FIITJEE INTERNAL TEST

RANK IMPROVEMENT TEST – IV

Batches: All 1921 batches

IIT- JEE 2021

QP CODE:

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

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

Instructions

Note:

1. The question paper contains 3 sections (Sec-1, Chemistry, Sec-II, Physics & Sec-III, Mathematics.)
2. Each section is divided into two parts, **PART-A and PART-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 Two Parts.

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

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

   For each question in the group **Q. 11 – 20** of **PART – A** you will be awarded
   Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
   Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
   Zero Marks: **0** If none of the bubbles is darkened.
   Negative Marks: **–1** In all other cases.

   For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–1** marks, as a wrong option is also darkened.

3. **PART-B (01 – 06)** contains 6 Numerical Based questions the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer. **There is no negative marking.**

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. The enthalpy change in kJ when mixing 100 mL of 0.2 M HCl and 200 mL of 0.2 M KOH would be
   (A) -1.71 kJ (B) -1.14 kJ
   (C) -1.07 kJ (D) None of these

1. B

2. ΔS will be negative for the following process
   (A) $2O_3(g) \rightleftharpoons 3O_2(g)$ (B) $C(s) + H_2O(\ell) \longrightarrow CO(g) + H_2(g)$
   (C) $C_{graphite} \longrightarrow C_{diamond}$ (D) Hard boiling of egg

2. C

3. ThO_2 exists in fluorite structure, what is the effective number of bivalent ion in the unit cell of ThO_2.
   (A) 2 (B) 4
   (C) 1 (D) 8

3. **D**

4. In fcc unit cell, what fraction of edge is not covered by atoms?
   (A) 0.134 (B) 0.24
   (C) 0.293 (D) none of these

4. **C**

5. An ideal gas having initial pressure P, volume V and temperature T is allowed to expand adiabatically until its volume becomes 5.66V while its temperature falls to T/2. The correct expression for the work done by the gas during the expansion as a function of the initial pressure P and volume V.
   (A) 1.25 PV (B) 3.55 PV (C) 2.29 PV (D) 3.56 PV

5. **A**

6. Which of the following is intensive property?
   (A) pH (B) Heat capacity (C) enthalpy (D) entropy

6. A

7. The species which by definition has zero standard molar enthalpy of formation at 298 K is:
   (A) $Br_2(g)$ (B) $Cl_2(g)$ (C) H_2O (g) (D) $CH_4(g)$

7. **B**

8. KCl crystallizes in the same type of lattice as does NaCl. The ionic radius of Na^+ is 0.5 of that of Cl^- and is 0.7 of that of K^+ the ratio of the side of the unit cell for KCl to that for NaCl is
   (A) 1.143 (B) 1.233
   (C) 1.134 (D) 1.552

8. **C**

9. Which one is the polar molecular solid?
   (A) $SO_{2(s)}$ (B) $AlN_{(s)}$
   (C) CaF_2 (D) $CO_{2(s)}$

9. A

10. In a face centred cubic arrangement of A and B atoms, where A atoms are at the corner of the unit cell and B atoms at the face centres, all the atoms are missing along one of the face diagonal, the simplest formula of the compound is (Assume it to be a hypothetical case)
(A) A_7B_{24} (B) AB_4
(C) A_3B_2 (D) A_3B_{10}

10. **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. The density of solids decreases in
(A) Schottky defect (B) Frenkel defect
(C) Metal excess defect (D) Metal deficiency defect

11. AD

12. In a AB unit crystal of NaCl types assuming Na^+ forming FCC
(A) the nearest neighbour of A^+ is 6 B^- ion (B) the nearest neighbour of B^- is 6 A^+ ion
(C) the second neighbour of A^+ is 12 A^+ (D) the packing fraction of AB crystal is $\frac{\sqrt{3}\pi}{8}$

12. ABC

13. Which of the following substance behave(s) as conductor or insulator depending upon temperature?
(A) TiO2 (B) SiO_2
(C) Li_2TiO_3 (D) MgO

13. C

14. Variation of heat of reaction with temperature is given by
(A) $\frac{\Delta H_2 - \Delta H_1}{\Delta T} = \Delta C_P$ (B) $\frac{d\Delta H}{dT} = \Delta C_P$
(C) $\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_V$ (D) $\Delta H_2 = \Delta H_1 - C_P(T_2 - T_1)$

14. AB

15. For the adiabatic expansion of an ideal gas
(A) PV^γ = constant (B) $TP^{1-\gamma}$ = constant
(C) $TV^{\gamma-1}$ = constant (D) None of these

15. AC

16. The molar heat capacity of iodine vapour and solid are 7.8 and 14 cal/mol respectively. If enthalpy of sublimation of iodine is 6096 cal/mol at 200°C then what is ΔU at 250°C in cal/mol
(A) 5360 (B) 4740
(C) 6406 (D) none of these

16. B

17. For a process to be spontaneous
(A) $(\Delta G_{system})_{T,P} = 0$ (B) $\Delta S_{system} + \Delta S_{surr} > 0$
(C) $\Delta G_{system} + \Delta S_{surr} < 0$ (D) $(\Delta G_{system})_{T,P} < 0$

17. **BD**

18. Which of the following statement is/are correct?
(A) The coordination number of each type of ion in CsCl is 8
(B) A metal that crystallized in BCC structure has a co-ordination number 12
(C) A unit cell of an ionic crystal shares some of its ions with other unit cells
(D) The length of the unit cell in NaCl is 552 pm
$\left(r_{Na^+} = 95\,pm\,; r_{Cl^-} = 181\,pm\right)$

18. **ACD**

19. Select the correct statement about hexagonal close packing (HCP).
(A) Tetrahedral holes between two layers share faces.
(B) Octahedral holes do not share faces
(C) Tetrahedral holes are staggered between layers.
(D) Tetrahedral holes share edges and vertices.

19. AD

20. Select the correct statement/s regarding defect in solids.
(A) ZnO (interstial metal excess defect) when heated with O_2 followed by cooling show decrease in conductivity.
(B) Metal deficiency defect is shown by those compounds in which metal can show variable oxidation state.
(C) Metal oxide(metal deficiency defect) when heated with O_2 followed by cooling show increase in conductivity.
(D) When KCl is heated with 'K' vapours it becomes blue-lilac due to formation of F-centres.

20. ABCD

PART – C

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

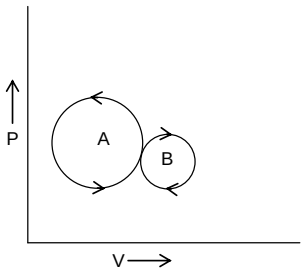
1. The atomic weight of a metal is 150 g mol^{-1}. What will be it's density in g cm^{-3} unit, if the edge length of it's FCC unit cell is 5×10^{-8} cm?
[Avogadro's number = 6×10^{23}]

1. 8

2. An oxide of calcium and aluminium contains oxide ions at the lattice points of FCC unit cell and the metal ions Ca^{2+} and Al^{3+} are present in the voids. If the relative number of oxide ions of the unit cell are replaced by carbide(C^{4-}) ions, how many anionic vacancy/vacancies is/are created per unit cell?

2. 2

3. In the given graph, the area of circle 'A' and 'B' are 25 units and 20 units respectively. Work done will be …….. unit

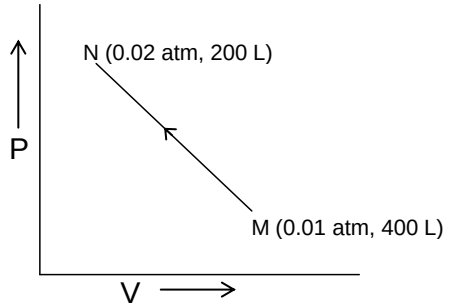


3. 5

4. How much work is done in kJ unit by reversible and isothermal compression of 0.523 moles of an ideal gas to $\frac{1}{100}$ times of its original volume at 400 K?

4. 8

5.



The irreversible work done along the process M $\rightarrow$ N in L atm unit in the above figure is:

5. **4**

6. How many moles of an ideal gas will absorb 2 Kcal heat when it is heated from 600 K to 700 K at constant pressure?

$\left[C_P = \frac{5R}{2}\right]$

6. 4

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space for rough work

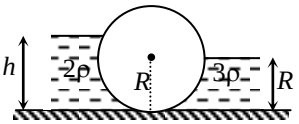
Section – II (Physics)

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.

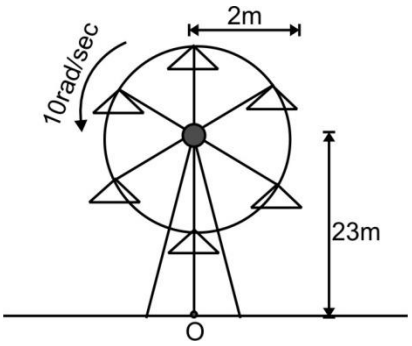
1. In the figure shown, the heavy cylinder (radius R) resting on a smooth surface separates two liquids of densities 2ρ and 3ρ. The height h for the equilibrium of cylinder must be



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

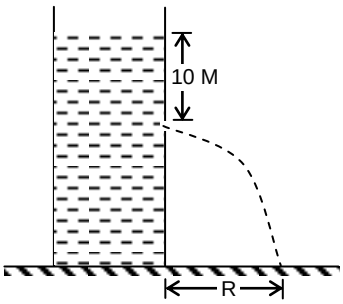
1. **B**

2. In a swing, (as shown in figure), it rotates with constant angular velocity of 10 rad/sec. The length of the rods are 2m each. When a person sitting in one of the seat reaches the top, suddenly the rod connecting the seat cracks, so that the person starts falling in air, while the seat and rod still connected to swing. Find the distance on the ground from the foot of the swing at which the person will fall.
(A) 22.4 m
(B) 44.8 m
(C) 67.2 m
(D) 11.2 m



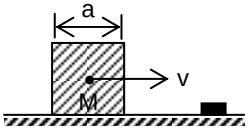
2. **B**

3. The range of water flowing out of a small hole made at a depth 10 M below water surface is a large tank is R. Find the extra force per unit area applied on water surface so that range becomes 2R. (in atm an approximate value).
(A) 1 (B) 2
(C) 3 (D) 4



3. **C**

4. A cubical block of side a moving with velocity v on a horizontal smooth plane as shown. It hits a ridge at point O. the angular speed of the block after it hits O is



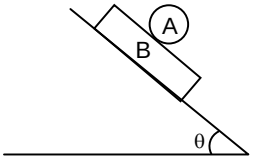
(A) $\frac{3v}{4a}$ (B) $\frac{3v}{2a}$ (C) $\sqrt{\frac{3}{2}}\,\frac{v}{a}$ (D) zero

4. **A**

5. Let I be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. The moment of inertia of the plat about the axis CD is
(A) I (B) $I\sin^2\theta$
(C) $I\cos^2\theta$ (D) $I\cos^2\left(\frac{\theta}{2}\right)$

5. **A**

6. A rolling body is kept on a plank B. There is sufficient friction between A and B and no friction between B and the inclined plane. Then body



(A) A slips on plank
(B) A does not experience any friction.
(C) A and B has equal acceleration and unequal velocities of their centre of mass.
(D) A rolls depending upon the angle of inclination θ.

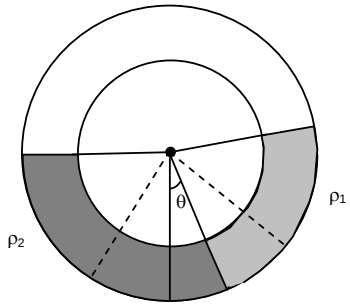
6. **B**

7. A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass is M. It is suspended by a string in a liquid of density ρ where it stays vertical. The upper surface of the cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is

(A) Mg
(B) Mg - Vρg
(C) $Mg + \pi R^2 h\rho g$
(D) $\rho g\left(V + \pi R^2 h\right)$

7. **D**

8. A small uniform tube is bent into a circle of radius r whose plane is vertical. Equal volumes of two immiscible liquids whose densities are ρ_1 and $\rho_2\,(\rho_1 > \rho_2)$ fill half the circle. The angle between radius passing through interface and vertical axis is given by



(A) $\tan^{-1}\left(\frac{\rho_1}{\rho_2}\right)$
(B) $\tan^{-1}\left(\frac{\rho_2}{\rho_1}\right)$
(C) $\tan^{-1}\left(\frac{\rho_1-\rho_2}{\rho_1+\rho_2}\right)$
(D) $\tan^{-1}\left(\frac{\rho_1+\rho_2}{\rho_1-\rho_2}\right)$

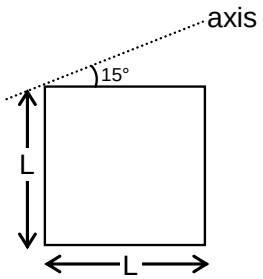
8. **C**

9. When a loaded boat enters into the sea from a river it rises because:

(A) There is more water in sea than in river
(B) Sea water is denser than river
(C) There is difference of temperature
(D) Sea is deeper than river

9. **B**

10. A square plate of mass M and edge L is shown in figure. The moment of inertia of the plate about the axis in the plane of plate passing through one of its vertex making an angle 15° from horizontal is $\frac{11ML^2}{4N}$ then value of 'N' is



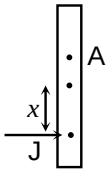
(A) 2
(B) 4
(C) 6
(D) 8

10. **C**

(Multiple Correct Choice Type)

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

11. A uniform rod of mass *m* and length *l* is placed in gravity free space and linear impulse *J* is given to the rod at a distance *x* = *l*/4 from centre and perpendicular to the rod. Point *A* is at a distance *l*/3 from centre as shown in the figure. Then

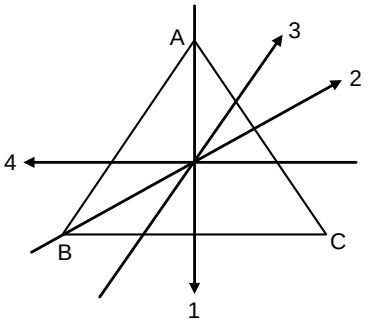


(A) Speed of centre of rod is $\frac{J}{m}$ (B) Speed of point *A* is zero

(C) Speed of upper end of rod is $\frac{J}{2m}$ (D) Speed of lower end of rod is $\frac{5}{2}\frac{J}{m}$

11. **ABCD**

12. The moment of inertia of a thin equilateral triangular plate ABC, of uniform thickness about an axis passing through centre of mass and perpendicular to its plane
(A) $I_1 + I_2$
(B) $I_3 + I_4$
(C) $I_1 + I_4$
(D) $\frac{1}{2}[I_1 + I_2 + I_3 + I_4]$

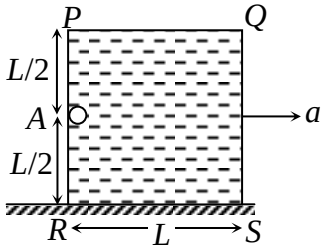


12. **ABCD**

13. A particle of mass m is projected with a velocity v making on angle θ with horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height 'H' is proportional to
(A) $V^{3/2}$ (B) V^3
(C) $H^{3/2}$ (D) H^3

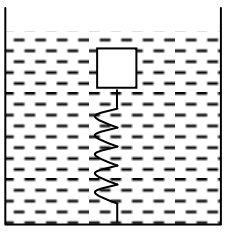
13. **BC**

14. 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 $t = \sqrt{\frac{2L}{3g}}$.



14. **BC**

15. A block of mass 'm' is attached by means of a spring to the bottom of a tank of water as shown in figure. At equilibrium, the spring is under compression. If the tank is now allowed to fall freely, then choose the correct alternative(s).
(A) the spring comes to its relaxed position
(B) the block will oscillate
(C) the buoyant force becomes zero
(D) there will be some elongation is the spring



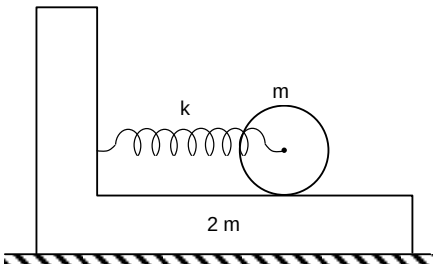
15. **BC**

16. An object is floating in a liquid, kept in a container. The container is placed in a lift. Choose the correct option(s)
(A) Buoyant force increases as lift accelerates up.
(B) Buoyant force decreases as lift accelerates up.
(C) Buoyant force remains constant as lift accelerates.

(D) The fraction of solid submerged into liquid does not change.

16. **AD**

17. A solid cylinder of mass m and radius R is kept on a block of mass 2m. The friction between surface in contact is sufficient for pure rolling. An ideal spring is attached to the axis of the cylinder, other end of which is fixed to a rigid wall of the block as shown in the figure. Initially the spring is compressed by x_0 and released. Then



(A) Maximum linear speed of the cylinder is $2\sqrt{\frac{2k}{21m}}x_0$

(B) Maximum linear speed of the block is $\sqrt{\frac{2k}{21m}}x_0$

(C) Maximum linear speed of the cylinder is $3\sqrt{\frac{2k}{21m}\frac{x_0}{R}}$

(D) Energy can not be conserved, thus all the above are wrong conclusion.

17. **AB**

18. A horizontal disc rotates freely about a vertical axis through its centre. A ring, having the same mass and radius as the disc, is now gently placed on the disc in such a way that their axes coincide. After some time, both rotate with a common angular velocity
(A) some friction exists between the disc and the ring.
(B) the angular momentum of the disc plus ring is conserved.
(C) the final common angular velocity is $\frac{2}{3}$ rd of the initial angular velocity of the disc.
(D) $\frac{2}{3}$ rd of the initial kinetic energy changes to heat.

18. **ABD**

19. A solid body rotates about a fixed axis with an angular velocity $\omega = \sqrt{a - b\theta}$ where a, b are constant and θ is an angle of rotation from the initial position, then
(A) angular acceleration = $-\frac{b}{2}$
(B) angle of rotation in first t sec = $\left(\sqrt{a} - \frac{bt}{4}\right)t$
(C) angle of rotation in first t sec = $\left(\sqrt{a} + \frac{bt}{4}\right)t$
(D) none of the above

19. **AB**

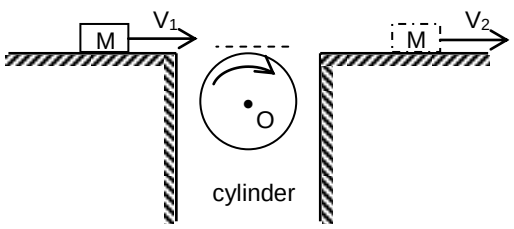
20. A uniform rod of mass 'm' length 'ℓ' is held vertically on a smooth horizontal surface. When the rod is released, choose the correct option(s).
(A) The centre of mass of the rod accelerates in the vertical direction.
(B) Initially, the magnitude of the normal reaction is mg.
(C) When the rod becomes just horizontal, the magnitude of the normal reaction becomes mg/2.
(D) When the rod becomes just horizontal, the magnitude of the normal reaction becomes mg/4.

20. **ABD**

PART – C

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

21. The cylinder shown in figure has a fixed axis and is initially at rest. The block of mass M is initially moving to the right without friction with sped v_1. It passes over the cylinder to the dotted position. When it first makes contact with the cylinder, it slips on the cylinder but the friction is large enough so that slipping ceases before M loses contact with the cylinder. If the value of v_2/v_1 is n then find the value of 'n'. ($I = 1/2\ MR^2$)

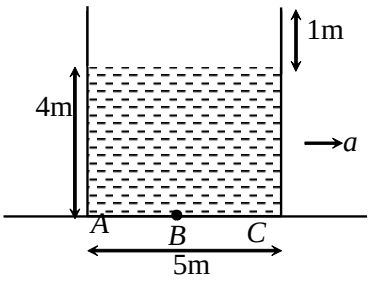


21. **0.66**

22. A boy of mass 30kg stands at the edge of a circular platform of radius 1 m rotating at an angular velocity of 2 rad/s about its axis. The moment of inertia of platform is 60 kg-m^2. The boy catches a ball of mass 2 kg moving horizontally with a velocity of 25 m/s along the tangent to the edge of the platform, which is thrown by his friend. The direction of motion of the ball and boy are same at the moment just before catching the ball. The final angular velocity of the platform is x rad/s, then find the value of 'x'.

22. **2.50**

23. A cubical open vessel of side 5m filled with liquid upto a height of 4m is accelerated with an acceleration a. If the minimum value of a so that pressure at mid point of AC is equals to atmospheric then find the value of $\frac{a}{g}$



23. **2**

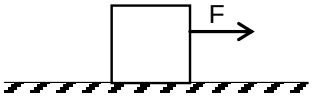
24. A test tube filled with a liquid of density ρ rotates about the vertical axis with an angular velocity ω. A small ball of radius 'r' and density σ is placed at a distance x from the axis of rotation. The radial acceleration of the ball is found to be $\frac{n\rho w^2 x}{\sigma r}$ the value of 'n' is

24. **0.75**

25. A mercury barometer reads 75 cm. If the tube be inclined by 60° from vertical the length of mercury in the tube will be n meter then find the value of 'n'.

25. **1.50**

26. A uniform cube of side ℓ and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point that is directly above the centre of the face at a height $3\ell/4$ above the base. Assuming that the cube may tip about an edge without slipping, if the angular acceleration of the cube when F is equal to mg is $\frac{3g}{NL}$ then value of 'N' is



26. **8**

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. Consider parabola $y^2 = 40x$, A circle $S = 0$ is drawn taking one of its focal chord as diameter. The extremeties of the focal chord being P_1 and P_2.

   (A) A point 'P' is taken on the circumference of S = 0, Then $\angle P_1PP_2 = \frac{\pi}{4}$

   (B) x = 10 is a tangent to S = 0

   (C) Combined equation of the tangents at P_1 and P_2 has $\left(\text{coeff. } x^2\right) + \left(\text{coeff. } y^2\right) = -2$

   (D) Orthocenter of ΔP_1PP_2 lies on it

1. D

2. The largest number among the following numbers is

   (A) $\tan 47^o + \cos 47^o$ (B) $\cot 47^o + \sqrt{2}\sin 47^o$

   (C) $\sqrt{2}\cos 47^o + \sin 47^o$ (D) $\tan 47^o + \cot 47^o$

2. D

3. If $\tan\theta_1$, $\tan\theta_2$, $\tan\theta_3$ and $\tan\theta_4$ are the roots of the equation $x^4 - x^3\sin 2\beta + x^2\cos 2\beta - x\cos\beta - \sin\beta = 0$ then $\tan\left(\theta_1 + \theta_2 + \theta_3 + \theta_4\right)$ is equal to

   (A) sin β (B) cos β

   (C) tan β (D) cot β

3. **D**

4. If $2p^2 - 3q^2 + 4pq - p = 0$ and a variable line $px + qy = 1$ always touches a parabola whose axis is parallel to x-axis, then the equation of the parabola is

   (A) $(y-4)^2 = 24(x-2)$ (B) $(y-3)^2 = 12(x-1)$

   (C) $(y-4)^2 = 12(x-2)$ (D) $(y-3)^2 = 24(x-1)$

4. C

5. The locus of the foot of perpendicular drawn from the centre of the ellipse $x^2 + 3y^2 = 6$ on any tangent to its

   (A) $\left(x^2 - y^2\right)^2 = 6x^2 + 2y^2$ (B) $\left(x^2 - y^2\right)^2 = 6x^2 - 2y^2$

   (C) $\left(x^2 + y^2\right)^2 = 6x^2 + 2y^2$ (D) $\left(x^2 + y^2\right)^2 = 6x^2 - 2y^2$

5. **C**

6. If the normal to a parabola $y^2 = 4ax$ at P meets the curve again in Q and if PQ and the normal at Q makes angles α and β respectively with the x – axis then $\tan\alpha\left(\tan\alpha + \tan\beta\right)$ has the value equal to:

   (A) 0 (B) –2 (C) –1/2 (D) –1

6. **B**

7. If a variable line $x\cos\alpha + y\sin\alpha = p$ which is a chord of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1(b > a)$ subtends a right angle at the centre of the hyperbola, then it always touches a fixed circle whose radius is

(A) $\frac{ab}{\sqrt{a^2 + b^2}}$ (B) $\frac{ab}{\sqrt{b^2 - a^2}}$

(C) $\frac{ab}{\sqrt{a^2 - b^2}}$ (D) none of these

7. B

8. In triangle ABC, the minimum value of $\sec^2\frac{A}{2} + \sec^2\frac{B}{2} + \sec^2\frac{C}{2}$ is equal to

(A) 3 (B) 4 (C) 5 (D) 6

8. **B**

9. If $\alpha = \frac{2\pi}{7}$ then the value of $\tan\alpha\tan 2\alpha + \tan 2\alpha\tan 4\alpha + \tan\alpha\tan 4\alpha$ is

(A) –4 (B) –7 (C) 4 (D) 7

9. **B**

10. A variable point P on the ellipse of eccentricity e is joined to the foci S and S'. Then the locus of the in-centre of the triangle PSS' is an ellipse whose eccentricity is

(A) $\sqrt{\frac{2e+1}{1+e}}$ (B) $\sqrt{\frac{2e}{2+e}}$ (C) $\sqrt{\frac{2e}{1+e}}$ (D) $\sqrt{\frac{2e}{1+2e}}$

10. C

(Multiple Correct Choice Type)

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

11. Let line L be a normal to the parabola $y^2 = 4x$. If L passes through the point (9, 6), then L can be

(A) $y - x + 3 = 0$ (B) $y + 3x - 33 = 0$

(C) $y + x - 15 = 0$ (D) $y - 2x + 12 = 0$

11. ABD

12. The line $y = x + 5$ is a tangent to

(A) $y^2 = 20x$ (B) $9x^2 + 16y^2 = 144$

(C) $\frac{x^2}{29} - \frac{y^2}{4} = 1$ (D) $x^2 + y^2 = 25$

12. ABC

13. The asymptotes of the hyperbola $xy = 5x + 4y$ are

(A) $x = 5$ (B) $y = 4$

(C) $x = 4$ (D) $y = 5$

13. CD

14. If $T(3,2)$ is the foot of perpendicular drawn from focus $S(2,-1)$ on a tangent to the parabola, and the directrix of parabola passes through $P(0,9)$, then

(A) Length of latus rectum of parabola is $8\sqrt{2}$
(B) Equation of tangent at vertex is $x+y-5=0$
(C) Equation of axis of the parabola is $x-y-3=0$
(D) Directrix is at a distance $2\sqrt{2}$ from focus

14. ABC

15. The equation of tangent to an ellipse E at point $P(1, 2)$ is $x+y=3$. If of the foci of E is $S(4, 3)$ and the equation of the minor axis is $3x+13y=229$, then

(A) the eccentricity of the ellipse is $\sqrt{\frac{89}{125}}$
(B) the equation of auxillary circle of ellipse is $(x-46)^2+(y-7)^2=250$
(C) the eccentricity of the ellipse is $\sqrt{\frac{178}{500}}$
(D) the equation of auxillary circle of ellipse is $(x-7)^2+(y-16)^2=250$

15. AD

16. Let F_1, F_2 be the foci of the ellipse and PT and PN be the tangent and the normal respectively to the ellipse at the point P, then

(A) PN bisects the angle $\angle F_1PF_2$ (B) PT bisects $\angle F_1PF_2$
(C) PT bisects angle $\left(180^0-\angle F_1PF_2\right)$ (D) $PF_1+PF_2=\ell(\text{major axis})$

16. ACD

17. If $\theta\in\left[-\frac{\pi}{9},-\frac{\pi}{36}\right]$, such that $f(\theta)=\tan\left(\theta+\frac{5\pi}{18}\right)+\cos\left(\theta+\frac{5\pi}{18}\right)-\tan\left(\theta+\frac{7\pi}{9}\right)$ has maximum and minimum values as a and b respectively, then

(A) $a=\frac{11}{\sqrt{3}}$ (B) $b=\frac{-3+2\sqrt{2}}{2}$
(C) $b=\frac{2\sqrt{2}+1}{\sqrt{2}}$ (D) $a=\frac{11}{2\sqrt{3}}$

17. CD

18. If $a_0=\sqrt{2}-\sqrt{3}+\sqrt{6}$ and $a_n=\tan\left(\frac{2^{n-3}\pi}{3}\right)+2$ then the value of $M=\sum_{n=0}^{3}\tan\left(\frac{2^{n-3}\pi}{3}\right).\sec\left(\frac{2^{n-2}\pi}{3}\right)$ is equal to

(A) a_4-a_0 (B) a_3-a_1
(C) a_1-a_0 (D) a_1-a_0-2

18. AD

19. If A, B, C are the three angles in the triangle such that $2\sin B\sin(A+B)-\cos A=1$ and $2\sin C\sin(B+C)-\cos B=0$, then:

(A) $A=120^o$ (B) $B=120^o$

(C) $C=30^o$ (D) B = C

19. ACD

20. In a triangle ABC, which of the following is NOT possible?

(A) $\tan A+\tan B+\tan C=0$

(B) $\frac{\sin A}{2}=\frac{\sin B}{3}=\frac{\sin C}{1}$

(C) $\sin A+\sin B=-\left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right),\ \cos A\cos B=\frac{\sqrt{3}}{4}=\sin A\sin B$

(D) $(a+b)^2=c^2+ab$ and $\sqrt{2}(\sin A+\cos A)=\sqrt{3}$

20. ABC

PART – C

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

1. If $3x+4y+k=0$ represents the equation of tangent-at-vertex of the parabola $16x^2-24xy+9y^2+14x+2y+7=0$, then the value of k is equal to

1. 3

2. If the line $\alpha x+y\sqrt{\alpha^2-1}=1,\ |\alpha|>1$ always touches a fixed hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ then let the eccentricity of the hyperbola be $\left(\frac{56}{k+1}\right)^{\frac{1}{k}}$, then k is equal to

2. 6

3. Find the number of tangents to the circle $x^2+y^2=3$ which are also the normals to the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$.

3. 0

4. Let $A(3,2)$ $B\left(\sqrt{7},\sqrt{2}\right)$ and $C\left(5,2\sqrt{5}\right)$ be the vertices of a triangle ABC. If the orthocenter of triangle ABC is $H(\alpha,\beta)$, then the value of $(\alpha-\beta)(\alpha+\beta)$ is equal to

4. 5

5. If CF is perpendicular from the centre C of the ellipse $\frac{x^2}{49}+\frac{y^2}{25}=1$ on the tangent at any point P, and G is the point where the normal at P meets the minor axis, then (C.F. PG)^2 is equal to $(40+\lambda)^2$ then $\lambda=$

5. 9

6. Let $S = \frac{1}{\sin 8^\circ} + \frac{1}{\sin 16^\circ} + \frac{1}{\sin 32^\circ} + ... + \frac{1}{\sin 4096^\circ} + \frac{1}{\sin 8192^\circ}$.

If $S = \frac{1}{\sin \alpha}$ where $\alpha \in (0, 90^\circ)$, then find α (in degree).

6. 4

space for rough work

FIITJEE INTERNAL TEST

RANK IMPROVEMENT TEST – IV

Batches: All 1921 batches

IIT- JEE 2021

QP CODE:

ANSWERS

QP CODE:

SECTION – I (Chemistry)

Part – A

Part – C

SECTION – II (Physics)

Part – A

Part – C

SECTION – III (Mathematics)

Part – A

Part – C