Test Code: JS-AT-03-24

1. **Answering Instructions:**
   The total number of questions to be answered is 90.
   For MCQs, choose the one correct option from the given choices.
   For integer-type questions, write the integer value as your answer.
2. **Marking Scheme**
   Each correct answer will be awarded +4 marks.
   Each incorrect answer will result in a deduction of 1 mark (-1).
   No marks will be awarded or deducted for unattempted questions.
3. **Multiple Choice Questions (MCQs):**
   - Physics: Questions 1-20
   - Chemistry: Questions 30-50
   - Mathematics: Questions 60-80
4. **Integer Type Questions:**
   - Physics: Questions 21-30
   - Chemistry: Questions 51-60
   - Mathematics: Questions 81-90
   - Out of these 10 integer-type questions, at most 5 questions can be attempted in each subject

Duration: 180 minutes | Total Marks: 300

Physics

Q1: When a wave traverses a medium, the displacement of a particle located at x at time 't' is given by
$y = a \cdot \sin(bt - cx)$
where a, b and c are constants of wave. The dimensions of b are the same as those of

A. wave velocity
B. amplitude
C. wave length
D. wave frequency

Q2: Given that $K =$ energy, $V =$ velocity $T =$ time. If they are chosen as the fundamental units, then what is dimensional formula for surface tension?

A. $\left[KV^{-2}T^{-2}\right]$
B. $\left[K^2V^2T^{-2}\right]$
C. $\left[K^2V^{-2}T^{-2}\right]$
D. $\left[KV^2T^2\right]$

Q3: The respective number of significant figures for the numbers $29.041, 0.0005$ and 4.5×10^{-3} are

A. $5, 1, 2$
B. $5, 1, 5$
C. $5, 5, 2$
D. $4, 4, 2$

Q4: The least count of a stop watch is $\frac{1}{5}\,sec$. The time of 20 oscillations of a pendulum is measured to be 25 sec. What is the maximum percentage error in the measurement of its time period?

A. 0.8%
B. 8%
C. 1%
D. 16%

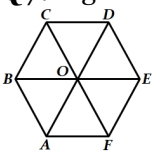
Q5: In a new system of unit length is α $metre$, mass is β kg and unit of time is γ $second$. The value of $1J$ in this system is

A. $\frac{\gamma^2}{\beta\alpha^2}$
B. $\frac{\gamma^2}{\alpha\beta^2}$
C. $\frac{\gamma\alpha}{\beta^2}$
D. $\alpha\beta\gamma$

Q6: The error in the measurement of the radius of a sphere is 0.3%. What is the maximum possible error in the measurement of the surface area of the sphere ($A = 4\pi r^2$)?

A. 0.3%
B. 0.9%
C. 0.09%
D. 0.6%

Q7: Figure shows $ABCDEF$ as a regular hexagon. What is the value of $\vec{AB} + \vec{AC} + \vec{AD} + \vec{AE} + \vec{AF}$.



A. $\vec{AO}$

B. $2\vec{AO}$

C. $4\vec{AO}$

D. $6\vec{AO}$

Q8: The velocity of a particle is $\vec{v} = 6\hat{i} + 2\hat{j} - 2\hat{k}$ component of the velocity parallel to a vector $\vec{a} = \hat{i} - \hat{j} - \hat{k}$ in vector form is

A. $2\hat{i} - 2\hat{j} - 2\hat{k}$

B. $2\hat{i} + 2\hat{j} + 2\hat{k}$

C. $2\sqrt{3}\,\hat{i} - 2\sqrt{3}\,\hat{j} + 2\sqrt{3}\,\hat{k}$

D. $2\sqrt{3}\,\hat{i} - 2\sqrt{3}\,\hat{j} - 2\sqrt{3}\,\hat{k}$

Q9: If $\vec{a} + \vec{b} + \vec{c} = 0$ then $\vec{a} \times \vec{b}$ is

A. $\vec{b} \times \vec{c}$

B. $\vec{c} \times \vec{b}$

C. $\vec{a} \times \vec{c}$

D. None of these

Q10: Hari is riding his motorcycle in a city. To move from a gym to his home, he used a road with varying traffic. He covers first half of the total distance with speed $50\,kmph$, one fourth of the total distance with $100\,kmph$ & the remaining distance with $25\,kmph$. His average speed is

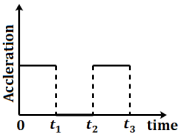
A. $\frac{400}{9}\,kmph$

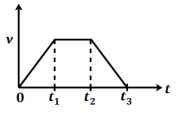
B. $\frac{200}{9}\,kmph$

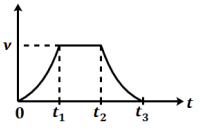
C. $\frac{700}{3}\,kmph$

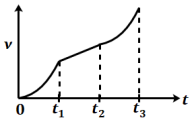
D. $50\,kmph$

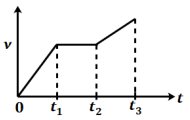
Q11: The velocity-time (v-t) graph for corresponding acceleration-time graph is



A. 

B. 

C. 

D. 

Q12: A particle is dropped from the top of a tower h heigh and at the same moment second particle is projected upwards from the bottom. They meet when the upper one has descended a distance $\frac{h}{n}$. The ratio of velocities when they meet are

A. $1:(n-1)$
B. $2:(n-2)$
C. $3:(n-3)$
D. $4:(n-4)$

Q13: Two particles are released from the same height at an interval of 1 s. How long after the first particle begins to fall, will the two particles be 10 m apart? $(g=10m/s^2)$

A. 1.5
B. 3
C. 1
D. 2

Q14: A student is at a distance 16 m from a bus when the bus begins to move with a constant acceleration of 9 ms^{-2}. The minimum velocity with which the student should run towards the bus so as the catch it is $\alpha\sqrt{2}ms^{-1}$. The value of α is

A. 10
B. 12
C. 15
D. 20

Q15: The displacement of a body along the **x**-axis depends on time as $\sqrt{x}=t+1$. Then, the velocity of the body

A. Increases linearly with time
B. Decreases linearly with time
C. Is independent of time
D. Increases non-linearly with time

Q16: Using the principle of homogeneity of dimensions, which of the following is correct?

A. $T^2=\frac{4\pi^2r^3}{GM}$
B. $T^2=4\pi^2r^3$
C. $T^2=\frac{4\pi^2r^3}{G}$
D. $T=\frac{2\pi^2r^3}{G}$

Q17: Two forces of 10 N and 15 N are acting at a point at an angle of 45° with each other. The magnitude of their resultant is about

A. 23.76 N
B. 13.45 N
C. 39.81 N
D. 8.14 N

Q18: Given : $\vec{a}+\vec{b}+\vec{c}=0$. Out of the three vectors $\vec{a},\vec{b}$ and $\vec{c}$ two equal in magnitude. The magnitude of the third vector is $\sqrt{2}$ times that of either of the two having equal magnitude. The angles between the vectors are:

A. $90^\circ,135^\circ,135^\circ$
B. $30^\circ,60^\circ,90^\circ$
C. $45^\circ,45^\circ,90^\circ$
D. $45^\circ,60^\circ,90^\circ$

Q19: Let $\vec{a}$ and $\vec{b}$ two non-null vectors such that $|\vec{a}+\vec{b}|=|\vec{a}-2\vec{b}|$. Then the value of $\frac{|\vec{a}|}{|\vec{b}|}$ may be:

A. $\frac{1}{4}$ **B.** $\frac{1}{8}$
C. 1 **D.** $\frac{1}{3}$

Q20: A sheet of area $40\,m^2$ in used to make an open tank with a square base, then find the dimensions of the base such that volume of this tank is maximum.

A. $x=\sqrt{\frac{20}{3}}m$ **B.** $x=\sqrt{\frac{30}{3}}m$
C. $x=\sqrt{\frac{10}{3}}m$ **D.** $x=\sqrt{\frac{40}{3}}m$

Q21: A ball is thrown upward with speed $10\,m/s$ from the top of the tower reaches the ground with a speed $20\,m/s$. The height of the tower is [Take $g=10\,m/s^2$]

Q22: A ball is dropped from a tower. If the distance travelled by it from $2s$ to $2.5\,s$ is $27\,m$, what is the total distance travelled until $2.5\,s$. the answer should be in meters.

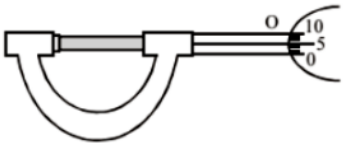
Q23: The position of a particle is given by $x=[-5t^3+2t^2+20]m$.
Find the acceleration (magnitude) of the particle at $t=5s$. [in m/s^2]

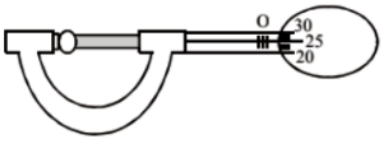
Q24: A physical quantity X is given by $X=\frac{a^{\frac{1}{3}}b^2d}{c^{\frac{1}{4}}}$, the % error in measurement of a, b, c and d are $1.5\%, 1\%, 4\%$ and 0.5% respectively. The maximum % error in X is

Q25: A ball dropped from the top of tower falls first half height of tower in $10\,s$. The total time spend by ball in air is nearly____seconds. [Take $g=10\,m/s^2$]

Q26: A juggler tosses a ball up in the air with initial speed u. At the instant it reaches its maximum height h, he tosses up a second ball with the same initial speed. If the two balls will collide at a height $\frac{xh}{4}$ then x is:

Q27: The number of circular divisions on the shown screw gauge is 50. It moves $0.5\,mm$ on main scale for one complete rotation. The diameter of the ball is $d(mm)$, Find $10\,d$; (in mm).





Q28: A particle initially at rest starts moving from reference point $x=0$ along x-axis, with velocity v that varies as $v=4\sqrt{x}m/s$. The acceleration of the particle is _____ ms^{-2}

Q29: A ball is projected vertically upwards. Its speed at half of maximum height is $20\,m/s$. The maximum height attained by it is [Take $g=10\,ms^2$]

Q30: The x and y components of a force are $2N$ and $-3N$. The force is $n\hat{i} - 3\hat{j}$. Find value of n.

Chemistry

Q31: Which of the following can never be the empirical formula of a compound?

A. X_2YZ
B. X_3Y_3Z
C. $X_2Y_2Z_4$
D. XY_2Z_3

Q32: Consider the reaction $2A + 3B \rightarrow C$. Initially, there were 2 moles of reactant A and 3 moles of reactant B. Then, which of the following statements is true?

A. A is the limiting reagent and will get consumed first.
B. Both the reactants A and B will get consumed at the same time.
C. B is the limiting reagent and will get consumed first.
D. Nothing can be said based on the given information.

Q33: Calculate the mass of 3.011×10^{23} atoms of hydrogen.

A. 2 g
B. 4 g
C. 1 g
D. 0.5 g

Q34: If a 0.24 g sample is burnt in air to produce 0.22 g of CO_2, what is the percent carbon in the sample ?

A. 92%
B. 55%
C. 25%
D. 10%

Q35: An element, X has the following isotopic composition
$X^{200} = 90\%$, $X^{199} = 8.0\%$, $X^{202} = 2.0\%$
The weighted average atomic mass of the naturally occurring element X is close to

A. 200 amu
B. 201 amu
C. 202 amu
D. 199 amu

Q36: How many moles of Na^+ ions are present in 20 mL of 0.40 M Na_3PO_4 ?

A. 0.0080
B. 0.024
C. 0.050
D. 0.20

Q37:
Assertion : One mole of $NaCl$ contains 6.023×10^{23} molecules of sodium chloride.
Reason : $58.5\ g$ of $NaCl$ also contains 6.023×10^{23} molecules of $NaCl$.

A. If both assertion and reason are true and reason is the correct explanation of assertion
B. If both assertion and reason are true but reason is not the correct explanation of assertion
C. If assertion is true but reason is false
D. If both assertion and reason are false.

A. A
B. B
C. C
D. D

Q38: To which of the following electron transitions in Bohr orbits of hydrogen does the fourth line in the Balmer series correspond?

A. $3 \rightarrow 1$
B. $5 \rightarrow 1$
C. $5 \rightarrow 2$
D. $6 \rightarrow 2$

Q39: Ratio of energy of a photon of wavelength $200\ nm$ to that of $400\ nm$ is

A. $\frac{1}{4}$
B. 4
C. $\frac{1}{2}$
D. 2

Q40:
Assertion : One mole of SO_2 contains double the number of molecules present in one mole of O_2
Reason : Molecular weight of SO_2 is three times that of O_2.

A. If both assertion and reason are true and reason is the correct explanation of assertion
B. If both assertion and reason are true but reason is not the correct explanation of assertion
C. If assertion is true but reason is false
D. If both assertion and reason are false.

A. A
B. B
C. C
D. D

Q41: A hydrocarbon is composed of 75% carbon. The empirical formula of the compound is

A. CH_2
B. CH_3
C. C_2H_5
D. CH_4

Q42: A given sample of pure compound contains $9.81\ g$ of Zn, 1.8×10^{23} atoms of chromium, and 0.60 mol of oxygen atoms. What is the simplest formula?

A. $ZnCr_2O_7$
B. $ZnCr_2O_4$
C. $ZnCrO_4$
D. $ZnCrO_6$

Q43: If 0.5 moles of $BaCl_2$ is mixed with 0.20 moles of Na_3PO_4, the maximum number of moles of $Ba_3(PO_4)_2$ that can be formed is

A. 0.1
B. 0.2
C. 0.5
D. 0.7

Q44: A gaseous mixture contains $CO_2(g)$ and $N_2O(g)$ in a 2 : 5 ratio by mass. The ratio of the number of molecules of $CO_2(g)$ and $N_2O(g)$ is

A. 5 : 2
B. 2 : 5
C. 1 : 2
D. 5 : 4

Q45: The energy of a photon having the same wavelength as the de Broglie wavelength of a $100g$ tennis ball moving at $10m/s$ is

A. $3 \times 10^9 J$
B. $3 \times 10^7 J$
C. $3 \times 10^8 J$
D. $3 \times 10^{11} J$

Q46: How much pure water to be mixed with $BaCl_2.2H_2O$ to prepare $50g$ of 12.0% (by wt.) $BaCl_2$ solution? (Molar weight of $Ba = 137,\ Cl = 35.5$)

A. 32.96 gm
B. 48.6 gm
C. 42.96 gm
D. 50 gm

Q47: Light of wavelength $621nm$ is incident on each of the following metal surfaces, whose work functions are given.
Li : $2.42eV$ $\quad Na$: $2.3eV$ $\quad Cs$: $1.9eV$
Photoelectrons will be emitted by which of the metals?

A. Only Li & Na
B. Only Li
C. Only Cs
D. Na, Cs & Li

Q48: The maximum wavelength of the Balmer series of hydrogen atom is (R = Rydberg's constant)

A. $\frac{4}{3R}$
B. $\frac{1}{R}$
C. $\frac{4}{R}$
D. $\frac{36}{5R}$

Q49: Out of the following pairs of electrons, identify the pairs of electrons present in degenerate orbitals.

A. I. $n = 3, l = 2, m_l = -2, m_s = -\frac{1}{2}$
II. $n = 3, l = 2, m_l = -1, m_s = -\frac{1}{2}$
B. I. $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$
II. $n = 3, l = 1, m_l = 1, m_s = -\frac{1}{2}$
C. I. $n = 4, l = 2, m_l = 1, m_s = +\frac{1}{2}$
II. $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$
D. I. $n = 3, l = 2, m_l = +2, m_s = -\frac{1}{2}$
II. $n = 4, l = 2, m_l = +2, m_s = +\frac{1}{2}$

Q50: A spectral line in the spectrum of H atom has a wavenumber of $15222.22 cm^{-1}$. The transition responsible for this radiation is (Rydberg constant $R = 109677 cm^{-1}$)

A. $2 \rightarrow 1$ **B.** $4 \rightarrow 2$

C. $3 \rightarrow 2$ **D.** $1 \rightarrow 2$

Q51: The transition energy (in eV) of an electron from 1^{st} excited state to 2^{nd} excited state for hydrogen atom approximately is : (**Write your answer to the closest integer**)

Q52: The total no. of spectral lines, when an electron makes transition from 7^{th} excited state to 2^{nd} stationary state, is

Q53: Consider 'Cr' atom in ground state. The sum of number of electrons with azimuthal quantum number $l = 1$ and 2 is

Q54: If the number of photons emitted per second by a $100\,W$ source of monochromatic light of wavelength $662.6\,nm$ is $a \times 10^{19}$. The value of $3a$ is? $[h = 6.626 \times 10^{-34} Js]$

Q55: The number of radial nodes in the $3p$ orbital is

Q56: $1\,g$ of mixture of equal number of moles of Li_2CO_3 and M_2CO_3 required $44.44\,mL$ of $0.5\,M$ HCl for completion of the reactions,
$Li_2CO_3 + 2HCl \rightarrow 2LiCl + H_2O + CO_2$
$M_2CO_3 + 2HCl \rightarrow 2MCl + H_2O + CO_2$
If atomic mass of Li is 7, then find atomic mass of M.

Q57: $20\,ml$ of $0.1\,M$ H_3BO_3 solution on complete neutralization requires $x\,ml$ of $0.05\,M$ $NaOH$ solution. Find out the value of "x".

Q58: If the total number of hydrogen atom in $25\,g$ of CH_4 is y, then what will be the value of $y \times 10^{-23}$?

Q59: A drop of water is about $0.1\,mL$. The density of water at room temperature is about $1.0\,g/mL$. How many H_2O molecules are present in a drop of water. Report your answer after dividing by 1.67×10^{20}

Q60: $0.5\,mole$ of H_2SO_4 is mixed with $0.2\,mole$ of $Ca(OH)_2$. The maximum number of moles of $CaSO_4$ formed is (x).Calculate 10x value.

Maths

Q61: $\log_2\left[\log_7\left(x^2 - x + 37\right)\right] = 1$ then what could be the value of x?

A. 3 **B.** 5

C. 4 **D.** 6

Q62: If $A = \log_{10}\left(\frac{ab+\sqrt{(ab)^2-4(a+b)}}{2}\right) + \log_{10}\left(\frac{ab-\sqrt{(ab)^2-4(a+b)}}{2}\right)$
where, $a = 43$ & $b = 57$
and $B = \left(2^{\log_6 18}\right) \cdot \left(3^{\log_6 3}\right)$
Then the value of $A.B$ is equal to:

A. 12
B. 21
C. 2
D. 6

Q63: The value of $\left(\frac{1}{\log_3 60} + \frac{1}{\log_4 60} + \frac{1}{\log_5 60}\right)$ is:

A. 0
B. 1
C. 5
D. 60

Q64: Consider the equation $\log_{x^2} 16 + \log_{2x} 64 = 3$.
Which of the following statement is INCORRECT with respect to solution of the given equation.

A. One irrational solution
B. No prime solution
C. Two real solutions
D. Two integral solution

Q65: Two finite sets have m and n elements. The total number of subsets of the first set is 56 more than the total number of subsets of the second set. The values of m and n are

A. $7, 6$
B. $6, 3$
C. $5, 1$
D. $8, 7$

Q66: If $\log 2 = 0.3010$ and $\log 3 = 0.4771$, find value of $\log_5 512$

A. 2.870
B. 2.967
C. 3.876
D. 3.912

Q67: The relation "less than" in the set of natural numbers is

A. Only symmetric
B. Only transitive
C. Only reflexive
D. Equivalence relation

Q68: Find x
$\log_{10} 3 + \log_{10}(4x+1) = \log_{10}(x+1) + 1$

A. $\frac{7}{2}$
B. $\frac{5}{2}$
C. $\frac{1}{2}$
D. $\frac{9}{2}$

Q69: A function is a relation

A. Every pre- image has its own image
B. Range and domain of relation is equal
C. Never
D. For all conditions

Q70: If f is a function of real variable x satisfying $f(x) = x^2$ then the expression for $f(x+4) - f(x+2) + f(x)$ is

A. $x^2 + 4x - 12$
B. $x^2 - 4x + 12$
C. $x^2 - 12x + 12$
D. $x^2 + 4x + 12$

Q71: Function f defined by $f(x) = 1/\sqrt{(x - |x|)}$, has domain

A. R
B. $R - \{0\}$
C. R^+
D. None of the above

Q72: The value of x satisfying $\log_2(3x - 2) = \log_{1/2} x$ is

A. $-1/3$
B. 2
C. $1/2$
D. 1

Q73: The domain of the function $f(x) = \sqrt{(\log_2(x))} + \sqrt{7x - x^2 - 6}$ is

A. $[1, 6]$
B. $(1, 6)$
C. $[1, 6)$
D. $(1, 6]$

Q74: What is the domain of the function $f(x) = \log(\log(x + 2))$?

A. $x > -2$
B. $x > -1$
C. $x > 0$
D. None of these

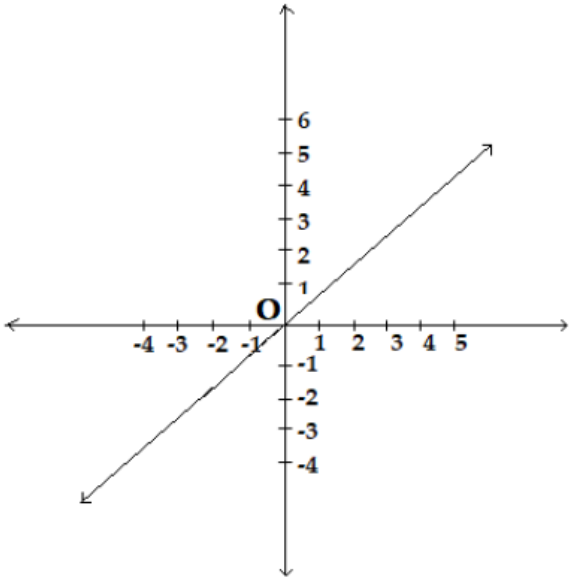
Q75: Number of solution of equation.
$4^x - 3^{x-\frac{1}{2}} = 3^{x+\frac{1}{2}} - 2^{2x-1}$ is

A. 0
B. 1
C. 2
D. infinite

Q76: The function $f(x) = \log\left(x + \sqrt{x^2 + 1}\right)$, is

A. neither an even nor an odd function
B. an even function
C. an odd function
D. a periodic function

Q77: Which of the following functions represents the given graph?



A. Modulus Function
B. Identity Function
C. Constant Function
D. None of the above

Q78: If $n(A) = 9,\ \ n(B) = 12$, then $n(A \cap B) =$

A. 10
B. 9
C. 12
D. Cannot be determined

Q79: If $\frac{1}{3}\log_3 M + 3\log_3 N = 1 + \log_{0.008} 5$

A. $M^9 = \frac{9}{N}$
B. $N^9 = \frac{9}{M}$
C. $M^3 = \frac{3}{N}$
D. $N^9 = \frac{3}{M}$

Q80: If $4^A + 9^B = 10^C$, where $A = \log_{16} 4$, $B = \log_3 9$, $C = \log_x 83$, then the value of x :

A. 10
B. 1
C. 0
D. 100

Q81: Find the value of $n\{P[P(P(\phi))]\}$

Q82: If $n(A) = 35, n(A \cap B) = 11$ and $n((A \cup B)') = 17, n(\cup) = 57$, find $n(B)$.

Q83: If $A = \{1, 2, 3, 4\}$ and $B = \{1, 2, 3\}$, then $n((A \times B) \cap (B \times A))$ is

Q84: Suppose that a function $f : R \to R$ satisfies $f(x + y) = f(x)f(y)$ for all $x, y \in R$ and $f(1) = 3$. If $\sum_{i=1}^{n} f(i) = 363$, then n is equal to

[2020, 6 Sep. Shift - II]

Q85: Two functions are given as $f(x) = x^2, g(x) = 3x + 2$
The value of $(fg)(-1)$ is $-n$. Find n.

Q86: If $f(x) = x^3 - \frac{1}{x^3}$, then find $f(x) + f\left(\frac{1}{x}\right)$.

Q87: If $x + \log_{10}(1 + 2^x) = x\log_{10}5 + \log_{10}6$, then $x =$

Q88: If $\log_2 x + \log_4 x + \log_{16} x = \frac{21}{4}$, then $x =$?

Q89: Number of positive integer solutions of inequality $|2x-3| + |x + 5| \leq |x-8|$ is

Q90: Let R_1 and R_2 be relations on the set $\{1, 2, \ldots, 50\}$ such that
$R_1 = \{(p, p^n) : p$ is a prime and $n \geq 0$ is an integer$\}$ and
$R_2 = (p, p^n) : p$ is a prime and $n = 0$ or $1\}$.
Then, the number of elements in $R_1 - R_2$ is _____.