M. Prakash Institute Entrance Examination
for IIT JEE Training Batch 2022-24

January 23, 2022 | 9.00 am to 12.00 noon | Total marks: 150

Chemistry

Note: Take Avagadro's Number as 6×10^{23}
Atomic Numbers:
H:1, C:6, N:7, O:8, F:9, Na:11, Mg:12, Al:13, Si:14 S:16, Cl:17, K:19, Ca:20, Mn:25, Fe:26, Cu:29, Br:35
Atomic Masses:
H:1, C:12, N:14, O:16, F:19, Na:23, Mg:24, Al:27, Si:28, S:32, Cl:35.5, K:39, Ca:40, Mn:55, Fe:56, Cu:63.5, Br: 80

Q1. There are two cylinders, maintained at STP. One of them contains 12×10^{24} molecules of ammonia gas and the other contains 48×10^{23} molecules of carbon monoxide gas. Then calculate the difference between the masses (in grams) of these two gases.

Q2. Silica, which is soluble in sodium hydroxide, is present as impurity in alumina. What is the sum of mass of silica and sodium hydroxide required when 3.6 grams of water is produced?

Q3. The element which belongs to second group and fourth period in modern periodic table reacts with second homologue of formic acid so as to form a salt 'A'. What is the molecular mass of salt 'A'?

Q4. 1.6 grams of NaOH is dissolved in 100 mili-litres of water to make a solution. What is the molarity of this solution?

Q5. When 570 grams of $FeSO_4$ is completely oxidized by $KMnO_4$ in the presence of dilute sulphuric acid, a neutral oxide (A) is formed. Calculate the mass of oxide (A) formed in grams.

Q6. Calculate the volume (in mL) of 0.1 molar NaOH solution, which contains 0.08 grams of NaOH.

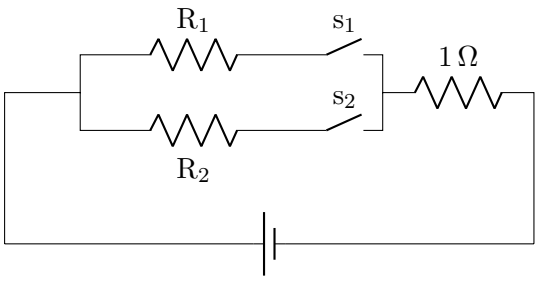
Q7. The element which belongs to 1^{st} group and 3^{rd} period of modern periodic table reacts with an alcohol which has 4 carbon atoms in its alkyl group. According to the balanced chemical equation, determine the total mass of the non-gaseous product.

Q8. One of the heavier elements is kept before the lighter element in the 5th period of modern periodic table. Write the atomic number of that heavier element.

Q9. When copper metal is treated with aqueous solution of nitric acid, a neutral gaseous oxide is produced at STP. What number of molecules of nitric acid is required to produce 12 molecules of neutral gaseous oxide?

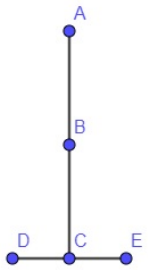
Q10. Orange colour of 0.75 mole bromine liquid is decolourised by an unsaturated hydrocarbon to produce 133 grams of a saturated product in an addition reaction. Find the maximum number of double bonds present in 1 mole of this reactant hydrocarbon.

Physics



Q.11 When switch S_1 is closed and S_2 is open, the circuit resistance is R_3. When switch S_1 is open and S_2 is closed, it is R_4. When both switches are closed, it is R_5. It is given that $R_3 : R_4$ is $8 : 5$ and $R_3 : R_5$ is $2 : 1$. Find the value of R_1 in ohms. (The battery is ideal.)

Q.12 A toy train car of mass 300 gm is moving on a straight horizontal frictionless railway track at a constant speed of 1 m/sec. It collides with another identical toy train car which is stationary. They are stuck together after collision and continue to move with constant velocity. Now the two cars collide with the next identical stationary toy train car. The three cars are stuck together after collision. Find the total energy loss in this entire journey in Joules. Ignore friction.



Q.13 The diagram shows a vertical line $A - B - C$ and the horizontal ground level $D - C - E$. Distance AB is 80 meters. A particle A_1 is released from rest at point A. The moment it crosses B, another particle B_1 is released from rest at B. It is observed that particle B_1 reaches point C two seconds after particle A_1 reaches point C. Find distance BC in meters. Take $g = 10\ m/sec^2$.

Q.14 Two vehicles start from a point and travel along a circular road of length 150 meters in the opposite direction. Vehicle V_1 travels at constant speed of 5 m/s. Vehicle V_2 starts from rest and travels at constant acceleration of 2 m/s^2. After how many seconds from start will they cross each other the second time?

Q.15 There are two electric water heaters. First heater has a resistance of R_1 ohms. Second heater's resistance is R_2 ohms. $R_1 > R_2$. It takes t_1 seconds to increase temperature of 10 liters of water through 30° when the heaters are connected in series. It takes t_2 seconds to increase temperature of 10 liters of water through 30° when the heaters are connected in parallel. If it is given that $\frac{t_1}{t_2} = 4.9$ then $\frac{R_1}{R_2} = ?$

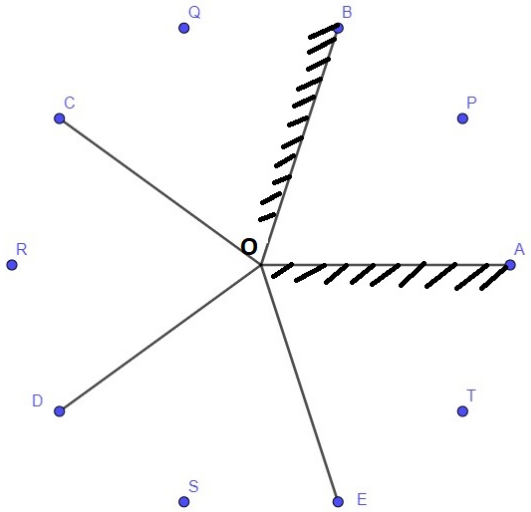
Q.16 1064 gm of water at $30°C$ is kept in a container which does not absorb or release heat. 20 gm of ice at $-10°C$ and 100 gm of steam at $110°C$ are added to it. Find the equlibrium temperature in $°C$ of the mixture.
Use the following data:
Specific heat capacities in $cal/gm°C$: Water: 1, ice and steam: 0.5.
Latent heat of fusion of water: 80 cal/gm, latent heat of vaporisation of water: 540 cal/gm

Q.17 There is a stationary point charge of $+Q_1$ coulombs at origin. Stationary point charges are kept at points on X axis at $A(-1, 0), B(2, 0), C(x, 0)$. Charges at $A : +Q,\ B : +3Q,\ C : +4Q$ coulombs. The net resultant electrostatic force on charge at O due to charges at A, B, C is zero. Calculate x

Q.18 A solid wooden cube A (10 cm × 10 cm × 10 cm) is floating in water such that 20% of cube is above water. Now another block of material B having cross section area 10 cm × 10 cm is placed on top of the wooden block A such that no part of block B is outside water. (the top surface of block B coincides with water level.) density of material B is 1.4 gm/cc. Now, both the blocks are put in a liquid with density 1.25 gm/cc with B on top of A. What will be the

height of the portion of block B above the liquid surface level? Express your answer in cm.

Q.19 There is a fixed point object at point A. There is a screen at position B. A converging lens of focal length f cm is kept at position C as shown and a sharp image of the object is obtained on the screen. Now the lens is kept at position G. Again, a sharp image of the object is obtained on the screen. Distance $AB = 25\ cm$ and distance between the two positions of the lens is 5 cm. Calculate f in cm.



Q.20 The diagram shows two plane mirrors OA and OB. OC, OD, OE are images of mirrors in mirrors. A person represented by point P is exactly midway between the mirrors OA, OB as shown. The images of the person are Q, R, S, T. The person P is walking towards the origin at the constant speed of $\frac{10}{\sin 72^\circ}\ m/sec$. At what rate is the distance between P and R reducing? Write your answer in m/sec.

Mathematics

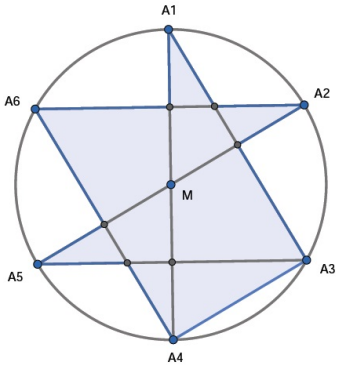
Q.21 Given $x^2 - 7x + 1 = 0$. Find T if $x^6 - Tx^3 + 1 = 0$.

Q.22 Find sum of all angles x in degrees in right angled triangle satisfying

$$\frac{2 + cosec^2 x}{cotx - cosx} + \frac{sec^2 x - sin^2 x}{cosx - cotx} = cotx + cosx.$$

Q.23 Perfectly Conical shaped hill has circumferance of base equal to 2π kms. It's slant height is 6 kms. Mathematician terkker wishs to complete one round around the hill. What is the minimum length that he needs to walk in kms before reaching the starting point on the circumference of the base.

Q.24 Regular hexagon $A_1A_2A_3A_4A_5A_6$ is inscribed in a circle with radius 12 and center M. The area of shaded region is $K\sqrt{3}$. Find K.



Q.25 $ABCD$ is square with side 30. P is on $\overline{AB}$ such that $AP : PB = 2 : 1$ Q is on $\overline{BC}$ such that $BQ : QC = 1 : 2$. $\overline{AC}$ intersects $\overline{DP}$ at S and $\overline{DQ}$ at R. Find area of $PQRS$.

Q.26 For $x \neq \dfrac{9}{4}$, $f(x)$ is defined as,

$$f(x) = \frac{8x\sqrt{x} + 3 - 2\sqrt{x} - 12x}{2\sqrt{x} - 3}.$$

Find $f(9) + f(10) + f(11) + \cdots + f(16)$.

Q.27 $ABCD$ is square with area 25. $\triangle APB$ is drawn such that it is isosceles and outside square $ABCD$ with $m\angle APB = 30^o$. Similarly $\triangle BQC$, $\triangle CRD$, $\triangle DSA$ are drawn. Then area of $PQRS$ is $\dfrac{X}{2 - \sqrt{3}}$. Find X.

Q.28 x, y are real numbers satisfying $\dfrac{x^2}{y} + \dfrac{y^2}{x} = 18,\ x + y = 12$. Find $x^2 + y^2$

Q.29 In $\triangle ABC$, internal angle bisector of $\angle BAC$ intersects $\overline{BC}$ at D. Given $A(5, 8),\ B(1, 2),\ C(3, 11)$. If $D(h, k)$ find $3(h + k)$.

Q.30 The symbol $[x]$ means the integral part of x. For example $[5.7] = 5,\ [\sqrt{17}] = 4$. Find the value of

$$[\sqrt{1}] + [\sqrt{2}] + [\sqrt{3}] + \cdots + [\sqrt{99}] + [\sqrt{100}]$$

Answers

Qno	1	2	3	4	5	6	7	8	9	10
Answer	116	28	186	0.4	54	20	192	52	48	3
Qno	11	12	13	14	15	16	17	18	19	20
Answer	3	0.1	45	15	2.5	80	4	3	6	20
Qno	21	22	23	24	25	26	27	28	29	30
Answer	322	60	6	138	320	392	75	80	31	625