

- (b) If both assertion and reason are CORRECT, but reason is NOT the CORRECT explanation of the assertion.
(c) If assertion is CORRECT, but reason is INCORRECT.
(d) If assertion is INCORRECT but reason is CORRECT.

Assertion (column 1)	Reason (column 2)
Q5. The first ionization energy of Be is greater than that of B.	2p orbital is lower in energy than 2s.
Q6. 1-butene on reaction with HBr in the presence of a peroxide produces Bromobutane	It involves the formation of a primary radical.
Q7. The heat absorbed during the isothermal expansion of an ideal gas in vacuum is zero	The work done by the molecules of an ideal gas against vacuum is zero
Q8. The pressure of a fixed amount of an ideal gas is proportional to its temperature.	Frequency of collisions and their impact both increase in proportion to the square root of temperature.
Q9. Phenol is more reactive than benzene towards electrophilic substitution reaction.	In the case of phenol, the intermediate carbocation is more resonance stabilized.
Q10. Let $f(\theta) = \sin \theta (\sin \theta + \sin 3\theta)$. Then $f(\theta)$	
(a) ≥ 0 only when $\theta \geq 0$	(b) ≤ 0 for all real θ
(c) ≥ 0 for all real θ	(d) ≤ 0 only when $\theta \leq 0$
Q11. If $x+y=k$ is normal to $y^2=12x$, then k is	
(a) 3	(b) 9
(c) -9	(d) -3
Q12. The dimension of $(1/2) \epsilon_0 E^2$ (ϵ_0 : permittivity of free space; E: electric field) is	
(a) $ML T^{-1}$	(b) $ML^2 T^{-2}$
(c) MLT^2	(d) $ML^2 T^{-1}$

Q13. The electron in a hydrogen atom makes a transition from an excited state to the ground state. Which of the following statements is true?

- (a) Its kinetic energy increases and its potential and total energies decrease.
- (b) Its kinetic energy decreases, potential energy increases and its total energy remains the same.
- (c) Its kinetic and total energies decrease and its potential energy increases.
- (d) Its kinetic, potential and total energies decrease.

Q14. In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then, in the interference pattern

- (a) the intensities of both the maxima and the minima increase.
- (b) the intensity of the maxima increases and the minima has zero intensity.
- (c) the intensity of the maxima decreases and the minima has zero intensity.

Q15. A hollow double concave lens is made up of very thin transparent material. It can be filled with air or either of two liquids L_1 and L_2 having refractive indices n_1 and n_2 respectively ($n_2 > n_1 > 1$). The lens will diverge a parallel beam of light if it is filled with

- (a) air and placed in air.
- (b) Air and immersed in L_1
- (c) L_1 and immersed in L_2
- (d) L_2 and immersed in L_1

Q16. A coil of wire having finite inductance and resistance has a conducting ring placed coaxially within it. The coil is connected to a battery at time $t=0$, so that a time dependent current $I_1(t)$ starts flowing through the coil. If $I_2(t)$ is the current induced in the ring, and $B(t)$ is the magnetic field at the axis of the coil due to $I_1(t)$, then as a function of time ($t > 0$), the product $I_2(t) B(t)$

- (a) increases with time
- (b) decreases with time
- (c) does not vary time
- (d) passes through a maximum.

Q17. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The done by the gas is W_1 if the

process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic. Then

- (a) $W_2 > W_1 > W_3$
- (b) $W_2 > W_3 > W_1$
- (c) $W_1 > W_2 > W_3$
- (d) $W_1 > W_3 > W_2$

Q18. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be $1/e$ after a time

- (a) $1/(10\lambda)$
- (b) $1/(11\lambda)$
- (c) $11/(10\lambda)$
- (d) $1/(9\lambda)$

Q19. In a compound microscope, the intermediate image is

- (a) virtual, erect and magnified
- (b) real, erect and magnified
- (c) real, inverted and magnified.
- (d) Virtual, erect and reduced.

Q20. Electrons with energy 80 keV are incident on the tungsten target of an X-ray tube. K shell electrons of tungsten have 72.5 keV energy. X-ray emitted by the tube contain only.

- (a) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of $\sim 0.155 \text{ \AA}$.
- (b) a continuous X-ray spectrum (bremsstrahlung) with all wavelengths.
- (c) the characteristic X-ray spectrum of tungsten.
- (d) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of $\sim 0.155 \text{ \AA}$.

Q21. An ionized gas contains both positive and negative ions. If it is subjected simultaneously to an electric field along the +x direction and a magnetic field along the +z direction, then

- (a) positive ions deflect towards +y direction and negative ions towards -y direction.
- (b) all ions deflect towards +y direction.
- (c) all ions deflect towards -y direction.
- (d) positive ions deflect towards -y direction and negative ions towards +y direction.

Q22. Three charges Q , $+q$ and $+q$ are placed at the vertices of a right-angled isosceles triangle as shown. The net electrostatic energy of the configuration is zero Q is equal to

- (a) angular velocity and total energy (kinetic and potential)
- (b) total angular momentum and total energy.
- (c) Angular velocity and moment of inertia about the axis of rotation.
- (d) Total angular momentum and moment of inertia about the axis of rotation.

Q23. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are the same. Then, R is equal to

- (a) $\frac{L}{\sqrt{2\pi}}$
- (b) $2\pi L$
- (c) L
- (d) $\frac{L}{2\pi}$

Q24. Which of the following compounds will exhibit geometrical isomerism?

- (a) 1-phenyl-2-butene
- (b) 3-phenyl-1-butene
- (c) 2-phenyl-1-butene
- (d) 1,1-diphenyl-1-propene

Q25. Benzoyl chloride is prepared from benzoic acid by

- (a) Cl_2 , $h\nu$
- (b) SO_2 , Cl_2
- (c) SOCl_2
- (d) Cl_2 , H_2O

Q26. The correct order of radii is

- (a) $\text{N} < \text{Be} < \text{B}$
- (b) $\text{F}^- < \text{O}^{2-} < \text{N}^{3-}$
- (c) $\text{Na} < \text{Li} < \text{K}$
- (d) $\text{Fe}^{3+} < \text{Fe}^{2+} < \text{F}^{4+}$

Q27. The number of nodal planes in a p_x orbital is

- (a) one
- (b) two
- (c) three
- (d) zero

Q28. Which of the following has the highest nucleophilicity?

- (a) F^-
- (b) OH^-
- (c) CH_3^-
- (d) NH_2^-

Q29. The rms velocity hydrogen is $\sqrt{7}$ times the rms velocity of nitrogen. If T is the temperature of the gas.

- (a) $T(H_2) = T(N_2)$
- (b) $T(H_2) > T(N_2)$
- (c) $T(H_2) < T(N_2)$
- (d) $T(H_2) = \sqrt{7} T(N_2)$

Q30. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

- (a) Excited state
- (b) Ground state
- (c) Cationic form
- (d) anionic state

Q31. The chemical processes in the production of steel from haematite ore involves

- (a) reduction
- (b) oxidation
- (c) reduction followed by oxidation
- (d) oxidation followed by reduction.

Q32. Among the following] identify the species with an atom in +6 oxidation state

- (a) MnO_4^-
- (b) $Cr(CN)_6^{3-}$
- (c) NiF_6^{2-}
- (d) CrO_2Cl_2

Q32. The compressibility of a gas is less than unity at STP. Therefore,

- (a) $V_m > 22.4$ litres
- (b) $V_m < 22.4$ litres
- (c) $V_m = 22.4$ litres
- (d) $V_m < 44.8$ litres

Q33. Among the following, the strongest base is

- (a) $C_6H_5NH_2$
- (b) $p\text{-NO}_2\text{-C}_6\text{H}_4\text{NH}_2$
- (c) $m\text{-NO}_2\text{-C}_6\text{H}_4\text{NH}_2$
- (d) $C_6H_5CH_2NH_2$

Q34. When two reactants, A and B are mixed to give products C & D, the reaction quotient, Q, at the initial stages of the reaction

- (a) is zero
- (b) decreases with time
- (c) is independent of time
- (d) increases with time

Q35. The rate constant for the reaction, $2N_2O_5 \rightarrow 4NO_2 + O_2$, is $3.0 \times 10^{-5} \text{ sec}^{-1}$. If the rate is $2.40 \times 10^{-5} \text{ mol litre}^{-1} \text{ sec}^{-1}$, then the concentration of N_2O_5 (in mol litre^{-1}) is

- (a) 1.4
- (b) 1.2
- (c) 0.04
- (d) 0.8

Q36. Propyne and propene can be distinguished by

- (a) conc. H_2SO_4
- (b) Br_2 in CCl_4
- (c) Dil. $KmMnO_4$
- (d) $AgNO_3$ in ammonia

Q36. At 100°C and 1 atm, if the density of liquid water is 1.0 g cm^{-3} and that of water vapor is 0.0006 g cm^{-3} , then the volume occupied by water molecules in 1 litre of steam at that temperature is

- (a) 6 cm^3
- (b) 60 cm^3

- (c) 0.6 cm^3
- (d) 0.06 cm^3

Q37. Electrolytic reduction of alumina to aluminium by Hall-Heroult process is carried out

- (a) in the presence of NaCl.
- (b) in the presence of fluorite.
- (c) in the presence of cryolite which forms a melt with lower melting temperature.
- (d) in the presence of cryolite which forms a melt with lower melting temperature.

Q38. The number of P-O-P bonds in cyclic metaphosphoric acid is

- (a) Zero
- (b) Two
- (c) Three
- (d) Four

Q39. The order of reactivities of the following alkyl halides for a S_N2 reaction is

- (a) $RF > RCl > RBr > RI$
- (b) $RF > RBr > RCl > RI$
- (c) $RCl > RBr > RF > RI$
- (d) $RI > RBr > RCl > RF$

Q40. Molecular shapes of SF_4 , CF_4 and XeF_4 are

- (a) The same, with 2, 0 and 1 lone pairs of electrons respectively.
- (b) The same, with 1, 1 and 1 lone pairs of electrons respectively.
- (c) Different, with 0, 1 and 2 lone pairs of electrons respectively.
- (d) Different, with 1, 0 and 2 lone pairs of electrons respectively.

Q41. The hybridization of atomic orbitals of nitrogen in NO_2^+ , NO_3^- and NH_4^+ are

- (a) sp_2 , sp^3 and sp^2 respectively.
- (b) Sp_2 , sp^2 and sp^3 respectively
- (c) Sp^2 , sp and sp^3 respectively.
- (d) Sp^2 , sp^3 and sp respectively.

Q42. Which of the following has the most acidic hydrogen?

- (a) 3-Hexanone
- (b) 2,4-hexanedione
- (c) 2,5-hexanedione
- (d) 2,3-hexanedione

Q43. The correct order of acidic strength is

- (a) $\text{Cl}_2\text{O}_7 > \text{SO}_2 > \text{P}_4\text{O}_{10}$
- (b) $\text{CO}_2 > \text{N}_2\text{O}_5 > \text{SO}_3$
- (c) $\text{Na}_2\text{O} > \text{MgO} > \text{Al}_2\text{O}_3$
- (d) $\text{K}_2\text{O} > \text{CaO} > \text{MgO}$

Q44. A wind-powered generator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy. For wind speed, v , the electrical power output will be proportional to

- (a) v
- (b) v^2
- (c) v^3
- (d) v^4

Q45. Consider an infinite geometric series with first term a and common ratio r . If its sum is 4 and the second term is $\frac{3}{4}$, then

(a) $a = \frac{7}{4}$, $r = \frac{3}{7}$

(b) $a = 2$, $r = \frac{3}{8}$

(c) $a = \frac{3}{2}$, $r = \frac{1}{2}$

(d) $a = 3$, $r = \frac{1}{4}$

x

Q46. Let $g(x) = \int_0^x f(t)dt$, where f is such that $\frac{1}{2} \leq f$ for $t \in [0,1]$ and $0 \leq f(t) \leq \frac{1}{2}$ for $t \in [1,2]$ Then $g(2)$ satisfies the inequality,

(a) $-\frac{3}{2} \leq g(2) < \frac{1}{2}$

(b) $0 \leq g(2) < 2$

(c) $\frac{3}{2} < g(2) \leq \frac{5}{2}$

(d) $2 < g(2) < 4$

Q47. In a triangle ABC, let $\angle C = \pi/2$. If r is the in radius and R is the circum radius of the triangle, then $2(r+R)$ is equal to

(a) $a+b$

(b) $b+c$

(c) $c+a$

(d) $a+b+c$

Q48. How many different nine digit numbers can be formed from the number 223355888 by rearranging its digits so that the odd digits occupy even positions?

(a) 16

(b) 36

(c) 60

(d) 180

Q49. If $\arg(z) < 0$, then $\arg(-z) - \arg(z) =$

(a) π

(b) $-\pi$

(c) π

(d) $-\frac{\pi}{2}$

(d) $\frac{\pi}{2}$

Q50. Let PS be the median of the triangle with vertices P(2,2), Q(6,-1) and R(7,3). The equation of the line passing through (1,-1) and parallel to PS is

- (a) $2x-9y-7=0$
- (b) $2x-9y-11=0$
- (c) $2x+9y-11=0$
- (d) $2x+9y+7=0$

Q51. A pole stands vertically inside a triangular park ΔABC . If the angle of elevation of the top of the pole from each corner of the park is same, then in ΔABC the foot of the pole is at the

- (a) centroid
- (b) circumcentre
- (c) incentre
- (d) orthocenter

Q52. If α and β ($\alpha < \beta$), are the roots of the equation $x^2+bx+c=0$, where $c < b$, then

- (a) $0 < \alpha < \beta$
- (b) $\alpha < \beta < |\alpha|$
- (c) $\alpha < \beta < 0$
- (d) $\alpha < 0 < |\alpha| < \beta$

Q53. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be any function. Define $g: \mathbb{R} \rightarrow \mathbb{R}$ by $g(x) = |f(x)|$ for all x . Then g is

- (a) onto if f is onto
- (b) one-one if f is one-one
- (c) continuous if f is continuous
- (d) Differentiable if f is differentiable.

Q54. The domain of definition of the function $y(x)$ given by the equation $2^x + 2^y = 2$ is

- (a) $0 < x \leq 1$
- (b) $0 \leq x \leq 1$
- (c) $-\infty < x \leq 0$
- (d) $-\infty < x < 1$

Q55. $x^2+y^2 = a$, then

- (a) $yy'' - 2(y')^2 + 1 = 0$
- (b) $yy'' + (y')^2 + 1 = 0$
- (c) $yy'' - (y')^2 - 1 = 0$
- (d) $yy'' + 2(y')^2 + 1 = 0$

Q56. If a, b, c, d , are positive real numbers such that $a+b+c+d=2$, then $M=(a+b)(c+d)$ satisfies the relation

- (a) $0 \leq M \leq 1$
- (b) $1 \leq M \leq 2$
- (c) $2 \leq M \leq 3$
- (d) $3 \leq M \leq 4$

Q57. If the system of equations $x-ky-z=0$, $kx-y-z=0$, $x+y-z=0$ has a nonzero solution, then the possible values of k are

- (a) $-1, 2$
- (b) $1, 2$
- (c) $0, 1$
- (d) $-1, 1$

Q58. The triangle PQR is inscribed in the circle $x^2+y^2=25$. If Q and R have co-ordinates $(3,4)$ and $(-4,3)$ respectively, then $\angle QPR$ is equal to

- (a) $\frac{\pi}{2}$
- (b) $\frac{\pi}{3}$
- (c) $\frac{\pi}{4}$
- (d) $\frac{\pi}{6}$

Q60. In a triangle ABC, $2ac \sin \frac{1}{2}(A-B+C) =$

- (a) $a^2+b^2-c^2$
- (b) $c^2+a^2-b^2$
- (c) $b^2-c^2-a^2$
- (d) $c^2-a^2-b^2$

Q61. Consider the following statements:

S: Both $\sin x$ and $\cos x$ are decreasing functions in the interval $(\pi/2, \pi)$.

R: If a differentiable function decreases in an interval (a, b) , then its derivative also decreases in (a, b) Which of the following is true?

- (a) Both S and R are wrong
- (b) Both S and R are correct, but R is not the correct explanation of S.
- (c) S is correct and R is the correct explanation of S.
- (d) S is the correct and R is wrong

Q62. Let $f(x) = e^x(x-1)(x-2)$. Then f decreases in the interval

- (a) $(-\infty, 2)$
- (b) $(-2, -1)$
- (c) $(1, 2)$
- (d) $(2, +\infty)$

Q63. If the circles $x^2+y^2+2x+2ky+6=0$ and $x^2+y^2+2ky+k=0$ intersect orthogonally, then k is

- (a) 2 or $-\frac{3}{2}$
- (b) -2 or $-\frac{3}{2}$
- (c) 2 or $\frac{2}{3}$
- (d) -2 or $\frac{2}{3}$

Q64. If the vectors a , b , and c form the sides BC, CA, and AB respectively, of a triangle ABC, then

- (a) $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a} = 0$

- $\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$
 (b) $a \times b = b \times c = c \times a$
 $\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$
 (c) $a \cdot b = b \cdot c = c \cdot a$
 $\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$
 (d) $a \times b + b \times c + c \times a = 0$

Q65. If the normal to the curve $y = f(x)$ at the point (3,4) makes an angle $3\pi/4$ with the positive x-axis, then $f''(3) =$

- (a) -1
 (b) $-\frac{3}{4}$
 (c) $-\frac{4}{3}$
 (d) 1

Q66. Let the vectors a, b, c and d be such that $(a \times b) \times (c \times d) = 0$.

Let P_1 and P_2 be planes determined by the pairs of vectors a, b and c, d respectively. Then the angle between P_1 and P_2 is

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

Q67. Let $f(x) = \begin{cases} |x| & \text{for } 0 < |x| \leq 2 \\ 1 & \text{for } x = 0 \end{cases}$ then at $x = 0$, f has

- (a) a local maximum
- (b) no local maximum
- (c) a local minimum
- (d) no extremum

Q68. If \vec{a} , \vec{b} and \vec{c} are unit coplanar vectors, then the scalar triple product
$$\begin{vmatrix} \vec{a} & \vec{b} & \vec{c} \\ 2\vec{a} - \vec{b} & 2\vec{b} - \vec{c} & 2\vec{c} - \vec{a} \end{vmatrix} =$$

- (a) 0
- (b) 1
- (c) $-\sqrt{3}$
- (d) $\sqrt{3}$

Q69. If $b > a$, then the equation $(x-a)(x-b) - 1 = 0$, has

- (a) both roots in $[a, b]$
- (b) both roots in $(-\infty, a)$
- (c) both roots in $(b, +\infty)$
- (d) one root in $(-\infty, a)$ and other in (b, ∞)

Q70. For the equation $3x^2 + px + 3 = 0$, $p > 0$, if one of the roots is square of the other, then p is equal to

- (a) $1/3$
- (b) 1
- (c) 3
- (d) $2/3$

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