26/07/2022
Morning

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.

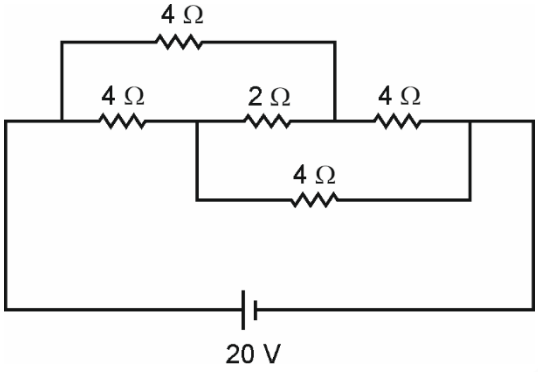
(ii) **Section-B:** This section contains 10 questions. In Section-B, attempt any **five questions out of 10.** The answer to each of the questions is a numerical value. Each question carries **4 marks** for correct answer and **–1 mark** for wrong answer. For Section-B, the answer should be rounded 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. 

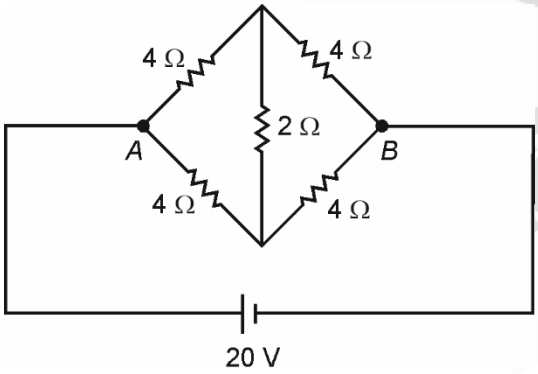
Find current through cell?

(1) 2 A (2) 4 A

(3) 5 A (4) 10 A

Answer (3)

Sol. The circuit can be redrawn as

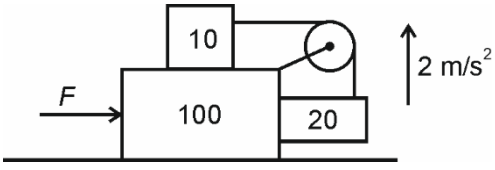


The circuit is a balanced Wheatstone bridge

$R_{eq(AB)} = 4\ \Omega$

$\Rightarrow$ Current through cell $= \frac{20}{4}$ A = 5 A

2. Assume all surfaces are friction less. Find value of force required such that 20 kg block moves with acceleration 2 m/s^2

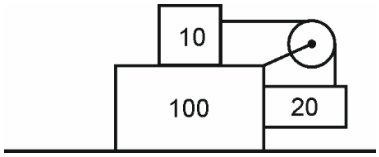


(1) 2080 N (2) 3360 N

(3) 2420 N (4) 2820 N

Answer (2)

Sol.



If T is the tension in thread and a be the acceleration of 100 kg block

$10a - T = 2 \times 10$

$T - 20 \times 10 = 20 \times 2$

$\Rightarrow$ $10a = 3 \times 20 + 20 \times 10 = 260$

$a = 26$ m/s^2

$F - T = 120a$

$F = 3360$ N

3. A charged particle moving in a uniform magnetic field $B = 2\hat{i} + 3\hat{j}$ has acceleration $a = (\alpha\hat{i} - 4\hat{j})$. The value of α is equal to

(1) 6 (2) 2

(3) $-\frac{8}{3}$ (4) $\frac{4}{5}$

Answer (1)

Sol. As magnetic force is perpendicular to the magnetic field so

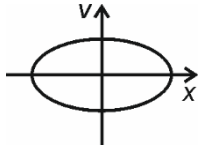
$\bar{a} \cdot \bar{B} = 0$

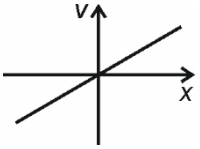
$(\alpha\hat{i} - 4\hat{j}) \cdot (2\hat{i} + 3\hat{j}) = 0$

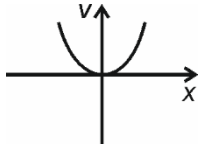
$\Rightarrow$ $2\alpha = 12$

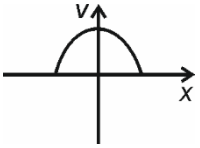
$\Rightarrow$ $\alpha = 6$

4. In S.H.M. v-x graph will be

(1) 

(2) 

(3) 

(4) 

Answer (1)

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

$v = \omega A\cos(\omega t + \phi)$

$\Rightarrow$ $\frac{x^2}{A^2} + \frac{v^2}{\omega^2 A^2} = 1$

Or v vs x graph would be elliptical

5. In an LR circuit if $X_L = R$ then power factor is P_1. In another LCR series circuit if $X_L = X_C$ then power factor is P_2. Then value of $\frac{P_1}{P_2}$ is equal is

(1) 1 : 1 (2) 1 : 2

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

Answer (3)

Sol. $P_1 = \frac{R}{Z} = \frac{R}{\sqrt{2}R} = \frac{1}{\sqrt{2}}$

$P_2 = \frac{R}{Z} = \frac{R}{R} = 1$

$\frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$

6. A coil of 200 turns and another coil of 400 turns have same length 20 cm. Find ratio of magnetic field at centre.

(1) 1 : 2 (2) 2 : 1

(3) 1 : 4 (4) 4 : 1

Answer (3)

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

$= \frac{N^2\mu_0 I\pi}{(2\pi r)N} = \frac{N^2\pi\mu_0 I}{\ell}$

$\Rightarrow \frac{B_1}{B_2} = \frac{N_1^2}{N_2^2} = \frac{1}{4}$

7. A monkey climbs rope with 4 m/s^2 acceleration and when it climbs down his acceleration is 5 m/s^2. Weight of monkey is 50 kg and maximum tension is 350 N.

Find correct option.

(1) T = 700 N, when climbs upwards

(2) T = 350 N, when climbs downwards

(3) Rope will break when climbs upward

(4) Rope will break when climbs downward

Answer (3)

Sol. Assuming the rope doesn't break

$T_{up} = 50 \times (14) = 700$ N

but $T_{max} = 350$

$\Rightarrow$ Rope breaks if the monkey climbs up with acceleration 4 m/s^2

$T_{down} = 50(10 - 5) = 250$ N

8. Wave equation is given.

$y = 2 \times 10^{-8} \sin(kx + \omega t + \phi)$ (cm) Find amplitude?

(1) 2×10^{-8} cm (2) 5×10^{-6} cm

(3) 4×10^{-6} cm (4) 8×10^{-6} cm

Answer (1)

Sol. Comparing with standard equation of a wave

$y = A\sin(kx + \omega t + \phi)$

$A = 2 \times 10^{-8}$ cm

9. In YDSE experiment fringe width β = 12 cm is given, if the setup is dipped in medium having refractive index $\mu = \frac{4}{3}$ find new fringe width.

(1) 6 (2) 9

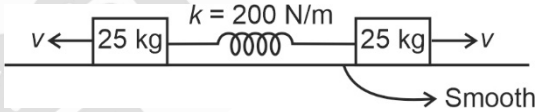
(3) 12 (4) 16

Answer (2)

Sol. $\beta = \frac{\lambda D}{d}$

$\beta' = \frac{\lambda D}{\mu d} = \frac{\beta}{\mu} = \frac{12}{\frac{4}{3}}$

β' = 9 cm

10. 

With spring at its natural length two blocks are given velocity v = 1 m/s. The maximum extension in the spring is equal to

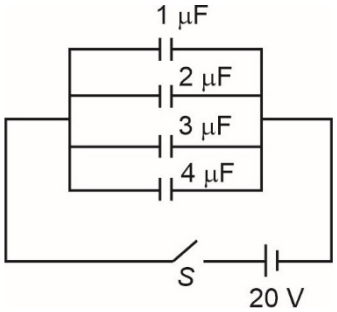
(1) 5 cm (2) 0.5 m

(3) 0.25 m (4) 0.1 m

Answer (2)

Sol. $\frac{1}{2}kx^2 = 2 \times \frac{1}{2} \times 25(v)^2$

$\Rightarrow x = \sqrt{0.25} = 0.5$

11. 

After closer of the switch S find the total charge flown through the switch.

(1) 100 μC (2) 50 μC

(3) 45 μC (4) 200 μC

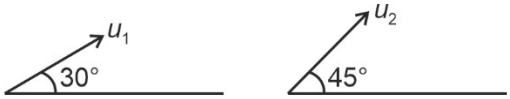
Answer (4)

Sol. $C_{eq} = 10\ \mu F$

$Q = 20\ V \times 10\ \mu F$

$= 200\ \mu C$

12. For the two projectiles shown below:



Find $\frac{u_1}{u_2}$ if time to reach maximum height is same

(1) $\sqrt{2}:1$ (2) $1:\sqrt{2}$

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

Answer (1)

Sol. As time of flight is same

$$\Rightarrow \frac{2u_1\sin\theta_1}{g} = \frac{2u_2\sin\theta_2}{g}$$

$$\Rightarrow \frac{u_1}{u_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \sqrt{2}:1$$

13. The decrease in weight of a rocket when it in 32 km above surface of earth.

(1) 1% (2) 2%

(3) 3% (4) 4%

Answer (1)

Sol. $g' = \frac{g(R)^2}{(R+h)^2}$

$$\Rightarrow \frac{\Delta W}{W} = \frac{2\Delta r}{r}$$

$$\Rightarrow \frac{\Delta W}{W} = \frac{2\times 32}{6400}$$

$\Rightarrow$ Decrease in weight = 1%

14. If velocity of electron is x times than neutron and de-Broglie wavelengths are same then find x.

(1) 2531 (2) 2000

(3) 1835 (4) 729

Answer (3)

Sol. $\lambda_e = \lambda_n$

$\Rightarrow m_e v_e = m_n v_n$

$$\Rightarrow v_e = \left(\frac{m_n}{m_e}\right)v_n$$

$$\Rightarrow x = \frac{m_n}{m_e}$$

$x \cong 1835$

15.

16.

17.

18.

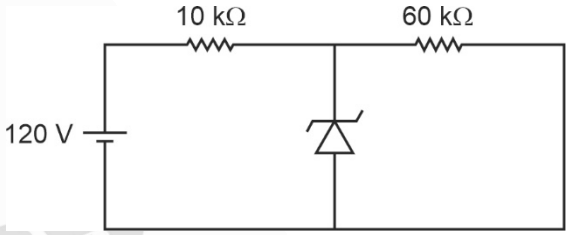
19.

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.



In the circuit shown the potential drop across the diode is 60 V then current through diode is ____ mA.

Answer (05)

Sol. $I_{60\ k\Omega} = \frac{60\ V}{60\times 10^3\ \Omega} = 10^{-3}\ A$

$$\Rightarrow I_{10\ k\Omega} = \frac{60\ V}{10\times 10^3\ \Omega} = 6\times 10^{-3}\ A$$

$\Rightarrow$ Current through diode = $6 \times 10^{-3}\ A - 10^{-3}\ A$

$= 5 \times 10^{-3}\ A$

$= 5\ mA$

22. A drop breaks in 729 smaller identical droplets. It T is the surface tension and R is the radius of bigger drop then change in the surface potential energy is $n\pi R^2 T$. The value of n is _____.

Answer (32)

Sol. $E_i = 4\pi(R)^2 T$

$$E_f = 729\times 4\pi\left(\frac{R}{9}\right)^2 T$$

$= 36\pi R^2 T$

$\Delta E = E_f - E_i = 32\pi R^2 T$

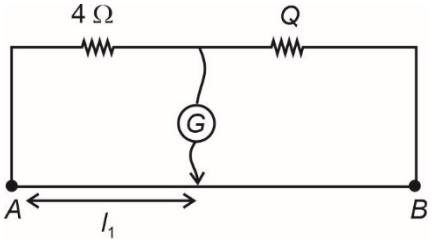
23. In an EM wave if amplitude of magnetic field component is 2×10^{-8} T then the value amplitude of electric field component is _____ V/m.

Answer (6)

Sol. $E_0 = cB_0$

$= 3 \times 10^8 \times 2 \times 10^{-8}$

$= 6$ V/m

24. 

In a meter bridge experiment balance point is $l_1 = 40$ cm away from point A. Now if an unknown resistance of x Ω is added to 4 Ω resistance in series then balance point is 80 cm from point A. Then value of x is _____.

Answer (20)

Sol. $\frac{4}{40} = \frac{Q}{60}$

$\Rightarrow Q = 6\ \Omega$

Now $\frac{4+x}{80} = \frac{6}{20}$

$\Rightarrow 4 + x = 24$

$\Rightarrow x = 20\ \Omega$

25. Temperature of 7 moles of a monoatomic gas is raised by 40 K. The change in internal energy of the sample is equal to _____ R. (R is universal gas constant)

Answer (420)

Sol. $\Delta U = \frac{f}{2} nR\Delta T$

$= \frac{3}{2} \times 7 \times 40 \times R$

$= 420R$

26. Find the number of photons coming out per unit time of a source that emits a light of wavelength 900 nm of intensity 100 W/m^2 through its surface area of 1 m^2. (In multiple of 10^{19})

Answer (45)

Sol. $P = IA$

$= 100$ W

Energy of one photon = $\frac{hC}{\lambda}$

Number of photons coming out per unit time

$= \frac{100 \times \lambda}{hC} = \frac{100 \times 9 \times 10^{-7}}{6.625 \times 10^{-34} \times 3 \times 10^8}$

$= 45 \times 10^{19}$

27. Trajectory of a projectile is $5y = 5x\left(1 - \frac{x}{10}\right)$. Find initial velocity

Answer (10)

Sol. Comparing with standard equation

$y = x\tan\theta\left(1 - \frac{x}{R}\right)$

$\tan\theta = 1$ or $\theta = 45°$

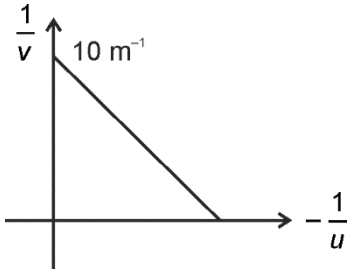
and $R = 10$

$\Rightarrow \frac{u^2 \sin 2\theta}{g} = 10$

or $u^2 = 100$

$\Rightarrow u = 10$

28. In a biconvex lens graph between $\frac{1}{v}$ and $-\frac{1}{u}$ is as shown. The focal length of lens is equal to _____ cm



Answer (10)

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

from graph

$\frac{1}{10} = \frac{1}{f}$ or $f = 10$ cm

29.

30.

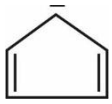
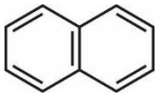
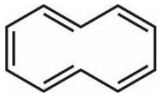
CHEMISTRY

SECTION – A

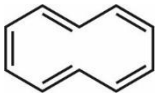
Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Which of the following is not an aromatic compound?

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

Answer (4)

Sol.  is not an aromatic compound as it is not planar.

2. Which of the following can be used as a stabilizer to preserve H_2O_2?

(1) Urea (2) C_2H_5OH
(3) HCHO (4) HCOOH

Answer (1)

Sol. Urea can be added as a stabilizer to preserve H_2O_2.

3. Products formed in the given reaction are

$$BeCl_2 + LiAlH_4 \longrightarrow$$

(1) BeH_2, LiCl and $AlCl_3$ (2) LiH, $BeCl_2$, AlH_3
(3) LiH, BeH_2, $AlCl_3$ (4) LiCl, BeH_2, AlH_3

Answer (1)

Sol. $BeCl_2 + LiAlH_4 \longrightarrow 2BeH_2 + LiCl + AlCl_3$

$LiAlH_4$ reacts with $BeCl_2$ to give BeH_2, LiCl and $AlCl_3$.

4. Column-I contains molecules and Column-II contains their corresponding shapes.

Column-I	Column-II
(A) PCl_5	(i) Bent
(B) BrF_5	(ii) Square pyramidal
(C) O_3	(iii) Trigonal bipyramidal

The correct match is

(1) (A) → (iii), (B) → (ii), (C) → (i)
(2) (A) → (i), (B) → (ii), (C) → (iii)
(3) (A) → (ii), (B) → (iii), (C) → (i)
(4) (A) → (i), (B) → (iii), (C) → (ii)

Answer (1)

Sol.

Molecules	Correct shapes
PCl_5	Trigonal bipyramidal
BrF_5	Square pyramidal
O_3	Bent

5. Which type of Detergent or soap is formed when polyethylene glycol reacts with stearic acid

(1) Soap (2) Cationic Detergent
(3) Anionic Detergent (4) Non Ionic Detergent

Answer (4)

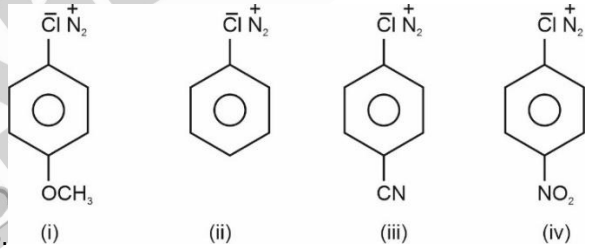
Sol. Non ionic detergents do not contain any ion in their constitution.

When stearic acid reacts with polyethylene glycol it forms non ionic detergent

$$CH_3(CH_2)_{16}COOH + HO(CH_2CH_2O)_n CH_2CH_2OH \xrightarrow{-H_2O}$$

$$CH_3(CH_2)_{16}COO(CH_2CH_2O)_n CH_2CH_2OH$$

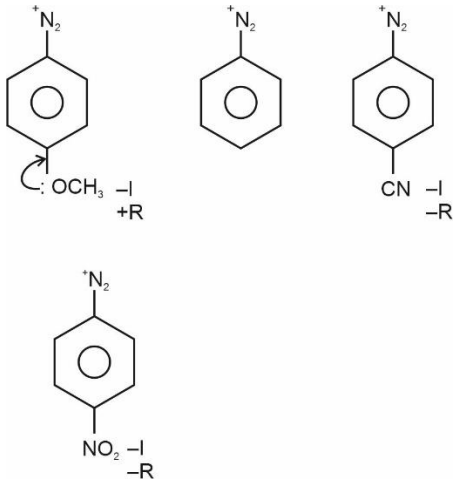
Non-ionic Detergent

6. 

Correct order of stability of the given species is

(1) (i) > (ii) > (iii) > (iv) (2) (ii) > (i) > (iii) > (iv)
(3) (iii) > (i) > (ii) > (iv) (4) (iv) > (iii) > (ii) > (i)

Answer (1)

Sol. 

The –I and – R effect of $-NO_2$ is greater than that of – CN. Hence the correct order of stability is (i) > (ii) > (iii) > (iv)

7. Match the matrix

(A) $N_2 + 3H_2 \rightarrow 2NH_3$ (I) Pt

(B) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ (II) Fe

(C) $2SO_2 + O_2 \rightarrow 2SO_3$ (III) V_2O_5

(1) (A) - (I); (B) - (III); (C) - (II)

(2) (A) - (II); (B) - (I); (C) - (III)

(3) (A) - (I); (B) - (II); (C) - (III)

(4) (A) - (III); (B) - (I); (C) - (II)

Answer (2)

Sol. $N_2 + 3H_2 \xrightarrow{Fe} 2NH_3$

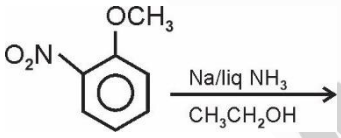
$4NH_3 + 5O_2 \xrightarrow{Pt} 4NO + 6H_2O$

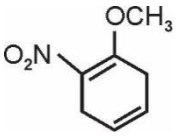
$2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$

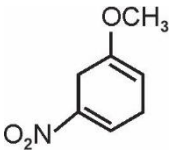
Correct match is

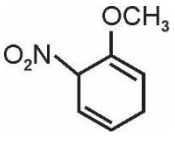
(A) - (ii); (B) - (I); (C) - (III)

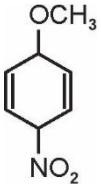
8. The major product formed in the given reaction is,



(1) 

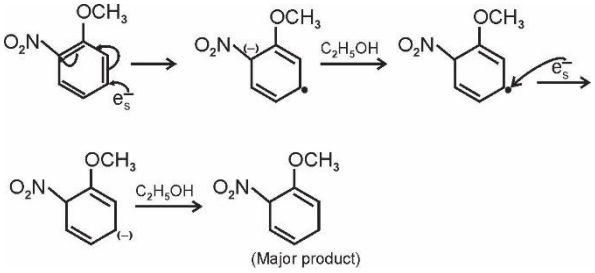
(2) 

(3) 

(4) 

Answer (3)

Sol. $Na + (x+y)NH_3 \rightarrow Na(NH_3)_x^+ + e(NH_3)_y^-$ or e_s^-



9. Which of the following is a non-reducing sugar

(1) Sucrose (2) Maltase

(3) Lactose (4) Glucose

Answer (1)

Sol. The carbohydrates which reduce Fehling solution and Tollen's reagent are referred as reducing sugars.

The reducing groups of glucose and fructose are involved in glycosidic bond formation thus sucrose is a non-reducing sugar

10. Consider the following reactions:

$Cu^{+2}_{(aq)} + 2Ag(s) \rightleftharpoons Cu(s) + 2Ag^{\oplus}_{(aq)}, K_1 = 2\times10^{15}$

$Ag^{\oplus}_{(aq)} + \frac{1}{2}Cu(s) \rightleftharpoons Ag(s) + \frac{1}{2}Cu^{+2}_{(aq)}, K_2 = ?$

Equilibrium constant, K_2 is

(1) 1.14×10^{-7} (2) 2.23×10^{-8}

(3) 3.24×10^{-8} (4) 2.56×10^{-7}

Answer (2)

Sol. $K_2 = \frac{1}{\sqrt{K_1}}$

[As 2nd equation is reverse of 1st equation, further multiplied by $\frac{1}{2}$]

$K_2 = \frac{1}{\sqrt{2\times10^{15}}}$

$= 0.223 \times 10^{-7}$

$= 2.23 \times 10^{-8}$

11. Which of the following reaction will give borazine?

(A) $NH_3 + B_2H_6$ (B) $HN_3 + B(OH)_3$

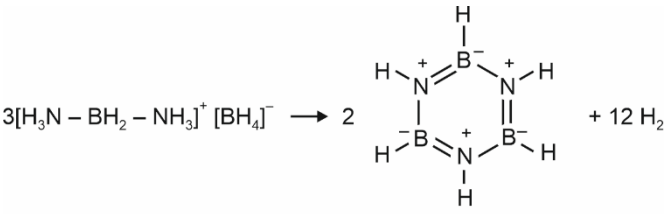
(C) $N_2 + B_2H_6$ (D) $NH_3 + B(OH)_3$

(1) (D) (2) (B)

(3) (C) (4) (A)

Answer (4)

Sol. $2NH_3 + B_2H_6 \rightarrow [H_3N-BH_2-NH_3]^+[BH_4]^-$



(Borazine)

12. In summer season, methane reacts with chlorine atoms forming chlorine sink preventing ozone depletion. The products formed in the reaction are:

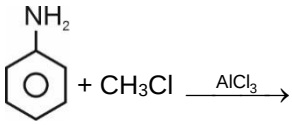
(1) $\dot{C}H_3, HCl$ (2) C_2H_6, HCl

(3) $Cl_2, \dot{C}H_3$ (4) H_2, Cl_2

Answer (1)

Sol. $\dot{Cl}(g) + CH_4(g) \rightarrow \dot{C}H_3(g) + HCl(g)$

This reaction is usually observed in summer season.

13. 

S_1 : Ortho and para substituted products are not formed as major product.

S_2 : Aniline reacts with $AlCl_3$ (Lewis acid base reaction) meta substituted product is formed. Which of the following option is correct?

(1) Both S_1 and S_2 are correct

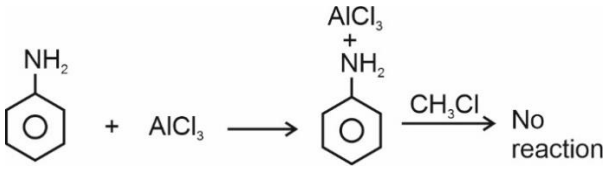
(2) Both S_1 and S_2 are wrong

(3) Only S_1 is correct

(4) Only S_2 is correct

Answer (3)

Sol. Friedel-craft's reaction is not possible in aniline because $–NH_2$ group forms complex with Lewis acid and deactivates the ring.



14.

15.

16.

17.

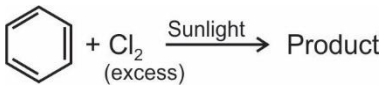
18.

19.

20.

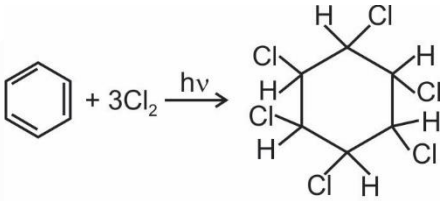
SECTION - B

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. 

Number of hydrogen atoms in the compound are

Answer (06.00)

Sol. 

B. H. C

Benzene reacts with Cl_2 in presence of sunlight to give benzene hexachloride (B.H.C.).

Number of H-atoms in the product = 6.

22. If wavelength of first line in Lyman series of H spectrum is λ_L and wavelength difference between second transition of Balmer and third transition of Paschen series of line spectrum of H atom is $\alpha\lambda_L$. Find the value of α?

Answer (05.00)

Sol. $\frac{1}{\lambda_L} = Rz^2\left(1-\frac{1}{4}\right)$

$= R(z)^2 \times \frac{3}{4} \Rightarrow \lambda_L = \frac{4}{3R}$ (for z = 1)

$\frac{1}{\lambda_B} = R\left(\frac{1}{4}-\frac{1}{16}\right) = \frac{3R}{16} \Rightarrow \lambda_B = \frac{16}{3R}$

$\frac{1}{\lambda_P} = R\left(\frac{1}{9}-\frac{1}{36}\right) = \frac{R}{9}\left(\frac{3}{4}\right) = \frac{R}{12} \Rightarrow \lambda_P = \frac{12}{R}$

$|\lambda_B - \lambda_P| = \left(\frac{16}{3R}-\frac{12}{R}\right) = \frac{20}{3R}$

$= 5 \times \frac{4}{3}R = 5\lambda_L$

$\Rightarrow \alpha = 5$

23. $[Co(H_2O)_6]Cl_2$ and $[Co(H_2O)_6]Cl_3$

Find the difference between the spin only magnetic moment of the given compounds. (Round off to the nearest integer).

Answer (04.00)

Sol. $[Co(H_2O)_6]\ Cl_2$

$Co^{2+} : 3d^7$ Hybridisation of $Co^{2+} : sp^3d^2$

No. of unpaired electrons = 3

$\mu_1 = \sqrt{15}\,BM \simeq 4\ BM$

$[Co(H_2O)_6]Cl_3$

$Co^{3+} : 3d^6$ Hybridisation of $Co^{3+} : d^2sp^3$

No. of unpaired electrons = 0

$\mu_2 = 0\ BM$

Difference in spin only magnetic moment = 4 BM

24. The velocity of electron is x times the velocity of a neutron.
If the wavelength of electron is equal to the wavelength of neutron, find the value of x.
{Given mass of electron = 9.1×10^{-31} kg}
{mass of neutron = 1.6×10^{-27} kg}
(Round off to nearest integer)

Answer (1758.00)

Sol. $\lambda_e = \dfrac{h}{m_e v_e}$

$\lambda_n = \dfrac{h}{m_n v_n}$

Given, $\lambda_e = \lambda_n$

$m_e v_e = m_n v_n$

$(9.1 \times 10^{-31}) \times v_e = (1.6 \times 10^{-27}) v_n$

$x = \dfrac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}} = 1758.24$

$x \simeq 1758$

25. Consider a reaction
$A \rightarrow 2\ B + C$
It is given that $t_{\frac{1}{2}}$ = 100 sec when initial amount of A is 0.5 mol and $t_{\frac{1}{2}}$ is 50 seconds when initial amount of A is 1 mol.
Find the order of the reaction.

Answer (02.00)

Sol. $t_{\frac{1}{2}} \propto \dfrac{1}{(A)_0^{n-1}}$

$\dfrac{\left(t_{\frac{1}{2}}\right)_I}{\left(t_{\frac{1}{2}}\right)_{II}} = \left(\dfrac{(A)_{0I}}{(A)_{0II}}\right)^{1-n}$

$\dfrac{100}{50} = \left(\dfrac{1}{2}\right)^{1-n}$

$2 = (2)^{n-1}$

$n - 1 = 1$

$n = 2$

26. 800 ml of 0.5 M HNO_3 is heated. The volume of the solution reduces to half of the initial value and mass of HNO_3 remaining is 11.5 g. Find the molarity of the final solution.

Answer (00.46)

Sol. Molarity of HNO_3 $= \dfrac{11.5 \times 1000}{63 \times 400}$

$\simeq 0.46\ M$

27. On titration of acidic KMnO4 with sodium oxalate, the change in oxidation state of manganese is _____

Answer (05.00)

Sol. $\overset{+7}{MnO_4^-} + 5\ C_2O_4^{2-} + 16H^+ \longrightarrow \overset{+2}{2Mn^{2+}} 10CO_2 + 8H_2O$

Oxidation state of Mn changed from +7 to +2.

28. A mixture of H_2 and O_2 contains 40% of H_2 by mass. If total pressure is 2.2 atm, then calculate the partial pressure of O_2 (in atm)?

Answer (00.19)

Sol. $\dfrac{W_{H_2}}{W_{O_2}} = \dfrac{40}{60} = \dfrac{2}{3}$

$P_{O_2} = X_{O_2} \times P_{Total}$

$= \dfrac{n_{O_2}}{n_{O_2} + n_{H_2}} \times 2.2$

$= \dfrac{\left(W_{O_2}/32\right) \times 2.2}{\dfrac{W_{O_2}}{32} + \dfrac{W_{H_2}}{2}} = \dfrac{\left(W_{O_2}/32\right) \times 2.2}{\dfrac{W_{O_2}}{32} + \dfrac{W_{O_2}}{3}}$

$= \dfrac{3}{35} \times 2.2 \simeq 0.19\,atm$

29. Chlorophyll is extracted from a leaf. The amount of Mg was 48 ppm. The number of millimoles of Mg in 2 litre of solution is _____.
[Consider density of solution as 1 gm/ml & molar mass of Mg = 24 gm/mol]

Answer (04.00)

Sol. $\dfrac{W_{Mg}}{W_{solution}} \times 10^6 = 48$

$\dfrac{W_{Mg}}{2000} \times 10^6 = 48$

$W_{Mg} = \dfrac{48 \times 2000}{10^6} = 96 \times 10^{-3}$

Moles of Mg = $\dfrac{96 \times 10^{-3}}{24} = 4 \times 10^{-3}$

Millimoles of Mg = 4

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. If $\frac{dy}{dx}+2y\tan x=\sin x, y\left(\frac{\pi}{3}\right)=0$ then maximum value of $y(x)$ is

(1) $\frac{1}{8}$

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

(3) 1

(4) 2

Answer (1)

Sol. $\frac{dy}{dx}+(2\tan x)y=\sin x$

$\text{I.F.}=e^{\int 2\tan x dx}=e^{2\ln\sec x}=\sec^2 x$

$\Rightarrow \quad y\cdot\sec^2 x=\int \sin x\cdot\sec^2 x dx+C$

$\Rightarrow \quad y\sec^2 x=\sec x+C$

$\because \quad y\left(\frac{\pi}{3}\right)=0 \Rightarrow C=-2$

$\Rightarrow \quad y=\cos x-2\cos^2 x=\frac{1}{8}-2\left(\cos x-\frac{1}{4}\right)^2$

So maximum value of $y(x)$ is $\frac{1}{8}$.

2. Area bounded by the curves

$y = 1, y = 3, y^a = x, (x > 0)$ and $x = 0$ is $\frac{364}{3}$ then a is equal to

(1) 4

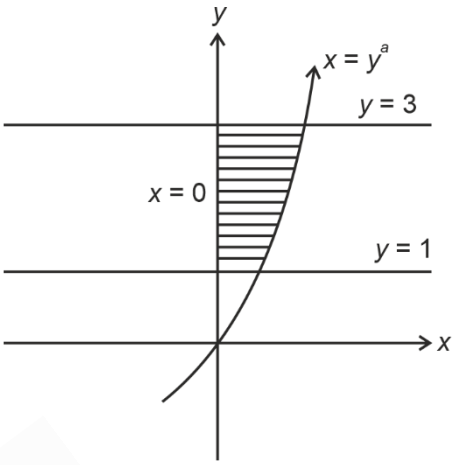
(2) 5

(3) 6

(4) 7

Answer (2)

Sol.



Area of shaded region = $\frac{364}{3}$

$\Rightarrow \quad \int_1^3 y^a dy=\frac{364}{3}$

$\Rightarrow \quad \frac{y^{a+1}}{a+1}\Big|_1^3=\frac{364}{3}$

$\Rightarrow \quad \frac{3^{a+1}-1}{a+1}=\frac{364}{3}$

$\therefore \quad \boxed{a=5}$

3. If the line $\frac{x+1}{4}=\frac{y-2}{3}=\frac{z-1}{4}$ intersects the plane $x + y - z = 0$ at point P, then distance of P from $Q(2, 4, -1)$ is

(1) $\sqrt{13}$ (2) $\sqrt{17}$

(3) $\sqrt{15}$ (4) $\sqrt{11}$

Answer (2)

Sol. L : $\frac{x+1}{4}=\frac{y-2}{3}=\frac{z-1}{4}=t$

Let $P(4t - 1, 3t + 2, 4t + 1)$

Since P also lies in $x + y - z = 0$

$\therefore \quad 3t = 0 \quad \Rightarrow \quad t = 0$

$\therefore \quad P(-1, 2, 1)$ and $Q(2, 4, -1)$

$\therefore \quad PQ=\sqrt{3^2+2^2+(-2)^2}$

$=\sqrt{9+4+4}=\sqrt{17}$ units

4. If $\lim\limits_{n\to\infty}\sum\limits_{k=1}^{n}\left(\frac{2n}{n^2+k^2}\right)=a$ and $f(x)=\sqrt{\frac{1-\cos x}{1+\cos x}}$, then $f'\left(\frac{a}{2}\right)$ is equal to

(1) $2+\sqrt{2}$ (2) $\sqrt{2}+1$

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

Answer (3)

Sol. $\lim\limits_{n\to\infty}\sum\limits_{k=1}^{n}\left(\frac{2n}{n^2+k^2}\right)=a$

$\Rightarrow \lim\limits_{n\to\infty}\sum\limits_{k=1}^{n}\frac{1}{n}\left(\frac{2}{1+\frac{k^2}{n^2}}\right)=a$

$\Rightarrow \int_0^1\frac{2}{1+x^2}dx=a \Rightarrow \boxed{a=\frac{\pi}{2}}$

Now, $f(x)=\sqrt{\frac{1-\cos x}{1+\cos x}}=\left|\tan\frac{x}{2}\right|$

$\therefore \quad f'\left(\frac{a}{2}\right)=\left(\frac{1}{2}\sec^2\frac{x}{2}\right)$ at $x=\frac{\pi}{4}$

$=\frac{1}{2}\sec^2\frac{\pi}{8}$

$=\frac{\sqrt{2}}{\sqrt{2}+1}=2-\sqrt{2}$

5. A tangent is drawn to $y^2 = 24x$ at (α, β) which is perpendicular to $2x + 2y = 7$. Then the equation of normal to hyperbola $\frac{x^2}{\alpha^2}-\frac{y^2}{\beta^2}=1$ at $(\alpha + 4, \beta + 4)$ is

(1) $2x + 5y = 100$ (2) $2x - 5y = 100$

(3) $2x + 5y = 10$ (4) $2x - 5y = 10$

Answer (1)

Sol. $\because \quad \beta^2 = 24\alpha$ and slope of tangent $=\frac{dy}{dx}(\alpha,\beta)$

$=\frac{12}{\beta}=1$

$\Rightarrow \beta = 12$ and $\alpha = 6$

Now normal to hyperbola $\frac{x^2}{36}-\frac{y^2}{144}=1$ at (10, 16) is

$2x + 5y = 100$

6.
7.
8.
9.
10.
11.
12.
13.
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 p, q, r are positive real numbers such that $(p^2+q^2)x^2-2q(p+r)x+q^2+r^2=0$ and $x^2 - 2x - 8 = 0$ has one root common then $\frac{q^2+r^2}{p^2}$ is equal to

Answer (272)

Sol. $\because \quad (px-q)^2+(qx-r)^2=0$

$\Rightarrow x=\frac{q}{p}=\frac{r}{q}=4$,

because roots of second equation are 4 or –2.

As p, q, r are positive so x must be 4

$q = 4p$ and $r = 4q = 16p$

So, $\frac{q^2+r^2}{p^2}=16+256=272$

22. $\tan\left(2\tan^{-1}\left(\frac{1}{8}\right)+\sec^{-1}\left(\frac{\sqrt{5}}{2}\right)+2\tan^{-1}\left(\frac{1}{5}\right)\right)$ is equal to

Answer (2)

Sol. $2\left(\tan^{-1}\left(\frac{1}{8}\right)+\tan^{-1}\left(\frac{1}{5}\right)\right)=2\tan^{-1}\left(\frac{\frac{1}{8}+\frac{1}{5}}{1-\frac{1}{40}}\right)$

$= 2\tan^{-1}\frac{1}{3}$

$= \tan^{-1}\frac{\frac{2}{3}}{1-\frac{1}{9}}=\tan^{-1}\frac{3}{4}$

$\therefore$ Given term reduces to

$\tan\left(\tan^{-1}\frac{3}{4}+\tan^{-1}\frac{1}{2}\right)$

$=\left(\frac{\frac{3}{4}+\frac{1}{2}}{1-\frac{3}{8}}\right)=2$

23. Let {3}, {6, 9, 12}, {15, 18, 21, 24, 27}, ……..

be any sequence, then find the sum of elements in the 11th set of this sequence.

Answer (6993)

Sol. {3}, {3.2, 3.3, 3.4}, {3.5, 3.6 ….., 3.7} ……..

$\therefore$ 11th set will be having = 1 + (10)2 = 21 elements

Number of elements up to set 10 will be

= 1 + 3 + ….. 10 terms

= 5[2 + 18] = 100 elements

$\therefore$ Set 11 = {3.101, 3.102, ….. 3.121}

Sum of these elements = 3(101 + 102 + ….. + 121)

$= 3\,.\left(\frac{21}{2}\right).(222)=6993$

24. The number of 5 digit number's whose product of the digits is 36 is

Answer (180)

Sol. Let the five digit number be $\overline{abcde}$.

$\because$ $a.b.c.d.e = 2^2.3^2$

We will solve this in three cases,

Case I : When exactly one digit is 1.

So (a, b, c, d, e) are permutations of (2, 2, 3, 3, 1)

No. of numbers = $\frac{\lfloor 5}{\lfloor 2\,\lfloor 2}=30$

Case II : When exactly two digits are 1.

So (a, b, c, d, e) are permutations of (4, 3, 3, 1, 1), (6, 2, 3, 1, 1), or (9, 2, 2, 1, 1)

Number of numbers $=\frac{\lfloor 5}{\lfloor 2\,\lfloor 2}+\frac{\lfloor 5}{\lfloor 2}+\frac{\lfloor 5}{\lfloor 2\,\lfloor 2}=120$

Case III : When exactly three digits are 1

So (a, b, c, d, e) are permutations of (4, 9, 1, 1, 1) or (6, 6, 1, 1, 1)

Number of numbers $=\frac{\lfloor 5}{\lfloor 3}+\frac{\lfloor 5}{\lfloor 3\,\lfloor 2}=30$

Total number of five digit numbers = 180

25. If $[A]_{2\times 2}$ and $|A| = -1$ and $|(A + I)(\text{adj } A + I)| = 4$, then $|\text{trace}(A)|$ is equal to

Answer (2)

Sol. $\because$ $\text{adj}\,A = |A|\cdot A^{-1} = -A^{-1}$

Now, $|(I+A)(I+\text{adj}A)|=4$

$\Rightarrow$ $|(I+A)(I-A^{-1})|=4$

$\Rightarrow$ $|A-A^{-1}|=4$

Let $A=\begin{bmatrix}a & b\\ c & d\end{bmatrix}\Rightarrow A^{-1}=-\begin{bmatrix}d & -b\\ -c & a\end{bmatrix}$

$\Rightarrow \begin{vmatrix}a+d & 0\\ 0 & a+d\end{vmatrix}=4$

$\Rightarrow (a+d)^2 = 4 \Rightarrow a+d=\pm 2$

$\text{Trace}(A)=\pm 2$

$|\text{Trace}(A)|=2$

26. Let f be a continuous function such that $f(3x) - f(x) = x$ and $f(8) = 7$ then (14) equals

Answer (10)

Sol. $\because$ $f(3x) - f(x) = x$

So $f(x)-f\left(\frac{x}{3}\right)=\frac{x}{3}$

$f\left(\frac{x}{3}\right)-f\left(\frac{x}{3^2}\right)=\frac{x}{3^2}$

_____

_____

_____

On adding we get

$f(x)-\lim_{n\to\infty} f\left(\frac{x}{3^n}\right)=x\left(\frac{1}{3}+\frac{1}{3^2}+\ldots\infty\right)$

$\Rightarrow \quad f(x)-f(0)=\frac{x}{2}$

$\because$ $f(8) = 7$, so $f(0) = 3$

Hence $f(x)=\frac{x}{2}+3$

And $f(14) = 10$

27. Given two G.P.s

$2, 2^2, 2^3, \ldots 2^{60}$

& $4, 4^2, \ldots 4^n$.

If G.M. of there $(60 + n)$ numbers is $2^{225/8}$ then n equals

Answer (20)

Sol. G.M. of all these $=\left(2^{1+2+3+\ldots+60}.4^{1+2+3+\ldots+n}\right)^{\frac{1}{60+n}}$

$=\left(2^{30\times61+n(n+1)}\right)^{\frac{1}{60+n}}$

$\because \quad \frac{30\times61+n(n+1)}{n+60}=\frac{225}{8}$

$\Rightarrow \quad 8n^2 - 217n + 1140 = 0$

$\Rightarrow \quad n = 20$

28. From a group of 10 boys $B_1, B_2, \ldots B_{10}$ and 5 girls $G_1, G_2, \ldots G_5$ three boys & 3 girls are selected such that B_1 & B_2 are not together in that group. The number of ways of doing this is

Answer (1120)

Sol. No. of ways of selecting 3 Girls = ${}^5C_3 = 10$

No. of ways of selecting 3 Boys = ${}^{10}C_3 - {}^8C_1 = 112$

Number of such selections = 10 × 112

= 1120

29.

30.

❑ ❑ ❑