FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: **Test- 20**

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

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Three Parts**: **Part-A, B & Part-C** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Part-A (01-06) –** Contains seven (06) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-B (07-12)** contains Six (06) Numerical based questions with single digit integer as answer, ranging from 0 to 9 (both inclusive) and each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-C (13-18)** contains Six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Two coherent waves represented by $y_1 = A\sin\left(\frac{2\pi x_1}{\lambda} - \omega t + \frac{\pi}{4}\right)$ and $y_2 = A\sin\left(2\pi\frac{x_2}{\lambda} - \omega t + \frac{\pi}{6}\right)$ are superposed. The two waves will produce

(A) constructive interference at $(x_1 - x_2) = \frac{11}{24}\lambda$

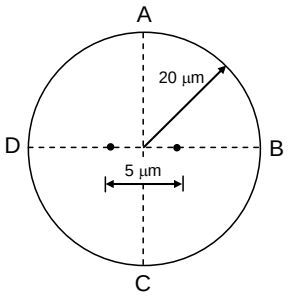
(B) constructive interference at $(x_1 - x_2) = \frac{23}{24}\lambda$

(C) destructive interference at $(x_1 - x_2) = \frac{23}{24}\lambda$

(D) destructive interference at $(x_1 - x_2) = \frac{11}{24}\lambda$

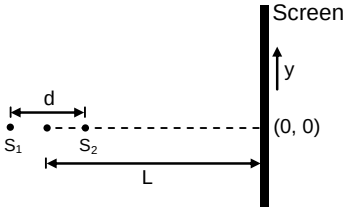
1. **BD**

2. Two point sources separated by d = 5 μm emit light of wavelength λ = 2 μm in phase. A circular wire of radius 20 μm is placed around the source as shown in figure. Which of following statements are incorrect?
(A) Point A and B are dark and points C and D are bright.
(B) Points A and B are bright and point C and D are dark.
(C) Points A and C are dark and points B and D are bright.
(D) Points A and C are bright and points B and D are dark.



2. **ABC**

3. The figure shows two point sources which emit light of wavelength λ in phase with each other and are a distance d = 5.5 λ apart along a line which is perpendicular to a large screen at a distance L from the center of the source. Assume that d is much less than L. Which of the following statements is (are) correct?
(A) Only five bright fringes appear on the screen.
(B) Only six bright fringes appear on the screen.
(C) Point y = 0 corresponds to the bright fringe.
(D) Point y = 0 corresponds to the dark fringe.

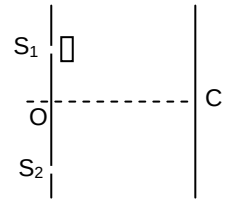


3. **AD**

4. White light is used to illuminate the two slits in Young's double slit experiment. The separation between the slits is b and the screen is at a distance d (>>b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are:
(A) $\lambda = b^2/d$ (B) $\lambda = 2b^2/d$ (C) $\lambda = b^2/3d$ (D) $\lambda = 2b^2/3d$

4. **AC**

5. A YDSE is performed in a medium of refractive index μ_1. In front of one of the slits say S_1 as shown a thin glass slab of refractive index $\mu_2(<\mu_1)$ is kept. If initially (without glass slab) the central maxima was formed on the central line OC then



(A) central maxima will shift upwards (after glass slab used).
(B) central maxima will shift downwards (after glass slab used).
(C) the waves reaching on the screen at C from S_1 will lead the waves reaching from S_2.
(D) the waves reaching C from S_1 will lag from the waves reaching from S_2.

5. **BC**

6. A thin film of thickness t and index of refraction 1.33 coats a glass with index of refraction 1.50. Which of the following thickness t will not reflect normally incident light with wavelength 640 nm in air?
(A) 120 nm (B) 360 nm
(C) 600 nm (D) 840 nm

6. **BCD**

PART – B
Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. In a Young's experiment, two coherent sources are placed 0.90 mm apart and the fringes are observed one meter away. If it produces the second dark fringe at a distance of 1 mm from the central fringe, if the wavelength of monochromatic light used is $\frac{3}{k}$cm, then find the value of 'k'.

7. **5**

8. The maximum intensity in Young's double slit experiment is I_0. Distance between the slits is
d = 5λ, where λ is the wavelength of monochromatic light used in the experiment. Find the ratio of the intensity of the central maxima to intensity of light in front of one of the slits on a screen at a distance D = 10 d?

8. **2**

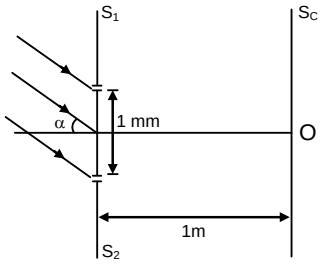
9. In Young's double slit experiment the width of one slit is double that of the other. The ratio of intensity of a bright band to that of a dark band in the interference pattern will be

9. **9**

10. In a Young's double slit experiment, the fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index (4/3), without disturbing the geometrical arrangement, if the new fringe width be $\left(\frac{k}{10}\right)$mm then, find the value of 'k'.

10. **3**

11. A plane wave of mono chromatic light of wavelength 6000 Å is incident on the plane of two slits S_1 and S_2 at angle of incidence $\alpha = (1.8/\pi)^0$. The widths of S_1 and S_2 are w and 2w respectively. A thin transparent film of thickness 4μm and R.I. 3/2 is placed in front of S_1. It absorbs 50% of light energy and transmits the remaining. The interference is observed on the screen. Point O is equidistant from S_1 and S_2. If the maximum intensity on the screen is I, then find minimum intensity is $\frac{I}{n}$. Find 'n'



11. **9**

12. In a Young's double-slit experiment, the slits are 2 mm apart and are illuminated with a mixture of two wavelengths λ = 750 nm and λ' = 900 nm. At what minimum distance (in mm) from the common central bright fringe on a screen 4m from the slits will a bright fringe from one interference pattern coincide with a bright fringe from the other?

12. **9**

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

1. In YDSE experiment if the screen is shifted by a distance of 0.4 m away from the slit, 3rd maxima is shifted by 3×10^{-4} m. If the slit width is 2×10^{-3}m, if the wavelength used in the experiment is 100 n mm then find the value of 'n'.

1. **3.2**

2. When a thin transparent sheet of refractive index $\mu = \frac{3}{2}$ is placed near one the slits in Young's double slits experiment, the intensity at the centre of the screen reduces to half of the maximum intensity. The minimum thickness of the sheet should be nλ where n is

2. **0.5**

3. The intensity of the light coming from one of the slits in a Young's double slit experiment is 25 times the intensity from the other slit. Find the ratio of the maximum intensity to the minimum intensity in the interference fringe pattern observed.

3. **2.25**

4. A beam of unpolarised light o intensity I_0 is passed through a Polaroid A and then through another Polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of a. The intensity of the emergent light is nI_0 where n is

4. **0.25**

5. A thin sheet of glass (μ=1.5) of thickness 6 microns introduced in the path of one of interfering beams of a double slit experiment shifts the central fringes to a position previously occupied by fifth bright fringe. If the wavelength of the light used is (in μm)

5. **0.6**

6. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals:

6. **0.33**

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which of the following statements are correct regarding ideal solution?
(A) $\Delta H_{mix} = 0$, $\Delta S_{mixsystem} = 0$ (B) $\Delta H_{mix} = 0$, $\Delta S_{mixsurrounding} = 0$
(C) $\Delta H_{mix} > 0$, $\Delta G_{mix} > 0$ (D) $\Delta H_{mix} = 0$, $\Delta V_{mix} = 0$

1. BD

2. Which of the following ligand(s) can not show linkage isomerism ?
(A) CN^- (B) NO_2^- (C) NH_3 (D) SCN^-

2. ABD

3. TiO_2 is used in paint and preferred over Pb-paints because
(A) it is non-toxic (B) it does not blacken if exposed to H_2S
(C) it is prepared by reaction with oxygen (D) it's highest oxidation state is +4

3. AB

4. Which of the following will make an ideal solution ?
(A) C_2H_5Cl, C_2H_5Br (B) C_6H_6 , $C_6H_5CH_3$
(C) $HCl + H_2O$ (D) $C_2H_5OH + H_2O$

4. AB

5. Which of the following statement(s) is/are correct for $Ni(CO)_4$?
(A) The hybridization of nickel is sp^3
(B) Back donation of d-electrons takes place
(C) The effective atomic number of nickel is identical to the atomic number of its nearest noble gas.
(D) The oxidation number of Ni is +2

5. ABC

6. In context with the transition elements, which of the following statements is incorrect? [2009]
(A) In addition to the normal oxidation state, the zero oxidation state is also shown by these elements in complexes.
(B) In the highest oxidation states, the transition metal shows basic character and forms cationic complexes.
(C) In the highest oxidation states of the first five transition elements(Sc to Mn) all the 4s and 3d electrons are used for bonding
(D) Once the d^5 configuration is exceeded, the tendency to involve all the 3d electron in bonding decreases.

6. B

PART – B

Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. 1.1 gm of $CoCl_3.6NH_3$ (mol weight = 267) was dissolved in 100 gm of water. The freezing point of the solution was – 0.29°C. How many moles of the solute particles exist in solution for each mole of solute particles introduced?

7. 4

8. what is/are the maximum number of atoms lying in one plane for the complex anion $[Cr(CN)_6]^{3-}$

8. 9

9. Sc^{2+}, Ti^{4+}, Fe^{3+}, Ni^{2+}, Cu^{+}, Zn^{2+}, Mn^{2+}, Fe^{2+} and Co^{2+}
How many of the above ion(s) form(s) colourless complex(es)?

9. 3

10. When glycerol is dripped into crystal of $KMnO_4$, the vigorous reaction takes place and glycerol is completely oxidized, while $KMnO_4$ is reduced into Mn_xO_y. What is value of $(x \times y)$?

10. 6

11. The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is

11. 6.

12. Find the total number of change in which acidic medium is required
(i) $CrO_4^{2-} \longrightarrow Cr_2O_7^{2-}$
(ii) $MnO_4^- + I^- \longrightarrow IO_3^- + MnO_2$
(iii) $Cr_2O_7^{2-} + H_2S \longrightarrow S + Cr^{3+}$
(iv) $H_2O_2 + MnO_4^- \longrightarrow O_2 + Mn^{2+}$
(v) $CO_3^{2-} \longrightarrow CO_2$

12. 4

PART – C

(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. $Hg\left[Co(NCS)_4\right]$ is often used to calibrate the magnetic balance. What is the magnetic moment of complex?

13. 3.87

14. What is the effective atomic number of iron in the complex $[Fe(CO_2)(NO)_2]$?

14. 36

15. 2.0 gm of benzoic acid dissolved in 25 gm of benzene shows a depression of freezing point equal to 1.62 K. Molal depression constant (K_f) of benzene is 4.9 kg mol^{-1} K. What is the percentage association of the acid?

15. 90.89%

16. Which of the following is the approximate radius of Hf (in Å unit), if radius of Zr is 1.45 Å ?

16. 1.44

17. How many linkage isomer(s) is/are possible for the following complex? [Consider the given complex as an isomer]
$[Fe(NH_3)_4(NO_2)(CN)]Cl$

17. 4

18. Calculate the amount of ice that will separate out on cooling a solution containing 50g of ethylene glycol in 200g water to – 9.3°C (K_f for water = 1.86 K mol^{-1} kg).

18. 38.71g

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Area bounded by the curves $y=\sqrt{|x-1|}$ and $\sqrt{y}=|x-1|$ is:

(A) $2\int_1^2\left(\sqrt{x-1}-(x-1)^2\right)dx$ (B) $2\int_0^1\left(\sqrt{x}-x^2\right)dx$

(C) $2\int_1^2\left(\sqrt{2-x}-(2-x)^2\right)dx$ (D) $\frac{2}{3}$

1. ABCD

2. Let $g(x)$ and $f(x)$ are two non negative functions such that $g(0)=1, f(0)=0$ and $g'(x)=1, f(0)=0$ and $g'(x)=f(x)\ f'(x)=g(x).f'(x),$ then

(A) minimum value of $g(x)+f(x)$ is 1

(B) minimum value of $g(x)+f(x)$ is $\frac{1}{2}$

(C) If $f(x)=x,$ then $g(x)=5$ has two solutions in the interval (0, 2)

(D) If $f(x)=x,$ then area bounded by the curves $y=g(x),$ the x – axis and the ordinates x= 0 and x = 1 is $\frac{4e-7}{2}$

2. AD

3. Area enclosed between the curves $|y|=1-x^2$ and $x^2+y^2=1$ is:

(A) enclosed area is symmetric with respect to coordinate axis

(B) $\pi-\frac{8}{3}$ sq. unit

(C) $2\pi-\frac{8}{3}$ sq. unit

(D) enclosed area is symmetric about y = 2 line

3. AB

4. If $y(x)$ is the solution of $(2+y)\frac{dy}{dx}+(x-1)=0$ and $y(0)=0$ and the area bounded by the curve y (x), x – axis and y – axis in first quadrant is A, then:

(A) $y(x)$ is circle of radius 5

(B) $y(x)$ is a circle of radius $\sqrt{5}$

(C) $\frac{5\pi}{8}-2<A<\frac{5\pi}{6}-2$

(D) $\frac{5\pi}{8}-2<A<\frac{5\pi}{4}-2$

4. BC

5. A curve which passes through origin and satisfies
$\left(y+\sin x.\cos^2(xy)\right)\sec^2(xy)dx+\left(x\sec^2(xy)+\sin y\right)dy=0$
will be :

(A) $\tan(xy)+2\left(1-\cos\left(\frac{x+y}{2}\right).\cos\left(\frac{x+y}{2}\right)\right)=0$

(B) $\sin(2xy)+2=\cos x+\cos y$

(C) $2-\sin(2xy)=\cos x-\cos y$

(D) $\sin(2xy)+\frac{4-2\cos x-2\cos y}{1+\tan^2(xy)}=0$

5. AD

6. Differential equation of a curve is given by
$\left(\sqrt{\cos^2 y-\sin^2 x\cos^2 y}\right)dx=\left(\sqrt{\sin^2 x-\cos^2 y\sin^2 x}\right)dy$ where $x,y\in\left(0,\frac{\pi}{2}\right)$ and curve passes through the point $\left(\frac{\pi}{4},\frac{\pi}{4}\right)$, then:

(A) equation of curve is $\sin(x+y)+\sin(x-y)=1$

(B) equation of curve is $y=\cos^{-1}\left(\frac{\operatorname{cosec} x}{2}\right)$

(C) curve does not intersect y – axis

(D) equation of curve is $y=\cos^{-1}\left(\frac{\operatorname{cosec} x}{\sqrt{2}}\right)$

6. ABC

PART – B
Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. If $f\left(\frac{x}{y}\right)=\frac{f(x)}{f(y)}\forall x,y\in R$ and $f'(1)$ exists, and area under the curve $f(x)$ bounded by x – axis , x = 0 and x = 1 is $\frac{1}{3}$, then find $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}e^{r/n}f\left(\frac{\sqrt{r}}{n}\right)$.

7. 1

8. Area bounded between maxima and minima of function $y=x^3-3x+4$ with curve and x – axis is A. Find number of even divisors of 3A.

8. 6

9. Area bounded by $y = x^2 - 3$ and $y = kx + 2$ is least for some value of k. Find the value of $k + 7$.

9. 7

10. If the family of integral curves of the differential equation $\frac{dy}{dx} + x^3 y = x$ is cut by the line $x = 2$; the tangents at the points of intersection are concurrent at (λ, μ). Then the value of $\left[\frac{\lambda}{\mu}\right]$, where [.] denotes greatest integer function is

10. 8

11. If the differential equation representing the family of curve $y = C_1 \cos 2x + C_2 \cos^2 x + C_3 \sin^2 x + C_4$ is $\lambda y' = y'' \tan 2x$, then λ is:

11. 2

12. If 'e' denotes the eccentricity of the hyperbola, satisfying the differential equation $2xy\frac{dx}{dy} = x^2 + y^2$ and passing through the point (2, 1), then $\left(e^2 - 1\right)$ is equal to:

12. 1

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. Let $y = f(x)$ be a curve 'C_1' passing through (2, 2) and $\left(8, \frac{1}{2}\right)$ and satisfying a differential equation $y\left(\frac{d^2y}{dx^2}\right) = 2\left(\frac{dy}{dx}\right)^2$. Curve '$C_2$' is the director circle of the circle $x^2 + y^2 = 2$. If the shortest distance between the curve C_1 and C_2 is $\sqrt{p} - q$ where $p, q \in N$, then find the value of $\left(p^2 - q\right)$.

13. 62

14. Given $y(0) = 2000$ and $\frac{dy}{dx} = 32000 - 20y^2$, then find the value of $\lim_{x \to \infty} y(x)$.

14. 40

15. If the differential equation corresponding to the family of curve, $y = (A + Bx)e^{3x}$ is given by $\frac{d^2y}{dx^2} = a\frac{dy}{dx} + by$, then $(a - b)$ equals:

15. 15

16. Area of the quadrilateral formed by tangents and normals at the extremities of the latus rectum of the parabola $x^2 - 4x + 4 + 12y = 0,$ is:

16. 72

17. If area bounded by inverse of function $y = x^3 + 2x + 1,$ x – axis and line $x + 2y = 6$ is $\frac{p}{q}$ (where p and q are coprime numbers), then pq is equal to:

17. 44

18. If line x = 1 divides the area bounded by the curve $2x + 1 = \sqrt{4y + 1},$ $y = x$ and $y = 2$ in two regions of area R_1 and $R_2,$ then $\frac{1}{R_1^2} + \frac{1}{R_2^2}$ is equal to

18. 13

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B