FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2021

PAPER –2

TEST DATE: 04-09-2021

Time Allotted: 3 Hours **Maximum Marks: 198**

General Instructions:

- The test consists of total **54** questions.
- Each subject (PCM) has **18** questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section – B & Section-C.**

Section-A (01 – 06, 19 – 24, 37– 42) *this section contains* ***18 multiple*** *choice questions.*
Each question has FOUR options. ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*
For each question, choose the option(s) corresponding to (all) the correct answer(s)
Answer to each question will be evaluated according to the following marking scheme:

Full Marks **: +4** If only (all) the correct option(s) is (are) chosen:
Partial Marks **: +3** If all the four options are correct but ONLY three options are chosen;
Partial Marks **: +2** If three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks **: +1** If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks **: 0** If none of the options is chosen (i. e. the question is unanswered);
Negative Marks **: –2** In all other cases

Section-B (07 – 12, 25 – 30, 43– 48) *contains* ***18 Numerical*** *based questions with* ***Single digit integer*** *as answer, ranging from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-C (13 – 18, 31 – 36, 49– 54) *contains* ***18 Numerical*** *answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***0 marks*** *for wrong answer.*

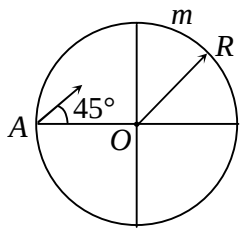
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A ring of mass m and radius R is placed on a frictionless horizontal surface. A particle of mass m is projected from point A with velocity v at an angle of 45° with AO as shown. The correct statements are



(A) The particle reaches the same point A on the ring after time $\frac{4R\sqrt{2}}{v}$.

(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

2. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i}+3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i}+b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

(A) value of a is -2

(B) value of a is $\frac{1}{2}$

(C) value of b is $\frac{1}{2}$

(D) value of b is –2

3. In the series L – C – R circuit, the voltage across resistance, capacitance and inductance are 30V each at frequency $f = f_0$.

(A) It the inductor is short-circuited, the voltage across the capacitor will be $30\sqrt{2}$ V.

(B) If the capacitor is short-circuited, the voltage drop across the inductor will be $\frac{30}{\sqrt{2}}$ V.

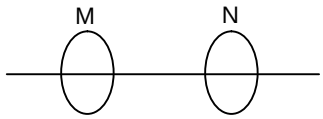
(C) If the frequency is changed to $2f_0$, the ratio of reactance of the inductor to that of the capacitor is 4 : 1.

(D) If the frequency is changed to $2f_0$, the ratio of the reactance of the inductor to that of the capacitor is 1 : 4.

4. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B=(T_A - 1.50)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$ then
   (A) the work function of A is 2.25 eV
   (B) the work function of B is 4.20 eV
   (C) $T_A = 2.00$ eV
   (D) $T_B = 2.75$ eV

5. A strip of wood of mass M and length ℓ is placed on a smooth horizontal surface. An insect of mass m starts at one end on the strip and walks to the other end in time t, moving with a constant speed.
   (A) the speed of the insect as seen from the ground is $< \frac{\ell}{t}$.
   (B) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{M}{M+m}\right)$
   (C) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{m}{M+m}\right)$
   (D) the total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{\ell}{t}\right)^2$

6. Two identical circular coils M and N are arranged coaxially as shown in the figure. Separation between the coils is large as compared to their radii. The arrangement is viewed from left along the common axis. The sign convention adopted is that currents are taken to be positive when they appear to flow in clockwise direction. Then

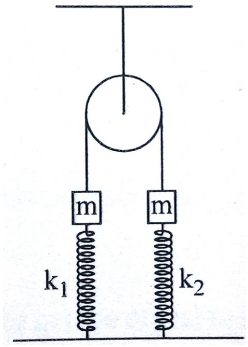


   (A) if M carries a constant positive current and is moved towards N, a positive current is induced in N
   (B) if M carries a constant positive current and N is moved towards M, a negative current is induced in N
   (C) if a positive current in M is switched off, a positive current is momentarily induced in N
   (D) if both coils carry positive currents, they will attract each other

SECTION – B
(Single Digit Integer Type)

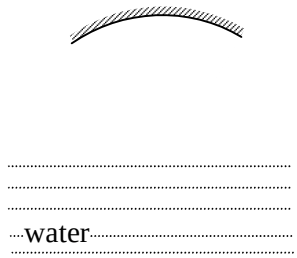
This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

7. On the diagram, two blocks of equal mass are connected by an ideal string. The values of m = 1 kg and k_2 = 100 N/m are given. Initially, both springs are relaxed. Then the left block is slowly pulled down a distance 0.1 m and released. The maximum possible value of k_1 (in N/m) for which both blocks will have same magnitude of acceleration just after releasing, is k. Both spring have natural length of 2m. Then find the value of $\frac{k}{100}$.

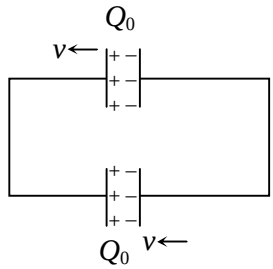


8. Suppose potential energy between electron and proton at separation r is given by U = k ln r, where k is constant. For such hypothetical hydrogen atom, find the ratio of energy difference between energy levels (n = 1 and n = 2) and (n = 2 and n = 4) is

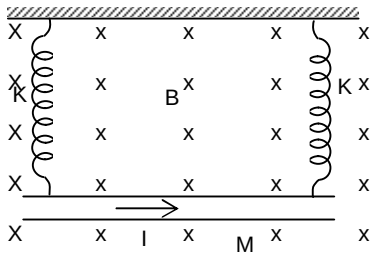
9. A concave mirror of focal length 15 cm is placed in air at a height of 45 cm above the water surface as shown. The axis of the mirror is vertical and the reflecting surface faces the water surface. A point object is placed on the axis of concave mirror at a distance 35 cm above the water surface. Find the position of image formed after two successive processes- first reflection from the concave mirror and then first refraction from the water (reflective Index of water 4/3). The distance of image from water surface (in m) is



10. Two identical capacitor connected as shown and having initial charge Q_0. Separation between plates of capacitor is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed. (given $\frac{Q_0 v}{2d}$=1 amp). Find the value of current (in amp) in the circuit.



11. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is x × 10^{-2} T (g = 10 m/s^2). Find the value of 2x.

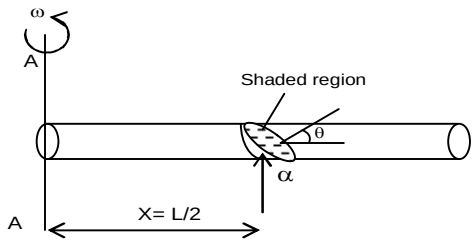


12. In YDSE experiment if the screen is shifted by a distance of 0.5 m away from the slit, 3rd maxima is shifted by 3 × 10^{-4} m. The slit width is 2 × 10^{-3}m. If the wavelength (in 100 nm) used in the experiment is 'k', find the value of 'k'.

SECTION – C
(Numerical Answer Type)

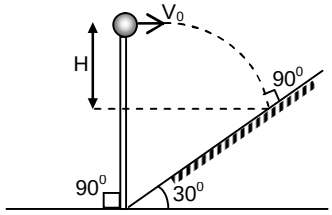
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A thin uniform metallic rod of mass m, length L, Young modulus of elasticity Y and cross–sectional area A is rotated by angular velocity ω about extreme end AA'. Consider a section on the rod at midpoint of rod. What will be the normal stress in N/m^2 on the shaded region? (Take the value of $\frac{M\omega^2L^2\cos^2\theta}{A} = 10\,N/m^2$)

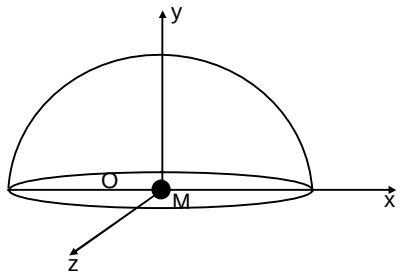


14. A rocket of mass 40kg has 360 kg of fuel. The exhaust velocity of the fuel is 2.0 km/sec. Calculate minimum rate of consumption of fuel in kg/s so that the rocket may rise from the ground (g = 10 m/sec^2).

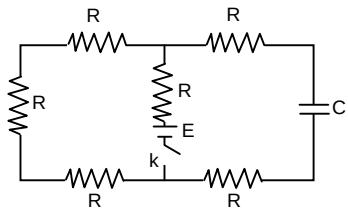
15. In the given figure, the angle of inclination of the inclined plane is 30^0. The horizontal velocity V_0 so that the particle hits the inclined plane perpendicularly is $\sqrt{ngh}$ where 'n' is



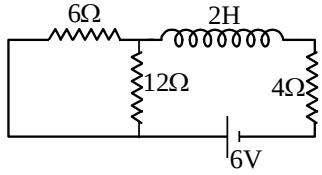
16. A hemispherical shell of mass 2M and radius 6R and a point mass M are performing circular motion due to their mutual gravitational interaction. Their positions are shown in figure at any moment of time during motion. If r_1 and r_2 are the radii of circular path of hemispherical shell and point mass respectively then the ratio of r_1 and r_2 is



17. In the given circuit initially the capacitor is uncharged. At t = 0 the key k is closed. The time constant of circuit is n times of RC. Find the value of 'n'.



18. For the circuit shown in the figure, the steady state current through the battery will be



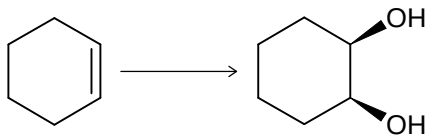
Chemistry

PART – II

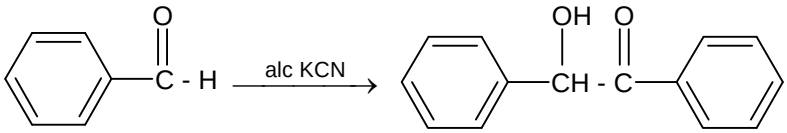
SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following concentrated terms are temperature independent?
(A) Molarity
(B) Molality
(C) Mole fraction
(D) PPM

20. 

The above transformation can be carried out by the following methods.
(A) Bayer's reagent
(B) $OsO_4/NaHSO_3$
(C) CH_3COOOH, H_3O^+
(D) m-CPBA, OH^-

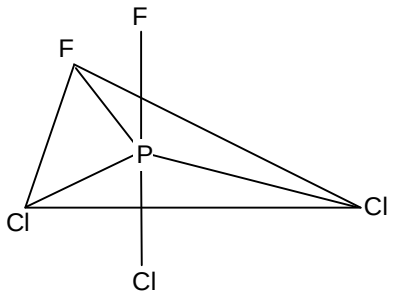
21. 

In the above reaction alcohol KCN performs the following function?
(A) Nucleophile
(B) Base
(C) Electron withdrawing
(D) Leaving group

22. Which of the following have identical bond order?
(A) CN^-
(B) O_2
(C) NO^+
(D) CN^+

23. Which of the following exists as polymer(s)?
(A) B_2H_6
(B) BN
(C) SiH_4
(D) H_3BO_3

24. Which of the following statement(s) is/are correct for PF_2Cl_3?



(A) Fluorine occupy the axial positions of the tbp geometry which triangular plane contains chlorine atoms at vertices and phosphorus at centre

(B) It's dipole moment is zero

(C) The orbitals used by phosphorus for hybridization are $3s,3p_x,3p_y$ which comprises the triangular plane with sp^2 hybridization, and $3p_z$ and $3dz^2$ which are perpendicular to the plane

(D) The structure of the molecule is

SECTION – B
(Single Digit Integer Type)

This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

25. The colour of an inorganic compound(X), containing four elements in orange. On heating it forms a green solid(Y), a colourless gas(Z) and a liquid which pH at room temperature is seven. What is the sum of the total number of atom(s) present in (Y) and (Z)?

26. The normal boiling point of water increases by 4.16^oC, if two moles of a salt is added to one kg water. What is the van't Hoff factor of the salt? [K_b of water = 0.52 K kg mol^{-1}]

27. $Zn(s) \mid Zn^{2+}(0.01\ M) \parallel H^+ \mid H_2(1\ atm), Pt$
The e.m.f of the above electrochemical cell is 0.6418 V. What is the pH of the cathode half-cell if $E^o_{Zn^{2+}/Zn} = -0.76\,V$

28. In the following reaction:
$P_4 + xNaOH + yH_2O \longrightarrow PH_3 + 3NaH_2PO_2$
Sum of x + y is

29. How many of the following polymer are co-polymer:
Nylon-6, Buna-N, Dacron, Buna-S, Teflon, PHBV

30. The ionic radii of A^+ and B^- are $1.7\,\mathring{A}$ and $1.8\,\mathring{A}$ respectively. Find the coordination number of A^+.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. What is the sum of the number of electrons with $\ell = 0$ and $\ell = 2$ present in Cu^+ ion?

32. How many moles of $C_2O_4^{2-}$ (oxalate ions) can be completely oxidized by one mole of MnO_4^- ions in acidic medium?
$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

33. How many gram of NaOH can be completely neutralized by 200 mL of 0.4 M HCl solution?

34. pH of 0.08 M solution of HOCl($K_a = 2.5 \times 10^{-5}$) is

35. The pH of 0.1 M NH_3 solution after 50 mL of this solution is treated with 25 mL of 0.1m HCl($K_b = 1.77 \times 10^{-5}$)

36. 200 mL of acidified 3 N H_2O_2 is reacted with $KMnO_4$ solution till there is a light tinge of purple colour. What is the volume of O_2 produced at STP in (L)?

Mathematics

PART – III

SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. A player tosses a coin. He sets one point for head and two points for tail. He plays till he gets sum of points equal to n. If p_n be the probability that his score becomes n, then

(A) $p_3 = \frac{1}{2}$

(B) $p_n = \frac{1}{2}P_{n-1} + \frac{1}{4}P_{n-2}$

(C) $p_4 = \frac{11}{16}$

(D) $p_n = \frac{1}{2}(p_{n-1} + p_{n-2})$

38. The number of solutions of equation $8\sin x = \frac{\sqrt{3}}{\cos x} + \frac{1}{\sin x}$

(A) 6 if $x \in (0, 2\pi)$

(B) 4 if $x \in (0, \pi)$

(C) 5, if $x \in \left(0, \frac{3\pi}{2}\right)$

(D) There does not exist any solution

39. Consider the function g defined by $g(x) = \begin{cases} x^2 \sin\frac{\pi}{x} + (x-1)^2 \sin\left(\frac{\pi}{x-1}\right), & x \neq 0,1 \\ 0, & \text{if } x = 0,1 \end{cases}$ then which of the following statement (s) is/are correct?

(A) $g(x)$ is differentiable $\forall x \in R$

(B) $g'(x)$ is discontinuous at $x = 0$ but continuous at x = 1

(C) $g'(x)$ is discontinuous at both $x = 0$ and $x = 1$

(D) Rolle's theorem is applicable for $g(x)$ in [0, 1]

40. If A and B are two orthogonal matrices of order n and $\det(A) + \det(B) = 0$, then which of the following must be correct

(A) $\det(A + B) = \det(A) + \det(B)$

(B) $\det(A + B) = 0$

(C) A + B = 0

(D) None of above are always correct

41. Diagonals of a square are along pair of lines $2x^2 - 3xy - 2y^2 = 0$. If (2, 1) is a vertex of square then sides of square can be
(A) $3x - y + 5 = 0$
(B) $x + 3y + 5 = 0$
(C) $2x - y - 5 = 0$
(D) $x - 2y = 0$

42. In the expansion of $(2x - 3y + z)^{10}$, then which of the following statement(s) is/are correct?
(A) The expansion will contain 66 terms
(B) Sum of all the coefficients is 0.
(C) The coefficient of $x^2y^3z^5$ equals $\left(\frac{-10! \times 9}{5!}\right)$
(D) None of these

SECTION – B
(Single Digit Integer Type)

This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

43. The 20^{th} term of an arithmetic sequence is $\log_{10} 20$ and the 32^{nd} term is $\log_{10} 32$. If exactly one term of the arithmetic sequence is a rational number which in lowest form is $\frac{p}{q}; (p, q \in N)$ then (p + q) = _____

44. Let $f(x)$ be a differentiable function in $[-1, \infty)$ and $f(0) = 1$ such that $\lim_{t \to x+1} \frac{t^2 f(x+1) - (x+1)^2 f(t)}{f(t) - f(x+1)} = 1$. Then value of $\lim_{x \to 1} \frac{\ln(f(x)) - \ell n 2}{x - 1} =$

45. Let z and ω be complex numbers such that $z + \omega = i$ and $z^2 + \omega^2 = 1$. If area of triangle formed by z, ω and origin is equal to A, then find the value of $16A^2$.

46. Let $f(x) = x^3 + 3x + 2$ and $g(x)$ be its inverse. If the area bounded by $g(x)$, x – axis and the ordinates x = – 2 and x = 6 is $\frac{p}{q}$ (where p& q are coprime), find value of $p + q - 1$

47. If $g(x) = \lim_{m \to \infty} \frac{x^m f(1) + h(x) + 1}{2x^m + 3x + 3}$ is continuous at x = 1 and $g(1) = \lim_{x \to 1} (\ell n ex)^{\frac{2}{\ell n x}}$ then evaluate $2g(1) + 2f(1) - h(1) + 2$. Assume that $f(x)$ and $h(x)$ are continuous at x = 1.

48. If $f(0) = 1, f(2) = 3$ and $f'(2) = 3$, then the value of $\int_0^1 x f''(2x)\,dx$ is _____

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

49. Given the equation of the ellipse $\frac{(x-3)^2}{16}+\frac{(y-4)^2}{49}$ = 1, a parabola is such that its vertex is the lowest point of the ellipse and it passes through the ends of the minor axis of the ellipse. The equation of the parabola is in the form $16y = A(x - H)^2 - K$. Determine the value of $\frac{A}{7}+\frac{H}{3}+\frac{K}{16}$ is equal to

50. If number of points common between $||x| - |y|| = 1$ and $2a|x||y| + 1 = 2|x| + a|y|$ are 8 then value of 3a (where a < 1) is ____.

51. In a triangle ABC, the equation of the side BC is $2x - y = 3$ and its circumcentre and orthocentre are at (2, 4) and (1, 2) respectively. The value of '$\sqrt{61}\sin B \sin C$' is equal to

52. Let $|\vec{a}|=1, |\vec{b}|=1$ and $|\vec{a}+\vec{b}|=\sqrt{3}$. If $\vec{c}$ be a vector such that $\vec{c}=\vec{a}+2\vec{b}-3(\vec{a}\times\vec{b})$ and $p=|(\vec{a}\times\vec{b})\times\vec{c}|$, then p^2 is equal to

53. If the line $3x+4y=12$ intersects the hyperbola $\frac{x^2}{16}-\frac{y^2}{4}=1$ at *P* & P' and its asymptotes at *Q* and *Q'* then value of $\frac{\frac{PQ}{P'Q'}+\frac{PQ'}{P'Q}}{100}$ is

54. Let $\vec{b}=4i+3j$ and $\vec{c}$ be two vectors perpendicular to each other in the xy – plane. If $\vec{r}_i, i=1,2,....n$ are the vectors in the same plane having projection 1 and 2 along b and c respectively $\sum_{i=1}^{n}|\vec{r}_i|^2$ is equal to k then $\frac{k+20}{3}$ equals to