FIITJEE INTERNAL TEST

RANK IMPROVEMENT TEST – VI

Batches:

IIT- JEE 2021

QP CODE:

Time: ***3 hours*** **Maximum Marks: 186**

- ***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-B**.
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 – 05)** contains 5 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** (**06 – 13)** contains 8 Multiple Choice Questions which have **One or More Correct** answer.

   For each question in the group **Q. 6 – 13** 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-B (01 – 05)** contains 5 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 **+3 marks** for correct answer. **There is no negative marking.**

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

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

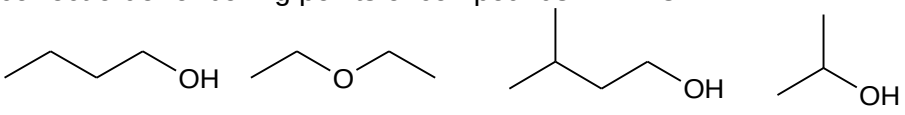
Section – I (Chemistry)

PART – A

(Single Correct Choice Type)

This section contains 5 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. The correct order of boiling points of compounds I – IV is

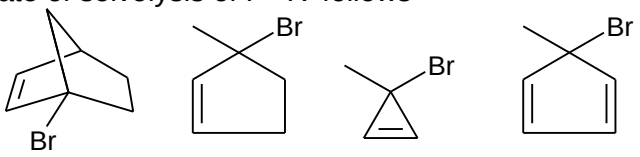


I II III IV

(A) II > I > III > IV (B) II > III > I > IV
(C) I > III > IV > II (D) I > IV > III > II

1. C

2. The rate of solvolysis of I – IV follows

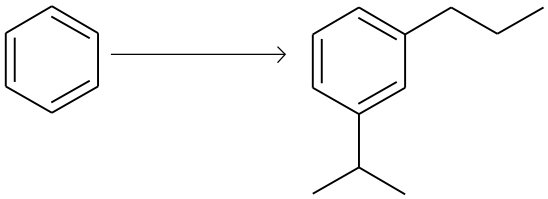


I II III IV

(A) I > II > III > IV (B) III > I > II > IV
(C) III > II > I > IV (D) IV > I > II > III

2. C

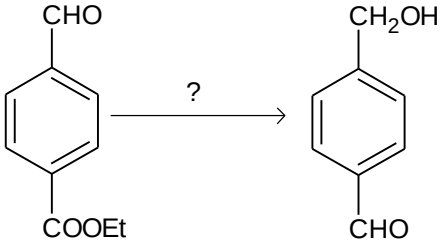
3. The sequence of three steps involved in the following conversion is

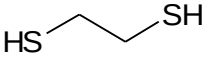


(A) (i) Friedel-craft alkylation (ii) Reduction (iii) Friedel craft acylation
(B) (i) Friedel craft acylation (ii) Friedel-craft alkylation (iii) Reduction
(C) (i) Friedel craft acylation (ii) Reduction (iii) Friedel-craft alkylation
(D) (i) Friedel-craft alkylation (ii) Friedel craft acylation (iii) Reduction

3. B

4. Identify the correct reagent required for the following transformation.

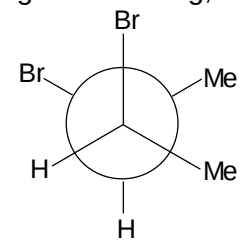


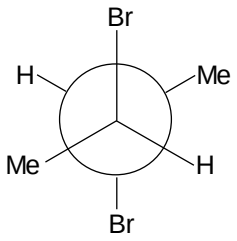
(A) (i) $NaBH_4$ (ii) H_3O^+ (B) (i) $LiAlH_4$ (ii) H_3O^+
(C) $HOCH_2CH_2OH$, H^+ (ii) $LiAlH_4$ (iii) H_3O^+ (D) (i) 

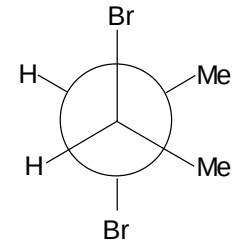
, H^+ (ii) $LiAlH_4$ (iii) H_3O^+

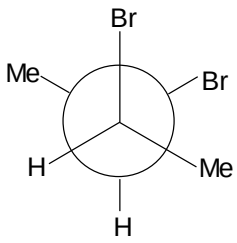
4. C

5. Among the following, the most stable conformation of meso 2, 3-dibromobutane is

(A) 

(B) 

(C) 

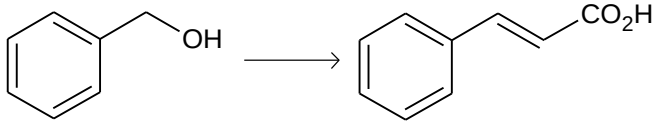
(D) 

5. B

(Multiple Correct Choice Type)

This section contains 8 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

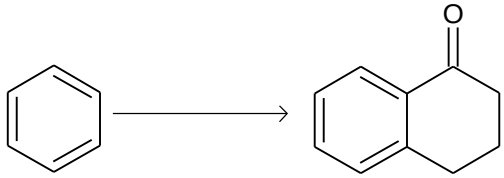
6. The appropriate reagents required for carrying out the following transformation are



(A) (i) PCC, CH_2Cl_2 (ii) Ph_3P = CHCOOEt (iii) aq. NaOH, Heat, then acidify
(B) (i) CrO_3, H_2SO_4, aq. acetone (ii) Ac_2O, NaOAc
(C) (i) MnO_2 (ii) $CH_2(CO_2H)_2$, piperidine, pyridine
(D) (i) PCC, CH_2Cl_2 (ii) $BrCH_2CO_2C(CH_3)_3$, Zn (iii) H_3O^+, heat

6. ACD

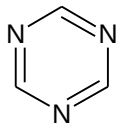
7. The appropriate reagents required for carrying out the following transformation is/are

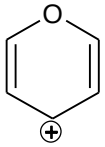


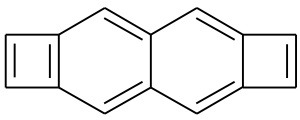
(A) (i) Succine anhydride, $AlCl_3$ (ii) Zn/Hg, HCl (iii) Polyphosphoric acid
(B) (i) Maleic anhydride, $AlCl_3$ (ii) $H_2N - NH_2$, KOH (iii) H_2SO_4
(C) (i) Succine anhydride, $FeCl_3$ (ii) $LiAlH_4$ (iii) H_2SO_4
(D) (i) Pthalic anhydride, $F_3B.OEt_2$ (ii) $HS(CH_2)_2SH$, H^+ (iii) Raney Ni (iv) Polyphosphoric acid

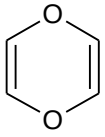
7. A

8. Which of the following species is/are aromatic in nature?

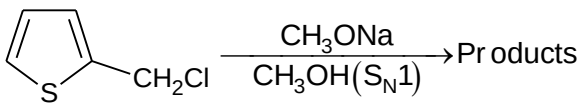
(A) 

(B) 

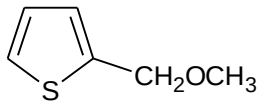
(C) 

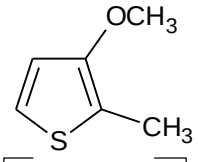
(D) 

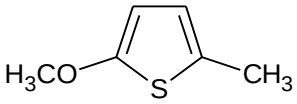
8. ABC

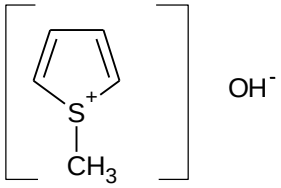
9. 

The product(s) formed in the above reaction is/are

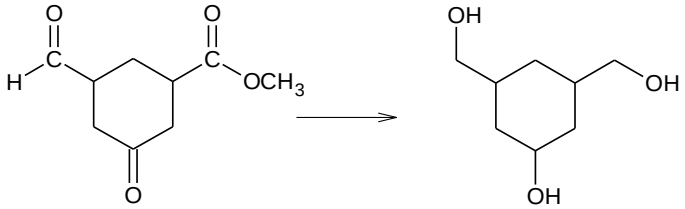
(A) 

(B) 

(C) 

(D) 

9. **ABC**

10. 

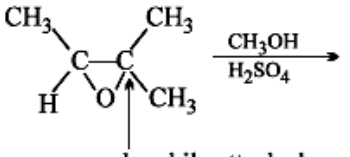
Which of the following reagent(s) can be used for the above change?

(A) $LiAlH_4$ (B) $NaBH_4$

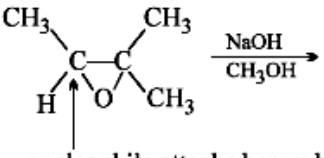
(C) $LiBH_4$ (D) Zn/ether

10. **AC**

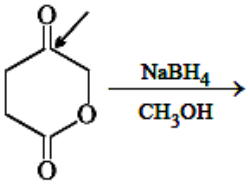
11. Which is/are the correct statement/s?

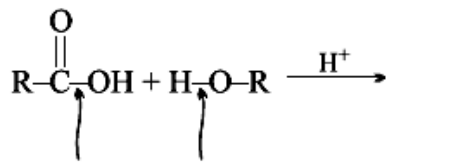
(A) 

nucleophile attacks here when epoxy linkage is cleaved

(B) 

nucleophile attacks here when epoxy linkage is cleaved

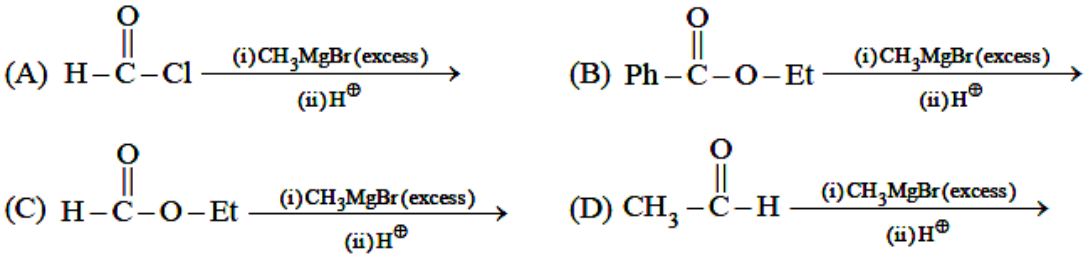
(C) This is only affected in reduction to 2° alcohol 

(D) 

These bonds undergo cleavage in the reaction

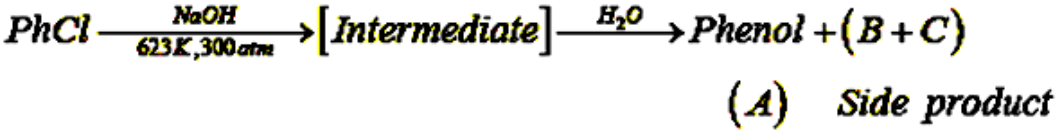
11. ABCD

12. End product of which of the following reaction gives positive iodoform test?



12. ABCD

13. In Dow's process for the manufacture of phenol, PhCl is fused with NaOH at elevated temperature under pressure.



Which of the following statements are correct:
(A) Phenol is formed via the formation of benzyne intermediate
(B) p-Phenyl phenol is also formed as a by-product
(C) Diphenylether is also formed as a by-product
(D) Biphyenylene is also formed as a by-product

13. ABC

PART – B

This section contains 5 Numerical Based questions.

1. The amount of bromine(at wt = 80) required (in gram) for the estimation of 42.3 g of phenol(mol wt = 94) is x gm. The value of x/27 is

1. 8

2. The total number of pair of enantiomers possible with molecular formula $C_5H_{12}O$ is

2. 4

3. The number of possible monoalkylated products formed in the Friedel-crafts reaction of anisole with 2-chloro-3-methylbutane in the presence of anhydrous $AlCl_3$ at 50^oC is

3. 4

4. The number of all possible isomers for the molecular formula C_6H_{14} is

4. 5

5. Specific rotation of the (R)-enantiomer of a chiral compound is 48. The specific rotation of a sample of this compound which contains 25% of (S)-enantiomers is a. The value of a/4 is

5. 6

space for rough work

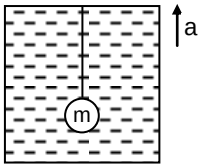
Section – II (Physics)

PART – A

(Single Correct Choice Type)

This section contains 5 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. A simple pendulum has time period T_o say, when it is placed in a liquid the time period decreases. Then we need to move the point of suspension with a vertical acceleration a to regain the time period of simple pendulum. The ratio of densities of liquid and the bob is



(A) $1 + \frac{a}{g}$ (B) $\frac{a}{g+a}$

(C) $\frac{g}{a}$ (D) none of these

1. **B**

2. A sinusoidal wave is propagating in negative x direction in a string stretched along x axis. A particle of string of x = 2m is found at its mean position and its it moving in positive y direction at t = 1sec. The amplitude of the wave, the wave length and angular frequency of the wave are 0.1 meter, $\frac{\pi}{4}$ meter and 4π rad/s respectively. The instantaneous power transfer through x = 2m and t = 1.125 second is

(A) 0 (B) 1 (C) 2 (D) none of these

2. **A**

3. One end of a string of length L is tied to ceiling of lift accelerating upwards with an acceleration 3g. The other end of the string is free. The linear mass density of string varies linearly from original zero to λ from bottom to top. Then correct statement for wave travelling in string

(A) Wave speed is increasing as it travels from bottom to top.

(B) Acceleration of wave on string is uniform.

(C) Time taken by pulse to reach from bottom to top will be $\sqrt{2L/g}$

(D) All of the above

3. **D**

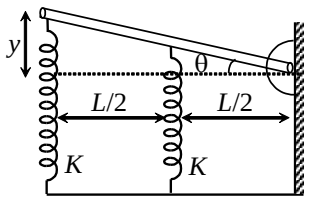
4. A string of length l is elongated by $\frac{l}{30}$, the time taken by the transverse wave to cover the string is t_1. If the string is elongated by a distance $\frac{l}{20}$, the time taken by the transverse wave to cover the sting is t_2. Then, $\frac{t_1}{t_2}$ =

(Assume that the string obey's Hook's law and neglect change in area of crossection of string)

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

4. **D**

5. A long uniform rod of length L, mass M is free to rotate in a horizontal plane about a vertical axis through its end. Two springs of constant K each are connected as shown. On equilibrium, the rod was horizontal. The frequency of oscillation will be



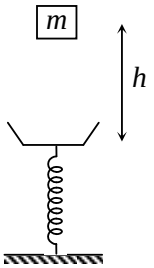
(A) $\frac{1}{2\pi}\sqrt{\frac{15K}{M}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{15}{4M}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{3K}{4M}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{15K}{4M}}$

5. **D**

(Multiple Correct Choice Type)

This section contains 8 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

6. A body of mass m fell from a height h at t = 0 onto the pan of a spring balance. The masses of the pan and the spring are negligible. The spring constant of the spring is $k = \frac{3mg}{2h}$. Having stuck to the pan, the body starts performing harmonic oscillations in vertical direction. Then choose the correct option(s).



(A) The time period of oscillation $2\pi\sqrt{\frac{2h}{3g}}$.

(B) The time period of oscillation $2\pi\sqrt{\frac{3h}{2g}}$.

(C) Time after which block reaches its extreme position for first time is (when block is performing SHM) $2\pi\sqrt{\frac{2h}{g}}+\frac{2\pi}{3}\sqrt{\frac{2h}{3g}}$

(D) Time after which block reaches its extreme position for first time is (when block is performing SHM) $\sqrt{\frac{2h}{g}}+\frac{2\pi}{3}\sqrt{\frac{2h}{3g}}$.

6. **AD**

7. An air column in a pipe, which is closed at one end, is in resonance with a vibrating tunning fork of frequency 264 Hz. If ν = 330 m/s, the length of the column in cm can be

(A) 31.25 (B) 62.50 (C) 93.75 (D) 125

7. **AC**

8. One end of a string of length L is tied to ceiling of lift accelerating upwards with an acceleration 3g. The other end of the string is free. The linear mass density of string varies linearly from original zero to λ from bottom to top. Then correct statement for wave travelling in string

(A) Wave speed is increasing as it travels from bottom to top.

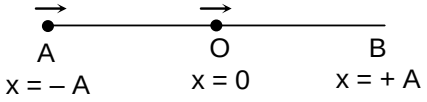
(B) Acceleration of wave on string is uniform.

(C) Time taken by pulse to reach from bottom to top will be $\sqrt{2L/g}$

(D) Time taken by pulse to reach from bottom to top will be $\sqrt{3L/g}$

8. **ABC**

9. Two particles undergo SHM along the same line with the same time period (T) and equal amplitudes (A). At a particular instant one particle is at x = –A and the other is at x = 0. They move in the same direction. They will cross each other at time t and at position x then



(A) $t = \frac{4T}{3}$ (B) $t = \frac{3T}{8}$ (C) $x = \frac{A}{2}$ (D) $x = \frac{A}{\sqrt{2}}$

9. **BD**

10. A coin is placed on a horizontal platform, which undergoes vertical simple harmonic motion of angular frequency ω. The amplitude of oscillation is gradually increased. The coin will leave contact with the platform for the first time
(A) at the highest position of the platform
(B) at the mean position of the platform
(C) for an amplitude of g/ω^2
(D) for an amplitude of $\sqrt{g/\omega}$

10. **AC**

11. Two identical straight wires are stretched so as to produce 6 beats per sec when vibrating simultaneously. On changing the tension slightly in one of them, the beat frequency remains unchanged. Denoting by T_1, T_2, the higher and the lower initial tensions in the strings, then it could be said that while making the above changes in tension:
(A) T_2 was decreased (B) T_1 was increased
(C) T_2 was increased (D) T_1 was decreased

11. **CD**

12. Two simple harmonic motions are represented by the equations:
$Y_1 = 10 \sin [3\pi t + \pi/4]$
$Y_2 = 5 [\sin 3\pi t + \sqrt{3} \cos 3\pi t]$

(A) The amplitude ratio of the two SHM is 1 : 1

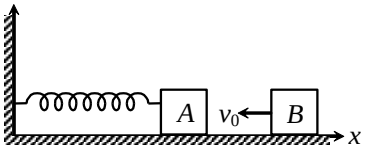
(B) The amplitude ratio of the two SHM is 2 : 1

(C) Time periods of both the SHMs are equal

(D) Time periods of two SHMs are different

12. **AC**

13. A block *A* of mass *m* connected with a spring of force constant *k* is executing SHM. The position (*x*) and time (*t*) equation of the block is $x = x_0 + a\sin\omega t$. An identical block *B* moving towards negative *x*-axis with velocity v_0 collides elastically with block *A* at time *t* = 0. Then



(A) displacement time equation of *A* after collision will be $x = x_0 - v_0\sqrt{\frac{m}{k}}\sin\omega t$.

(B) displacement time equation of *A* after collision will be $x = x_0 + v_0\sqrt{\frac{m}{k}}\sin\omega t$.

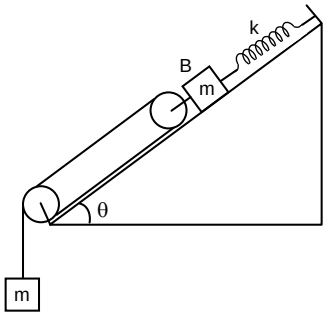
(C) velocity of *B* just after collision will be *a* ω towards positive *x*-direction.
(D) velocity of *B* just after collision will be v_0 towards positive *x*-direction.

13. **AC**

PART – B

This section contains 5 Numerical Based questions.

1. Find the natural angular frequency of the system shown in figure. Pullies are massless and friction is absent everywhere. Take m = 1 kg and k = 80 N/m.

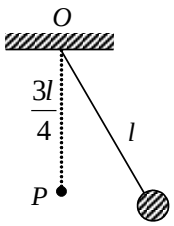


1. **4**

2. A steel rod with a cross-sectional area of 150 mm^2 is stretched between two fixed points. The tensile load at 20°C is 5000 N. If stress at –20° is $K\times10^6 N/m^2$ find the value of K. (assume α = 11.7μm/m°C and Y = 200 GN/m^2)

2. **127**

3. A pendulum has time period T for small oscillations. An obstacle P is situated below the point of suspension O at a distance $\frac{3l}{4}$. The pendulum is released from rest. Throughout the motion the moving string makes small angle with vertical. If the time after which the pendulum returns back to its initial position is N × T. Then find the value of 'N'.



3. **0.75**

4. A thin wire of area of crossection $A = 10^{-2}m^2$ is used to make a ring of radius $r = 10^{-1}m$. This ring is placed on a smooth horizontal floor & is given angular velocity $\omega = 2\ rad/s$ about its centre. Find out stress in the ring (mass per unit length of wire λ = 1 kg/m)

4. **4**

5. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at the both ends vibrating in its third overtone are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is N then N = ?

5. **0.38**

space for rough work

Section – III (Mathematics)

PART – A

(Single Correct Choice Type)

This section contains 5 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which only **ONE** option is be correct.

1. Let z be a non – real complex number with $z^{23} = 1$. Then $\sum_{k=0}^{22} \frac{3}{1+z^k+z^{2k}}$ equals

(A) 42 (B) 44
(C) 46 (D) 48

1. C

2. Suppose that a, b and c are positive real numbers such that $a^{\log_3 7} = 27$, $b^{\log_7 11} = 49$, and $c^{\log_{11} 25} = \sqrt{11}$. Then $a^{(\log_3 7)^2} + b^{(\log_7 11)^2} + c^{(\log_{11} 25)^2}$ =

(A) 694 (B) 946
(C) 649 (D) 469

2. D

3. Let $P(x) = 1 - x + x^2 - x^3 + ... + x^{18} - x^{19}$ and $Q(x) = P(x-1)$. What is the coefficient of x^2 in polynomial Q?

(A) 840 (B) 1140
(C) 969 (D) 1020

3. B

4. For certain real values of a, b, c and d, the equation $x^4 + ax^3 + bx^2 + cx + d = 0$ has four non – real roots. The product of two of these roots is 13 + i and the sum of the other two roots is $3 + 4i$, where $i = \sqrt{-1}$. Then the value of b equals

(A) 69 (B) 54
(C)51 (D) 46

4. B

5. The expression
$^nC_0 - {}^nC_1 + {}^nC_2 - {}^nC_3 + ... + (-1)^{m-1} . {}^nC_{m-1} =$ (where $2 \le m \le n$) equals

(A) $(-1)^{m-1} . {}^{n-1}C_{m-1}$ (B) $(-1)^m . {}^nC_m$
(C) 1 (D) $(-1)^{m-1} . {}^{n-1}C_m$

5. C

(Multiple Correct Choice Type)

This section contains 8 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

6. The value of r for which $\frac{^{2009}C_r}{(r+36)!}$ is maximum is

(A) 29 (B) 31
(C) 30 (D) 32

6. **AC**

7. If $z=\frac{\sqrt{5+12i}+\sqrt{5-12i}}{\sqrt{5+12i}-\sqrt{5-12i}}$ then

(A) $\arg(z)=-\frac{\pi}{2}$ (B) $|z|=\frac{2}{3}$
(C) $\arg(z)=\frac{\pi}{2}$ (D) $|z|=\frac{3}{2}$

7. **ABCD**

8. If $\frac{\sum_{r=0}^{9}(-1)^r.3^{9-r}.{}^{20}C_r.{}^{20-r}C_{9-r}}{2^9}={}^{20}C_a$ then $(a-7)$ can be

(A) 1 (B) 2
(C) 3 (D) 4

8. **BD**

9. The expression $2^{\left(\sqrt{\log_a \sqrt[4]{ab}+\log_b \sqrt[4]{ab}}-\sqrt{\log_a \sqrt[4]{\frac{b}{a}}+\log_b \sqrt[4]{\frac{a}{b}}}\right)\sqrt{\log_a b}}$ is equal to :

(A) $2^{\log_a b}$ if $1<a<b$ (B) 2 if $1<a<b$
(C) $2^{\log_a b}$ if $1<b<a$ (D) 2 if $1<b<a$

9. **BC**

10. Let $A(z_1), B(z_2), C(z_3)$ be points in complex plane such that
$z_1|z_2-z_3|-z_2|z_3-z_1|-z_3|z_1-z_2|=0$,
then which of the following may be correct?
(A) A, B, C are collinear such that A lies between B and C
(B) A, B, C are collinear such that B lies between A and C
(C) A, B, C are collinear such that C lies between A and B
(D) O(0) is the center of circle which touches the sides of triangle ABC

10. **AD**

11. Let $n \in \mathbb{N}$, $n \geq 4$ and $P = \prod_{r=0}^{n} {}^{n}C_{r}$, then

(A) $P > \left(\frac{2^n}{n+1}\right)^{n+1}$ (B) $P < \left(\frac{2^n}{n+1}\right)^{n+1}$

(C) $P < \left(\frac{2^n - 2}{n-1}\right)^{n-1}$ (D) $P < \left(\frac{2^n - 2}{n-1}\right)^{n}$

11. **BCD**

12. The value x satisfying the equation $\left(\log_2 2x\right)\left(\log_2{}^2 x + \log_2\left(\frac{2}{x}\right)\right) = 2$, is

(A) a prime number (B) a composite number
(C) an even number (D) an odd number

12. **AC**

13. Let S be the set of all complex numbers z satisfying $\left|z^2 + z + 1\right| = 1$. Then which of the following is/are TRUE?

(A) $\left|z + \frac{1}{2}\right| \leq \frac{1}{2}$ for all $z \in S$ (B) $|z| \leq 2$ for all $z \in S$

(C) $\left|z + \frac{1}{2}\right| \geq \frac{1}{2}$ for all $z \in S$ (D) The set S has exactly 4 elements

13. **BC**

PART – B

This section contains 5 Numerical Based questions.

1. Consider the polynomials $P(x) = x^6 - x^5 - x^3 - x^2 - x$ and $Q(x) = x^4 - x^3 - x^2 - 1$. Given that z_1, z_2, z_3 and z_4 are the roots of $Q(x) = 0$, then $P(z_1) + P(z_2) + P(z_3) + P(z_4)$ equals ____

1. **6**

2. The polynomial $P(x) = \left(1 + x + x^2 + x^3 + ... + x^{17}\right)^2 - x^{17}$ has 34-complex roots of the form $z_k = r_k\left(\cos(2\pi a_k) + i\sin(2\pi a_k)\right)$, where $k = 1,2,3,...,34$ with $0 < a_1 \leq a_2 \leq a_3 \leq ... \leq a_{34} < 1$ and $r_k > 0$. Given that $a_1 + a_2 + a_3 + a_4 + a_5 = \frac{m}{n}$ where m and n are relatively prime positive integers then $m + n - 580$ equals ___

2. **2**

3. If the expression
$${}^{n}C_1 - \left(1 + \frac{1}{2}\right){}^{n}C_2 + \left(1 + \frac{1}{2} + \frac{1}{3}\right){}^{n}C_3 - \left(1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}\right){}^{n}C_4 + ... + (-1)^{n-1}\left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n}\right){}^{n}C_n$$
equals k then kn equals ___

3. **1**

4. If the coefficient of 2nd, 3rd and 4th terms in the expansion of $(1+x)^{2n}$ are in AP, then $9n-2n^2$ equals ___

4. **7**

5. The expression $\dfrac{\left(\log_{\frac{a}{b}} p\right)^2+\left(\log_{\frac{b}{c}} p\right)^2+\left(\log_{\frac{c}{a}} p\right)^2}{\left(\log_{\frac{a}{b}} p+\log_{\frac{b}{c}} p+\log_{\frac{c}{a}} p\right)^2}$, wherever defined, simplifies to the number ____

5. **1**

space for rough work