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IIT-JEE

Batch – Growth (June) | Minor Test - 13

Time: 3:20 Hours **Test Date: 23rd February 2025** **Maximum Marks: 300**

Name of Candidate (In Capitals):_____

Roll Number (In figures):_____In words:_____

Test Centre (In Capitals):_____

Candidate's Signature: _____Invigilator's Signature:_____

READ THE INSTRUCTIONS CAREFULLY

1. The candidates should not write their Roll Number anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
2. This Test Booklet consists of 75 questions.
3. This question paper is divided into three parts **PART A - PHYSICS, PART B - CHEMISTRY** and **PART C - MATHEMATICS** having 25 questions each and every **PART** has four sections.
   (i) **Section-I** contains **20** Non-Negative Integer Value questions.
   Marking scheme: +3 for correct answer, 0 if not attempted and –1 in all other cases.
   (ii) **Section-II** contains **5** Question Multiple Choice Option with more than one correct answer.
   Marking scheme: (+4 for correct answer, 0 if not attempted and +1 partial marking –2 in all other cases.
4. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electronic device etc., except the Identity Card inside the examination hall/room.
5. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
6. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Room/Hall. However, the candidate is allowed to take away this Test Booklet with them.
7. **For integer-based questions, the answer should be in decimals only not in fraction.**
8. **If learners fill the OMR with incorrect syntax (say 24.5. instead of 24.5), their answer will be marked wrong**.

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TEST SYLLABUS

Batch – Growth (June) | Minor Test - 13 |

23rd February 2025

Mathematics: Statistics & Complex Number & (Limits - NCERT Level)

Physics: SHM & Waves

Chemistry: Hydrogen & its compound & S-block & Environmental Chemistry

Useful Data Chemistry:

Gas Constant	R	$= 0.0821\,\text{Lit atm K}^{-1}\text{mol}^{-1} = 8.314\,\text{JK}^{-1}\text{mol}^{-1}$
		$= 1.987 \approx 2\ \text{Cal K}^{-1}\text{mol}^{-1}$
Avogadro's Number	N_a	$= 6.023 \times 10^{23}$
Planck's Constant	h	$= 6.626 \times 10^{-34}\,\text{Js}$
		$= 6.25 \times 10^{-27}\,\text{erg.s}$
1 Faraday		= 96500 Coulomb
1 calorie		= 4.2 Joule
1 amu		$= 1.66 \times 10^{-27}\,\text{kg}$
1 eV		$= 1.6 \times 10^{-19}\,\text{J}$

Atomic No:
H = 1, D = 1, Li = 3, Na = 11, K = 19, Rb = 37, Cs = 55, F = 9, Ca = 20, He = 2, O = 8, Au = 79.

Atomic Masses:
He = 4, Mg = 24, C = 12, O = 16, N = 14, P = 31, Br = 80, Cu = 63.5, Fe = 56, Mn = 55, Pb = 207, Au = 197, Ag = 108, F = 19, H = 2, Cl = 35.5, Sn = 118.6

Useful Data Physics:

Acceleration due to gravity $g = 10\ \text{m/s}^2$

PART – A: MATHEMATICS

SECTION- I

1. Locus of a point z satisfying $|z| + \frac{1}{z} = z + \frac{1}{|z|}$ on the argand plane is -

(A) the union of two rays originating from the same point
(B) the union of a point and a ray
(C) the union of two points
(D) the union of a ray and a line originating from the same point

2. Let z is a complex number such that $az + b\bar{z} = c + id$ (where a, b, c, d $\in$ R), then z is equal to :

(A) $\frac{c}{(a+b)} + \frac{id}{(a-b)}$ (B) $\frac{c}{(a-b)} + \frac{id}{(a+b)}$ (C) $\frac{c}{(a-b)} - \frac{id}{(a+b)}$ (D) $\frac{c}{(a+b)} - \frac{id}{(a-b)}$

3. A complex number z satisfies the system of equation |z – 7| = |z – 7 - 6i| and |z – 2 + 3i| = |z – 5i| then $\frac{1}{Re z} + \left(\frac{1}{Im z}\right)^2 =$

(A) 0 (B) 2 (C) $\frac{1}{9}$ (D) $\frac{2}{9}$

4. If $A = \left\{z : \left|\frac{z-2}{z+2}\right| = 3, z \in C\right\}$ and $z_1, z_2, z_3, z_4 \in A$ are 4 complex numbers representing points P, Q, R, S respectively on the complex plane such that $z_1 - z_2 = z_4 - z_3$, then maximum value of area of quadrilateral PQRS is

(A) $\frac{9}{4}$ (B) $\frac{9}{2}$ (C) 9 (D) 16

5. Let a, b and c be three distinct complex numbers satisfying |a| = |b| = |c| = 1 and a + b + c = 0, then $|a^2 + b^2 + c^2|$ is equal to:

(A) 0 (B) 5 (C) 15 (D) 20

6. Let α be a complex number satisfying the equation |z – 2| = 2 and $\bar{z} - zi = 2(1-i)$. Then the area of triangle formed by α, $\bar{\alpha}$ and 2 is $(i = \sqrt{-1})$

(A) 10 (B) 5 (C) 13 (D) 2

7. Given a = cosq + isinq and the equation $az^2 + z + 1 = 0$ has a purely imaginary root and $f(x) = x^3 - 3x^2 + 3(1 + \cos\theta)x + 5$.
If p = Number of points of local extrema of y = f(x)
q = Number of points of inflection of y = f(x)
r = Number of points of negative real roots of equation f(x) = 0, then 'p + q + r' is equal to:

(A) 2 (B) 6 (C) 9 (D) 5

8. The equation of the hyperbola with vertices (3, 0) and (-3, 0) and semi latus rectum 4, is given by

(A) $4x^2 - 3y^2 + 36 = 0$ (B) $4x^2 - 3y^2 + 12 = 0$ (C) $4x^2 - 3y^2 - 36 = 0$ (D) none of these

9. If e and e' are the eccentricities of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ and its conjugate hyperbola, then the value of $\frac{1}{e^2} + \frac{1}{(e')^2}$ is equal to

(A) 0 (B) 1 (C) 2 (D) 3

10. The eccentricity of the conjugate hyperbola of the hyperbola $x^2 - 3y^2 = 1$ is

(A) 2 (B) $2/\sqrt{3}$ (C) 4 (D) 4/5

11. If the sum of the deviations of 50 observations from 30 is 50, then the mean of these observations is

(A) 50 (B) 51 (C) 30 (D) 31

12. The following data gives the distribution of height of students:

Height (in cm)	160	150	152	161	156	154	155
Number of students	12	8	4	4	3	3	7

The median of the distribution is

(A) 154 (B) 155 (C) 160 (D) 161

13. Find the equation of the hyperbola whose directrix is $2x + y = 1$, focus is (1, 2) and eccentricity is $\sqrt{3}$.

(A) $7x^2 + 2y^2 - 12xy + 2x - 14y + 22 = 0$ (B) $7x^2 - 2y^2 - 12xy - 2x - 14y - 22 = 0$

(C) $7x^2 - 2y^2 + 12xy - 2x + 14y - 22 = 0$ (D) None of these

14. Let the six numbers $a_1, a_2, a_3, a_4, a_5, a_6$, be in A.P. and $a_1 + a_3 = 10$. If the mean of these six numbers is (19/2) and their variance is σ^2, then $8\sigma^2$ is equal to

(A) 105 (B) 210 (C) 200 (D) 220

15. Let μ be the mean and σ be the standard deviation of the distribution

x_i	0	1	2	3	4	5
f_i	k + 2	2k	$k^2 - 1$	$k^2 - 1$	$k^2 + 1$	k - 3

Where $\Sigma f_i = 62$ If [x] denotes the greatest integer $\le x$, then $\left[\mu^2 + \sigma^2\right]$ is equal to

(A) 8 (B) 7 (C) 6 (D) 9

16. The position of the point (5, –4) relative to the hyperbola $9x^2 - y^2 = 1$, is

(A) outside the parabola (B) inside the parabola

(C) on the parabola (D) None of these

17. The equation to the hyperbola having its eccentricity 2 and the distance between its foci is 8 is

(A) $\frac{x^2}{12} - \frac{y^2}{4} = 1$ (B) $\frac{x^2}{4} - \frac{y^2}{12} = 1$ (C) $\frac{x^2}{8} - \frac{y^2}{2} = 1$ (D) $\frac{x^2}{16} - \frac{y^2}{9} = 1$

18. The eccentricity of the hyperbola whose latus-rectum is 8 and conjugate axis is equal to half the distance between the foci, is

(A) 4/3 (B) $4 / \sqrt{3}$ (C) $2 / \sqrt{3}$ (D) None of these

19. A student noted the number of cars passing through a spot on a road for 100 periods each of 3 minutes and summarized it in the table given below. Find the mode of the data:

Number of Cars	Frequency
0 – 10	7
10 – 20	14
20 – 30	13
30 – 40	12
40 – 50	20
50 – 60	11
60 – 70	15
70 – 80	8

(A) 44.7 (B) 41.7 (C) 46.7 (D) None of these

20. For a slightly asymmetric distribution, mean and median are 5 and 6, respectively. What is its mode?

(A) 5 (B) 6 (C) 7 (D) 8

SECTION-II

21. Let z_1 and z_2 be the points lying on the curve $|z| = 1$ and $|z - 1| + |z - 3| = 4$ respectively, then minimum value of $|z_1 - z_2|$ is equal to:

22. The length of the transverse axis of the hyperbola $9x^2 - 16y^2 - 18x - 32y - 151 = 0$ is

23. In a moderately asymmetrical distribution, the mean and median are 36 and 34 respectively, find out the value of empirical mode.

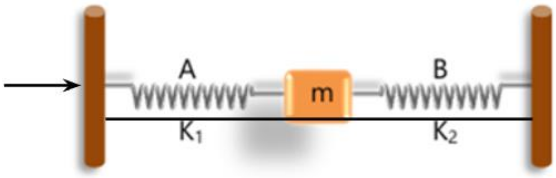
24. If the distance of one focus of hyperbola from its directrices is 5 and 3, then its eccentricity is

25. The length of the transverse axis of the rectangular hyperbola xy = 18 is

PART–B: PHYSICS

SECTION-I

26. In arrangement given in figure, if the block of mass m is displaced the frequency is given by



(A) $n = \frac{1}{2\pi}\sqrt{\left(\frac{k_1-k_2}{m}\right)}$ (B) $n = \frac{1}{2\pi}\sqrt{\left(\frac{k_1+k_2}{m}\right)}$ (C) $n = \frac{1}{2\pi}\sqrt{\left(\frac{m}{k_1+k_2}\right)}$ (D) $n = \frac{1}{2\pi}\sqrt{\left(\frac{m}{k_1-k_2}\right)}$

27. The instantaneous displacement of a simple pendulum oscillator is given by $x = A\cos\left(\omega t + \frac{\pi}{4}\right)$. Its speed will be maximum at time

(A) $\frac{\pi}{4\omega}$ (B) $\frac{\pi}{2\omega}$ (C) $\frac{\pi}{\omega}$ (D) $\frac{2\pi}{\omega}$

28. Length of a sonometer wire is either 60 cm or 80 cm, in both the cases a tuning fork produces 3 beats. Then find the frequency of tuning fork.

(1) 12 Hz (2) 15 Hz (3) 21 Hz (4) 18 Hz

29. Two mechanical waves $y_1 = 2\sin 2\pi(50t - 2x)$ and $y_2 = 4\sin 2\pi(ax + 100t)$ propagate in medium with same speed, intensities ratio of waves.

(A) $\frac{1}{16}$ (B) $\frac{1}{4}$ (C) $\frac{16}{1}$ (D) $\frac{4}{1}$

30. Which of the following is the equation of standing wave?

(A) Y = 2sin (50t - x) (B) Y = cos (100t - 2x)

(C) Y = 4sin (20t - 40x) (D) Y = 2sin (2x)cos (50πt)

31. A sine wave is travelling in a medium. The minimum distance between the two particles, always having same speed, is

(A) $\frac{\lambda}{4}$ (B) $\frac{\lambda}{3}$ (C) $\frac{\lambda}{2}$ (D) λ

32. A simple pendulum of length ℓ is hanging from ceiling of an elevator moving up with a constant velocity v. The time period of simple pendulum is

(A) $T = 2\pi\sqrt{\frac{\ell}{g}}$ (B) $T = 2\pi\sqrt{\frac{\ell}{g+v}}$ (C) $T = 2\pi\sqrt{\frac{v\ell}{g}}$ (D) $T = 2\pi\sqrt{\frac{\ell}{v}}$

33. Calculate the velocity of the transverse wave in a string which is stretched by a load of 15 kg. The mass of string is 3 x 10^{-2} kg and its length is 2 m. (g = 10 m/s^2)

(A) 100 mis (B) 95 m/s (C) 90 mis (D) 92 m/s

34. For a certain pipe, three successive resonance frequencies are observed at 425, 595 and 765 Hz. The speed of sound in air is 340 m/s. The pipe is a

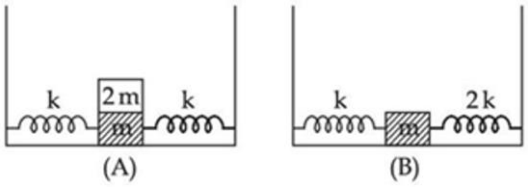
(A) Closed pipe of length 1 m (B) Closed pipe of length 2 m

(C) Open pipe of length I m (D) Open pipe of length 2 m

35. Two identical wire under same tension emits a note of frequency 100 Hz. If tension in one of the wire is changed by 4%, the beat frequency is

(A) 2Hz (B) 4 Hz (C) 6 Hz (D) 3 Hz

36. In figure (A), mass '2 m' is fixed on mass 'm' which is attached to two springs of spring constant k. In figure (B), mass 'm' is attached to two spring of spring constant 'k' and '2k'. If mass 'm' in (A) and (B) are displaced by distance 'x' horizontally and then released, then time period T_1 and T_2 corresponding to (A) and (B) respectively follow the relation.



(A) $\frac{T_1}{T_2}=\frac{3}{\sqrt{2}}$ (B) $\frac{T_1}{T_2}=\sqrt{\frac{3}{2}}$ (C) $\frac{T_1}{T_2}=\sqrt{\frac{2}{3}}$ (D) $\frac{T_1}{T_2}=\frac{\sqrt{2}}{3}$

37. A transverse wave is represented by y = 2sin (ωt - kx) cm. The value of wavelength (in cm) for which the wave velocity becomes equal to the maximum particle velocity, will be ;

(A) 4 π (B) 2 π (C) π (D) 2

38. When a particle executes simple Harmonic motion, the nature Of graph of velocity as function of displacement will be :

(A) Circular (B) Ellipitical (C) Sinusoidal (D) Straight line

39. A particle executes simple harmonic motion between x = -A and x = +A. If time taken by particle to go from x = 0 to $\frac{A}{2}$ is 2s; then time taken by particle in going from x = $\frac{A}{2}$ to A is :

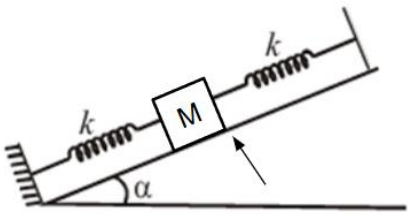
(A) 3 s (B) 2s (C) 1.5 s (D) 4s

40. Assume that the earth is a solid sphere of uniform density and a tunnel is dug along its diameter throughout the earth. It is found that when a particle is released in this tunnel, it executes a simple harmonic motion. The mass of the particle is 100 g. The time period of the motion of the particle will be (approximately) (take g = 10 ms^{-2},radius of earth = 6400 km)

(A) 24 hours (B) 1 hour 24 minutes

(C) 1 hour 40 minutes (D) 12 hours

41. In the given figure, a body of mass M is held between two massless springs, on a smooth inclined plane. The free ends of the springs are attached to firm supports. If each spring has spring constant k, the frequency of oscillation of given body is :



(A) $\frac{1}{2\pi}\sqrt{\frac{k}{2M}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{2k}{Mg\sin\alpha}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{2k}{M}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{k}{Mg\sin\alpha}}$

42. Which of the following equations represents a travelling wave ?

(A) y = Asin(15x - 2t) (B) y = $Ae^{-x^2}(vt+\theta)$

(C) y = $Ae^{x}\cos(\omega t - \theta)$ (D) y = Asinx cos ωt

43. Y = A sin(ωt +ϕ_0) is the time-displacement equation of a SHM. At t = 0 the displacement of the particle is Y = $\frac{A}{2}$ and it is moving along negative y-direction. Then the initial phase angle ϕ_0 will be :

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$ (C) $\frac{5\pi}{6}$ (D) $\frac{2\pi}{3}$

44. Two identical strings X and Z made of same material have tension T_x and T_z in them. If their fundamental frequencies are 450 Hz and 300 Hz, respectively, then the ratio T_x/T_z is :

(A) 0.44 (B) 1.5 (C) 2.25 (D) 1.25

45. A block of mass m attached to massless spring is performing oscillatory motion of amplitude 'A' on a frictionless horizontal plane. If half of the mass of the block breaks off when it is passing through its equilibrium point, the amplitude of oscillation for the remaining system become fA. The value of f is:

(A) $\frac{1}{2}$ (B) $\sqrt{2}$ (C) 1 (D) $\frac{1}{\sqrt{2}}$

SECTION- II

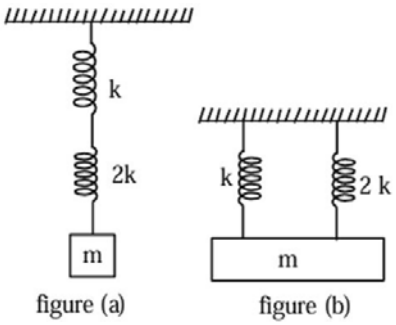
46. In Quincke's tube experiment the movable part is shifted by amount of 1.5 mm, then Sound detector receives intensity from maximum to minimum. If frequency of source is 30 kHz, find speed of wave-

47. The equation of stationary wave in a stretched string is given by y = 5 sin (πx/3) cos (4πt) where, x and y are in cm and t is in second. The separation between two adjacent nodes is_____ cm

48. Transverse pulses travel with a speed of 100 m/s along a taut copper wire whose area of cross-section is 1.50 mm^2. The density of copper is 9 g/cm^3. If tension in the wire is KN, then find K

49. A particle executes S.H.M. with time period T and amplitude A. The maximum possible average velocity in time $\frac{T}{4}$ is $\frac{n\sqrt{2}A}{T}$, Then find n.

50. As per given figures, two springs of spring constants K and 2K are connected to mass m. If the period of oscillation in figure (a) is 3s, then the period of oscillation in figure (b) will be $\sqrt{x}$. The value of x is



PART–C: CHEMISTRY

SECTION-I

51. Which one of the following statements is incorrect ?
(A) Atomic hydrogen is produced when H_2 molecules at a high temperature are irradiated with UV radiation.
(B) At around 2000 K, the dissociation of dihydrogen into its atoms is nearly 8.1%.
(C) Bond dissociation enthalpy of H_2 is highest among diatomic gaseous molecules which contain a single bond.
(D) Dihydrogen is produced on reacting zinc with HCl as well as NaOH(aq.)

52. Isotope(s) of hydrogen which emits low energy β^- particles with $t_{1/2}$ value > 12 years is/are
(A) Protium (B) Tritium (C) Deuterium (D) Deuterium and tritium

53. Dihydrogen of high purity (> 99.95%) is obtained through
(A) the reaction of Zn with dilute HCl
(B) the electrolysis of acidified water using Pt electrodes
(C) the electrolysis of brine solution
(D) the electrolysis of warm $Ba(OH)_2$ solution using Ni electrodes.

54. The metal that gives hydrogen gas upon treatment with both acid as well as base is
(A) magnesium (B) mercury (C) zinc (D) iron

55. Which one of the following methods is most suitable for preparing deionised water?
(A) Synthetic resin method (B) Clark's method
(C) Calgon's method (D) Permutit method

56. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is
(A) more efficient as it can exchange only cations
(B) less efficient as it exchanges only anions
(C) less efficient as the resins cannot be regenerated
(D) more efficient as it can exchange both cations as well as anions

57. Hydrogen peroxide reacts with iodine in basic medium to give
(A) IO^-_4 (B) IO^- (C) I^- (D) IO^-_3

58. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively.
(A) $(H_2O + O_2)$ and H_2O (B) $(H_2O + O_2)$ and $(H_2O + OH^-)$
(C) H_2O and $(H_2O + O_2)$ (D) H_2O and $(H_2O + OH^-)$

59. A S-block element (M) reacts with oxygen to form an oxide of the formula MO_2. The oxide is pale yellow in colour and paramagnetic. The element (M) is
(A) Mg (B) Na (C) Ca (D) K

60. The correct order of conductivity of ions in water is
(A) $Na^+ > K^+ > Rb^+ > Cs^+$ (B) $Cs^+ > Rb^+ > K^+ > Na^+$
(C) $K^+ > Na^+ > Cs^+ > Rb^+$ (D) $Rb^+ > Na^+ > K^+ > Li^+$

61. The metal mainly used in devising photoelectric cells is
(A) Na (B) Li (C) Cs (D) Rb

62. One of the by-products formed during the recovery of NH_3 from solvay process is
(A) $Ca(OH)_2$ (B) $NaHCO_3$ (C) $CaCl_2$ (D) NH_4Cl

63. In the following reactions, products (A) and (B), respectively, are

$$\underset{(\text{hot and conc.})}{NaOH} + Cl_2 \rightarrow (A) + \text{side product}$$

$$\underset{(\text{dry})}{Ca(OH)_2} + Cl_2 \rightarrow B + \text{side product}$$

(A) $NaClO_3$ and $Ca(OCl)_2$ (B) $NaClO_3$ and $Ca(ClO_3)_2$
(C) NaOCl and $Ca(OCl)_2$ (D) NaOCl and $Ca(ClO_3)_2$

64. The amphoteric hydroxide is
(A) $Be(OH)_2$ (B) $Ca(OH)_2$ (C) $Sr(OH)_2$ (D) $Mg(OH)_2$

65. In stratosphere most of the ozone formation is assisted by
(A) cosmic rays (B) γ-rays
(C) ultraviolet radiations (D) visible radiations

66. Reducing smog is a mixture of
(A) smoke, fog and 0_3 (B) smoke, fog and SO_2
(C) smoke, fog and $CH_2 == CH - CHO$ (D) smoke, fog and N_20_3

67. Thermal power plants can lead to
(A) acid rain (B) blue baby syndrome
(C) ozone layer depletion (D) eutrophication

68. Water sample is called cleanest on the basis of which one of the BOD values given below
(A) 11 ppm (B) 15 ppm (C) 3 ppm (D) 21 ppm

69. Which is wrong with respect to our responsibility as a human being to protect our environment?
(A) Restricting the use of vehicles (B) Avoiding the use of floodlighted facilities
(C) Setting up compost tin in gardens (D) Using plastic bags

70. What is DDT among the following?
(A) Green house gas (B) A fertilizer
(C) Biodegradable pollutant (D) Non-biodegradable pollutant

SECTION- II

71. Determine the total number of neutrons in three isotopes of hydrogen

72. Hydrogen has three isotopes, the number of possible diatomic molecules will be

73. A mixture containing 2.0 mol each of H_2 and O_2 is ignited so that water is formed. The amount of water formed is

74. Number of molecules of water of crystallization in $MgCl_2$ is

75. 6 m mols of pure gypsum is heated to convert it completely to plaster of paris. What is the number of m mols of steam evolved in the process

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