

Time: 3 Hour

Total Marks: 180

JEE Advance

Subject : Chemistry, Mathematics, Physics

Chemistry Section :1

MCQ SINGLE CORRECT

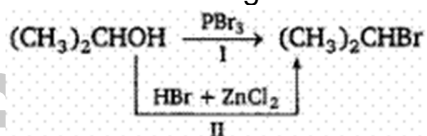
1. When an ideal gas expands in vacuum work done is :

- (a) R (b) $\frac{3}{2}R$
(c) 4R (d) 0

2. How many coulombs are required for oxidation of 1 mol H_2O to O_2 ?

- (a) $3.86 \times 10^5 C$ (b) $9.65 \times 10^4 C$
(c) $1.93 \times 10^5 C$ (d) $4.825 \times 10^4 C$

3. Consider following reactions



These reactions are of the type :

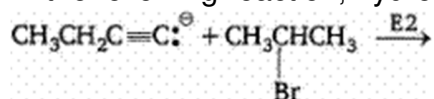
- (a) I S_N1 II S_N2 (b) I S_N2 II S_N1
(c) I S_N2 II S_N2 (d) I S_N1 II S_N1

MCQ MULTIPLE CORRECT

4. Select correct statements :

- (a) Gases which have high value of van der Waals constant 'a' are easily liquefied
(b) Easily liquefied gases are water soluble
(c) Ions forming gases in a solvent are soluble in that solvent.
(d) When CO_2 gas is dissolved in water, pressure is decreased

5. In the following reaction, hydrocarbons are



All The Best!!!

- (a) $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}(\text{CH}_3)_2$ (b) $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$
 (c) $\text{CH}_3\text{CH}=\text{CH}_2$ (d) $\text{CH}_3\text{C}\equiv\text{CCH}_3$

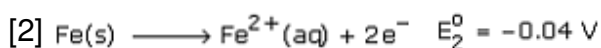
6. In water, or in aqueous solutions of HCl or H_2SO_4 , proton exists as:

- (a) H_3O^+ (b) $\text{H}(\text{H}_2\text{O})_4^+$
 (c) $\text{H}(\text{H}_2\text{O})_n^+$ (d) $[\text{H}_3\text{O}^+][\text{OH}^-]$

Chemistry Section :2 COMPREHENSION

Passage : 1

Read the following passage for the evaluation of E° when different number of electrons are involved. Consider addition of the following half-reactions:



Because half reactions [1] and [2] contain a different number of electrons, the net reaction [3] is another half-reaction, and E_3° can't be obtained simply by adding E_1° and E_2° . The free energy changes, however, are additive because G is a state function:

$$\Delta G_3^\circ = \Delta G_1^\circ + \Delta G_2^\circ$$

7. If number of electrons in the reaction are n_1 , n_2 and n_3 respectively, then standard electrode potential of reaction [3] is :

(a) $E_3^\circ = \frac{n_1 E_1^\circ + n_2 E_2^\circ}{n_3}$

(b) $E_3^\circ = \frac{n_1 E_1^\circ - n_2 E_2^\circ}{n_3}$

(c) $E_3^\circ = (E_1 - E_2)$

(d) $-E_3^\circ = (E_1 + E_2)$

8. Standard electrode potential for the half-cell $\text{Fe}^{3+} / \text{Fe}^{2+}$ of the reaction [3] is :

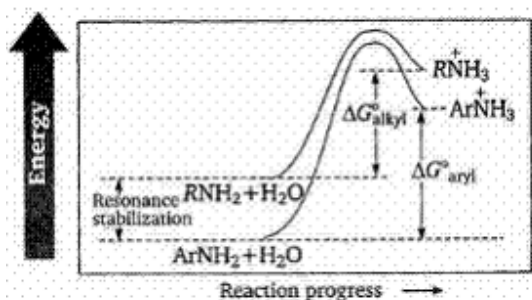
(a) 0.41 V

(b) 1.27 V

(c) 0.49 V

(d) - 1.27 V

Passage : 2

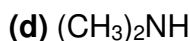
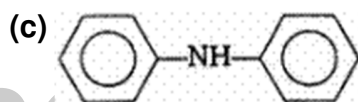
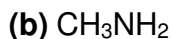
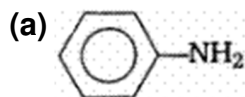


Questions given below are based on the above diagram.

9. Select correct statements :

- (a) Electron-donating groups (activating groups) increase the reactivity of the aromatic ring towards S_E reaction hence basicity of aryl amine is increased
- (b) Electron-withdrawing groups (deactivating groups) decrease the reactivity of the aromatic ring towards S_E reaction, hence basicity of aryl amine is increased
- (c) Both of the above are correct
- (d) None of the above are correct

10. Which has maximum negative value of protonation by H_2O ?



Chemistry Section :3

INTEGER TYPE

11. Calculate pH of 0.002 N NH_4OH having 2% dissociation.
12. How much solid $Na_2S_2O_3$ should be added to 1.0 L of water so that 0.0005 mole $Cd(OH)_2$ could just barely dissolve ?
- K_1 and K_2 for $S_2O_3^{2-}$ complexation with Cd^{2+} are 8.3×10^3 and 2.5×10^2 , respectively. $K_{sp}(Cd(OH)_2) = 4.5 \times 10^{-15}$
13. Among the complex ions, $[Co(NH_2 - CH_2 - CH_2 - NH_2)_2 Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH_2)]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2 - CH_2 - CH_2 - NH_2)_2(NH_3)Cl]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$ the number of complex ion(s) that show(s) cis-trans isomerism is
14. After electrolysis of a sodium chloride solution with inert electrodes for a certain period of time, 600 mL of the solution was left which was found to be 1 N in NaOH. During the same period 31.75 g of copper was deposited in the copper voltameter in series with the electrolytic cell. Calculate the percentage theoretical yield of NaOH obtained.

15. The time required for 10% completion of first order reaction at 298 K is equal to that required for its 25% completion at 308K. If the preexponential factor for the reaction is $3.56 \times 10^9 \text{ s}^{-1}$, calculate the energy of activation
16. A face centre atom corner atom in the hexagonal unit cell structure is shared with how many unit cells.
17. The number of geometric isomers possible for the complex $[\text{CoL}_2\text{Cl}_2]^-$ ($\text{L} = \text{H}_2\text{NCH}_2\text{CH}_2\text{O}^-$) is
18. In the reaction
- $$\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$$
- $$\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$$
- 10 ml of mixture containing CO and N_2 required 7 ml of oxygen to form CO_2 and NO on combustion. What is the volume of N_2 in the mixture?

Mathematics Section :1

MCQ SINGLE CORRECT

19. If $f : \mathbb{R} \rightarrow \mathbb{R}$ is a twice differentiable function such that $f''(x) > 0$ for all $x \in \mathbb{R}$, and $f\left(\frac{1}{2}\right) = \frac{1}{2}$, $f(1) = 1$, then
- (a) $f'(1) > 1$
- (b) $f'(1) < 1$
- (c) $0 < f'(1) \leq \frac{1}{2}$
- (d) $\frac{1}{2} < f'(1) \leq 1$
20. The equation of the line passing through the centre of a rectangular hyperbola is $x - y - 1 = 0$. If one of its asymptote is $3x - 4y - 6 = 0$, the equation of the other asymptote is
- (a) $4x - 3y + 8 = 0$
- (b) $4x + 3y + 17 = 0$
- (c) $3x - 2y + 15 = 0$
- (d) none of these
21. Let $f(x) = x^3 + x^2 + 100x + 7 \sin x$, then equation $\frac{1}{y-f(1)} + \frac{2}{y-f(2)} + \frac{3}{y-f(3)} = 0$ has
- (a) no real root
- (b) one real root
- (c) two real root
- (d) more than two real root

MCQ MULTIPLE CORRECT

22. Let $a, b \in \mathbb{R}$ and $a^2 + b^2 \neq 0$. Suppose $S = \left\{ z \in \mathbb{C} : z = \frac{1}{a+ibt}, t \in \mathbb{R}, t \neq 0 \right\}$, where $i = \sqrt{-1}$. If $z = x + iy$ and $z \in S$, then (x, y) lies on

(a) the circle with radius $\frac{1}{2a}$ and centre

$$\left(\frac{1}{2a}, 0\right) \text{ for } a > 0, b \neq 0$$

(c) the x - axis for $a \neq 0, b = 0$

(b) the circle with radius $-\frac{1}{2a}$ and centre

$$\left(-\frac{1}{2a}, 0\right) \text{ for } a < 0, b \neq 0$$

(d) the y-axis for $a = 0, b \neq 0$

23. In a plane, there are two families of lines $y = x + r, y = -x + r$, where $r \in \{0, 1, 2, 3, 4\}$. The number of squares of diagonals of length 2 formed by the lines is

(a) $\left(\frac{3}{2}\right)(3!)$

(b) 16

(c) 9

(d) $\left(\frac{2}{3}\right)(4!)$

24. In $\triangle ABC, A = 15^\circ, b = 10\sqrt{3}$ cm the value of 'a' for which these will be a unique triangle meeting these requirement is

(a) $10\sqrt{2}$ cm

(b) 15 cm

(c) $5(\sqrt{3} + 1)$ cm

(d) $5(\sqrt{3} - 1)$ cm

Mathematics Section :2

COMPREHENSION

Passage : 3

If p_1, p_2, p_3 are altitudes of a triangle ABC from the vertices A, B, C respectively and Δ is the area of the triangle and s is semi perimeter of the triangle.

On the basis of above information, answer the question:

25. The value of $\frac{\cos A}{p_1} + \frac{\cos B}{p_2} + \frac{\cos C}{p_3}$ is

(a) $\frac{1}{r}$

(b) $\frac{1}{R}$

(c) $\frac{a^2 + b^2 + c^2}{2R}$

(d) $\frac{1}{\Delta}$

26. If $\frac{1}{p_1} + \frac{1}{p_2} + \frac{1}{p_3} = \frac{1}{2}$ then the least value of $p_1 p_2 p_3$ is

(a) 8

(b) 27

(c) 125

(d) 216

Passage : 4

Different words are being formed by arranging the letters of the 'ARRANGE'. All the words obtained are written in the form of a dictionary.

On the basis of above information, answer the following question :

27. The number of words in which neither two 'R' nor two 'A' come together is

(a) 1260

(b) 660

(c) 900

(d) 240

28. The number of words in which the two 'R' are not together

(a) 1260

(b) 660

(c) 900

(d) 240

Mathematics Section :3

INTEGER TYPE

29. The three angles of a quadrilateral are 60° , 60° and $\frac{5\pi}{6}$, if fourth angle is λ° , then the value of λ must be

30. If e be the eccentricity of the ellipse $4(x - 2y + 1)^2 + 9(2x + y + 2)^2 = 25$, then the value of $2187e^2$ must be

31. If f be a function defined on the set of non-negative integers and taking values in the same set. Given that

[i] $x - f(x)$

$$= 19 \left[\frac{x}{19} \right] - 90 \left[\frac{f(x)}{90} \right]$$

for all non-negative integers.

[ii] $1900 < f(1990) < 2000$,

Then the sum of all possible values of $f(1990)$ must be

Notation : $[z]$ refers to the largest integer that is $\leq z$, eg $[3.1415] = 3$.

32. If $f(x) = \begin{cases} \frac{36^x - 9^x - 4^x + 1}{\sqrt{2} - \sqrt{1 + \cos x}}, & x \neq 0 \\ \lambda, & x = 0 \end{cases}$ is continuous at $x = 0$, then $\lambda = \sqrt{\mu} \ln 2$. In 3 then the value of μ must be

33. In a $\triangle ABC$, $a = 5$, $b = 4$ and $\cos(A - B) = 31/32$, then $12c$ must be

34. If $\int \frac{dx}{(1 + \sin x)}$
 $= \tan\left(\frac{x}{2} + a\right) + b$, then the value of $-\frac{2048a}{\pi}$ must be

35. If $\int \frac{\ln x}{x^3} dx = -\frac{\ln x}{ax^2} - \frac{1}{bx^2} + c$, then the value of $a^5 + b^4$ must be

36. If $\frac{1}{\cos 290^\circ} + \frac{1}{\sqrt{3} \sin 250^\circ} = \lambda$, then the value of $9\lambda^4 + 81\lambda^2 + 97$ must be

Physics Section :1

MCQ SINGLE CORRECT

37. In figure, the spring has a force constant k . The pulley is light and smooth, the spring and the string are light. The suspended block has a mass m . If the block is slightly displaced from its equilibrium position and then released, the period of its vertical oscillation is:

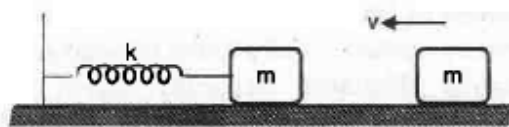


- (a) $2\pi\sqrt{\left(\frac{m}{k}\right)}$ (b) $4\pi\sqrt{\left(\frac{m}{k}\right)}$
 (c) $2\pi\sqrt{\left(\frac{k}{m}\right)}$ (d) $4\pi\sqrt{\left(\frac{k}{m}\right)}$

38. When a body is projected at an angle with the horizontal in the uniform gravitational field of the earth, the angular momentum of the body about the point of projection, as it proceeds along its path:

- (a) remains constant (b) increases
 (c) decreases (d) initially decreases and increases after its highest point

39. The collision between both blocks shown in figure is completely inelastic. The total energy of oscillation after collision is:



- (a) $\frac{1}{2}mv^2$ (b) $\frac{mv^2}{8}$
 (c) $\frac{mv^2}{4}$ (d) None of these

MCQ MULTIPLE CORRECT

40. Two blocks A and B of mass 4 kg and 2 kg respectively connected by a spring of force constant $k = 100 \text{ N/m}$ are placed on an inclined plane of inclination 30° as shown in figure. If the system is released from rest, which one of the following statement is/are correct ? ($g = 10 \text{ m/s}^2$)

- (a) There will be no compression/elongation in the spring if all surfaces are smooth
- (b) Maximum compression of the spring is 10 cm if all surfaces are smooth
- (c) Maximum elongation in the spring is 60 cm if all surfaces are smooth
- (d) There will be elongation in the spring if A is smooth and B is rough

41. Two spheres A and B have same radius but the heat capacity of A is greater than that of B. The surfaces of both are painted black. They are heated to the same temperature and allowed to cool. Then initially

- (a) A cools faster than B
- (b) both A and B cool at the same rate
- (c) at any common temperature the ratio of their rates of cooling is a constant
- (d) B cools faster than A

42. A thin and uniform rod of mass M and length L is held vertical on a floor with large friction. The rod is released from rest so that it falls by rotating about its contact-point with the floor without slipping. Which of the following statement(s) is/are correct, when the rod makes an angle 60° with vertical ? [g is the acceleration due to gravity]

- (a) The angular acceleration of the rod will be $\frac{2g}{L}$
- (b) The radial acceleration of the rod's center of mass will be $\frac{3g}{4}$

- (c) The angular speed of the rod will be $\sqrt{\frac{3g}{2L}}$
- (d) The normal reaction force from the floor on the rod will be $\frac{Mg}{16}$

Physics Section :2

COMPREHENSION

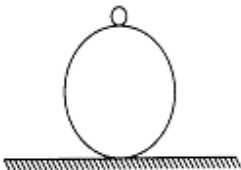
Passage : 5

A small ball (of negligible size) is placed over a sphere of same mass and radius 1 m as shown. All surfaces are smooth. A slight push is given to the ball. When the radius vector joining the ball makes an angle of 30° with vertical, speed of sphere is v. ($g = 10 \text{ m/s}^2$)

43. If mass of ball and sphere be 1 kg each then the normal reaction between the two at this instant is

- (a) 5.62 N
- (b) 7.68 N
- (c) 4.81 N
- (d) 3.47 N

44. Value of v in m/s is



- (a) 0.9
- (b) 1.6

(c) 2.4

(d) 0.4

Passage : 6

The center of mass (COM) is a point where the total mass of the system can be assumed to be concentrated. If no external force acts on the system then the center of mass moving with constant velocity will continue to move with the same velocity even if different parts of the system begin to move with different velocities. Let us consider a particular case in which a man of mass 80 kg is riding on a trolley of mass 40 kg which is rolling on a level smooth surface at a speed of 2 m/s. He jumps off the trolley in the direction opposite to the motion of the trolley with the speed of 1 m/s relative to the ground. Answer the following question.

45. The speed of the trolley when the man jumps off the trolley is

(a) 2

(b) 4

(c) 8

(d) 16

46. Velocity of COM just after the man jumps is

(a) 4 m/s

(b) 2 m/s

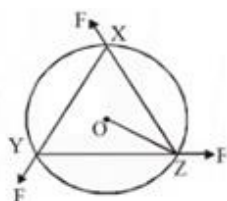
(c) 3 m/s

(d) 5 m/s

Physics Section :3

INTEGER TYPE

47. A uniform circular disc of mass 1.5 kg and radius 0.5 m is initially at rest on a horizontal frictionless surface. Three forces of equal magnitude $F = 0.5$ N are applied simultaneously along the three sides of an equilateral triangle XYZ with its vertices on the perimeter of the disc. One second after applying the forces, the angular speed of the disc in rad s^{-1} is



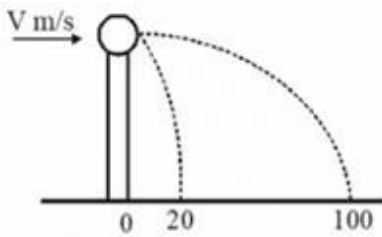
48. Determine the self-inductance of 4000 turn air-core solenoid of length 2m and diameter 0.04 m.

49. The sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are $7.7 \times 10^3 \text{ kg/m}^3$ and $2.2 \times 10^{11} \text{ N/m}^2$ respectively.

50. A solid horizontal surface is covered with a thin layer of oil. A rectangular block of mass $m = 0.4$ kg is at rest on this surface. An impulse of 1.0 N/s is applied to the block at time $t = 0$ so that it starts moving along the x-axis with a velocity $v(t) = v_0 e^{-t/\tau}$ where v_0 is a constant and $\tau = 4$ s. The displacement of the block, in metres, at $t = \tau$ is ... (take $e^{-1} = 0.37$)

51. A plane mirror is approaching you at a speed of 10 cm/ sec. You can see your image in it. At what speed will your image approach you

52. The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-at)$, where $\alpha = 0.2 \text{ s}^{-1}$. The measurement of A has an error of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at $t = 5 \text{ s}$ is
53. Rain is falling vertically downward with a velocity of 3 km/h. A man walks in the rain with a velocity of 4 km/h. Find the velocity with which (in km/h) the rain drops will fall on the man?
54. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, travelling with a velocity $v \text{ m/s}$ in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity v of the bullet is :



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