FIITJEE (JEE-Advanced)

BATCHES – NWCM721O1S, NWCM921X1W, NWCM921A1W & PANINI921-XIIG1

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Three Parts**: **Part-A, B & Part-C** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. 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 HB pencil 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.

C. Marking Scheme For All Three Parts.

(i) **Part-A (01-06) –** Contains seven (06) multiple choice questions which have **One or More** correct answer.
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.

(ii) **Part-B (07-12)** contains Six (06) Numerical based questions with single digit integer as answer, ranging from 0 to 9 (both inclusive) and each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-C (13-18)** contains Six (06) 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 and **there will be no negative marking.**

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

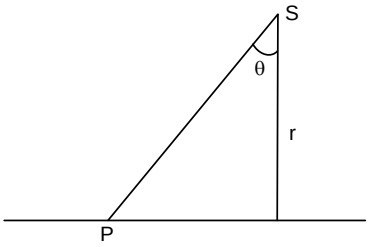
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

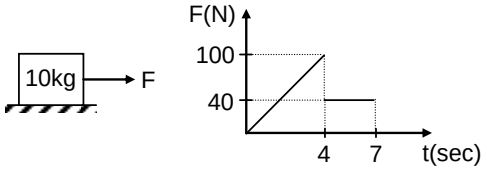
1. A spotlight S rotates in a horizontal plane with angular velocity 'ω'. The spot of light P moves along the rough vertical wall at a distance of 'r'. An insect of mass 'm' is crawling on the wall. And spot light is always focused on the insect.



(A) The centripetal force on the insect is $m\omega^2 r \sec\theta$.
(B) The centripetal force on the insect is zero.
(C) The magnitude of force exerted by the wall on the insect along the wall $m[g^2 + 4r^2\omega^4\sec^4\theta \tan^2\theta]^{1/2}$.
(D) The net force on the insect is not along the wall.

1. **BC**

2. The 10 kg block is resting on a horizontal surface when the force F is applied to it for 7 sec. The variation of force F with time is shown in the graph. The co-efficient of static and kinetic friction are both 0.50. ($g = 10\ m/s^2$)



(A) The maximum velocity reached by block during motion is 5 m/s.
(B) The maximum velocity reached by the block during motion is 16 m/s.
(C) The total time t during which the block is in motion is 7.4 sec.
(D) The total distance travelled during the motion is 37m.

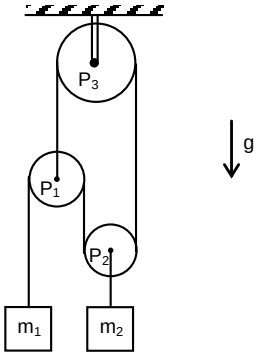
2. **AC**

3. A strip of wood of mass M and length l is placed on a smooth horizontal surface. An insect of mass m starts at one end of the strip and walks to the other end in time t, moving with a constant speed.

(A) The speed of the insect as seen from the ground is $< \frac{l}{t}$
(B) The speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{m}{M+m}\right)$
(C) The speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{M}{M+m}\right)$
(D) The total kinetic energy of the system is $\frac{1}{2}\frac{Mm}{m+M}\left(\frac{l}{t}\right)^2$

3. **ABD**

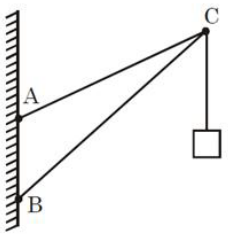
4. As situations shown in figure all pulleys and strings are massless and frictionless. The system is released from rest. Take g is the acceleration due to gravity in vertically downward direction.



(A) The acceleration of pulley P_1 will be g downward
(B) The acceleration of pulley P_1 will be 3g downward
(C) The acceleration of pulley P_2 will be zero
(D) The acceleration of pulley P_2 will be g downward

4. **BD**

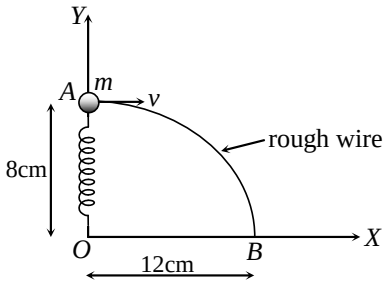
5. Find the forces in the hinged rods BC and AC, if AB = 60 cm, AC = 1.2 m, BC = 1.6 m (see figure). Hanging mass has a mass of 50 kg, the mass of the rods can be neglected. C is hinge.



(A) AC is in tension with force of 1000 N.
(B) AC is in tension with force of 4000/3 N.
(C) BC is in compression with force of 4000/3 N.
(D) BC is in compression with force of 400 N.

5. **AC**

6. A ring of mass 200 gram is attached to one end of a light spring of force constant 100 N/m and natural length 10 cm. The ring is constrained to move on a rough wire in the shape of quarter ellipse of major axis 24 cm and minor axis 16 cm with its centre at origin. The plane of ellipse is vertical and wire is fixed at points A and B as shown in figure. Initially ring is at A with other end of spring fixed at origin. If normal reaction of wire on ring at A is zero and ring is given a horizontal velocity of 10 m/s towards right so that it just reaches point B, then select the correct alternative (s) ($g = 10\ m/s^2$)



(A) Work done by friction is –10 Joule.
(B) At B energy stored in spring is more than energy stored at A.
(C) Work done by friction is –10.16 Joule.
(D) Work done by spring force is positive.

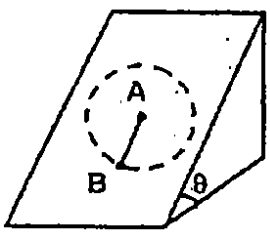
6. **C**

PART – B

Integer Answer Type

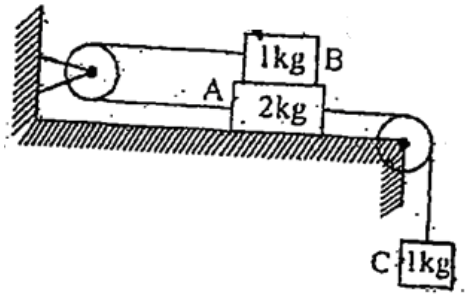
This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. Two particles A and B of same mass are connected by means of light inextensible string of length l and kept on an inclined plane of inclination θ($\sin\theta = 3/5$). The coefficient of friction between A and the plane is μ where as no friction act between B and the inclined plane. B is projected with some speed to complete the circle on the inclined pane. The minimum value of μ for the completion of circle is 21/n . Find the value of n.



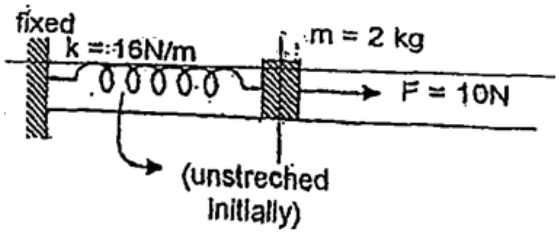
7. **4**

8. Friction coefficient between any two surfaces in contact is 0.2. Pulleys and strings are frictionless. Find the friction between blocks A and B (in Newton).



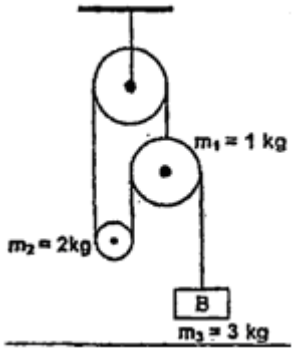
8. **2**

9. A spring-block system is placed on a smooth horizontal plane as shown. What initial velocity (in m/s) should be given to the block along the direction parallel to the force as shown in the figure, simultaneously when the force is applied so that the maximum elongation occurred in the spring is twice of the maximum compression occurred in it?



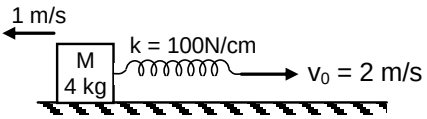
9. **5**

10. In the given system which mass (in kg) will move with acceleration greater than acceleration due to gravity (g).



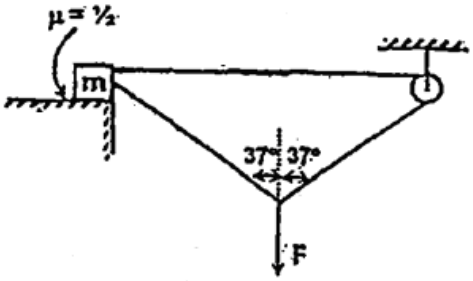
10. **1**

11. The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed v_0 = 2 m/s. At t = 0 sec, the spring of constant k = 100 N/cm is unstretched and the block has a speed 1 m/s to left. The maximum extension of the spring (in cm) is



11. **6**

12. A string is connected to block of mass m=1.2 kg placed over rough table surface as shown in the figure. Calculate minimum vertical force F(in Newton) required to move the block. Pulley and the string are ideal and coefficient of friction between the block and the table surface is ½. Take g = 10 m/s^2.

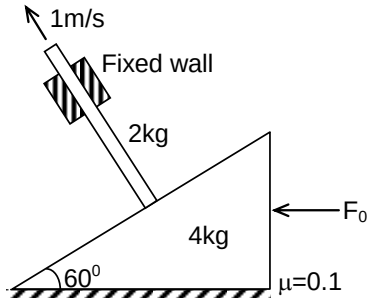


12. **8**

PART – C
(Numerical based)

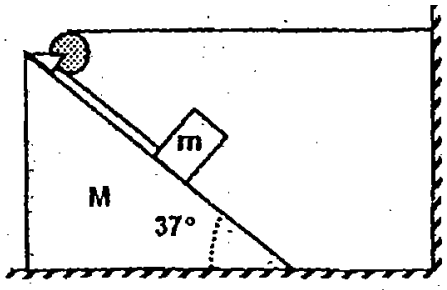
This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. A rod of mass 2kg is constrained to move perpendicular to inclined plane of wedge which is placed on rough horizontal surface having friction coefficient μ = 0.1. A constant force F_0 is applied on the wedge of mass 4 kg in such a way that the rod moves with constant velocity 1 m/s along the wall. The power delivered by F_0 (in watts) is



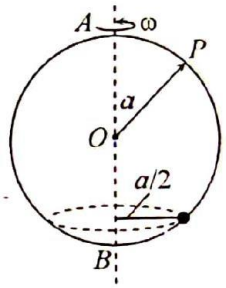
13. **15.19**
Range: 15.10 to 15.20

14. A block of mass m = 5kg is placed on the wedge of mass M=32 kg as shown in the figure. Find the acceleration of the wedge with respect to ground(in m/s2). (Neglect any type of friction. String and pulley are ideal).



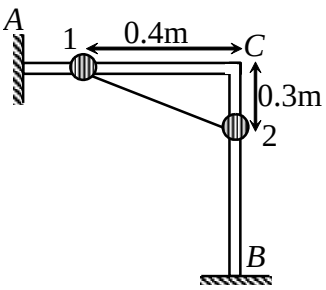
14. **0.60**

15. A smooth wire is bent into a vertical circle of radius a. A bead P can slide smoothly on the wire. The circle is rotated about diameter AB as axis with a speed ω as shown in figure. The bead P is at rest with respect to the circular ring in the position shown. Then the square of angular velocity of the frame is equal to(take a= 1 m)



15. **11.55**

16. Two identical beads of m = 100 gram are connected by an inextensible massless string can slide along the two arms AC and BC of a rigid smooth wire frame in a vertical plane. If the system is released from rest, the kinetic energy of the first particle when they have moved by a distance of 0.1 m is $x \times 10^{-3}$ J. Find the value of x. (g = 10 m/s^2)

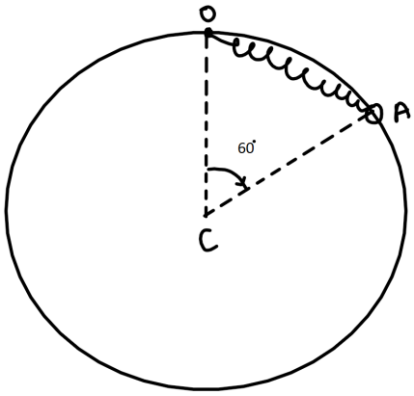


16. **64**

17. A horse pulls a wagon of 5000 kg from rest against a constant resistance of 90 N. The pull exerted initially is 600 N and it decreases uniformly with the distance covered to 400 N at a distance of 15 m from start. Find the velocity of wagon at this point.

17. **1.57 m/s**

18. A bead of mass 5 kg is free to slide on a smooth ring of radius r = 20 cm fixed in a vertical plane. The bead is attached to one end of a spring. Initially the bead is held at the rest at point A of the ring such that angle OCA = 60, C being the centre of the ring. The natural length of the spring is also equal to r. After the bead is released and slides down the ring, the contact force between the bead and the ring becomes zero when it reaches the lowest position B. Find the force constant of the spring in N/m.



18. **500**

SECTION-2 : CHEMISTRY

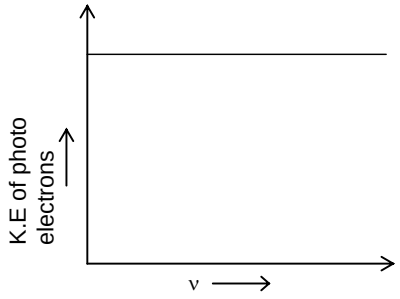
PART – A

(Multi Correct Choice Type)

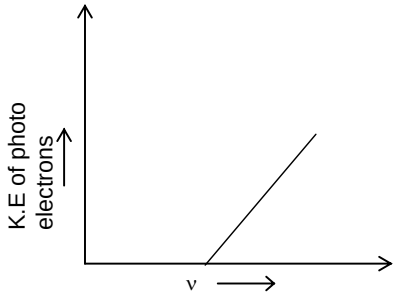
This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which is/are correct graph in photoelectric effect?

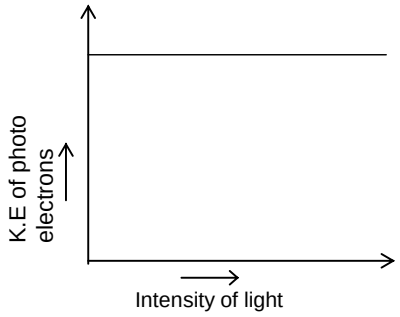
(A)



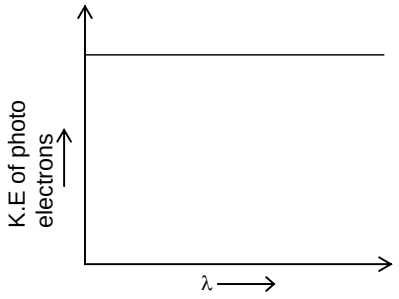
(B)



(C)



(D)



1. BC

2. Correct properties of wave function(Ψ) is/are
   (A) Ψ must be continuous
   (B) Ψ must be finite
   (C) Ψ must be single valued
   (D) The probability of finding the electron overall the space from + infinity to – infinity must be equal to 1
2. ABCD

3. The correct statement is/are
   (A) ionisation energy usually increases down the group
   (B) reactivity of s-block metal increases down the group
   (C) inert pair effect in 'p-block' elements usually increases down the group
   (D) group-16 is commonly known as chalcogen
3. ABCD

4. Correctly match property for 'd' block elements.
   (A) Cr show highest oxidation state for metal fluoride
   (B) W(Tungsten is the metal) which has highest melting point
   (C) Usually stability of highest oxidation state gradually increases down the group
   (D) Zinc is a transition metal
4. ABC

5. The first (Δ_1H_1) and second (Δ_1H_2) ionization enthalpies (in kJ mol^{-1}) and the ($\Delta_{eg}H$) electron gain enthalpy (in kJ mol^{-1}) of a few elements are given below:

Elements	ΔH_1	ΔH_2	$\Delta_{eg}H$
I	520	7300	-60
II	419	3051	-48
III	1681	3374	-328
IV	1008	1846	-295
V	2372	5251	+48
VI	738	1451	-40

Which of the above elements is likely to be
(A) the least reactive element is element V
(B) the most reactive metal is element II
(C) the most reactive non-metal is element III
(D) the metal which can form a stable binary halide of the formula MX_2(X = halogen) is element VI

5. ABCD

6. $\psi = \frac{1}{162}\left(\frac{1}{\pi a_0^3}\right)^{1/2} P^2 e^{-P/3} \sin^2\theta\, e^{i2\phi}$

Where $P = \frac{r}{a_0}$ and a_0 = bohr radius

Correct statement about above schrodinger wave equation
(A) for 'p' subshell (B) for 'd' sub-shell
(C) total no. of angular nodes will be 2 (D) it has no radial node

6. BCD

PART – B

Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. If magnetic moment of Cr^{x+} ion is 1.73 B.M. Value of x is

7. 5

8. When platinum is dissolved in aqua regia the oxidation number of platinum in the product is expressed as +x, what is x.

8. 4

9. Maximum number of electrons with $n + \ell = 5$, $|m| = 1$ and $s = \pm\frac{1}{2}$.

9. 8

10. The radial distribution curve of the orbital with double dumbbell shape in the fourth principal shell consists of 'n' nodes, n is

10. 1

11. If an element is having atomic no. 100, then its group number in periodic table will be

11. 3

12. The most common oxidation number of f-block element is

12. 3

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. What is the ratio of $\frac{\text{No. of correct statements}}{\text{No. of incorrect statements}}$

(i) Metallic radius of group 13 is in the order of B < Al > Ga < In < Tl
(ii) Ionisation energies of group 13 is in the order of B > Al < Ga > In < Tl
(iii) Ionisation power of halogens are in the order of $F_2 > Cl_2 > Br_2 > I_2$
(iv) Oxidising power of halogens are in the order of $F_2 > Cl_2 > Br_2 > I_2$
(v) Electronegativity of halogens are in the order of F > Cl > Br > I
(vi) Electron affinity are in the order of F > Cl > Br > I
(vii) Reactivity of 'p' block elements usually increases down the group
(viii) Reactivity of 'd' block elements usually increases down the group
(ix) Li is the only alkali metal which form nitride when react with N_2.

13. 3.50

14. $^{238}_{92}U$ is a radioactive and it emits α and β particles to form $^{206}_{82}Pb$. Calculate ratio of $\frac{\text{no. of } \alpha - \text{particles emitted}}{\text{no. of } \beta - \text{particles emitted}}$ in this conversion

14. 1.33

15. An electron in a hydrogen atom in its ground state absorbs 1.5 times as much energy as the minimum required escape from the atom. The velocity of the emitted electron is $X \times 10^6$ m/s. X is

15. 1.54
Range 1.53 to 1.55

16. The sum of the number of neutrons and protons in the isotope of hydrogen is

16. 6.00

17. What is the magnitude of potential energy in electron volt present in N-shell of the Be^{3+} ion?

17. 27.20

18. In a sample of H atoms, electron are de-excited form a level 'n' to ground state. Total number of Lyman lines emitted are 3. If the electron are ionized from this level 'n' by a photon of 15 eV. Then kinetic energy of emitted photon is 'x' eV. Find x?

18. 14.15

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. If one vertex of an equilateral triangle of side 'a' lies at the origin and the other lies on the line $x-\sqrt{3}y=0$ then the co – ordinates of the third vertex are :

(A) (0, a) (B) $\left(\frac{\sqrt{3}a}{2},-\frac{a}{2}\right)$

(C) (0, –a) (D) $\left(-\frac{\sqrt{3}a}{2},\frac{a}{2}\right)$

1. **ABCD**

2. If $\frac{x}{c}+\frac{y}{d}=1$ is a line through the intersection of $\frac{x}{a}+\frac{y}{b}=1$ and $\frac{x}{b}+\frac{y}{a}=1$ and the lengths of perpendiculars drawn from the origin to these lines are equal in lengths then:

(A) $\frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{c^2}+\frac{1}{d^2}$ (B) $\frac{1}{a^2}-\frac{1}{b^2}=\frac{1}{c^2}-\frac{1}{d^2}$

(C) $\frac{1}{a}+\frac{1}{b}=\frac{1}{c}+\frac{1}{d}$ (D) none

2. **AC**

3. If $a^2+9b^2-4c^2=6ab$ then the family of lines $ax+by+c=0$ are concurrent at :

(A) $\left(\frac{1}{2},\frac{3}{2}\right)$ (B) $\left(\frac{-1}{2},\frac{-3}{2}\right)$

(C) $\left(\frac{-1}{2},\frac{3}{2}\right)$ (D) $\left(\frac{1}{2},\frac{-3}{2}\right)$

3. **CD**

4. Tangents PA and PB are drawn to the circle $S=x^2+y^2-2y-3=0$ from the point P(3, 4). Which of the following alternative(s) is/are correct?

(A) The power of point P (3, 4) with respect to circle S = 10 is 14.

(B) The angle between tangents from P (3, 4) to the circle S = 0 is $\frac{\pi}{3}$

(C) The equation of circum circle of ΔPAB is $x^2+y^2-3x-5y+4=0$

(D) The area of quadrilateral PACB is $3\sqrt{7}$ square units where C is the centre of circle S = 0.

4. **AC**

5. The equation of a circle C_1 is $x^2+y^2+14x-4y+28=0$. The locus of the point of intersection of orthogonal tangent to C_1 is the curve C_2 and the locus of the point of intersection of perpendicular tangents to C_2 is the curve C_3 then the statement(s) which hold good?
(A) C_3 is a circle
(B) Area enclosed by C_3 is 100π sq. units
(C) Area of C_2 is $\sqrt{2}$ times the area of C_1.
(D) C_2 and C_3 are concentric circles.

5. **ABD**

6. Let RS be the diameter of the circle $x^2+y^2=1$, where S is the point $(1,0)$. Let P be a variable point(other than R and S) on the circle and tangents to the circle at S and P meet at the point Q. The normal to the circle at P intersects a line drawn through Q parallel to RS at point E. Then the locus of E passes through the point(s)
(A) $\left(\frac{1}{3},\frac{1}{\sqrt{3}}\right)$ (B) $\left(\frac{1}{4},\frac{1}{2}\right)$ (C) $\left(\frac{1}{3},-\frac{1}{\sqrt{3}}\right)$ (D) $\left(\frac{1}{4},-\frac{1}{2}\right)$

6. **AC**

PART – B
Integer Answer Type

This section contains **6 questions**. The answer to each of the questions is a single digit integer, ranging from **0 to 9**.

7. Let $S_1=0$ and $S_2=0$ be two circles intersecting at P (6, 4) and both are tangent to x – axis and line y = mx (where m > 0). If product of radii of the circle $S_1=0$ and $S_2=0$ is $\frac{52}{3}$, then the value of m^2 equals ____

7. **3**

8. If $16\ell^2+9m^2=24\ell m+6\ell+8m+1$ then find the radius of the circle which has the line $\ell x+my+1=0$ as its tangent.

8. **5**

9. The straight line $y=mx+c$ bisects the perimeter and the area of the triangle formed by the line $6x+8y=48$ and the co-ordinate axes. Then the value of $c+2m$ equals

9. **2**

10. Six points $(x_i, y_i), i=1,2,...,6$ are taken on the circle $x^2+y^2=4$ such that $\sum_{i=1}^{6}x_i=8$ and $\sum_{i=1}^{6}y_i=4$. The line segment joining orthocentre of the triangle made by any three points and the centroid of triangle formed by the other three points passes through a fixed point (h,k), then find the value of $h+k$.

10. **3**

11. A circle C_1 having its centre P on the x-axis passes through the centre of the circle **C:** $x^2 + y^2 = 1$. A common tangent to C_1 and **C** touches the circles at Q and R respectively. If the co-ordinates of the point Q be (h, k) then $h^2 =$ ____ .

11. **1**

12. If $x, y \in R$ what is the minimum value of

$$f(x,y) = \sqrt{4+y^2} + \sqrt{(x-2)^2 + (2-y)^2} + \sqrt{(4-x)^2 + 1}$$

12. **5**

PART – C
(Numerical based)

This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. Consider the circles, $x^2 + y^2 = 25$ and $x^2 + y^2 = 9$. From the point A (0, 5) two segments are drawn touching the inner circle at the points B and C while intersecting the outer circle at the points D and E. Then the length of the segment DE is _____

13. **1.4**

14. It is desired to construct a right – angled triangle ABC $\left(\angle C = 90^o\right)$ such that the two perpendicular sides are parallel to the co – ordinate axes. If the medians through A and B are respectively $y = 3x + 1$ and $y = mx + 2$, and if possible values of m be m_1 and m_2 then the value of $\sqrt{m_1 m_2}$ equals _____

14. **3**

15. Real number x, y satisfies $x^2 + y^2 = 1$. If the maximum and minimum value of the expression $z = \dfrac{4-y}{7-x}$ are M and m respectively, then find the value $(2M + 6m)$.

15. **4**

16. The parallelogram is bounded by the lines $y = ax + c;\ y = ax + d;\ y = bx + c$ and $y = bx + d$ and has the area equal to 18. The parallelogram bounded by the lines $y = ax + c;\ y = ax - d;\ y = bx + c$ and $y = bx - d$ has area 72. Given that a, b, c and d are positive integers, find the smallest possible value of $(a + b + c + d)$.

16. **16**

17. In a ΔABC, vertex A and B lie on x – axis and y – axis respectively, where A (a, 0) and B is a variable point such that $\angle C = \tan^{-1}\left(\dfrac{4}{3}\right)$ and AC = BC, and if locus of C is $\lambda x - \mu y + 3a = 0$ then $\lambda + \mu$ equals____.

17. **6**

18. In ΔABC, right angled at C at AB = 60 and medians BE and AD are $y = x + 3$ and $y = 2x + 4$. Determine area of ΔABC.

18. **400**

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B