# FIITJEE INTERNAL TEST

## RANK IMPROVEMENT TEST – IX

**Batches: 1921**

## IIT- JEE 2021

## QP CODE:

**Time: *3 hours*** **Maximum Marks: 282**

- ***Please read the instructions carefully. You are allotted 5 minutes specially for this purpose.***
- ***You are not allowed to leave the examination hall before end of the test.***
- ***Use Blue/Black Ball Point Pen only*** *for writing particulars on* ***Side–1 and Side–2*** *of the Answer Sheet.* ***Use to Pencil is strictly prohibited.***

## Instructions

**Note:**

1. The question paper contains 3 sections (Sec-1, Chemistry, Sec-II, Physics & Sec-III, Mathematics.)
2. Each section is divided into two parts, **PART-A and PART-C**.
3. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
4. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

**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 ***Blue/Black Ball Point Pen*** 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.

**Marking Scheme For All Three Parts.**

1. **PART – A (01 – 10)** contains 10 Multiple Choice Questions which have **Only One Correct answer**. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.

2. **PART – A** (**11 – 20)** contains 10 Multiple Choice Questions which have **One or More Correct** answer.

   For each question in the group **Q. 11 – 20** of **PART – A** you will be awarded
   *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*: **–1** 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 **–1** marks, as a wrong option is also darkened.

3. **PART-C (01 – 06)** contains 6 Numerical Based questions with Single Digit Integer as answer, ranging from 0 to 9 and each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

***Name of the Candidate*** **:** ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

***Enrolment Number*** **:** ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

# Section – I (Chemistry)

## PART – A

### (Single Correct Choice Type)

This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. If the radiator of an automobile contains 12 L of water, how much would the freezing point be lowered by the addition of 5 Kg of prestone(glycol $C_2H_4(OH)_2$). How many Kg of zeron(methyl alcohol) would be required to produces the same result?
   (A) -12°C, 58.2 kg (B) 12K, 25.8kg
   (C) -12°C, 2.58kg (D) 12K, 250.8gm

1. C

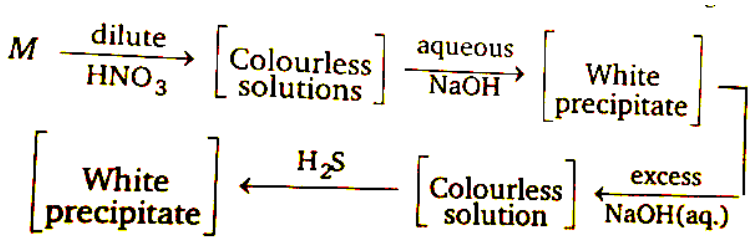
2. 0.5 m solution of acetic acid(Mw = 60) in benzene(Mw = 78) boils at 80.80°C. The normal boiling point of benzene is 80.10°C and $\Delta_{vap}H$ = 30.775 kJ $mol^{-1}$. Calculate the percent of association of acetic acid in benzene.
   (A) 53.2% (B) 2.63%
   (C) 26.5% (D) 93.6%

2. D

3. Calculate the Van't Hoff factor when 0.1 mol $NH_4Cl$ is dissolved in 1 L of water. The degree of dissociation of $NH_4Cl$ is 0.8 and its degree of hydrolysis is 0.1.
   (A) 1.67 (B) 2.68
   (C) 1.20 (D) 3.7

3. B

4. A metal M and its compound can give the following observable changes in a consequence reactions.




   (A) Mg (B) Pb
   (C) Zn (D) Sn

4. C

5. When mercury(II) chloride is treated with excess of stannous chloride, the products obtained are
   (A) liquid Hg and $SnCl_4$ (B) $Hg_2Cl_2$ and $SnCl_4$
   (C) $Hg_2Cl_2$ and $[SnCl_4]^{2-}$ (D) Liquid Hg and $[SnCl_4]^{2-}$

5. A

6. Give the correct order of initials T or F for the following statements. Use T if statement is true and F if it is false
   (I) Sulphide ions reacts with $Na_2[Fe(CN)_5(NO)]$ to form a purple coloured compound $Na_4[Fe(CN)_5(NOS)]$. In the reaction, the oxidation state of iron changes.
   (II) Pt(IV) compounds are relatively more stable than NI(IV) compounds
   (III) The welding of magnesium can be done in the atmosphere of Helium
   (IV) $LiAlH_4$ on hydrolysis will give $H_2$
   (A) FFTT (B) FTTT
   (C) TFTF (D) TFTT

6. B

7. $CuSO_4(aq) \xrightarrow{H_2S\uparrow} M\downarrow \xrightarrow[\text{of KCN}]{\text{Excess}} N + O$

Then final products N and O are respectively

(A) $[Cu(CN)_4]^{3-}$, $(CN)_2$ (B) CuCN, $(CN)_2$

(C) $[Cu(CN)_4]^{2-}$, $(CN)_2$ (D) $Cu(CN)_2$, $K_2S$

7. A

8. In a certain reaction $B^{n+}$ is getting converted to $B^{(n+4)+}$ in solution. The rate constant for the reaction is measured by titrating a volume of the solution with a reducing agent which reacts only with $B^{n+}$ and $B^{(n+4)+}$. In this process it converts $B^{n+}$ to $B^{(n-2)}$ and $B^{(n+4)+}$ to $B^{(n-1)+}$. At t = 0, the volume of reagent consumed is 25 mL and at t = 10 min, the volume used is 32 mL. Calculate the rate constant for conversion of $B^{n+}$ to $B^{(n+4)}$ assuming it to be first order reaction.

(A) $2 \times 10^{-4}\ min^{-1}$ (B) $4 \times 10^{-5}\ min^{-1}$

(C) $2.07 \times 10^{-2}\ min^{-1}$ (D) $5 \times 10^{-4}\ min^{-1}$

8. C

9. Milk at room temperature (20°C) turns sour in about 64 hr. In a refrigerator at 3°C, milk can be stored three times as long before it sours. How long should the milk take to sour at 40°C?

(A) 30.50 hr (B) 20.50hr

(C) 5.90hr (D) 43.46hr

9. B

10. The decomposition of compound A in solution is a first order process with an activation energy of 52.3 kJ $mol^{-1}$. A 10% solution of A is 10% decomposed in 10 min at 10°C. How much decomposition would be observed with a 20% solution after 20 min at 20°C.

(A) 62% (B) 40%

(C) 36.1% (D) 56.4%

10. C

**(Multiple Correct Choice Type)**

This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

11. When chromtie ore is heated with $Na_2CO_3$ powder in the presence of air

(A) one gaseous product is formed

(B) one product is water insoluble which is dark brown in colour

(C) one product is water soluble which is red in colour

(D) one product is water soluble which is yellow in colour

11. ABD

12. $K_2MnO_4$ is unstable in solution and the green solution obtained is changed into purple colouration. Correct statements regarding the above change are

(A) It is a disproportionation reaction

(B) It produces $KMnO_4$

(C) Overall solution becomes alkaline

(D) It produces black precipitate of hydrated $MnO_2$

12. ABCD

13. Two miscible liquids A and B having vapour pressure in pure state $P_A^o$ and $P_B^o$ are mixed in mole fraction $\chi_A$ and $\chi_B$ to get a mixture having total vapour pressure of mixture $P_M$. Which of the following relations are correct?

(A) $\chi_A = \dfrac{P_M - P_B^o}{P_A^o - P_B^o}$ (B) $\dfrac{\chi_{A(l)}}{\chi'_{A(V)}} = \dfrac{P_M}{P_A^o}$

(C) $\frac{\chi_{A(l)}}{\chi'_{A(V)}} = \frac{P_M}{P_B^o}$ (D) All of these

13. AB

14. 1.2575 g sample of $[Cr(NH_3)_6]SO_4Cl$(Mw = 251.5) is dissolved to prepare 250 mL solution showing an osmotic pressure of 1.478 atm of Hg at 27°C. Which of the following statements is/are correct about this solution?
(A) Each molecule furnishes three ions in solution
(B) The Van't Hoff factor is = 3
(C) The equilibrium molarity of $[Cr(NH_3)_6]SO_4Cl$ = 0
(D) The equilibrium molarity of $[Cr(NH_3)_6]^{3+}$ = 0.02 M

14. ABCD

15. 2 L of 1 molar solution of a complex salt $CrCl_3.6H_2O$(Mw = 266.5) shows an osmotic pressure of 98.52 atm. The solution is now treated with 1 L of 6 M $AgNO_3$, which of the following are correct?
(A) Weight of AgCl precipitated is 861 g
(B) The clear solution will show an osmotic pressure of 98.52 atm
(C) The clear solution will shown an osmotic pressure of 65.68 atm
(D) 2 mol of $[Cr(H_2O)_6](NO_3)_3$ will be present in solution

15. ACD

16. Which relations are not correct for an aqueous dilute solution of $K_3PO_4$ if its degree of dissociation is $\alpha$?

(A) $\frac{\Delta P}{P^o} = \frac{\text{Molality} \times 18 \times (1+3\alpha)}{1000}$ (B) $\frac{\Delta P}{P^o} = \frac{\pi_{obs} \times 18 \times (1+3\alpha)}{RT \times 1000}$

(C) $\frac{\Delta P}{P^o} = \frac{\Delta T_{f\,obs} \times 18}{K_f \times 1000}$ (D) Mw of $K_3PO_4 = Mw_{obs} \times (1 + 3\alpha)$

16. ACD

17. The rate expression for the reaction:
$NH_4CNO \rightleftharpoons NH_2CONH_2$ can be derived form the mechanism:

i. $NH_4CNO \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NH_4NCO$ (Fast)

ii. $NH_4NCO \xrightarrow{k_3} NH_3 + HNCO$ (Fast)

iii. $NH_3 + HNCO \xrightarrow{k_4} NH_2CONH_2$ (Slow)

Which of the following statement(s) is/are correct about the rate expression?

(A) $\frac{d_{[urea]}}{dt} = \frac{k_1 k_3}{k_2}[NH_4NCO]$ (B) $\frac{d_{[urea]}}{dt} = \frac{k_1 k_3}{k_2 k_4}[NH_4NCO]$

(C) $\frac{d_{[urea]}}{dt} = k_1[NH_4NCO]$ (D) $\frac{d_{[urea]}}{dt} = \frac{k_1 \times k_2}{k_3 \times k_4}[NH_4NCO]$

17. A

18. $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

The half-life period is independent of the concentration of zinc at constant pH. For the constant concentration of Zn the rate becomes 100 times when pH is decreased from 3 to 2. Hence,

(A) $\frac{dx}{dt} = k[Zn]^0\left[H^+\right]^2$

(B) $\frac{dx}{dt} = k[Zn]\left[H^+\right]^2$

(C) Rate is not affected if the concentration of zinc is made four times and that of $H^+$ ion is halved.

(D) Rate becomes four times if the concentration of $H^+$ ion is doubled at constant Zn concentration.

18. BCD

19. Which of the following statement(s) is/are correct?

(A) The rate constant for the reaction $2N_2O_5 \longrightarrow 4NO_2 + O_2$, is $3.0 \times 10^{-5}$ $s^{-1}$. If the rate is $2.40 \times 10^{-5}$ mol $L^{-1}$ $s^{-1}$, then the concentration of $N_2O_5$ = 0.8 mol $L^{-1}$.

(B) In the Arrhenius equation, k = Aexp(-E/RT), A may be termed as the rate constant at very low temperature

(C) If I is the intensity of absorbed light and c is the concentration of AB for the photochemical process $AB + hv \longrightarrow AB^*$, the rate of formation of $AB^*$ is directly proportional to $I^2$.

(D) The rate constant, the activation energy, and the Arrhenius parameter of a chemical reaction at 25°C are $3.0 \times 10^{-4}$ $s^{-1}$, 104.4 kJ $mol^{-1}$ and $6.0 \times 10^{14}$ $s^{-1}$, respectively. The value of the rate constant as $T \to \infty$ is $6.0 \times 10^{14}$ $s^{-1}$.

19. AD

20. Pick out the correct statement(s)

(A) $MnO_2$ dissolves in conc. HCl but does not form $Mn^{4+}$ ions.

(B) Decomposition of acidic $KMnO_4$ is not catalysed by sunlight

(C) $MnO_4^{2-}$ is strongly oxidizing and stable only in very strong alkali. In dilute alkali water or acidic solutions it disproportionates

(D) $KMnO_4$ does not act as oxidizing agent in alkaline medium

20. AC

## PART – C

This section contains 06 **multiple choice questions**. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive)

1. Hydrolysis of an alkyl halide(RX) by dilute alkali $[\overset{\ominus}{O}H]$ takes place simultaneously by $S_N2$ and $S_N1$ pathways. A plot of $-\frac{1}{[RX]}\frac{d[R-X]}{dt}$ vs $[\overset{\ominus}{O}H]$ is a straight line of slope equal to $2 \times 10^3$ $mol^{-1}$ L $h^{-1}$ and intercept equal to $1 \times 10^2$ $h^{-1}$. Calculate the initial rate (mole $L^{-1}$ $min^{-1}$) of consumption of RX when the reaction is carried out taking 1 mol $L^{-1}$ of RX and 0.1 mol $L^{-1}$ of $[\overset{\ominus}{O}H]$ ions

1. 5

2. The initial concentrations of both the reactants of a second order reaction are equal and 60% of the reaction gets completed in 30 s. How much time will be taken in 20% completion of the reaction?

2. 5

3. Compound $PdCl_4.6H_2O$ is a hydrated complex; 1 m aqueous solution of it has freezing point 269.28 K. Assuming 100% ionization of complex, calculate the number of ions furnished by complex in the solution

3. 2

4. The osmotic pressure of urea solution at $10^oC$ is 200 mm becomes 105.3 mm when it is diluted and temperature raised to $25^oC$. The extent of dilution is

4. 2

5. The number of the following reagents that produce ppt. with $ZnSO_4$ solution is _____
NaOH, $Na_2CO_3$, NaCl, $Na_2HPO_4$, $Na_2S$, $CH_3CO_3Na$

5. 4

6. How many $\pi$-bonds are present in ferrocene?

6. 6

***space for rough work***

# Section – II (Physics)

## PART – A

### (Single Correct Choice Type)

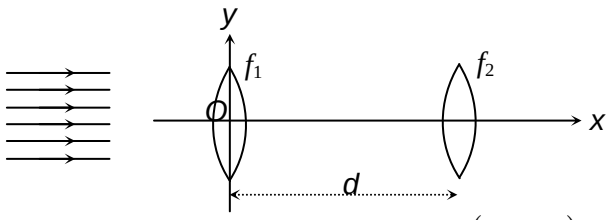
This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. The *x-z* plane separates two media *A* and *B* of refractive indices $\mu_1$ = 1.5 and $\mu_2$ =2. A ray of light travels from *A* to *B*. Its directions in the two media are given by unit vectors $\vec{u}_1 = a\hat{i} + b\hat{j}$ and $\vec{u}_2 = c\hat{i} + d\hat{j}$. Then

(A) $\frac{a}{c} = \frac{4}{3}$ (B) $\frac{a}{c} = \frac{3}{4}$ (C) $\frac{b}{d} = \frac{4}{3}$ (D) $\frac{b}{d} = \frac{3}{4}$

1. **A**

2. Two thin convex lens of focal lengths $f_1$ and $f_2$ are separated by a horizontal distance *d* (where $d < f_1$, $d < f_2$). Taking the origin of coordinates, *O* at the centre of left lens, the *x* coordinate of the focal point of this lens system, for a parallel beam of rays coming from the left is

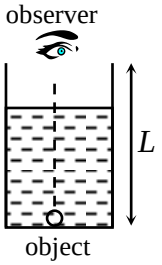



(A) $x = \frac{f_1 f_2}{f_1 + f_2}$ (B) $x = \frac{f_1(f_2 + d)}{f_1 + f_2 - d}$

(C) $x = \frac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}$ (D) $x = \frac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}$

2. **C**

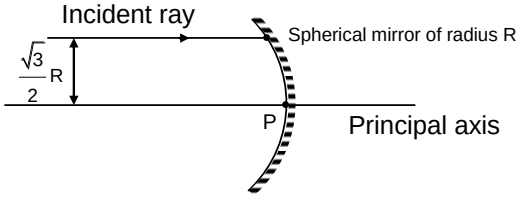
3. A cylinder is filled with a liquid of refractive index $\mu$. The radius of the cylinder is decreasing at a constant rate *K*. The volume of the liquid inside the container remains constant at *V*. The observer and the object *O* are in a state of rest and at a distance *L* from each other. The apparent velocity of the object as seen by the observer, (when radius of cylinder is *r*)




(A) $\frac{(1-\mu)2KV}{(\pi\mu r^3)}$ (B) $\frac{(1-\mu)2KV}{(\pi\mu Lr^2)}$ (C) $\frac{(1-\mu)2K}{\mu}$ (D) $\frac{(1-\mu)K}{2\mu}$

3. **A**

4. As situation shown in figure, the angle of deviation of the ray when the ray is moving away from the mirror




(A) 120°

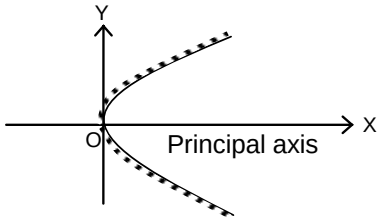
(B) 90°

(C) 180°

(D) none of these

4. **C**

5. A mirror of parabolic shape as shown in figure the equation of mirror surface is $y^2 = 8x$. An inclined ray of inclination 15° is incident on the mirror at a point (2, 4). The co-ordinate of the point of the intersection of x-axis and reflected ray will be




(A) $4\sqrt{3}-6$

(B) $2-\sqrt{3}$

(C) 1

(D) none of these

5. **A**

6. *x*-axis is normal to the reflecting surface of a plane mirror. If object is moving with velocity $(3\hat{i}+4\hat{k})\text{m/sec}$. The relative velocity of image w.r.t. object will be along

(A) –x axis (B) +x axis (C) –z axis (D) +z axis

6. **A**

7. In YDSE, water is filled in the space between the slits and screen. Then,
(A) fringe pattern shifts upward but fringe width remains unchanged.
(B) fringe width decreases and fringe pattern shifts upward.
(C) fringe width remains unchanged and central fringe does not shift.
(D) fringe width decreases and fringe pattern does not shift.

7. **D**

8. In a double-slit experiment, the distance between the slits is d. The screen is at a distance D from the slits. If a bright fringe is formed opposite to a slit on the screen, the order of the fringe is

(A) $\frac{d^2}{2\lambda D}$ (B) $\frac{d}{2\lambda D}$

(C) $\frac{d^2}{4\lambda D}$ (D) 0

8. **A**

9. 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, the wavelength of monochromatic light used would be

(A) $60 \times 10^{-4}$ cm (B) $10 \times 10^{-4}$ cm (C) $10 \times 10^{-5}$ cm (D) $6 \times 10^{-5}$ cm

9. **D**

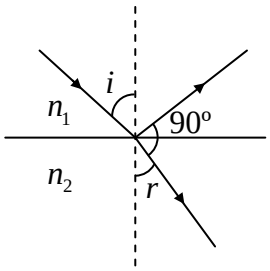
10. In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then in the interference pattern
(A) the intensities of both the maxima and minima increase
(B) the intensity of the maxima increases and the minima has zero intensity
(C) the intensity of the maxima decreases and that of minima increases
(D) the intensity of the maxima decreases and the minima has zero intensity

10. **A**

**(Multiple Correct Choice Type)**

This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

11. Light incident on a surface separating two media is partly reflected and partly refracted as shown in the figure [$\theta_c$ is critical angle and $n_1 < n_2$], then




(A) $\sin i = \dfrac{n_2}{(n_1^2 + n_2^2)^{1/2}}$ (B) $\tan i = \dfrac{n_1}{n_2}$

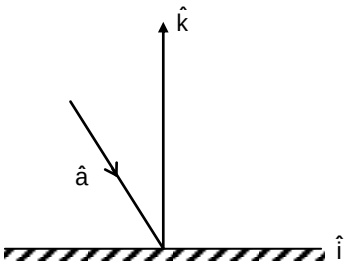
(C) $\sin \theta_c = \cot i$ (D) $\sin \theta_c = \sec i$

11. **AC**

12. The distance between a screen and an object is 120 cm. A convex lens is placed closed to the object and is moved along the line joining object and screen, towards the screen. Two sharp images of the object are found on the screen. The ratio of magnification of two real images is 1 : 9. Then,
(A) focal length of the lens is 22.5 cm
(B) smaller image is brighter than the larger one
(C) larger image is brighter than the smaller one
(D) brightness of both the images is same

12. **AB**

13. If x–y plane is the reflecting surface and ray of light in the direction of $\hat{a}$ as shown in figure. Then the reflected ray will be represented by




(A) $\hat{a} - 2(\hat{a}\cdot\hat{n})\hat{n}$, if normal $\hat{n}$ is along the $(-\hat{k})$

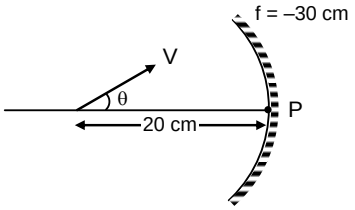
(B) $\hat{a} - 2(\hat{a}\cdot\hat{n})\hat{n}$, if normal $\hat{n}$ is along the $(\hat{k})$

(C) $\hat{a} + 2(\hat{a}\cdot\hat{n})\hat{n}$, if normal $\hat{n}$ is along the $(-\hat{k})$

(D) $\hat{a} + 2(\hat{a}\cdot\hat{n})\hat{n}$, if normal $\hat{n}$ is along the $(\hat{k})$

13. **AB**

14. A ball is projected with initial speed v at a distance 20 cm from pole of a concave mirror as shown in the figure. Speed of image can be
(A) 2V
(B) 3 V
(C) 5 V
(D) 10 V

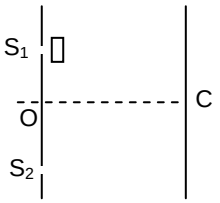



14. **BC**

15. In Young's double-slit experiment, two wavelengths of light are used simultaneously where $\lambda_2 = 2\lambda_1$. In the fringe pattern observed on the screen,
(A) maxima of wavelength $\lambda_2$ can coincide with minima of wavelength $\lambda_1$.
(B) fringe width of $\lambda_2$ will be double that of fringe width of $\lambda_1$.
(C) $n^{th}$ order minima of $\lambda_2$ will coincide with $(2n - 1)^{th}$ order maxima of $\lambda_1$.
(D) none of the above

15. **BC**

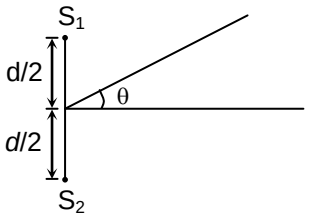
16 A YDSE is performed in a medium of refractive index $\mu_1$. In front of one of the slits say $S_1$ as shown a thin glass slab of refractive index $\mu_2 (< \mu_1)$ is kept. If initially the central maxima was formed on the central line OC then




(A) central maxima will shift upwards
(B) central maxima will shift downwards
(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 $S_2$

16. **BC**

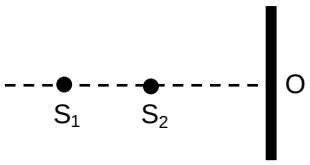
17. In an interference arrangement, similar to Young's double slit experiment, the slits $S_1$ and $S_2$ are illuminated with coherent microwave sources, each of frequency $10^6$ Hz. The sources are synchronized to have zero phase difference. The slits are separated by distance $d$ = 150.0 m. The intensity $I_{(\theta)}$ is measured as a function of $\theta$, where $\theta$ is defined as shown in the figure. If $I_0$ is maximum intensity, then $I_{(\theta)}$ for $0 \le \theta \le 90$ is given by




(A) $I_{(\theta)} = I_0$ for $\theta = 0°$
(B) $I_{(\theta)} = (I_0 / 2)$ for $\theta = 30°$
(C) $I_{(\theta)} = (I_0 / 4)$ for $\theta = 90°$
(D) $I_{(\theta)}$ is constant for all values of $\theta$

17. **AB**

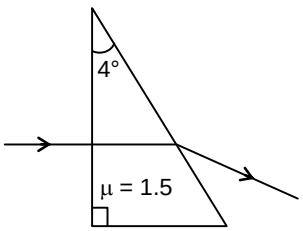
18. Two monochromatic and coherent point sources of light of wavelength $\lambda$ are placed on the dotted line in front of an finite screen. The source emit waves in phase with each other. The distance between $S_1$ and $S_2$ is $d$ while their distance from the screen is much larger. Then




(A) If $d = 7\lambda/2$, $O$ will be a minima
(B) If $d = 4.3\,\lambda$, there will be a total of 8 minima on screen
(C) If $d = 7\,\lambda$, $O$ will be a maxima
(D) If $d = \lambda$, there will be only one maxima on the screen

18. **ACD**

19. As situation shown in figure. Then choose the correct option(s)
(A) The angle of deviation suffered by the length ray is 2° (nearly).
(B) The ray in side the prism is parallel to the base of the prism.
(C) It is the case of minimum deviation.
(D) None of these.




19. **AB**

20. Refractive index of a material in the visible part of electromagnetic spectrum can be expressed as $\mu = B$, B is constant and A > 1.2, white light traveling in air is incident on a prism made of this material which of the following are correct?
(A) Violet colour is deviated more than red.
(B) The prism causes deviation without dispersion.
(C) There is dispersion without deviation.
(D) All colours travel at the same speed inside the prism.

20. **BD**

## PART – C

This section contains 06 **multiple choice questions**. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive)

21. The sun (diameter d) subtends an angle $\theta$ radians at the pole of a concave mirror of focal length f. If the diameter of the image of the sun formed by the mirror is $\theta^n$ f then find the value of 'n'.

21. **1**

22. In a Young's double-slit experiment, the slits are 2 mm apart and are illuminated with a mixture of two wavelengths $\lambda$ = 750 nm and $\lambda'$ = 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?

22. **9**

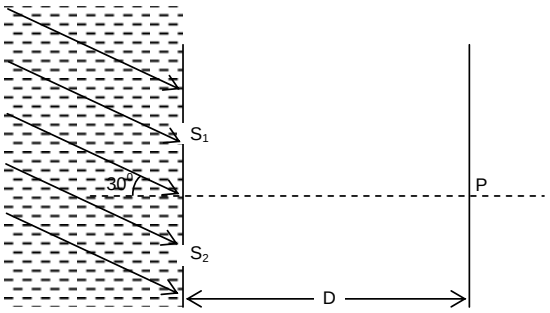
23. A concave mirror of focal length 10 cm and a convex mirror of focal length 15 cm are placed facing each other 40 cm apart. A point object is placed between the mirrors, on their common axis and 15 cm from the concave mirror. Find the distance (in cm) between image and convex mirror. If the image produced by the successive reflections, first at concave mirror and then at convex mirror.

23. **6**

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

24. **9**

25. The given below figure shows a YDSE apparatus. Parallel monochromatic coherent light rays are incident on slits $S_1$ and $S_2$ ( $S_1S_2 = \frac{2}{3}$mm ) at an angle $30^o$ with the horizontal. The medium on left side of the slits is water $\left(\mu_w = 4/3\right)$. To obtain the central maxima at point P, a glass slab $\left(\mu_g = 3/2\right)$ inside water is introduced in front of slit $S_1$. Find thickness of the glass slab (in mm) required for this purpose is




25. **2.67**
Range: 2.65 to 2.69

26. In YDSE distance between the slits plane and screen is 1 m and distance between two slits is 5 mm. If slabs of thickness 2 mm and 1.5 mm having refractive index 1.5 and 1.4 are placed in front of two slits, find the shift (in metre) of central maxima.

26. **0.08**
Range: 0.07 to 0.09

*space for rough work*

# Section – III (Mathematics)

## PART – A

### (Single Correct Choice Type)

This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. A mapping is selected at random from the set of all mapping of the set A = (1, 2, 3,……..n) into itself. The probability that the mapping selected is bijective, is

   (A) $\frac{1}{n!}$ (B) $\frac{1}{n^n}$

   (C) $\frac{n!}{2^n}$ (D) $\frac{n!}{n^n}$

1. D

2. 36 identical balls are randomly distributed in 8 different boxes in such a manner that no box is empty & no two boxes have same number of balls. If $B_i$ denotes number of balls in $i^{th}$ box then the probability that $B_1 < B_3 < B_5 < B_7$ & $B_2 > B_4 > B_6 > B_8$ is

   (A) $\frac{1}{12 \times 4!}$ (B) $\frac{1}{24 \times 4!}$

   (C) $\frac{1}{8!}$ (D) $\frac{2}{8!}$

2. A

3. Consider all functions that can be defined from the set $A = \{1,2,3\}$ to the set $B = \{1,2,3,4,5\}$. A function $f(x)$ is selected at random from these functions. The probability that, selected function satisfies $f(i) \le f(j)$ for $i < j$, is equal to:

   (A) $\frac{6}{25}$ (B) $\frac{7}{25}$ (C) $\frac{2}{5}$ (D) $\frac{12}{25}$

3. **B**

4. The are of region bounded in first quadrant by $y = x^{1/3}$; $y = -x^2 + 2x + 3$; $y = 2x - 1$ and the axis of ordinates is:

   (A) 12/55 (B) 55/12 (C) 32/55 (D) none of these

4. B

5. The area of the region on plane bounded by $\max(|x|, |y|) \le 1$ and $xy \le \frac{1}{2}$ is

   (A) $\frac{1}{2} + \ell n\, 2$ (B) $3 + \ell n\, 2$ (C) $\frac{31}{4}$ (D) $1 + 2\ell n\, 2$

5. B

6. One of the values of 'a' for which the area bounded by the curve $y = 8x^2 - x^5$, straight lines $x = 1$, $x = a$ and x -axis is equal to $\frac{16}{3}$, is

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

6. C

7. The equation of the curve satisfying the differential equation $\frac{d^2y}{dx^2}(x^2+1) = 2xy$, passing through the point (0, 1) and having slope of tangent at x = 0 as 3, is

   (A) $y = x^2 + 3x + 2$ (B) $y^2 = x^2 + 3x + 1$ (C) $y = x^3 + 3x + 1$ (D) none of these

7. C

8. The differential equation for all the straight lines which are at a unit distance from the origin is

(A) $\left(y - x\frac{dy}{dx}\right)^2 = 1 - \left(\frac{dy}{dx}\right)^2$ (B) $\left(y + x\frac{dy}{dx}\right)^2 = 1 + \left(\frac{dy}{dx}\right)^2$

(C) $\left(y - x\frac{dy}{dx}\right)^2 = 1 + \left(\frac{dy}{dx}\right)^2$ (D) $\left(y + x\frac{dy}{dx}\right)^2 = 1 - \left(\frac{dy}{dx}\right)^2$

8. C

9. Integral curve satisfying $y' = \frac{x^2 + y^2}{x^2 - y^2}$, $y(1) = 2$, has the slope at the point (1, 2) of the curve, equal to

(A) $-\frac{5}{3}$ (B) $-1$ (C) 1 (D) $\frac{5}{3}$

9. A

10. The solution of the differential equation $\left(x^2 \sin^3 y - y^2 \cos x\right)dx + \left(x^3 \cos y \sin^2 y - 2y \sin x\right)dy = 0$

(A) $x^3 \sin^3 y = 3y^2 \sin x + C$ (B) $x^3 \sin^3 y + 3y^2 \sin x = C$

(C) $x^2 \sin^3 y + y^3 \sin x = C$ (D) $2x^2 \sin y + y^2 \sin x = C$

10. A

**(Multiple Correct Choice Type)**

This section contains 10 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

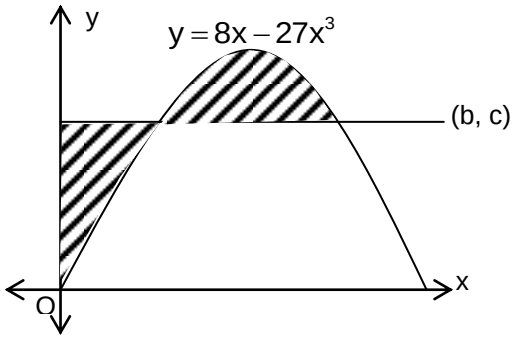
11. If $A_1$ denotes area of the region bounded by the curves $C_1 : y = (x-1)e^x$, tangent to $C_1$ at (1, 0) and y – axis and $A_2$ denotes the area of the region bounded by $C_1$ and co – ordinate axes in fourth quadrant, then

(A) $A_1 > A_2$ (B) $A_1 < A_2$

(C) $2A_1 + A_2 = 2$ (D) $A_1 + 2A_2 = 4$

11. **BC**

12. The figure shows a horizontal line $y = c$ passing through (b, c) intersecting the curve $y = 8x - 27x^3$. If the shaded areas are equal, then




(A) $b = \frac{1}{9}$

(B) $b = \frac{4}{9}$

(C) $c = \frac{32}{27}$

(D) $c = \frac{23}{27}$

12. **BC**

13. Consider a curve passing through (1, 1) such that perpendicular distance of normal drawn at any point P from origin is equal to ordinate of the point P. Then which of the following statement(s) is/are correct?
(A) The curve passes through origin.
(B) The equation of tangent at (2, 0) is x = 2
(C) The differential equation for the curve is $\frac{dy}{dx}=\frac{y^2-x^2}{2xy}$
(D) The differential equation for the curve is $\frac{dy}{dx}=\frac{x^2-y^2}{2xy}$

13. **ABC**

14. In an experimental performance of a single throw of a pair of unbiased normal dice, let three events $E_1, E_2$ and $E_3$ are defined as follows:
$E_1$ : getting prime numbered face on each dice.
$E_2$ : getting the same number on each dice.
$E_3$ : getting total on two dice equal to 4
Which of the following is/are TRUE?
(A) The probabilities $P(E_1), P(E_2), P(E_3)$ are in A.P.
(B) The events $E_1$ and $E_2$ are independent.
(C) $P\left(\frac{E_3}{E_1}\right)=\frac{2}{9}$
(D) $P(E_1+E_2)+P(E_2-E_3)=\frac{17}{36}$

14. **AD**

15. A bag contains four tickets marked with 112, 121, 211, 222 one ticket is drawn at random from the bag. Let $E_i\,(i=1,2,3)$ denote the event that $i^{th}$ digit on the ticket is 2. Then:
(A) $E_1$ and $E_2$ are independent
(B) $E_2$ and $E_3$ are independent
(C) $E_3$ and $E_1$ are independent
(D) $E_1, E_2, E_3$ are independent

15. **ABC**

16. For $P(A)=\frac{3}{8}; P(B)=\frac{1}{2}; P(A\cup B)=\frac{5}{8}$ which of the following do/does hold good?
(A) $P\left(\frac{A^C}{B}\right)=2P\left(\frac{A}{B^C}\right)$
(B) $P(B)=P\left(\frac{A}{B}\right)$
(C) $8P\left(\frac{A^C}{B^C}\right)=15P\left(\frac{B}{A^C}\right)$
(D) $P\left(\frac{A}{B^C}\right)=P(A\cap B)$

16. ABCD

17. The letters of the word PROBABILITY are written down at random in a row. Let $E_1$ denote the event that the two I's are together and $E_2$ denote the event that the two B's are together. Then
(A) $P(E_1)=P(E_2)=\frac{2}{11}$
(B) $P(E_1\cap E_2)=\frac{2}{55}$
(C) $P(E_1\cup E_2)=\frac{19}{55}$
(D) $P(E_1/E_2)=\frac{1}{5}$

17. ABD

18 Let $f(x)=\begin{cases}-1 & ; \ x<0 \\ 0 & ; \ x=0 \\ 1 & ; \ x>1\end{cases}$, g(x) = x (1 – $x^2$) and h" (x) = 6x – 4. If h(x) has local minima value 5 at x = 1, then which of the following are (is) correct?

(A) Tangent to y = h (x) at (2, 7) is 5x – y =3

(B) Area bounded by y = h(x), y = g(f(x)) between x = 0 and x = 2 is $\frac{32}{3}$

(C) Area bounded by ordinates of lock maxima, local minima, y = h(x) and x-axis can be expressed as $\int_{\frac{1}{3}}^{1}\left(\left(\frac{4}{3}-x\right)^3-2\left(\frac{4}{3}-x\right)^2-x+\frac{19}{3}\right)dx$

(D) Area bounded by y = h(x), its tangent at (2, 7) and y – axis is $\frac{20}{3}$

18. ABCD

19. Solution of the differential equation $\frac{dy}{dx}+\frac{1+y^2}{\sqrt{1-x^2}}=0$

(A) $\tan^{-1}y+\sin^{-1}x=c$ (B) $\tan^{-1}x+\sin^{-1}y=c$

(C) $\tan^{-1}y.\sin^{-1}x=c$ (D) $\cot^{-1}\frac{1}{y}+\cos^{-1}\sqrt{1-x^2}=c$

19. AD

20. The solution of $x^2\left(\frac{dy}{dx}\right)^2+xy\left(\frac{dy}{dx}\right)-6y^2=0$ are

(A) $y = Cx^2$ (B) $x^2y = C$

(C) $\frac{1}{2}\ell n\ y=C+\log x$ (D) $x^3y = C$

20. ACD

## PART – C

This section contains 06 **multiple choice questions**. The answer to each question is a single digit integer, ranging from 0 to 9 (both inclusive)

1. If the x – axis divide the area of the region bounded by the parabolas $y=4x-x^2$ and $y=x^2-x$ in the ratio of $a:b$ then $\frac{ab}{121}$ is equal to

1. 4

2. Four people sit round a circular table, and each person will roll a normal six sided die once. The probability that no two people sitting next to each other will roll the same number is $\frac{N}{1296}$. Then the value of $\frac{N-600}{10}$

2. **3**

3. The content of 3 bags w.r.t. green and red marbles is as given in the table shown.

| **Bag** | **Green** | **Red** |
|---|---|---|
| **A** | 3 | 1 |
| **B** | 2 | 2 |
| **C** | 1 | 3 |

A child randomly selects one of the bags, and draws a marble from it and retains it. If the marble is green, the child draws the second marbles randomly from one of the two remaining bags. If the first marble drawn is red the child draws one more marble from the same bag. The probability that the second drawn marble is green is expressed as $\frac{m}{n}$ (where m and n are co-prime). Then the value of $\frac{n-m}{71}$ is

3. 1

4. A curve y = f(x) is such that f(x) $\geq$ 0 and f(0) = 0 and bounds a curvilinear trapezoid with the base [0, x] whose area is proportional to $(n + 1)^{th}$ power of f(x). If f(1) = 1, then $(f(10))^n - 1$ is

4 9

5. The differential equation of all conics whose axes coincide with the axes of coordinates is of order

5. 2

6. The value of $\lim_{x\to\infty} y(x)$ obtained from the differential equation $\frac{dy}{dx} = y - y^2$, where y (0) = 2 is

6. 1

***space for rough work***

# FIITJEE INTERNAL TEST

## RANK IMPROVEMENT TEST – IX

**Batches: 1921**

## IIT- JEE 2021

## QP CODE:

# ANSWERS

### SECTION – I (Chemistry)

**Part – A**

**Part – C**

### SECTION – II (Physics)

**Part – A**

**Part – C**

### SECTION – III (Mathematics)

**Part – A**

**Part – C**