English

Reliable INSTITUTE *Unleashing Potential*

CLASSROOM CONTACT PROGRAMME

Target :JEE(MAIN + ADVANCED) 2022

Test Pattern

JEE (Main)

MFST-1

23-01-2022

COURSE : R-VIJETA (01R-JP)

Do not open this Test Booklet until you are asked to do so. **Read carefully the Instructions on this Test Booklet.**	**Paper : Physics, Chemistry & Mathematics**

Important Instructions :

1. Immediately fill in the form number on this page of the Test Booklet with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.
2. The candidates should not write their Form Number anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
3. The test is of **3 hours** duration.
4. The Test Booklet consists of **90** questions. The maximum marks are **300**.
5. There are **three** parts in the question paper 1,2,3 consisting of **Physics**, **Chemistry** and **Mathematics** having **30 questions** in each subject and each subject having **Two sections.**
   - **(i)** Section-I contains 20 multiple choice questions with **only one correct** option.
     Marking scheme : +4 for correct answer, 0 if not attempted and –1 in all other cases.
   - **(ii)** Section-II contains 10 **Numerical Value Type** questions. You have to answers any **five** question out of these ten question
     Marking scheme : +4 for correct answer and 0 in all other cases.
6. Use **Blue/Black Ball Point Pen only** for writting particulars/marking responses on **Side–1** and **Side–2** of the Answer Sheet. **Use of pencil is strictly prohibited**.
7. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electronic device etc, except the Identity Card inside the examination hall/room.
8. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
9. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Room/Hall. **However, the candidate are allowed to take away this Test Booklet with them.**
10. **Do not fold or make any stray marks on the Answer Sheet.**

Name of the Candidate (in Capitals) _____

Form Number : in figures _____

: in words _____

Centre of Examination (in Capitals) : _____

Candidate's Signature :_____ Invigilator's Signature :_____

SPACE FOR ROUGH WORK / रफ कार्य के लिये जगह

PART 1 – PHYSICS

SECTION–I : (Maximum Marks : 80)

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks **:** +4 If only the bubble corresponding to the correct option is darkened.

Zero Marks **:** 0 If none of the bubbles darkened.

Negative Marks **:** –1 In all other cases

1. A uniform rod of length 1m is to be suspended from a point at a distance x from the centre of mass such that when given small oscillation, its time period is equal to a seconds pendulum of length 1m. The value of x is :-

(1) $\frac{1}{2}-\frac{1}{\sqrt{6}}$ (2) $\frac{1}{2\sqrt{3}}$

(3) $\frac{1}{2}-\frac{1}{\sqrt{3}}$ (4) $\frac{1}{2}$

2. A magnetic needle resting in stable equilibrium in a uniform magnetic field requires W work to rotate it through 60°. The work required to rotate it further by 60° (in the same sense) will be :-

(1) – W (2) W

(3) –2W (4) 2W

3. A monatomic ideal gas has its density inversely proportional to its temperature in a process. The molar specific heat of the gas in this process is :-

(1) $\frac{3R}{2}$ (2) $\frac{5R}{2}$

(3) $\frac{7R}{2}$ (4) $\frac{R}{2}$

4. Two conducting uncharged plates are placed close to each other. One of them is given charge Q. The energy stored in the region between the plates becomes E_0. Other plate is now given charge –Q, keeping the charge on 1st plate same. The energy stored in the region between plates becomes

(1) E_0

(2) $2E_0$

(3) $4E_0$

(4) 0

5. Which 'type' of electromagnetic waves are responsible for the Green house effect ?

(1) Cosmic rays

(2) Radio waves

(3) Infrared rays

(4) Visible light

Space for Rough Work

6. A block of mass m can move on x-axis where coefficient of friction μ depends on position x as $\mu = \mu_0 \frac{|x|}{L}$ where L is a constant. The block initially placed at x = – L is pulled horizontally with a force of magnitude $F = mg\frac{|x|}{L}$ towards positive side. The velocity of the block when it crosses the x = L, is(given $\mu_0 < 1$)

(1) $\sqrt{2gL\mu_0}$

(2) $\sqrt{gL(1-\mu_0)}$

(3) $\sqrt{2gL(1-\mu_0)}$

(4) 0

7. A uniform disc of mass m kept in a vertical plane on a rough horizontal floor is hit such that its center acquires a speed of v_0 . The angular speed of the disc is zero after it is hit. The total impulse of friction on the disc till it starts rolling purely is of magnitude

(1) mv_0

(2) $\frac{2}{3}mv_0$

(3) $\frac{mv_0}{3}$

(4) 0

8. An elastic conducting ring is placed perpendicular to uniform magnetic field of strength B. It is stretched and has radius R. It is released to contract and contracts to $\frac{R}{2}$ in interval Δt. The charge that must have flown through any cross-section at any point of the ring is :- (the ring has a constant resistance of $2\pi R\lambda$, assume charge is flowing at constant rate)

(1) $\frac{3BR}{4\lambda}$ (2) $\frac{3BR}{8\lambda}$

(3) $\frac{3B}{4\lambda}$ (4) $\frac{3B}{2\lambda}$

9. The dependence of g on geographical latitude at sea level is given by $g = g_0(1 + \beta\sin^2\phi)$ where ϕ is the latitude angle and β is a dimensionless constant. If Δg is the error in the measurement of g then the error in measurement of latitude angle is :-

(1) 0

(2) $\Delta\phi = \frac{\Delta g}{g_0\beta\sin(2\phi)}$

(3) $\Delta\phi = \frac{\Delta g}{g_0\beta\cos(2\phi)}$

(4) $\Delta\phi = \frac{\Delta g}{g_0}$

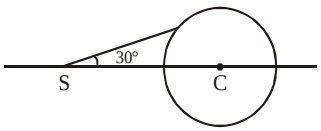
Space for Rough Work

10. A total charge Q is distributed over two concentric hollow spheres of radii a and b, (b > a), such a way that their surface charge densities are equal. The potential at the common centre is given by

(1) $\frac{Q}{4\pi\varepsilon_0}\cdot\frac{(a+b)}{(a^2+b^2)}$ (2) $\frac{Q}{4\pi\varepsilon_0}\cdot\frac{(b-a)}{(a^2+b^2)}$

(3) $\frac{Q}{4\pi\varepsilon_0}\cdot\frac{(a+b)}{(a+b)^2}$ (4) $\frac{Q}{4\pi\varepsilon_0}\cdot\frac{(b-a)}{(a+b)^2}$

11. In front of a glass sphere of radius 3m a point source of light is kept at a distance $3\sqrt{3}$ m from its center. A ray of light making angle 30° with the line joining the source and the center of sphere is incident on the sphere. At what height above the line the ray emerges from the sphere? [Refractive index of glass = $\sqrt{3}$]



(1) $\frac{3}{2}$ (2) $\frac{3\sqrt{3}}{2}$

(3) $\frac{\sqrt{3}}{2}$ (4) 0

12. White light consisting of wavelengths 380 nm $\le\lambda\le$ 750 nm is incident on a lead surface. For which one of the following ranges of wavelengths will photoelectrons be emitted from the lead surface that has a work function $W_0 = 6.63\times10^{-19}$ J?

(1) 380 nm $\le\lambda\le$ 750 nm

(2) 380 nm $\le\lambda\le$ 630 nm

(3) 380 nm $\le\lambda\le$ 540 nm

(4) No photoelectrons will be emitted.

13. A metal string is fixed between rigid supports. It is initially at negligible tension. Its Young modulus is Y, density is ρ and coefficient of thermal expansion is α. If it is now cooled through a temperature 't', transverse waves will move along it with speed.

(1) $Y\sqrt{\frac{\alpha t}{\rho}}$

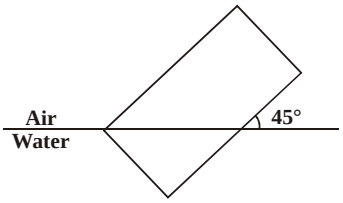
(2) $\alpha t\sqrt{\frac{Y}{\rho}}$

(3) $\sqrt{\frac{Y\alpha t}{\rho}}$

(4) $t\sqrt{\frac{Y\alpha}{\rho}}$

Space for Rough Work

14. An object of weight W has a uniform rectangular crosssection of a × 2a and density of 0.25 g/cm^3. Part of it is immersed in water and the rectangle is tilted by 45º, while one of its corners is just at the water surface. Find the torque of the buoyant force about the center of mass of the object.



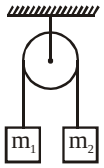
(1) $2\sqrt{2}aW$

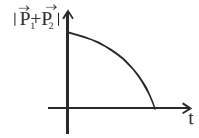
(2) $\frac{aW}{\sqrt{2}}$

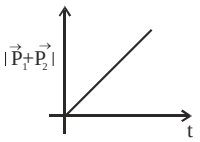
(3) $\frac{aW}{2}$

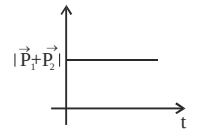
(4) $\frac{aW}{2\sqrt{2}}$

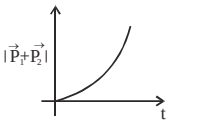
15. In an atwood machine, m_1 is greater then m_2 while pulley and string are ideal. The system is released from rest. The magnitude of sum of momentum of m_1 and m_2 is plotted against time, choose the correct plot.



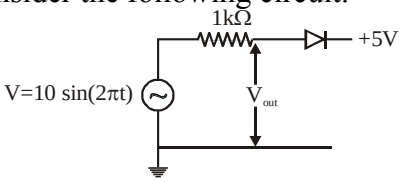
(1) 

(2) 

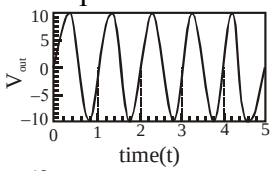
(3) 

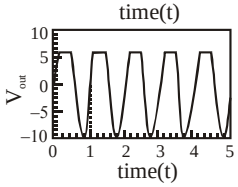
(4) 

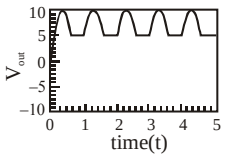
16. Consider the following circuit.

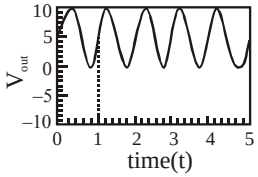


Which of the graphs given below is a correct representation of V_{out}?

(1) 

(2) 

(3) 

(4) 

Space for Rough Work

17. A galvanometer G deflects full scale when a potential difference of 0.50 V is applied. The internal resistance of the galvanometer r_g is 25 ohms. An ammeter is constructed by incorporating the galvanometer and an additional resistance R_s. The ammeter deflects full scale when a measurement of 2.0 A is made. The resistance R_S is closest to :

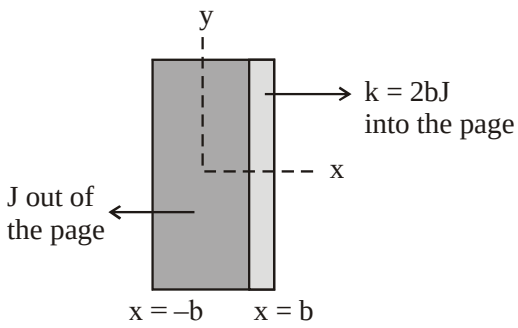
(1) 0.25 Ω

(2) 2.5 Ω

(3) 0.45 Ω

(4) 0.1 Ω

18. A current of density $\vec{J} = J\hat{z}$ exists in a slab between the infinite planes at x = –b and x = b. Additionally, a surface current of current/length k = 2bJ points in $-\hat{z}$ direction on the plane x = b. The magnetic field as a function of x inside the slab is –



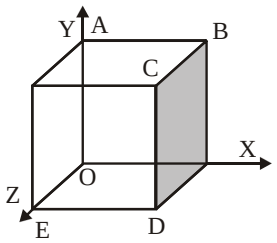
(1) $2\mu Jb$

(2) $\mu_0 J\left(\frac{x}{2}+b\right)$

(3) $\mu_0 J(b+x)$

(4) $2\mu_0 J(b+x)$

19. A particle moves under the influence of the force $F = y\hat{i} + z\hat{j} + x\hat{k}$ N along the edge of a unit cube (edge length = 1m) on the path OA–AB–BC–CD–DE–EO. Then the



(1) total work done is zero

(2) total work done is 1 joule

(3) total work done is 3 joule

(4) force F is conservative.

20. An electric bulb is designed to consume 55 W when operated at 110 V. It is connected to a 220 V, 50 Hz line through a choke coil in series. What should be the inductance of the coil for which the bulb gets correct voltage ?

(1) 1.2 H

(2) 0.6 H

(3) 2.4 H

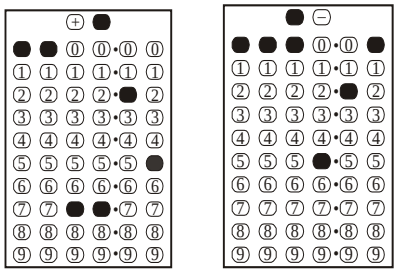
(4) 0.2 H

Space for Rough Work

SECTION-II : (Maximum Marks: 20)

- This section contains **TEN** questions.
- You have to answers any **FIVE** questions out of these **TEN** questions
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows.

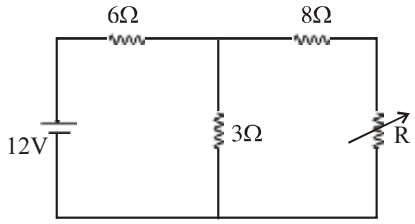


- Answer to each attempted question will be evaluated according to the following marking scheme:

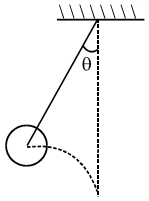
  Full Marks : +4 If ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 In all other cases.

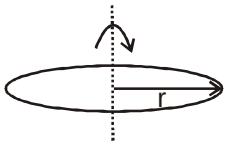
1. Find the maximum power (in W) delivered to resistance R.



2. A ball is held in the position shown with string of length 1 m just taut & then projected horizontally with a velocity of 3 m/s. If the string becomes taut again when it is vertical. Find angle θ (in degrees)



3. A ring of radius r made of wire of density ρ is rotated about a stationary vertical axis passing though its centre and perpendicular to the plane of the ring as shown in figure. Determine the angular velocity (in rad/s) of ring at which the ring breaks. The wire breaks at tensile stress σ. Ignore gravity. (Take $\frac{\sigma}{\rho} = 4$ and r = 1m)



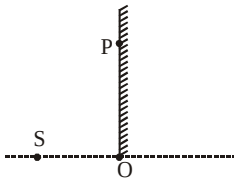
Space for Rough Work

4. When the current in a certain inductor coil is 5.0 A and is increasing at the rate of 10.0 A/s, the magnitude of potential difference across the coil is 140 V. When the current is 5.0 A and decreasing at the rate of 10.0 A/s, the potential difference is 60 V. The self inductance of the coil is xH, find the value of x.

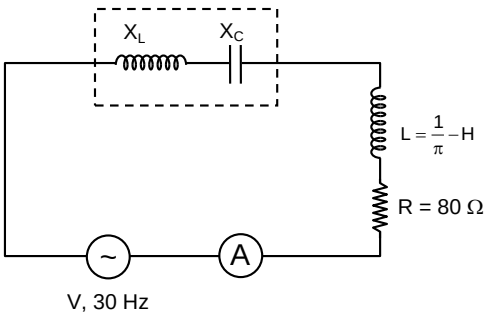
5. Two wires of length ℓ and 2ℓ and of same cross-section area and different materials are in resonance. Tension in the smaller wire is 10N and that in longer wire is 80N. The longer wire oscillates with one loop and the shorter with 4 loops. Find the ratio of density of materials in shorter to the longer wire.

6. In a vessel of water equivalent 20g, 10g ice and 40g water are in equilibrium. A liquid of specific heat one third of water is mixed with the contents in the vessel. The initial temperature of the liquid is 50°C. The amount of liquid (in g) required to make the final temperature 20°C.

7. A monochromatic linear source of light S has λ = 400 nm. It is placed 2mm away from a plane mirror. A point P is 1m away from O on the mirror. On a perpendicular line passing through point P, there is a point Q of maximum intensity. Find the distance of that point from P (in mm).

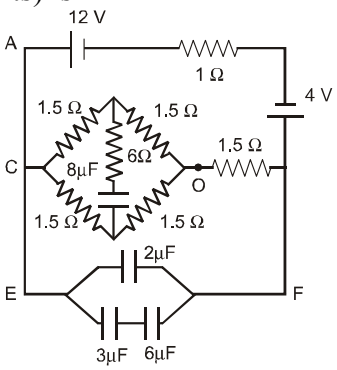


8. In figure below if $X_L = X_C$ and reading of AC ammeter is 1 A. Source voltage is V Volt. Find $\frac{V}{20}$ in Volt.

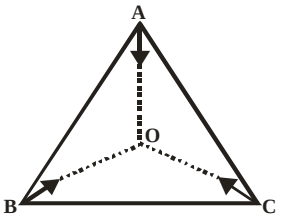


Space for Rough Work

9. In the given circuit, the potential difference across the 6μF capacitor in steady state (in volts) is



10. Three particles of equal masses are initially at the vertices of equilateral triangle of side $2\sqrt{3}$ m in horizontal plane. They start moving towards centroid O with equal speed 2 m/sec. After collision at O, A stops and C retraces its path with same speed. Distance between B and C just after one second of the collision is α m. Here α is an integer. Find α.



Space for Rough Work

PART-2: CHEMISTRY

SECTION-I: (Maximum Marks: 80)

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks:	+4	If only the bubble corresponding to the correct option is darkened.
Zero Marks:	0	If none of the bubbles is darkened.
Negative Marks:	–1	In all other cases

1. The oxidation states of 'P' in $H_4P_2O_7$, $H_4P_2O_5$ and $H_4P_2O_6$, respectively, are :

(1) 7, 5 and 6 (2) 5, 4 and 3

(3) 5, 3 and 4 (4) 6, 4 and 5

2. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A: $SO_2(g)$ is adsorbed to a large extent than $H_2(g)$ on activated charcoal.

Reason R: $SO_2(g)$ has a higher critical temperature than $H_2(g)$.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Both **A** and **R** are correct but **R** is not the correct explanation of **A**.

(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

(3) **A** is not correct but **R** is correct.

(4) **A** is correct but **R** is not correct.

Space for Rough Work

3. The **CORRECT** order of first ionisation enthalpy is :

(1) Mg < S < Al < P

(2) Mg < Al < S < P

(3) Al < Mg < S < P

(4) Mg < Al < P < S

4. If the Thompson model of the atom was correct, then the result of Rutherford's gold foil experiment would have been :

(1) All of the α-particles pass through the gold foil without decrease in speed.

(2) α-Particles are deflected over a wide range of angles.

(3) All α-particles get bounced back by 180^o

(4) α-Particles pass through the gold foil deflected by small angles and with reduced speed.

5. Number of Cl = O bonds in chlorous acid, chloric acid and perchloric acid respectively are :

(1) 3, 1 and 1 (2) 4, 1 and 0

(3) 1, 1 and 3 (4) 1, 2 and 3

6. The addition of silica during the extraction of copper from its sulphide ore :

(1) converts copper sulphide into copper silicate

(2) converts iron oxide into iron silicate

(3) reduces copper sulphide into metallic copper

(4) reduces the melting point of the reaction mixture

7. Which one of the following 0.10 M aqueous solutions will exhibit the largest freezing point depression ?

(1) hydrazine (2) glucose

(3) glycine (4) $KHSO_4$

8. Match **List-I** with **List-II**

List-I (Parameter)	**List-II (Unit)**
(a) Cell constant	(i) S cm^2 mol^{-1}
(b) Molar conductivity	(ii) Dimensionless
(c) Conductivity	(iii) m^{-1}
(d) Degree of dissociation of electrolyte	(iv) Ω^{-1} m^{-1}

Choose the **most appropriate** answer from the options given below :

(1) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

(2) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

(3) (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)

(4) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

Space for Rough Work

9. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): Lithium salts are hydrated.

Reason (R): Lithium has higher polarising power than other alkali metal group members.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **(A)** and **(R)** are correct but **(R)** is NOT the correct explanation of **(A)**.

(2) **(A)** is correct but **(R)** is not correct.

(3) **(A)** is not correct but **(R)** is correct.

(4) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**.

10. In the given chemical reaction, colors of the Fe^{2+} and Fe^{3+} ions, are respectively :

$$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$$

(1) Yellow, Orange

(2) Yellow, Green

(3) Green, Orange

(4) Green, Yellow

11. Given below are two statements:

Statement-I: Aniline is less basic than acetamide.

Statement-II: In aniline, the lone pair of electrons on nitrogen atom is delocalised over benzene ring due to resonance and hence less available to a proton.

Choose the **most appropriate** option ;

(1) Statement-I is true but statement-II is false.

(2) Statement-I is false but statement-II is true.

(3) Both statement-I and statement-II are true.

(4) Both statement-I and statement-II are false.

12. Which one of the following statements is **NOT** correct ?

(1) Eutrophication indicates that water body is polluted.

(2) The dissolved oxygen concentration below 6 ppm inhibits fish growth.

(3) Eutrophication leads to increase in the oxygen level in water.

(4) Eutrophication leads to anaerobic conditions.

Space for Rough Work

13. Presence of which reagent will affect the reversibility of the following reaction, and change it to a irreversible reaction:

$$CH_4 + I_2 \underset{\text{Reversible}}{\overset{h\nu}{\rightleftharpoons}} CH_3 - I + HI$$

(1) HOCl (2) dilute HNO_2

(3) liquid NH_3 (4) concentrated HIO_3

14. Which one among the following chemical tests is used to distinguish monosaccharide from disaccharide?

(1) Seliwanoff's test (2) Iodine test

(3) Barfoed test (4) Tollen's test

15. Match **List-I** with **List-II** :

List-I (Drug)	**List-II (Class of Drug)**
(a) Furacin	(i) Antibiotic
(b) Arsphenamine	(ii) Tranquilizers
(c) Dimetone	(iii) Antiseptic
(d) Valium	(iv) Synthetic antihistamines

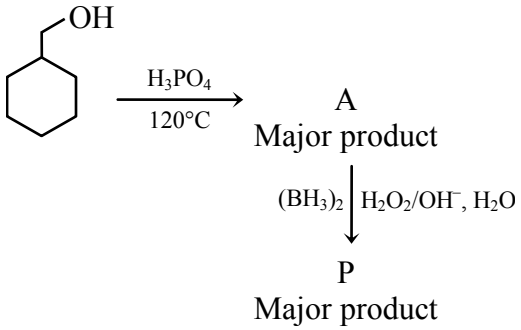
Choose the **most appropriate** match :

(1) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

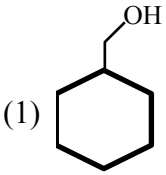
(2) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

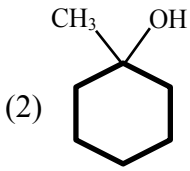
(3) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

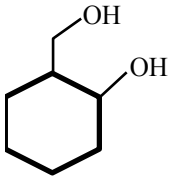
(4) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

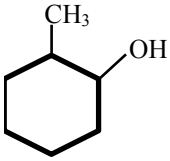
16. 

Consider the above reaction and identify the Product P :

(1) 

(2) 

(3) 

(4) 

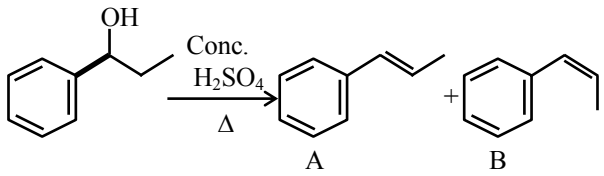
17. $R-CN \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H} R-Y$

Consider the above reaction and identify "Y"

(1) $-CH_2NH_2$ (2) $-CONH_2$

(3) –CHO (4) –COOH

Space for Rough Work

18. 

consider the above reaction, and choose the correct statement:

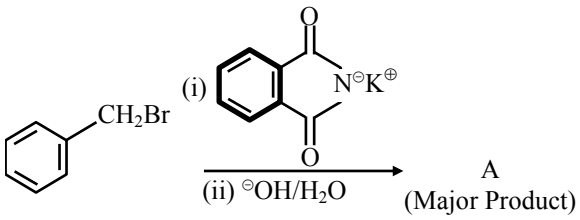
(1) The reaction is not possible in acidic medium.

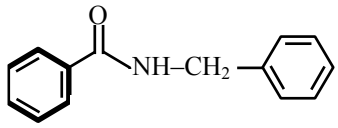
(2) Both compounds **A** and **B** are formed equally.

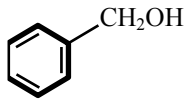
(3) Compound **A** will be the major product.

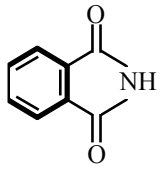
(4) Compound **B** will be the major product.

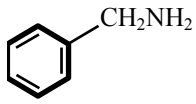
19. What is A in the following reaction?



(1) 

(2) 

(3) 

(4) 

20. In the following sequence of reactions a compound **A**, (molecular formula $C_6H_{12}O_2$) with a straight chain structure gives a C_4 carboxylic acid. **A** is :

$$\mathbf{A} \xrightarrow[H_3O^+]{LiAlH_4} \mathbf{B} \xrightarrow{\text{Oxidation}} C_4 - \text{carboxylic acid}$$

(1) $CH_3–CH_2–COO–CH_2–CH_2–CH_3$

(2) $CH_3–CH_2–\underset{\displaystyle OH}{\underset{|}{CH}}–CH_2–O–CH=CH_2$

(3) $CH_3–CH_2–CH_2–COO–CH_2–CH_3$

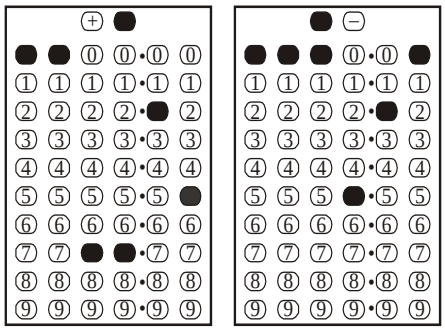
(4) $CH_3–CH_2–CH_2–O–CH=CH–CH_2–OH$

Space for Rough Work

SECTION-II: (Maximum Marks: 20)

- This section contains **TEN** questions.
- You have to answers any **FIVE** questions out of these **TEN** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

For Example : If answer is –77.25, 5.2 then fill the bubbles as follows.



- Answer to each attempted question will be evaluated according to the following marking scheme:

Full Marks:	+4	If ONLY the correct numerical value is entered as answer.
Negative Marks:	0	In all other cases

1. The number of geometrical isomers possible in triamminetrinitrocobalt (III) is X and in trioxalatochromate (III) is Y. Then the value of X + Y is _____.

Space for Rough Work

2. The equilibrium constant for the reaction

$$A(s) \rightleftharpoons M(s) + \frac{1}{2}O_2(g)$$

is $K_p = 4\ atm^{1/2}$. At equilibrium, the partial pressure of O_2 is _____ atm.

(Round off to the nearest integer)

3. When 400 mL of 0.2M H_2SO_4 solution is mixed with 600 mL of 0.1 M NaOH solution, the increase in temperature of the final solution is _____ $\times 10^{-2}$ K.

(Round off to the nearest integer).

[Use: $H^+(aq) + OH^-(aq) \rightarrow H_2O$;

$\Delta_\gamma H = -57.1\ kJ\ mol^{-1}$]

Specific heat of $H_2O = 4.18\ J\ K^{-1}\ g^{-1}$

Density of $H_2O = 1.0\ g\ cm^{-3}$

Assume no change in volume of solution on mixing.

4. 3 moles of metal complex with formula $Co(en)_2Cl_3$ gives 3 moles of silver chloride on treatment with excess of silver nitrate. The secondary valency of Co in the complex is _____.

(Round off to the nearest integer)

5. Consider the sulphides HgS, PbS, CuS, Sb_2S_3, As_2S_3 and CdS. Number of these sulphides soluble in 50% HNO_3 is _____.

6. The empirical formula for a compound with a cubic close packed arrangement of anions and with cations occupying all the octahedral sites is A_xB. The value of x is _____.

(Integer answer)

Space for Rough Work

7. For the reaction A $\rightarrow$ B, the rate constant k (in s^{-1}) is given by

$$\log_{10} k = 20.35 - \frac{(2.47\times10^3)}{T}$$

The energy of activation in kJ mol^{-1} is _____. (Nearest integer)

[Given: R = 8.314 J K^{-1} mol^{-1}]

8. According to molecular orbital theory, the number of unpaired electron(s) in O_2^{2-} is :

9. The number of atoms in 8 g of sodium is x × 10^{23}. The value of x is_____. (Nearest integer)

[Given : N_A = 6.02 × 10^{23} mol^{-1}

Atomic mass of Na = 23.0 u]

10. The total number of reagents from those given below, that can convert nitrobenzene into aniline is _____. (Integer answer)

I. Sn–HCl

II. Sn–NH_4OH

III. Fe–HCl

IV. Zn–HCl

V. H_2–Pd

VI. H_2–Raney Nickel

Space for Rough Work

PART 3 – MATHEMATICS

SECTION–I : (Maximum Marks : 80)

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

  Full Marks **:** +4 If only the bubble corresponding to the correct option is darkened.

  Zero Marks **:** 0 If none of the bubbles darkened.

  Negative Marks **:** –1 In all other cases

1. If the value of $(1 + \tan1°)(1 + \tan2°)(1 + \tan3°) \ldots\ldots (1 + \tan44°)(1 + \tan45°)$ is 2^{λ}, then the sum of the digits of the number λ is-

(1) 3

(2) 6

(3) 5

(4) 4

2. If $2f(xy) = (f(x))^y + (f(y))^x$ for all $x, y \in R$ and $f(1) = 3$, then the value of $\sum_{r=1}^{10} f(r)$ is equal to-

(1) $\frac{3}{2}(3^{10} - 1)$

(2) $\frac{3}{2}(3^9 - 1)$

(3) $\frac{3^{10} - 1}{2}$

(4) $\frac{1}{2}\left(3^9 - 1\right)$

Space for Rough Work

3. In $(0, 2\pi)$, the total number of points where $f(x) = \max. \{\sin x, \cos x, 1 - \cos x\}$ is not differentiable, are equal to-

(1) 3

(2) 4

(3) 5

(4) 6

4. A flag-staff of 5 meters high stands on a building of 25 meters height. For an observer at a height of 30 meters, the flag-staff and the building subtend equal angles. The distance of the observer from the top of the flag-staff is-

(1) $\frac{5\sqrt{3}}{2}$ m

(2) $5\sqrt{\frac{3}{2}}$ m

(3) $5\sqrt{\frac{2}{3}}$ m

(4) None of these

5. If in the expansion of $(1 + x)^m (1 - x)^n$, the coefficients of x and x^2 are 3 and –6 respectively, then the value of m is $(m, n \in N)$

(1) 6

(2) 9

(3) 12

(4) 24

6. The area between the curve $y = 2x^4 - x^2$, the x-axis and the ordinates of the two minima of the curve is-

(1) $\frac{11}{60}$ sq. units

(2) $\frac{7}{120}$ sq. units

(3) $\frac{1}{30}$ sq. units

(4) $\frac{7}{90}$ sq. units

Space for Rough Work

7. The contrapositive of the statement "If two triangles are identical, then they are similar" is-

(1) If two triangles are not similar, then they are not identical

(2) If two triangles are not identical, then they are not similar

(3) If two triangles are not identical, then they are similar

(4) If two triangles are not similar, then they are identical

8. If $f(x) = a - (x - 3)^{8/9}$, then the maximum value of f(x) is-

(1) 3

(2) a – 3

(3) a

(4) None of these

9. If the three distinct lines $x + 2ay + a = 0$, $x + 3by + b = 0$ and $x + 4ay + a = 0$ are concurrent, then the point (a, b) lies on a

(1) circle

(2) straight line

(3) parabola

(4) hyperbola

10. If $f(x) = \sin\left(\lim\limits_{t\to 0}\frac{2x}{\pi}\cot^{-1}\frac{x}{t^2}\right)$, then

$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} f(x)\,dx$ is equal to (where, $x \neq 0$)

(1) –2

(2) –1

(3) 0

(4) 2

Space for Rough Work

11. If x is rational and

$4\left(x^2+\frac{1}{x^2}\right)+16\left(x+\frac{1}{x}\right)-57=0$, then the product of all possible values of x is-

(1) 4

(2) 3

(3) 2

(4) 1

12. A relation R is defined from {2, 3, 4, 5} to {3, 6, 7, 10} by x Ry $\Rightarrow$ x is relatively prime to y, then domain of R is-

(1) {2, 3, 5}

(2) {3, 5}

(3) {2, 3, 4}

(4) {2, 3, 4, 5}

13. The mean and variance of 20 observations are found to be 10 and 4, respectively. On rechecking, it was found that an observation 9 was incorrect and the correct observation was 11, then the correct variance is-

(1) 3.99 (2) 4.01

(3) 4.02 (4) 3.98

14. A computer producing factory has only two plants T_1 and T_2. Plant T_1 produces 20% and plant T_2 produces 80% of the total computers produced. 7% of computers produced in the factory turn out to be defective. It is known that,

P (computer turns out to be defective given that it is produced in plant T_1)

= 10 P(computer turns out to be defective given that it is produced in plant T_2)

Where, P(E) denotes the probability of an event E. A computer produced in the factory is randomly selected and it does not turn out to be defective. Then the probability that it is produced in plant T_2 is-

(1) $\frac{38}{73}$ (2) $\frac{47}{79}$

(3) $\frac{78}{93}$ (4) $\frac{75}{83}$

Space for Rough Work

15. If $\vec{a},\vec{b},\vec{c}$ are mutually perpendicular vectors having magnitude 1, 2, 3 respectively, then $\left[\vec{a}+\vec{b}+\vec{c} \quad \vec{b}-\vec{a} \quad \vec{c}\right]$ =

(1) 0

(2) 6

(3) 12

(4) 18

16. The solution of the differential equation $\frac{dy}{dx} + x(2x + y) = x^3(2x + y)^3 - 2$ is

(C being an arbitrary constant)

(1) $\frac{1}{2x+xy} = x^2 + 1 + Ce^x$

(2) $\frac{1}{(2x+xy)^2} = x^2 + 1 + Ce^{x^2}$

(3) $\frac{1}{2x+y} = x + 1 + Ce^{-x^2}$

(4) $\frac{1}{(2x+y)^2} = x^2 + 1 + C$

17. If $\begin{vmatrix} x-4 & 2x & 2x \\ 2x & x-4 & 2x \\ 2x & 2x & x-4 \end{vmatrix} = (A + Bx)(x - A)^2$,

then the ordered pair (A, B) is equal to-

(1) (4, 5)

(2) (–4, –5)

(3) (–4, 3)

(4) (–4, 5)

18. The point of intersection of the lines

$\vec{r} = 7\hat{i}+10\hat{j}+13\hat{k} + s(2\hat{i}+3\hat{j}+4\hat{k})$

$\vec{r} = 3\hat{i}+5\hat{j}+7\hat{k} + t(\hat{i}+2\hat{j}+3\hat{k})$ is-

(1) $\hat{i}+\hat{j}-\hat{k}$

(2) $2\hat{i}-\hat{j}+4\hat{k}$

(3) $\hat{i}-\hat{j}+\hat{k}$

(4) $\hat{i}+\hat{j}+\hat{k}$

Space for Rough Work

19. Let ΔABC is an isosceles triangle with AB = AC. If B = (0, a), C = (2a, 0) and the equation of AB is $3x - 4y + 4a = 0$, then the equation of side AC is-

(1) $y = 8x - 16a$

(2) $3y = 4x - 8a$

(3) $x = 2a$

(4) $y + 8x = 16a$

20. Let A(0, 3) and B(0, 12) be two vertices of a ΔABC where C = (x, 0). If the circumcircle of ΔABC touches the x-axis, then the value of $\cos 2\theta$ is (where, θ is angle ACB)

(1) $\frac{1}{3}$

(2) $\frac{1}{2}$

(3) $\frac{8}{15}$

(4) $\frac{7}{25}$

SECTION-II : (Maximum Marks: 20)

- This section contains **TEN** questions.
- You have to answers any **FIVE** questions out of these **TEN** questions
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

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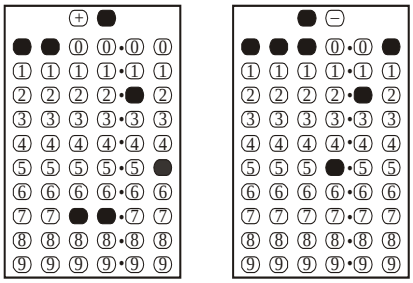

- Answer to each attempted question will be evaluated according to the following marking scheme:

  Full Marks : +4 If ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 In all other cases.

Space for Rough Work

1. The number of elements in the set $\{(a, b) : a^2 + b^2 = 50; a, b \in Z\}$, where Z is the set of all integers, is-

2. If the line $y - 2 = 0$ is the directrix of the parabola $x^2 - ky + 32 = 0$, $k \neq 0$ and the parabola intersects the circle $x^2 + y^2 = 8$ at two real distinct points, then the absolute value of k is-

3. If z_1, z_2 and z_3 are three complex numbers such that $|z_1|=|z_2|=|z_3|=\left|\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}\right|=1$ then $|z_1 + z_2 + z_3|$ is-

4. If $\int \frac{dx}{\sqrt{x}+\sqrt[3]{x}} = a\sqrt{x} + b(\sqrt[3]{x}) + c(\sqrt[6]{x}) + d$ In $(\sqrt[6]{x}+1)+e$, e being an arbitrary constant, then the value of $20a+b+c+d$ is-

5. If $y = \tan^{-1}(\sec x - \tan x)$, $0 < x < \frac{\pi}{2}$, then the value of $\frac{dy}{dx}$ is-

6. The volume of a cube is increasing at the rate of $18cm^3$ per second. When the edge of the cube is 12 cm, then the rate in cm^2/s at which the surface area of the cube increases is-

Space for Rough Work

7. If $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & -2 & 4 \end{bmatrix}$, $I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and $A^{-1} = \frac{1}{6}(A^2 + cA + dI)$ then the sum of values of c and d is-

8. If A, B, C are in arithmetic progression and $B = \frac{\pi}{4}$, then tanA tanB tanC =

9. If $f(x) = \begin{cases} px+q & : & x \le 2 \\ x^2 - 5x + 6 & : & 2 < x < 3 \\ ax^2 + bx + 1 & : & x \ge 3 \end{cases}$

is differentiable everywhere, then $|p| + |q| + \left|\frac{1}{a}\right| + \left|\frac{1}{b}\right|$ is equal to-

10. If common tangents of $x^2 + y^2 = r^2$ and $\frac{x^2}{16} + \frac{y^2}{9} = 1$ forms a square, then the length of diagonal of the square is-

Space for Rough Work

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