer (2)

Sol. ${}^{51}C_3 + {}^{50}C_3 + {}^{49}C_3 + \dots + \underbrace{{}^{45}C_3 + {}^{45}C_4 - {}^{45}C_4}_{{}^{46}C_4}$
 ${}^{51}C_3 + {}^{50}C_3 + {}^{49}C_3 + {}^{48}C_3 + {}^{47}C_3 + \underbrace{{}^{46}C_3 + {}^{46}C_4 - {}^{45}C_4}_{{}^{47}C_4}$
 \vdots
 $\Rightarrow {}^{52}C_4 - {}^{45}C_4$

2. If $f(x) = 2x^n + \lambda$ and $f(4) = 133$, $f(5) = 255$, then sum of positive integral divisors of $f(3) - f(2)$ is
- (1) 60 (2) 22
 (3) 40 (4) 6

Answer (1)

Sol. $2 \cdot 4^n + \lambda = 133$... (i)
 $2 \cdot 5^n + \lambda = 255$... (ii)
 $2(5^n - 4^n) = 122$
 $n = 3$
 $f(x) = 2x^3 + \lambda$
 $f(3) - f(2) = 2(3^3 - 2^3)$
 $= 38$
 Divisors = 1, 2, 19, 38

3. If $\left| \frac{z+2i}{z-i} \right| = 2$ is a circle, then centre of the circle is
- (1) (0, 0) (2) (0, 2)
 (3) (2, 0) (4) (-2, 0)

Answer (2)

Sol. $(z + 2i)(\bar{z} - 2i) = 4(z - i)(\bar{z} + i)$
 $\Rightarrow \bar{z}\bar{z} + 2i\bar{z} - 2iz + 4 = 4z\bar{z} - 4i\bar{z} + 4iz + 4$
 $\Rightarrow 3z\bar{z} - 6i\bar{z} + 6iz = 0$
 $\Rightarrow z\bar{z} - 2i\bar{z} + 2iz = 0$
 \therefore Centre = $2i$ i.e., (0, 2)

4. If $\frac{dy}{dt} + \alpha \cdot y = \gamma \cdot e^{-\beta t}$, then $\lim_{t \rightarrow \infty} y(t)$, where $\alpha > 0, \beta > 0, \gamma > 0, \alpha \neq \beta$, is equal to
- (1) 0 (2) 1
 (3) Does not exist (4) $\alpha\beta$

Answer (1)

Sol. $\frac{dy}{dt} + \alpha y = \gamma e^{-\beta t}$
 Integrating factor (I.F.) = $e^{\alpha t}$
 Solution of D.E.
 $ye^{\alpha t} = \gamma \int e^{(\alpha-\beta)t} dt$
 $\Rightarrow ye^{\alpha t} = \frac{\gamma}{\alpha - \beta} \cdot e^{(\alpha-\beta)t} + C$
 $\Rightarrow y(t) = \frac{\gamma}{\alpha - \beta} \cdot \alpha^{-\beta t} + C \cdot e^{-\alpha t}$
 $\lim_{t \rightarrow \infty} y(t) = 0$

5. If $(p \rightarrow q) \nabla (p \Delta q)$ is tautology, then operator ∇, Δ denotes
- (1) $\Delta \rightarrow$ OR (2) $\Delta \rightarrow$ AND
 $\nabla \rightarrow$ AND $\nabla \rightarrow$ OR
 (3) $\Delta \rightarrow$ AND (4) $\Delta \rightarrow$ OR
 $\nabla \rightarrow$ AND $\nabla \rightarrow$ OR

Answer (4)

- Sol.** $(p \rightarrow q) \nabla (p \Delta q) \equiv T$
 Only if ∇ is OR and Δ is OR
6. Number of numbers between 5000 and 10000 by using the digits 1,3,5,7,9 without repetition is equal to
- (1) 120 (2) 72
 (3) 12 (4) 6

Answer (2)

11. Let $\vec{a} = -\hat{i} - \hat{j} + \hat{k}$ such that $\vec{a} \cdot \vec{b} = 1$ and $\vec{a} \times \vec{b} = \hat{i} - \hat{j}$ then $\vec{a} - 6\vec{b}$ equals

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

Answer (1)

Sol. $(\vec{a} \times \vec{b}) = \hat{i} - \hat{j}$

$$\Rightarrow \vec{a} \times (\vec{a} \times \vec{b}) = (-\hat{i} - \hat{j} + \hat{k}) \times (\hat{i} - \hat{j})$$

$$\Rightarrow (\vec{a} \cdot \vec{b})\vec{a} - (\vec{a} \cdot \vec{a})\vec{b} = \hat{i} + \hat{j} + 2\hat{k}$$

$$\Rightarrow 3\vec{b} = -2\hat{i} - 2\hat{j} - \hat{k}$$

$$\begin{aligned} \therefore \vec{a} - 6\vec{b} &= 3\hat{i} + 3\hat{j} + 3\hat{k} \\ &= 3(\hat{i} + \hat{j} + \hat{k}) \end{aligned}$$

12. $16 \int_1^2 \frac{dx}{x^3(x^2+2)^2}$ is equal to

- (1) $\frac{11}{12} + \ln 4$
- (2) $\frac{11}{12} - \ln 4$
- (3) $\frac{11}{6} - \ln 4$
- (4) $\frac{11}{6} + \ln 4$

Answer (3)

Sol. $I = \int \frac{dx}{x^3(x^2+2)^2}$

$$\begin{aligned} &= \frac{1}{4} \int \frac{x}{x^2+2} dx + \frac{1}{4} \int \frac{x}{(x^2+2)^2} dx - \frac{1}{4} \int \frac{1}{x} dx + \frac{1}{4} \int \frac{1}{x^3} dx \\ &= \frac{\ln(x^2+2)}{8} - \frac{\ln x}{4} - \frac{1}{8(x^2+2)} - \frac{1}{8x^3} \end{aligned}$$

$$16 \int_1^2 \frac{dx}{x^3(x^2+2)^2} = 2\ln 6 - 2\ln 3 - 4\ln 2 + \frac{11}{6}$$

13. If $A = \begin{bmatrix} 3 & 1 \\ \sqrt{10} & \sqrt{10} \\ -1 & 3 \\ \sqrt{10} & \sqrt{10} \end{bmatrix}$ and $B = \begin{bmatrix} 1 & -i \\ 0 & 1 \end{bmatrix}$

If $M = A^T B A$, then the matrix $A M^{2023} A^T$ is

- (1) $\begin{bmatrix} 1 & -2023i \\ 0 & 1 \end{bmatrix}$
- (2) $\begin{bmatrix} 1 & 2023i \\ 0 & 1 \end{bmatrix}$
- (3) $\begin{bmatrix} 1 & -2023i \\ 0 & -1 \end{bmatrix}$
- (4) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

Answer (1)

Sol. $AA^T = I$

$$M = A^T B A$$

$$A M^{2023} A^T$$

$$= A \underbrace{(A^T B A)(A^T B A)(A^T B A) \dots (A^T B A)}_{2023 \text{ times}} A^T$$

$$= B^{2023}$$

$$B^2 = \begin{bmatrix} 1 & -i \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -i \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -2i \\ 0 & 1 \end{bmatrix}$$

$$B^3 = \begin{bmatrix} 1 & -2i \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -i \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -3i \\ 0 & 1 \end{bmatrix}$$

$$B^{2023} = \begin{bmatrix} 1 & -2023i \\ 0 & 1 \end{bmatrix}$$

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

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24. If $a, b, \frac{1}{18}$ are in G.P. and $\frac{1}{10}, \frac{1}{a}, \frac{1}{b}$ are in A.P. then

find value of $a + 180b$

Answer (20.00)

Sol. $b^2 = \frac{a}{18}, \frac{2}{a} = \frac{1}{10} + \frac{1}{b}$

$$\Rightarrow a = \frac{20b}{10+b}$$

$$\text{OR } 18b^2 = \frac{20b}{10+b}$$

$$b = 0 \text{ (rejected)}$$

$$\text{OR } 9b = \frac{10}{10+b}$$

$$90b + 9b^2 = 10$$

$$\Rightarrow 9b^2 + 90b - 10 = 0$$

$$a + 180b = 18b^2 + 180b$$

$$= 20$$

25. In a city, 25% of the population is smoker and a smoker has 27 times more than chance of being diagnosed with lung cancer. A person is selected at random and found to be diagnosed with lung cancer. If the probability of him being smoker is $\frac{K}{40}$, find the value of K .

Answer (36.00)

Sol. Probability of a person being smoker = $\frac{1}{4}$

Probability of a person being non smoker = $\frac{3}{4}$

$$P\left(\frac{\text{Person is smoker}}{\text{Person diagnosed with cancer}}\right) = \frac{\frac{1}{4} \cdot 27P}{\frac{1}{4} \cdot 27P + \frac{3}{4}P}$$

(P is probability that a non-smoker is diagnosed with cancer)

$$= \frac{27}{30} = \frac{9}{10} = \frac{36}{40}$$

26.

27.

28.

29.

30.



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