

**PHYSICS, CHEMISTRY & MATHEMATICS**

Pattern - CPT-1

QP Code:

PAPER - 1

Time Allotted: 3 Hours

Maximum Marks: 183

- 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 **Two Parts: Part-A & B** 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 Two Parts.**

- (i) **Part-A (01-07)** – Contains seven (07) 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: –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.
- (i) **Part-A (08-13)** – Contains six (06) multiple choice questions which have **ONLY ONE CORRECT** answer  
Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.
- (ii) **Part-B (01-05)** contains five (05) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer and **there will be no negative marking**.

Name of the Candidate : \_\_\_\_\_

Batch : \_\_\_\_\_ Date of Examination : \_\_\_\_\_

Enrolment Number : \_\_\_\_\_

# SECTION-1 : PHYSICS

## PART – A

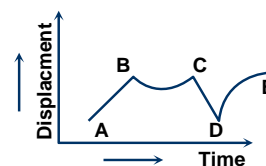
### (Multi Correct Choice Type)

This section contains 7 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which of the following statements are true for a moving body?
- (A) If its speed changes, its velocity must change and it must have some acceleration.  
 (B) If its velocity changes, its speed must change and it must have some acceleration.  
 (C) If its velocity changes, its speed may or may not change, and it must have some acceleration.  
 (D) If its speed changes but direction of motion does not change, its velocity may remain constant.

1. **AC**

2. The figure shows the displacement of a particle, moving along X-axis, as a function of time. The force acting on the particle is zero in the region.



- (A) AB (B) BC  
 (C) CD (D) DE

2. **AC**

3. The potential energy of a particle of mass 0.1 kg, moving along the x-axis, is given by  $U = 5x(x-4)$  J, where x is in meters. It can be concluded that

- (A) The particle is acted upon by a variable force.  
 (B) The minimum potential energy during motion is  $-20$  J  
 (C) The speed of the particle is maximum at  $x = 2$  m.  
 (D) The motion of the particle is periodic.

3. **ABCD**

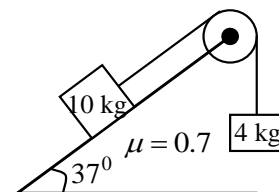
4. A particle of mass m moved on the x-axis as follows: it starts from rest  $t = 0$  from the point  $x = 0$ , and comes to rest at  $t = 1$  at the point  $x = 1$ . No other information is available about its motion at intermediate times ( $0 < t < 1$ ). If  $\alpha$  denotes the instantaneous acceleration of the particle, then

- (A)  $\alpha$  cannot remain positive for all t in the interval  $0 \leq t \leq 1$   
 (B)  $|\alpha|$  cannot exceed 2 at any point in its path  
 (C)  $|\alpha|$  must be  $\geq 4$  at some point or points in its path  
 (D)  $\alpha$  must change sign during the motion, but no other assertion can be made with the information given

4. **AC**

5. In the arrangement shown in figure, which statement(s)

is/are true  $\left[ \sin 37^\circ = \frac{3}{5} \text{ and } \cos 37^\circ = \frac{4}{5} \right]$



- (A) direction of force of friction is up the plane.  
 (B) the magnitude of force of friction is zero.  
 (C) the tension in the string is 40 N.  
 (D) magnitude of force of friction is 56 N.

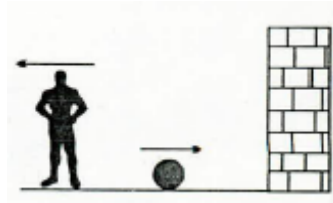
5. **AC**

6. Two balls of equal masses are thrown simultaneously in vertical upward direction with same speeds 10 m/s and 20 m/s. Which of the following is true about maximum height reached by centre of mass?

- (A) it is equal to mean of the maximum height reached by the balls.  
 (B) it is less than the mean of maximum height reached by the balls.  
 (C) it is more than the mean of maximum height reached by the balls.

- (D) acceleration of centre of mass of balls is  $g$  till first ball strikes the ground.
6. **BD**

7. A man of mass  $M$  is carrying a ball of the mass  $M/2$ . The man is initially in the state of rest at a distance  $D$  from fixed vertical wall. He throws the ball towards the wall with a velocity  $V$  with respect to earth at  $t = 0$ . As a result of throwing, the man also starts moving backward. The ball rebounds elastically from the wall. The man finally collects the ball. Assuming friction to be absent.



- (A) The velocity of the man + ball system after the man has collected the ball is  $\frac{2V}{3}$
- (B) Impulse by the ball on man is  $\frac{MV}{3}$
- (C) Impulse by the ball on man is  $\frac{MV}{6}$
- (D) He catches the ball again at  $t = \frac{4D}{V}$
7. **ACD**

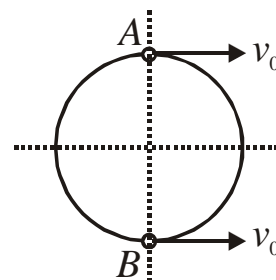
### (Single Correct Choice Type)

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

8. Twelve persons are initially at the twelve corners of a regular polygon of twelve sides of side  $a$ . Each person now moves with uniform speed  $V$  in such a manner that 1 is always directed towards 2, 2 towards 3, 3 towards 4 and so on. The distance travelled by each person before they meet is
- (A)  $\frac{2a}{2 + \sqrt{3}}$       (B)  $\frac{2a}{2 - \sqrt{3}}$       (C)  $\frac{2a}{\sqrt{3}}$       (D)  $\frac{a}{2 + \sqrt{3}}$

8. **B**

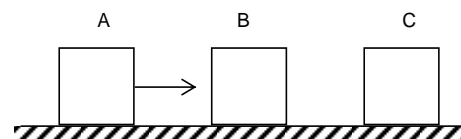
9. A fixed ring of mass  $m$  has two beads A, B of mass  $m$  each; both being able to slide on the ring without friction. Initially the ring lies on a frictionless horizontal table and the beads are given velocities  $v_0$ , relative to the ring, in the same direction. The initial relative acceleration of the beads (w.r.t. each other)



- (A) zero      (B)  $\frac{v_0^2}{R}$
- (C)  $\frac{2v_0^2}{R}$       (D)  $\frac{v_0^2}{2R}$
- (where  $R$  is the radius of the ring)

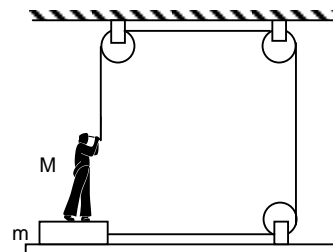
9. **C**

10. Three identical blocks A, B and C are placed on horizontal frictionless surface. The blocks B and C are at rest. But A is approaching towards B with a speed  $10$  m/s. The coefficient of restitution for all collisions is  $0.5$ . The speed of the block C just after collision is



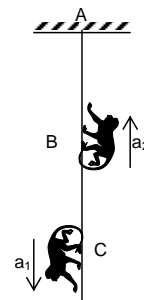
- (A)  $5.6$  m/s  
 (B)  $6$  m/s  
 (C)  $8$  m/s  
 (D)  $10$  m/s
10. **A**

11. The friction coefficient between the board and the floor shown in figure is  $\mu$ . The maximum force that the man can exert on the rope so that the board does not slip on the floor is



- (A)  $\frac{\mu}{1+\mu} (M+m)g$  (B)  $\frac{\mu}{1+\mu} (M-m)g$   
 (C)  $\mu \frac{M}{m} g$  (D)  $\mu \frac{m}{M} g$
11. **A**

12. Two monkeys each of mass  $m$  move with acceleration  $a_1 = a_2 = \frac{g}{2}$  relative to the light inextensible string as shown in the figure. The ratio of tensions in the portions AB and BC of the string is



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

12. **C**

13. **Statement-1:**

When one object collides with another object, the impulse during deformation and restitution will be in same direction.

**Statement-2:**

Due to this impulse the objects first deform and due to the same impulse they again try to regain its original shape.

- (A) If both the Statements are True and Statement-2 is the correct explanation of Statement-1.  
 (B) If both the Statements are True but Statement-2 is not the correct explanation of Statement-1.  
 (C) If Statement-1 is True and Statement-2 is false.  
 (D) If Statement-1 is False and Statement-2 is True.

13. **C**

**PART – B**  
**(Numerical based)**

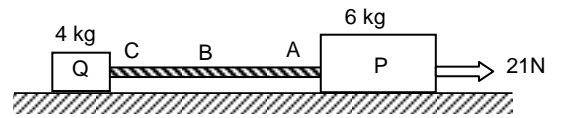
1. The motion of a body is given by

$$\frac{dv(t)}{dt} = 6 - 3v(t)$$

Where  $v(t)$  is the velocity (in  $\text{ms}^{-1}$ ) of the body at time  $t$  in second. If the body was at rest at  $t = 0$ , its velocity is  $4n$  (in  $\text{ms}^{-1}$ ) when the acceleration is half the initial value. Find the value of 'n'.

1. **0.25**

2. Two blocks of masses 6 kg and 4 kg connected by a rope of mass 4 kg are resting on frictionless floor as shown. If a constant force of 21 Newton is applied to 6 kg block, tension (In N) in the rope at point B is (CB : BA = 1 : 1)

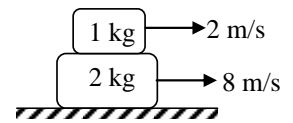


2. **9**

3. A force  $\vec{F} = (-y\hat{i} + x\hat{j})$  N acts on a particle as it undergoes counterclockwise circular motion in x-y plane in a circle of radius 4 m and with the centre at origin. The work done by the force when the particle undergoes one complete revolution is (assume x, y are in m)  $p \times 4\pi$  Joule, then p is

3. **8**

4. Coefficient of friction between two blocks shown in figure is  $\mu = 0.4$ . Floor is smooth. The blocks are given velocities of 2 m/s and 8 m/s in the directions shown in figure at  $t = 0$ . The time when relative motion between them will stop is  $2n$  (in sec.). Find the value of 'n'.



4. **0.50**

5. A particle of mass  $m$  is fixed to one end of a light rigid rod of length  $\ell$  and rotated in a vertical circular path about its other end. The minimum speed of particle at its lowest point is  $\sqrt{5KgL}$ . Find the value of 'K'.

5. **0.20**

## **SECTION-2 : CHEMISTRY**

### **PART – A**

#### **(Multi Correct Choice Type)**

This section contains 7 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which of the following substance(s) form(s)  $\text{CO}_2$  gas upon simple heating?  
 (A)  $\text{Na}_2\text{CO}_3$  (B)  $\text{Li}_2\text{CO}_3$   
 (C)  $\text{NaHCO}_3$  (D)  $\text{LiHCO}_3$

1. **BCD**

2. Which of the following species contain(s) eight electrons in its/their valence shell(s)?  
 [At. No. of Na = 11, S = 16, Mg = 12 & C = 6]  
 (A)  $\text{Na}^+$  (B)  $\text{S}^{2-}$   
 (C)  $\text{Mg}^{2+}$  (D)  $\text{C}^{4-}$

2. **ABCD**

3. Which of the following statement(s) is/are correct for oxygen atom? (At. No. = 8)  
 (A) It contains four electrons with  $l = 0$  and  $m = 0$   
 (B) It contains one unpaired electron in the 2p sub-shell  
 (C) It attains a half-filled electron configuration by losing one electron  
 (D) One of its isotope contains 9 protons

3. **AC**

4. Which of the following molecule(s) do/does not follow the Octet rule?  
 (A)  $\text{SF}_4$  (B)  $\text{CF}_4$   
 (C)  $\text{SiF}_4$  (D)  $\text{BF}_3$

4. **AD**

5. The dipole moment of which of the following substance(s) is/are higher than that of  $\text{CO}_2$ ?  
 (A)  $\text{HCl}$  (B)  $\text{SCl}_2$   
 (C)  $\text{BeCl}_2$  (D)  $\text{PF}_3$

5. **ABD**

6. Which of the following electronic transition(s) in hydrogen atom take(s) place in visible region of the spectrum?  
 (A)  $n = 2 \rightarrow n = 1$  (B)  $n = 3 \rightarrow n = 2$   
 (C)  $n = 4 \rightarrow n = 2$  (D)  $n = 4 \rightarrow n = 3$

6. **BC**

7. Which of the following characteristic(s) about magnesium atom is/are correct?  
 (A)  $I.E_2 > I.E_1$   
 (B)  $r_{\text{Mg}^+} > r_{\text{Mg}^{2+}}$   
 (C) Number of electrons with  $l = 0$  is same as the number of electrons with  $l = 1$   
 (D) It may contain six electrons with  $s = +\frac{1}{2}$

7. **ABCD**

**(Single Correct Choice Type)**

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

8. How many maximum number of electrons will have the following set of quantum numbers?

$$n = 4$$

$$l = 0, 1, 2$$

$$m = 0, \pm 1$$

$$s = \pm \frac{1}{2}$$

(A) 16

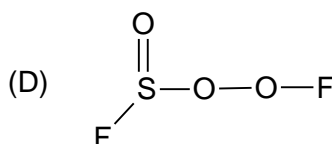
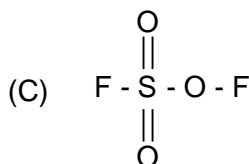
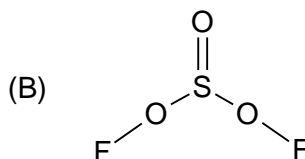
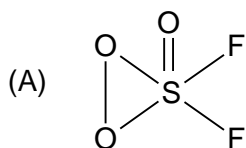
(B) 14

(C) 18

(D) 12

8. **B**

9. The most stable structure of  $\text{SO}_3\text{F}_2$  is



9. **C**

10.  $2\text{POCl}_3(\text{g}) \rightleftharpoons 2\text{PCl}_3(\text{g}) + \text{O}_2(\text{g})$

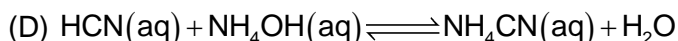
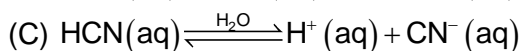
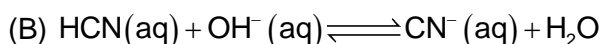
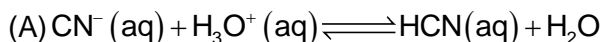
Initially one mole of  $\text{POCl}_3$  was taken in a one litre vessel. What will be the equilibrium constant  $K_C$  of the reaction, if the equilibrium concentration of  $\text{POCl}_3$  and  $\text{PCl}_3$  are same?

(A)  $4 \text{ mol L}^{-1}$ (B)  $\frac{1}{2} \text{ mol L}^{-1}$ (C)  $\frac{1}{4} \text{ mol L}^{-1}$ (D)  $2 \text{ mol L}^{-1}$ 

10. **C**

11.  $\text{CN}^-(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{HCN}(\text{aq}) + \text{OH}^-(\text{aq})$

The equilibrium constant of above reaction is  $10^{-4}$ . For which of the following reaction, the equilibrium constant will be  $10^{-10}$ ?



11. **C**

12. Which of the following can absorb moisture from atmosphere?

(A) NaCl

(B) NaOH

(C) NaBr

(D)  $\text{NaNO}_3$ 

12. **B**

13. Which of the following is not a property of  $\text{H}_2\text{O}_2$ ?
- (A) It decomposes before boiling (B) It decolourise certain colour substances  
(C) It oxidizes  $\text{KNO}_3$  to  $\text{KNO}_2$  (D) It produces  $\text{I}_2$ , upon reaction with KI
13. **C**

**PART – B**  
**(Numerical based)**

1. How many radial node(s) is/are associated with the orbital of potassium, that contains its most energetic electron?
1. **3**
2.  $\text{X} + \text{Y} \longrightarrow \text{Product}$   
The rate of above reaction increases by four times if the concentration of both X and Y are doubled, what is the overall order of the reaction?
2. **2**
3. What is the pH of  $10^{-4}$  M aqueous solution of  $\text{HNO}_3$ ?
3. **4**
4. 
$$\text{Na}_2\text{O}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + (\text{X})$$

$$\text{PbSO}_4 \longleftarrow \text{PbS}$$
- How many polar covalent bond(s) is/are present in one molecule of (X)?
4. **2**
5. What is the pH of 0.1 M  $\text{NH}_4\text{NO}_3$  solution?  
[ $K_b$  of  $\text{NH}_4\text{OH} = 10^{-5}$ ]
5. **5**



## **SECTION-3 : MATHEMATICS**

### **PART – A**

#### **(Multi Correct Choice Type)**

This section contains 7 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Let  $f(x) = \begin{cases} 0, & \text{for } x = 0 \\ x^2 \sin\left(\frac{\pi}{x}\right), & \text{for } -1 < x < 1, (x \neq 0) \\ x|x|, & \text{for } x \geq 1 \text{ or } x \leq -1 \end{cases}$

then

- (A)  $f(x)$  is an odd function                      (B)  $f(x)$  is an even function  
 (C)  $f(x)$  is neither odd nor even              (D)  $f'(x)$  is an even function

1. AD

2. Which of the following function(s) has/have the same range?

- (A)  $f(x) = \frac{1}{1+x}$     (B)  $f(x) = \frac{1}{1+x^2}$   
 (C)  $f(x) = \frac{1}{1+\sqrt{x}}$     (D)  $f(x) = \frac{1}{\sqrt{3-x}}$

2. BC

3. Let  $h(x) = f(x) - (f(x))^2 + (f(x))^3$  for every real number  $x$ , then

- (A)  $h$  is increasing when ever  $f$  is increasing  
 (B)  $h$  is increasing when ever  $f$  is decreasing  
 (C)  $h$  is decreasing whenever  $f$  is decreasing  
 (D) nothing can be said general

3. AC

4. If  $\lim_{x \rightarrow \infty} 4x \left( \frac{\pi}{4} - \tan^{-1} \frac{x+1}{x+2} \right) = y^2 + 4y + 5$ , then  $y$  can be equal to

- (A) 1    (B) -1  
 (C) -4    (D) -3

4. BD

5. Which of the following functions is (are) injective (one-one)

- (A)  $f(x) = |x+1|, x \in [-1, \infty)$                       (B)  $f(x) = x + \frac{1}{x}, x \in (0, \infty)$   
 (C)  $f(x) = x^2 + 4x - 5, x \in (0, \infty)$               (D)  $f(x) = e^{-x}, x \in [0, \infty)$

5. ACD

- 6 The function  $f(x) = \begin{cases} 5x - 4 & \text{for } 0 < x \leq 1 \\ 4x^2 - 3x & \text{for } 1 < x < 2 \\ 3x + 4 & \text{for } x \geq 2 \end{cases}$
- (A) continuous at  $x=1$  and  $x=2$   
 (B) continuous at  $x=1$  but not derivable at  $x=2$   
 (C) continuous at  $x=2$  but not derivable at  $x=1$   
 (D) continuous at  $x=1$  and  $2$  but not derivable at  $x=1$  and  $x=2$
- 6 AB
- 7 The value of  $\int_0^1 \cot^{-1}(1+x^2-x) dx$  is
- (A)  $\frac{\pi}{2} - \log 2$  (B)  $\pi - \log 2$   
 (C)  $\frac{\pi}{4} - \log 2$  (D)  $2 \int_0^1 \tan^{-1} x dx$
- 7 AD

**(Single Correct Choice Type)**

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

8. The domain of the function  $\sqrt{x^2 - [x]^2}$ , where  $[x]$  is greatest integer function, is
- (A) any +ive number (B) any -ive number  
 (C) any +ive number or -ive integer (D) none
8. C
9. If  $f(x) = x^3 + bx^2 + cx + d$  and  $0 < b^2 < c$ , then in  $(-\infty, \infty) f(x)$
- (A) is increasing (B) has local maxima  
 (C) is decreasing (D) is bounded
9. C
10. If  $0 < a < b$ , then  $\lim_{n \rightarrow \infty} (b^n + a^n)^{1/n}$  is equal to
- (A) e (B) a  
 (C) b (D) none of these
10. C
11. If the function  $f(x) = \begin{cases} \left(1 + |\sin x|^{\frac{a}{|\sin x|}}\right), & -\frac{\pi}{6} < x < 0 \\ b, & x = 0 \\ e^{\frac{\tan 2x}{\tan 3x}}, & 0 < x < \frac{\pi}{6} \end{cases}$  is continuous at  $x = 0$ , then
- (A)  $a = \log_e b, a = \frac{2}{3}$  (B)  $b = \log_e a, a = \frac{2}{3}$   
 (C)  $a = \log_e b, b = 2$  (D) none of these
11. A

12. If  $I_n = \int_0^{\pi/4} \tan^n x \, dx$ , then

(A)  $I_{10} + I_8 = \frac{1}{9}$

(B)  $I_5 + I_7 = \frac{1}{5}$

(C)  $I_{12} + 2I_{10} + I_8 = \frac{20}{61}$

(D)  $I_8 - I_{12} = \frac{2}{77}$

12. A

13. If  $\int \frac{\log(x + \sqrt{1+x^2})}{\sqrt{1+x^2}} dx = (f \circ g)x + c$  then the functions  $f$  and  $g$  are respectively

(A)  $\log \sqrt{1+x^2}, x$

(B)  $\log(x + \sqrt{1+x^2}), x^2$

(C)  $\frac{x^2}{2}, \log(x + \sqrt{1+x^2})$

(D) none

13. C

### PART – B (Numerical based)

1. If the greatest value of  $y = \frac{x}{\log x}$  on  $[e, e^3]$  is  $u$  then  $\frac{e^3}{u}$  is equal to \_\_\_\_\_

1. 3

2. If  $f(x)$  is a polynomial satisfying  $f(x) \cdot f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right)$ , and  $f(3) = 28$ , and  $f(4)$  is given by  $K$  then  $\frac{K}{13}$  equals to

2. 5

3. If  $I = \int \frac{x^5}{\sqrt{1+x^3}} dx$ , then  $I$  is equal to  $\frac{k}{9} \sqrt{1+x^3} (x^3 - k) + c$ , where  $k$  is \_\_\_\_\_

3. 2

4. The number of solutions of the equation  $2[x] = x + 2\{x\}$  is \_\_\_\_\_

4. 3

5. The maximum value of the function  $f(x) = 2x^3 - 15x^2 + 36x - 48$  on the set  $A = \{x \mid x^2 + 20 \leq 9x\}$  is

5. 7

# ANSWERS

## **SECTION-1 : PHYSICS**

PART – A

PART – B

# **PAPER – 1 : CHEMISTRY**

**PART – A**

**PART – B**

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# **SECTION – 3 : MATHEMATICS**

**PART – A**

**PART – B**