FIITJEE INTERNAL TEST

RANK BOOSTER TEST SERIES – X

Batches: AII1719 (R & W)

IIT- JEE 2019

QP CODE: 120120

Time: ***3 hours*** **Maximum Marks: 264**

- ***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 one part, **Part-A**.
3. **Part – A** contains 26 questions which are further divided as follows:

- **Q. 1 – 10** are multiple choice questions. Each question has four choices (A), (B), (C) and (D), out of which **only one is correct**.
- **Q. 11 – 20** are multiple correct answer type questions. Each question has four choices (A), (B), (C) and (D), out of which **one or more answer(s) is/are correct**.
- **Q. 21 – 26)** contains 2 Paragraphs. Based upon each paragraph, 3 Multiple Choice Questions. Each question has four choices (A), (B), (C) and (D), out of which **only one is correct**.

Marking Scheme

1. For each question in the group **Q. 1 – 10** to **Part – A** you will be awarded **3 marks** if you have darkened only the bubble corresponding to the answer and zero marks if no bubble is darkened. In all other cases, **minus one (–1) mark will be awarded.**
2. For each question in the group **Q. 11 – 20** to **Part – A**, 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: **–2** In all other cases.

   For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.
3. For each question in the group **Q. 21 – 26** of **Part – A** you will be awarded **3 marks** if you have darkened all the bubble(s) corresponding to the correct answer and **zero marks** if no bubble is darkened. In all other cases, **minus one (–1) mark** will be awarded.

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. Which of the following ratio of the characteristics of an orbit and electron is equal to principal quantum number of the orbit?

(A) $\frac{\text{Area of orbit}}{\text{Frequency of electron motion}}$ (B) $\frac{\text{Circumference of orbit}}{\text{Wavelength of electron motion}}$

(C) $\frac{\text{Radius of orbit}}{\text{Wave number of electron motion}}$ (D) $\frac{\text{Area of orbit}}{\text{Circumference of orbit}}$

2. $(NH_4)_2Cr_2O_7 \longrightarrow Cr_2O_3 + 4H_2O + N_2$

What is the equivalent weight of $(NH_4)_2Cr_2O_7$ (Molar mass = M g) in the above reaction?

(A) $\frac{M}{4}$ (B) $\frac{M}{3}$ (C) $\frac{M}{6}$ (D) $\frac{M}{8}$

3. The radius of each atom of helium is r. What would be the excluded volume for an atom of helium which touches other helium atoms in a vessel at high pressure and low temperature.

(A) $\frac{4}{3}\pi r^3$ (B) $\frac{8}{3}\pi r^3$ (C) $\frac{16}{3}\pi r^3$ (D) $\frac{32}{3}\pi r^3$

4. The orbital represented by which of the following wave function has maximum number of radial node?

(A) $\Psi_{4, 2, 0}$ (B) $\Psi_{3, 0, 0}$ (C) $\Psi_{3, 1, 1}$ (D) $\Psi_{4, 3, 1}$

5. A red colored mixed oxide (X) on treatment with conc. HNO_3 gives a compound (Y). (Y) with HCl produces a chloride (Z) which is insoluble in cold water but soluble in hot water. (Z) can also be formed by treating (X) with conc. HCl. Compounds (X), (Y) and (Z) are

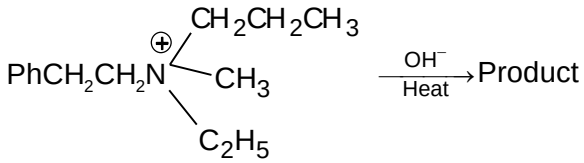
(A) Pb_3O_4, PbO_2, $PbCl_2$ (B) Mn_3O_4, MnO_2, $MnCl_2$

(C) Fe_3O_4, Fe_2O_3, $FeCl_3$ (D) Fe_3O_4, FeO, $FeCl_2$

6. In aqueous solution $BeSO_4$ exists as

(A) $[Be(H_2O)_2]^{2+}$ and SO_4^{2-} (B) $[Be(H_2O)_4]^{2+}$ and SO_4^{2-}

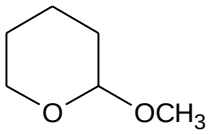
(C) $[Be(H_2O)_6]^{2+}$ and SO_4^{2-} (D) $[Be(H_2O)_3]^{2+}$ and SO_4^{2-}

7. 

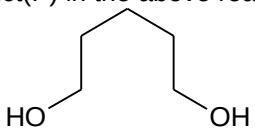
The major product of the reaction is:

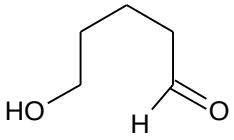
(A) $CH_2 = CH_2$ (B) $CH_3CH = CH_2$ (C) $PhCH = CH_2$ (D) $(CH_3)_2NC_2H_5$

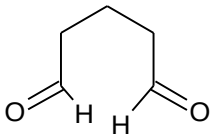
space for rough work

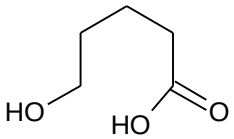
8.  $\xrightarrow[H_2O]{H^+}(P)+CH_3OH$

Product(P) in the above reaction is:

(A) 

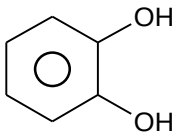
(B) 

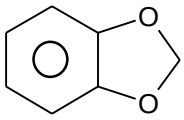
(C) 

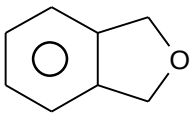
(D) 

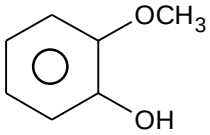
9. The compound that will react most readily with NaOH to form methanol is:-

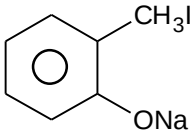
(A) $(CH_3)_4\overset{+}{N}I^-$ (B) $CH_3 - O - CH_3$ (C) $(CH_3)_3\overset{+}{S}I^-$ (D) $(CH_3)_3C - Cl$

10.  $+CH_2I_2+NaOH\longrightarrow A$ 'A' is

(A) 

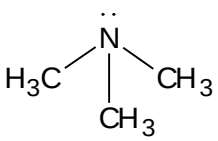
(B) 

(C) 

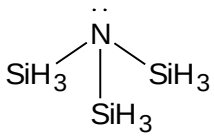
(D) 

(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. 

[X]



[Y]

Which of the following property/properties of the above compounds is/are correct?

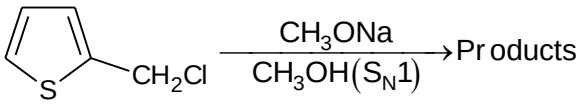
(A) Basic strength: X > Y (B) Bond angle: $\angle CNC > \angle SiNSi$

(C) Boiling point: X < Y (D) Dipole moment: X > Y

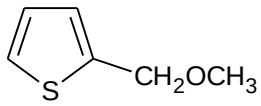
12. When a solution of benzoic acid was titrated with NaOH the pH of the solution when half the acid neutralized was 4.2. Dissociation constant of the acid is

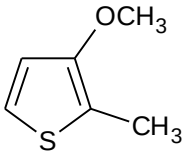
(A) 6.31×10^{-5} (B) 3.2×10^{-5} (C) 8.7×10^{-8} (D) 6.42×10^{-4}

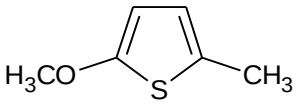
space for rough work

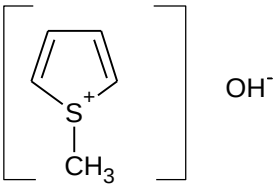
13. 

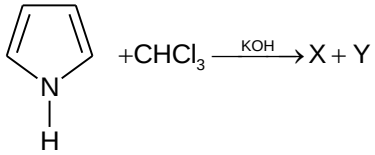
The product(s) formed in the above reaction is/are

(A) 

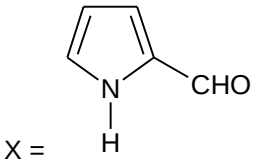
(B) 

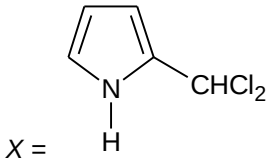
(C) 

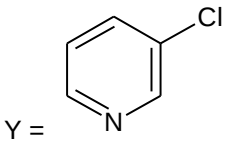
(D) 

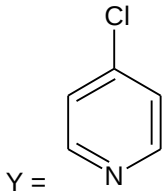
14. 

X & Y are

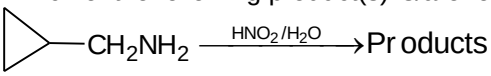
(A) 

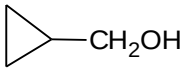
(B) 

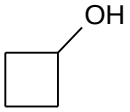
(C) 

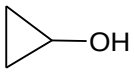
(D) 

15. Which of the following product(s) is/are formed in the following reaction?



(A) 

(B) 

(C) 

(D) 

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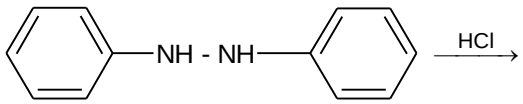
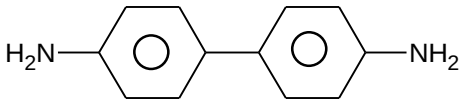
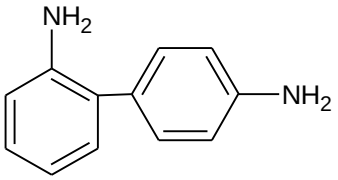
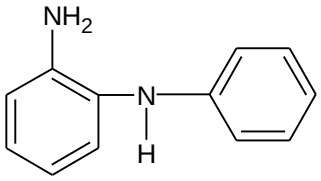
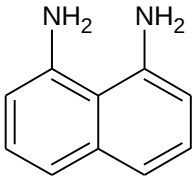
16. Find out the products which are formed by the following reaction:



(A) 

(B) 

(C) 

(D) 

17. $H_3PO_4 + 2NaOH \longrightarrow Na_2HPO_4 + 2H_2O$

Which of the following statement(s) is/are correct for the above reaction?

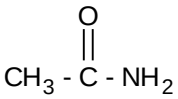
(A) The equivalent mass of H_3PO_4 is 49.

(B) The acidity of NaOH is 2.

(C) H_3PO_4 will be the limiting reactant if equal mass of H_3PO_4 and NaOH are taken for the reaction.

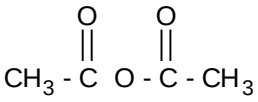
(D) The maximum n-factor of H_3PO_4 can be three.

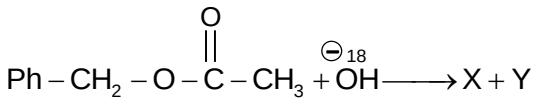
18. $[X] \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4} CH_3CH_2OH$ Compound [X] in the above reaction can be

(A) 

(B) CH_3COOH

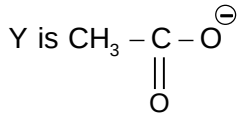
(C) CH_3CHO

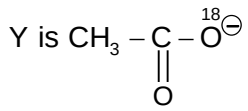
(D) 

19. 

(A) X is $Ph - CH_2 - \overset{18}{O}H$

(B) X is $Ph - CH_2 - OH$

(C) Y is 

(D) Y is 

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20. Which of the following compound shows geometrical as well as optical isomerism?

(A) $CH_2 = CH - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

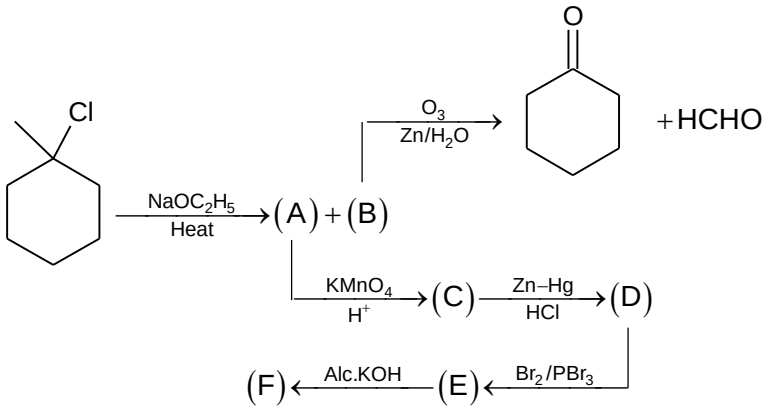
(B) $CH_3 - CH = CH - CH = CH - CH_3$

(C) $CH_3 - CH = CH - CH_2 - \underset{\displaystyle Cl}{\underset{|}{CH}} - CH_3$

(D) $CH_2 = CH - \underset{\displaystyle Cl}{\underset{|}{CH}} - CH = CH_2$

Comprehension Type

Paragraph for question nos. 21 – 23



Answer the following questions on the basis of above write up.

21. Which of the following statement is correct for the compound(E)?

(A) It is a vicinal bromide
(B) It is an α-bromo acid
(C) It is a β-bromo acid
(D) It reacts with HCl to form acid chloride

22. Which of the following is 'F'?

(A) $CH_3CH_2CH_2CH_2\underset{\displaystyle OH}{\underset{|}{CH}}COOH$

(B) $CH_3CH = CHCH_2CH_2COOK$

(C) $CH_3CH_2CH_2CH = CH - COOK$

(D) $CH_3CH_2CH_2\underset{\displaystyle OH}{\underset{|}{CH}}CH_2COOK$

23. Compound(C) is a/an

(A) hydroxyl acid
(B) keto acid
(C) unsubstituted acid
(D) bromo acid

space for rough work

Paragraph for question nos. 24 – 26

Compound(P) forms 3, 4-dimethyl hexane, when treated with sodium metal in presence of ether. Reaction of (P) with alcoholic KOH, forms (Q) and (R). (Q) exhibits geometrical isomerism and (R) is a terminal alkene. Reductive ozonolysis of (Q) with O_3/Zn forms two moles of (S). Oxidation of (R) with acidified $KMnO_4$ solution forms (T) and CO_2.

Answer the following questions on the basis of above write up.

24. Which of the following is compound(S)?
(A) CH_3CH_2OH (B) CH_3CHO
(C) CH_3COOH (D) CH_3OCH_3

25. Which of the following is (T)?
(A) CH_3COOH (B) HCOOH
(C) CH_3CH_2COOH (D) $CH_3CH_2CH_2COOH$

26. Which isomerism is NOT displayed by (P)?
(A) Chain isomerism (B) Positional isomerism
(C) Optical isomerism (D) Geometrical isomerism

space for rough work

Section – II (Physics)

PART – A

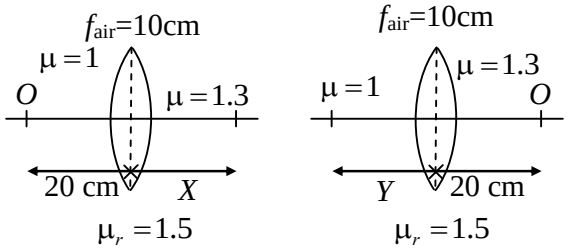
(Single Correct Choice Type)

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. A diatomic molecule having atoms of masses m_1 and m_2 has its potential energy function about the equilibrium position r_0 as given by $U(r) = -A + B(r - r_0)^2$ where A and B are constants. When the atom vibrate at high temperature condition, the square of angular frequency of vibration will be

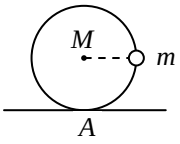
(A) $\frac{2B}{m_1}$ (B) $\frac{2B}{m_2}$ (C) $\frac{2B(m_1+m_2)}{m_1m_2}$ (D) $\frac{B(m_1+m_2)}{2m_1m_2}$

2. An equiconvex lens made up of a material of refractive index 1.5 has focal length of 10 cm when placed in air as shown in the figure. One side of the medium is replaced by another medium of refractive index 1.3. If X and Y are the image distances when the object is placed at a distance of 20cm from optical centre in the medium with refractive index 1 and 1.3 respectively, then



(A) $X > 1.3Y$ (B) $X < 1.3Y$
(C) $X = 1.3Y$ (D) cannot be determined

3. A uniform body of mass M of radius R has a small mass m attached at edge as shown in the figure. The system is placed on a perfectly rough horizontal surface such that mass m is at the same horizontal level as the centre of body. It is assumed that there is no slipping at point A. If I_A is the moment of the inertia of combined system about point of contact A then the normal reaction at point A just after the system is released from rest is (M = 6 kg, m = 2 kg, I_A = 4kg m^2, R = 1m, g = 10m/s^2)

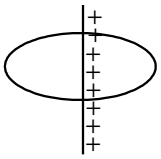


(A) 60N (B) 80 N (C) 75 N (D) 70 N

4. A circuit consists of a capacitor and a resistor having resistance R = 220 Ω connected in series. When an alternating e.m.f. of peak voltage V_0 = 220 $\sqrt{2}$ V is applied to the circuit, the peak current in steady state is observed to be I_0 = 1A. The phase difference between the current and the voltage is

(A) 30° (B) 45° (C) 60° (D) 90°

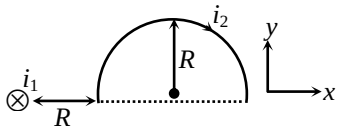
5. A very long uniformly charged rod falls with a constant velocity V through the center of a circular loop. Then the magnitude of induced emf in loop is (charge per unit length of rod = λ)



(A) $\frac{\mu_0}{2\pi}\lambda V^2$ (B) $\frac{\mu_0}{2}\lambda V^2$ (C) $\frac{\mu_0}{2\lambda}V$ (D) zero

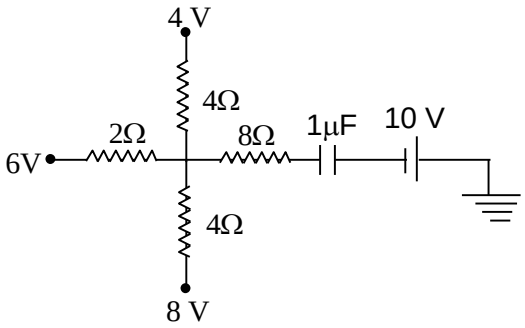
space for rough work

6. A very long current carrying wire is placed along *z*-axis having current of magnitude i_1 towards negative *z*-axis. A semicircular wire of radius *R* and having current i_2 is placed in *x*-*y* plane, such that line joining two end points of the semicircular wire passes through long wire as shown in figure. Nearest distance of semicircular wire from long wire is *R*. Net magnetic force on semicircular wire will be

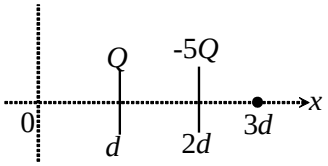


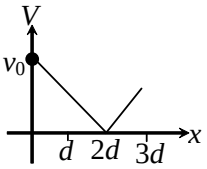
(A) $\frac{\mu_0 i_1 i_2}{2\pi}\ln 3$ (B) $\frac{\mu_0 i_1 i_2}{2\pi}\ln\frac{3}{2}$ (C) zero (D) $\frac{\mu_0 i_1 i_2}{2\pi}$

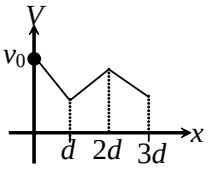
7. Figure shows a network of a capacitor and resistors. The charge on capacitor in steady state is
(A) 4 μC
(B) 6 μC
(C) 10 μC
(D) 16 μC

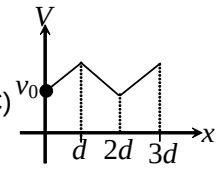


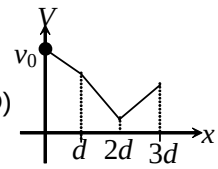
8. Two large identical plates are placed in front of each other at $x = d$ and $x = 2d$ as shown in figure. If charges on plates are *Q* and -5*Q*, the potential versus distance graph for region $x = 0$ to $x = 3d$ is (*d* is very small and potential at $x = 0$ is v_0)



(A) 

(B) 

(C) 

(D) 

9. Two longitudinal waves propagating in the *X* and *Y* directions superimpose. The wave equations are as below $\psi_1 = A\cos(\omega t - kx)$ and $\psi_2 = A\cos(\omega t - ky)$. Trajectory of the motion of a particle lying on the line $y = x + \frac{(2n+1)\lambda}{2}$ will be

(A) straight line (B) circle (C) ellipse (D) none of these

10. The equation of a particle executing SHM is given by $x = 3\cos\left(\frac{\pi}{2}\right)t$ cm, where *t* is in second. The distance travelled by the particle in the first 8.5 s is

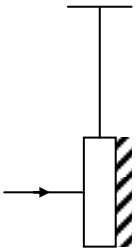
(A) $\left(24 + \frac{3}{\sqrt{2}}\right)$ cm (B) $\left(27 - \frac{3}{\sqrt{2}}\right)$ cm (C) $\left(24 - \frac{3}{\sqrt{2}}\right)$ cm (D) $\left(27 + \frac{3}{\sqrt{2}}\right)$ cm

space for rough work

(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. A small mirror is suspended by a thread as shown in figure. A short pulse of monochromatic light rays is incident normally on the mirror and gets reflected. Which of the following statements are correct?



(A) mirror will starts oscillating
(B) wavelength of reflected rays will be greater than that of incident rays
(C) wavelength of reflected rays may be less than that of incident rays
(D) mirror will be at rest after some time

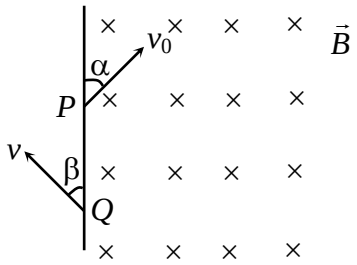
12. Two different coils have self inductances L_1 = 8 mH and L_2 = 2 mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain instant of time, the power given to the two coils is the same. At this time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and U_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and U_2 respectively. Then

(A) $\frac{i_1}{i_2}=\frac{1}{4}$ (B) $\frac{i_1}{i_2}=4$ (C) $\frac{U_2}{U_1}=4$ (D) $\frac{V_2}{V_1}=\frac{1}{4}$

13. The magnetic field perpendicular to the plane of conducting ring of radius r changes at the rate $\frac{dB}{dt}=\alpha$. Then

(A) Emf induced in the ring is $\pi r^2\alpha$
(B) Emf induced in the ring is $2\pi r\alpha$
(C) the potential difference between diametrically opposite points on the ring is half of induced emf
(D) all points on the ring are at same potential

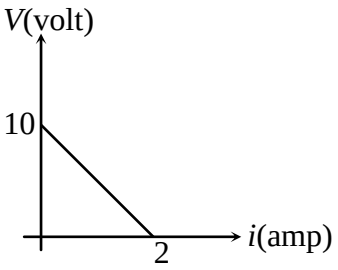
14. A particle of charge $-q$ and mass m enters a uniform magnetic field $\vec{B}$ (perpendicular to paper inwards) at P with a velocity v_0 at an angle α and leaves the field at Q with velocity v at angle β as shown in the figure. Then



(A) $\alpha=\beta$
(B) $v=v_0$
(C) $PQ=\frac{2mv_0\sin\alpha}{Bq}$
(D) particle remains in the field for time $t=\frac{2m(\pi-\alpha)}{Bq}$

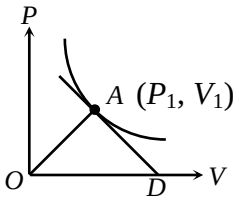
space for rough work

15. A battery of emf E and internal resistance *r* is connected across a resistance *R*. Resistance *R* can be adjusted to any value greater than or equal to zero. A graph is plotted between the current passing through the resistance (*i*) and potential difference across the terminals of the battery (V). Select the correct alternative (s)



(A) internal resistance of the battery is 5 Ω
(B) emf of the battery is 10 V
(C) maximum current which can be taken from the battery is 2A
(D) V-*i* graph can never be a straight line as shown in the figure

16. *n* moles of an ideal gas undergo an isothermal process at temperature *T*. P-V graph of the process is as shown in the figure. A point *A* (V_1, P_1) is located on the P-V curve. Tangent at point *A*, cuts the *V*-axis at point *D*. *AO* is the line joining the point *A* to the origin *O* of PV diagram. Then,



(A) coordinates of points *D* is $\left(\frac{3V_1}{2}, 0\right)$

(B) coordinates of points *D* is $(2V_1, 0)$

(C) area of the triangle *AOD* is *nRT*

(D) area of the triangle *AOD* is $\frac{3}{4}nRT$

17. A particle of mass *m* is moving in a field where the potential energy is given by $U(x) = U_0(1-\cos ax)$ where U_0 and *a* are constants and *x* is the displacement from mean position . Then (for small oscillations)

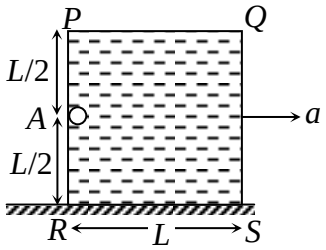
(A) the time period is $T = 2\pi\sqrt{\frac{m}{aU_0}}$

(B) the speed of particle is maximum at *x* = 0

(C) the amplitude of oscillations is $\frac{\pi}{a}$

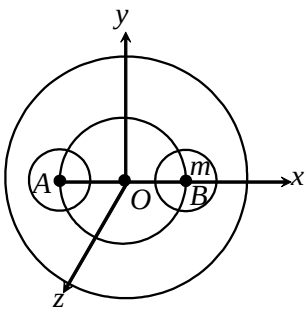
(D) the time period is $T = 2\pi\sqrt{\frac{m}{a^2U_0}}$

18. A small solid ball of density ρ is held inside at point *A* a cubical container of side *L*, filled with an ideal liquid of density 4ρ as shown in the figure. Now, if the container starts moving with constant acceleration *a* horizontally and the ball is released from point *A* simultaneously, then



(A) For ball to hit the top of container at end *Q*, *a* = 3g
(B) For ball to hit the top of container at end *Q*, *a* = 2g
(C) Ball hits the top of container at end *Q* after a time *t* = $\sqrt{\frac{L}{3g}}$
(D) Ball hits the top of container at end *Q* after a time *t* = $\sqrt{\frac{2L}{3g}}$

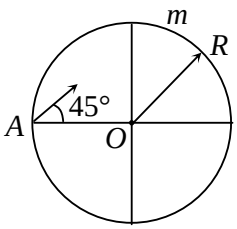
space for rough work



19. A solid sphere of uniform density and radius 4 units is located with its centre at the origin *O* of co-ordinates. Two spheres of equal radii 1 units, with their centres at *A*(–2,0,0) and *B* (2, 0 ,0) respectively, are taken out of the solid leaving behind spherical cavities as shown in figure. Then
(A) the gravitational field due to this object at the origin is zero.
(B) the gravitational field at the point *B*(2, 0, 0)is zero

(C) the gravitational potential is same at all points on the circle $y^2 + z^2 = 36$
(D) the gravitational potential is same at all points on the circle $y^2 + z^2 = 4$

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



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

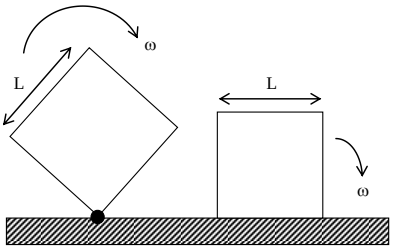
(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

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

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

Comprehension Type
Paragraph for question nos. 21 – 23

There is a cube of mass M and side L. It is hinged at one of its edge as shown in figure. If initially it is kept as shown in figure, and a very slight clockwise impulse is given to it so that it first starts toppling (w = 0) about hinged edge, it begins to rotate clockwise. When the face of the cube strikes the ground ,it immediately comes to rest. Then



21. The angular velocity of the cube just before it strikes the ground is

(A) $\sqrt{\frac{2g}{3L}\left(\sqrt{2}-1\right)}$ (B) $\sqrt{\frac{1}{3}\frac{g}{L}\left(\sqrt{2}-1\right)}$ (C) $\sqrt{\frac{3}{2}\frac{g}{L}\left(\sqrt{2}-1\right)}$ (D) $\sqrt{\frac{g}{L}\left(\sqrt{2}-1\right)}$

22. The total impulsive reaction in the vertical direction that has acted on the cube during the collision with the ground.

(A) $M\sqrt{\frac{3gL}{5}(\sqrt{2}-1}$ (B) $M\sqrt{\frac{3gL\left(\sqrt{2}-1\right)}{8}}$ (C) $M\sqrt{\frac{gL}{5}\left(\sqrt{2}-1\right)}$ (D) $M\sqrt{\frac{gL}{8}(\sqrt{2}-1}$

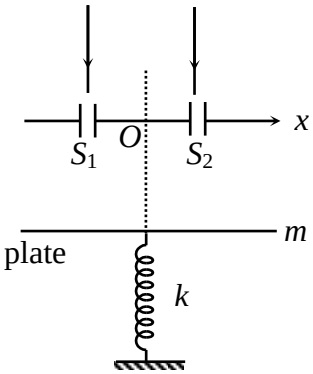
space for rough work

23. The impulsive torque about the hinged edge that has acted on the cube during the collision

(A) $\sqrt{\frac{2M^2L^3g\left(\sqrt{2}-1\right)}{3}}$ (B) $\sqrt{\frac{M^2L^3g\left(\sqrt{2}-1\right)}{3}}$ (C) $\sqrt{\frac{4}{3}M^2L^3g\left(\sqrt{2}-1\right)}$ (D) $\sqrt{\frac{3}{8}M^2L^3g\left(\sqrt{2}-1\right)}$

Paragraph for question nos. 24 – 26

Two slits S_1 and S_2 lie on the x-axis and symmetric with respect to y-axis are illuminated by a parallel monochromatic light beam of wavelength λ as shown. The distance between slits is d (>> λ). Point O is the mid point of the line S_1S_2 and this point is considered as the origin. The slits are in horizontal plane. The interference pattern is observed on a horizontal plate (acting as screen) of mass m which is connected to one end of a vertical massless spring of spring constant k. The other end of the spring fixed to ground. At t = 0, the plate is at a distance D (>> d) below the plane of slits and spring is in its natural length. The plate is released from rest from its initial position.



24. The rate by which fringe, width will increase when acceleration of plate is zero, is

(A) $\frac{\lambda g}{d}\sqrt{\frac{m}{k}}$ (B) $\frac{\lambda g}{3d}\sqrt{\frac{m}{k}}$ (C) $\frac{\lambda g}{4d}\sqrt{\frac{m}{k}}$ (D) $\frac{\lambda g}{2d}\sqrt{\frac{m}{k}}$

25. The difference between two fringe widths when plate is at rest for a moment is

(A) $\frac{2\lambda}{d}$ (B) $\frac{\lambda mg}{dk}$ (C) $\frac{2\lambda mg}{dk}$ (D) $\frac{mg}{k}\frac{d}{\lambda}$

26. A thin slab of refractive index μ is kept in front of one of slits such that position of first maxima shift to the position of central maxima at the instant when plate has been held at rest initially. The thickness of slab is

(A) $\frac{d}{(\mu-1)}$ (B) $\frac{d\lambda}{D(\mu-1)}$ (C) $\frac{D\lambda}{d(\mu-1)}$ (D) $\frac{\lambda}{\mu-1}$

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. If from point (4, 4) perpendicular to the straight lines $3x + 4y + 5 = 0$ and $y = mx + 7$ meet at Q and R respectively such that area of triangle PQR is maximum, then m is equal to

   (A) $\frac{4}{3}$ (B) $-\frac{3}{4}$ (C) -1 (D) 1

2. The equations $x^3 + 5x^2 + px + q = 0$ and $x^3 + 7x^2 + px + r = 0$ have two roots in common. If third root of each equation is represented by x_1, x_2 respectively, then ordered pair (x_1, x_2) is

   (A) $(5,-7)$ (B) $(-5,7)$ (C) $(-5,-7)$ (D) $(5,7)$

3. $\lim\limits_{x\to 0}\frac{1}{x}\left(\int\limits_{y}^{4} e^{\cos^2 t}dt - \int\limits_{x+y}^{4} e^{\cos^2 t}dt\right)$ is equal to

   (A) $e^{\cos^2 y}$ (- $\sin^2 y$) (B) $e^{\cos^2 y}$ (C) 0 (D) e^4 - $e^{\cos^2 y}$

4. If $f(x) = \sin x - x$, then $\int\limits_{-2\pi}^{2\pi} |f^{-1}(x)|\,dx$ equals

   (A) π^2 (B) $2\pi^2$ (C) $3\pi^2$ (D) $4\pi^2$

5. 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) $\frac{2}{8!}$

6. A line from (–1, 0) intersects the parabola $x^2 = 4y$ at A & B. Then the locus of centroid of ΔOAB is

   (A) $3x^2 - 2x = 4y$ (B) $3y^2 - 2y = 4x$ (C) $3x^2 + 2x = 4y$ (D) none

7. The foot of perpendicular from the complex number (3–i) to the straight line $iz = \bar{z}$ is

   (A) 2 + 2i (B) 3 + 4i (C) 2 + i (D) 2 – 2i

8. If $y = \tan^{-1}\left(\frac{\cos x + \sin x}{\sqrt{2}}\right)$, then

   (A) $|y| \le \frac{\pi}{6}$ (B) $|y| \le \frac{\pi}{4}$ (C) $|y| \le \frac{\pi}{3}$ (D) $|y| \le \frac{\pi}{2}$

space for rough work

9. If lines $\frac{x-1}{2}=\frac{y-2}{x_1}=\frac{z-3}{x_2}$ and $\frac{x-2}{3}=\frac{y-3}{4}=\frac{z-4}{5}$ lies in the same plane then for equation $x_1t^2+(x_2+2)t+a=0$

(A) $2x_1+x_2=1$ (B) sum of roots of above equation = –2

(C) $2x_1+x_2=-4$ (D) sum of roots is 0

10. The expression $(x+2y)^{20}$ contain two terms with the same coefficient, $k\,x^a y^b$ and $k\,x^{a+1}y^{b-1}$, then a is

(A) 8 (B) 5 (C) 7 (D) 6

(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. $$f(x)=\begin{cases} x^2\left|\cos\frac{\pi}{x}\right| & when \quad x\neq 0 \\ 0 & when \quad x=0 \end{cases}$$

(A) $f(x)$ is not differentiable at $x=0$

(B) $f(x)$ is differentiable at $x=0$

(C) $f(x)$ is not differentiable at $x=\frac{2}{2n+1}: n\in Z$

(D) $f(x)$ is differentiable at $x\neq\frac{2}{2n+1}: n\in Z$

12. 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) $P\left(\frac{A}{B^C}\right)=P(A\cap B)$

13. If $y=f(x)=\int_0^x (x-t)^6\sin t\,dt$ then the true statements among the following are

(A) $y''+y=x^6$ (B) $y'(0)=0$ (C) $y''-y=x^6$ (D) $y'(0)=1$

space for rough work

14. The sum of certain number of consecutive positive integers is 1000. If n be the number of terms, then n can be equal to
(A) 5 (B) 25 (C) 16 (D) 20

15. Each of the circles $|z - 1 - i| = 1$ and $|z - 1 + i| = 1$ touches internally a circle of radius 2. The equation of the circle touching all the three circles can be
(A) $3z\bar{z} + z + \bar{z} - 1 = 0$ (B) $3z\bar{z} - 7(z + \bar{z}) + 15 = 0$
(C) $z\bar{z} - z - \bar{z} - 3 = 0$ (D) $3z\bar{z} + (z + \bar{z}) + 1 = 0$

16. If $\sin^{-1}\left(a^2x^2 + b^2y^2\right) + \cos^{-1}|ax + by| = \pi$, where $ab < 0$, then
(A) $ab = \frac{1}{2}$, $xy = 1$ (B) $ax = \pm\frac{1}{\sqrt{2}}$, $by = \pm\frac{1}{\sqrt{2}}$
(C) $ay = -\frac{1}{2}, bx = 1$ (D) $a = b = x = y = 1$

17. If M is the skew symmetric matrix of order n × n, then
(A) det (M – I) = det (M + I) (B) det (M –I) = – det (M + I) if n is odd
(C) det (M – I) = det (M + I) if n is even (D) det (I – M) $(I + M)^{-1}) = 1$, det (I + M) $\neq 0$

18. If $L = \sum_{r=0}^{99} \frac{1}{100}\sin\left(\frac{\pi r}{200}\right)$ and $M = \sum_{r=1}^{100} \frac{1}{100}\sin\left(\frac{\pi r}{200}\right)$, then
(A) $L = M = \frac{2}{\pi}$ (B) $L < \frac{2}{\pi}$ (C) $M > \frac{2}{\pi}$ (D) $L < M < \frac{2}{\pi}$

19. If $f'(x) > 0$, $f''(x) > 0$, $\forall x \in (0, 1)$, $f(0) = 0$, $f(1) = 1$ then
(A) $f\left(\frac{1}{2}\right) f^{-1}\left(\frac{1}{2}\right) < \frac{1}{4}$ (B) $f\left(\frac{1}{3}\right) f^{-1}\left(\frac{1}{3}\right) < \frac{1}{9}$
(C) $f\left(\frac{1}{6}\right) f^{-1}\left(\frac{1}{6}\right) > \frac{1}{6}$ (D) $f\left(\frac{1}{5}\right) f^{-1}\left(\frac{1}{5}\right) > \frac{1}{25}$

20. Three vectors $\vec{p}, \vec{q}, \vec{r}$ are such that $\vec{p} \times \vec{q} = \vec{p} \times 3\vec{r}$. Also $|\vec{p}| = |\vec{q}| = 1$; $|\vec{r}| = \frac{1}{3}$.
The angle between $\vec{q}$ and $\vec{r}$ is 60^0 then
(A) $\vec{q} = 3\vec{r} + \vec{p}$ (B) $\vec{q} = 3\vec{r} - \vec{p}$ (C) $\vec{q} = 3\vec{r} + 2\vec{p}$ (D) $\vec{q} = 3\vec{r} - 2\vec{p}$

Comprehension Type
Paragraph for question nos. 21 – 23

A bag contains n balls in which some balls are red and remaining white. The probability that bag contains 'i' number of red ball is proportion to i^2, $\forall$ i = 0, 1, 2, ... , n.

21. A ball is drawn from the bag, then the probability that is red, is
(A) $\frac{1}{n+1}$ (B) $\frac{n+1}{2n+1}$ (C) $\frac{3}{2}\frac{(n+1)}{(2n+1)}$ (D) $\frac{1}{2n+1}$

space for rough work

22. If ball drawn from the bag is found to be red, then the probability that no other ball in the bag is red, is

(A) $\frac{1}{n^2}$ (B) $\frac{4}{n^2(n+1)^2}$

(C) $\frac{1}{n+1}$ (D) $\frac{2n+1}{n(n+1)}$

23. If conditional probability that all the balls in the bag are red, given that drawn ball from the bag is red, is $\frac{5}{9}$, then 'n' is equal to

(A) 4 (B) 6
(C) 8 (D) 5

Paragraph for question nos. 24 – 26

Tangent is drawn at any point (x_i, y_i) on the curve $y = f(x)$, which intersects the x-axis at $(x_{i+1}, 0)$. Now again a tangent is drawn at (x_{i+1}, y_{i+1}) on the curve intersects the x-axis at $(x_{i+2}, 0)$ and the process is repeated *n* times i.e.
(*i* = 1, 2, … *n*)

24. If $x_1, x_2, ..., x_n$ form an A.P. with common difference equal to $\log_2 e$ and curve passes through (0, 2), the curve is

(A) $y = 2e^x$ (B) $y = 2e^{-x}$

(C) 2^{1-x} (D) 2^{1+x}

25. If $x_1, x_2, ..., x_n$ form a G.P. with common ratio equal to 2, then curve is

(A) parabola (B) ellipse
(C) rectangular hyperbola (D) none of these

26. If $x_1, x_2, ..., x_n$ are in H.P., then possible curve is

(A) $y = kxe^{-cx}$ (B) $y = \frac{k}{x}e^{-cx}$

(C) $y = \frac{k}{x}e^{-c/x}$ (D) $y = kxe^{-c/x}$

space for rough work