

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern - CPT-1

QP Code:

Test - 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 : _____

BATCHES – 2022

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. 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

1. **AB**

2. If the sum of all forces acting on a body is zero, then

(A) the body must be in equilibrium

(B) the body may be in equilibrium

(C) the body must be in partial equilibrium.

(D) the body may be in partial equilibrium.

2. **BC**

3. 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) $\frac{1}{2}[I_1 + I_2 + I_3 + I_4]$

3. **ABCD**

4. A particle A starts circulating along a circle of radius R so that its position vector \vec{r} relative to a point O rotates with the constant angular acceleration α as shown in figure then

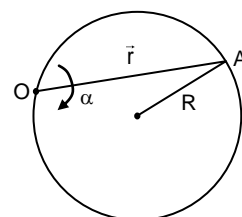
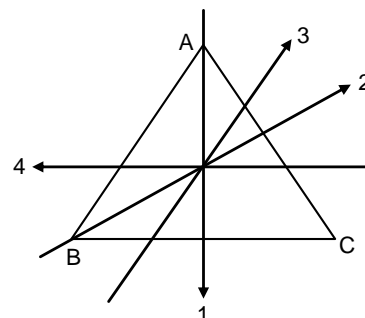
(A) magnitude of velocity of the particle in the first t sec = $2\alpha tR$

(B) the angle subtended by path followed by the particle at the centre of the circle in the first t sec = αt^2 .

(C) magnitude of its acceleration in the first t sec = $2\alpha R$.

(D) none of the above

4. **AB**



5. 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

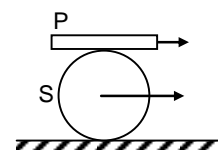


- (A) Speed of centre of rod is $\frac{J}{m}$ (B) Speed of point A is zero
- (C) Speed of upper end of rod is $\frac{J}{2m}$ (D) Speed of lower end of rod is $\frac{5J}{2m}$
5. **ABCD**
6. A solid sphere rolls without slipping on a rough horizontal floor, moving with a speed v . It makes an elastic collision with a smooth vertical wall. After impact
- (A) it will move with a speed v initially
 (B) its motion will be rolling without slipping
 (C) its motion will be rolling with slipping initially and its rotational motion will stop momentarily at same instant
 (D) its motion will be rolling without slipping only after some time
6. **ACD**
7. 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.
7. **ABD**

(Single Correct Choice Type)

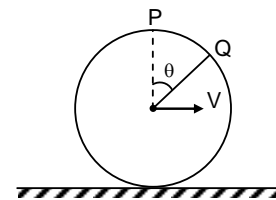
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

8. Moment of inertia of solid hemisphere of mass 'M' radius 'R' about an axis touching the curved surface and parallel to the base (circular and flat surface)
- (A) $\frac{7}{5}MR^2$ (B) $\frac{2}{5}MR^2$
 (C) $\frac{13}{20}MR^2$ (D) $\frac{13}{10}MR^2$
8. **C**
9. A plank P is placed on a solid cylinder S , which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the kinetic energy of S is
- (A) 1 : 1 (B) 2 : 1
 (C) 8 : 3 (D) 11 : 8
9. **C**



10. A ring of radius R is rolling without slipping on a horizontal surface at a linear speed ' v '. We consider the two points on the ring as shown in figure. The radius of curvature of the path travelled by P is observed by Q will be

- (A) R (B) $2R \sin \frac{\theta}{2}$
 (C) $R \sin \frac{\theta}{2}$ (D) None of these



10. **B**

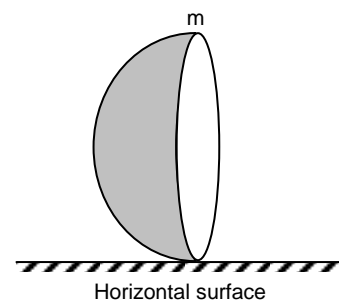
11. A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on the axis is

- (A) zero (B) vertical
 (C) horizontal and intersecting the axis (D) none of these

11. **C**

12. A solid hemisphere of mass ' m ' is released from rest from a position shown in figure. If there is no slipping then the magnitude of the friction on the sphere at just after the released will be

- (A) 0 (B) $\frac{15}{28}mg$
 (C) $\frac{15}{56}mg$ (D) none of these



12. **C**

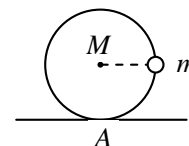
13. A cuboidal block of mass m , side length are ℓ , b and h slides down a rough inclined plane of inclination θ with a uniform speed. Then line of action of the resultant of normal reaction and friction will pass

- (A) through centre of mass of the block
 (B) through some distance left from centre of mass of the block
 (C) through some distance right from centre of mass of the block.
 (D) none of these

13. **A**

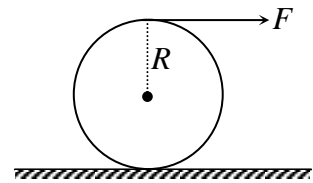
PART – B (Numerical based)

1. 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 (in N) at point A just after the system is released from rest is ($M = 6$ kg, $m = 2$ kg, $I_A = 4\text{kg m}^2$, $R = 1\text{m}$, $g = 10\text{m/s}^2$)



1. **70**

2. A hollow sphere of radius 2 m. lies on a smooth horizontal surface. If is pulled by a horizontal force acting tangentially at the highest point. Find the distance travelled in meter by the sphere during the time it makes one revolution.

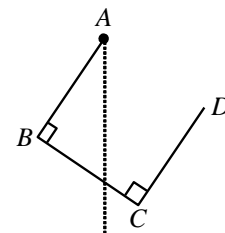


2. **8.37**
Range: 8.30 to 8.40

3. A uniform thin rod of length L stands vertically on one end on the floor. Its top is now given a tiny push so that the rod begins to topple. Assuming that the base of the rod is not slipping find the tangential acceleration (in m/s^2) of upper tip of rod when the rod makes 60° with floor ($g=10 \text{ m/s}^2$)

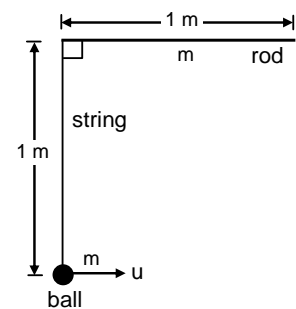
3. **7.50**

4. Three identical rods are joined and hinged at A as shown. If the angle made by the rod AB with the vertical in equilibrium is θ then find the value of $5\tan \theta$



4. **3.75**

5. As situation shown in figure the ball has been given a velocity u . Find the ratio of magnitude of the acceleration of left end of the rod to the magnitude of acceleration of the ball.



5. **5**

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

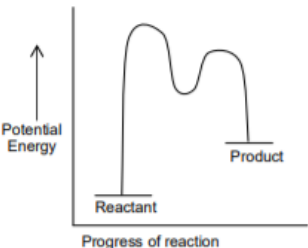
This section contains 7 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which among the following statements is/are correct?
 - (A) pH of 10^{-8} M HCl is equal to 8.
 - (B) Conjugate base of H_2PO_4^- is HPO_4^{2-} .
 - (C) pH of 0.1 M NaCl (aqueous solution) = $\frac{1}{2} \text{p}K_w$
 - (D) Ionization of water increases with decrease in temperature.

1. BC
2. In which of the following pairs of solutions is there no effect on the pH upon dilution?
 - (A) 0.1 M NH_3 and 0.1 M $(\text{NH}_4)_2\text{SO}_4$
 - (B) 0.1 M NaH_2PO_4 and 0.1 M Na_2HPO_4
 - (C) 0.1 M HCl and 0.01 M NaOH
 - (D) 0.1 M KCl and 0.1 M HCl

2. AB
3. Which of the following solution in water act as buffer?
 - (A) 0.1 mol of NaOH + 0.15 mol of CH_3COOH .
 - (B) $\text{CH}_3\text{COONH}_4$
 - (C) 0.5 mol of pyridine + 0.5 mol of Pyridinium chloride.
 - (D) 0.25 mol of NH_4Cl + 0.5 mol of NaOH.

3. ABC
4.



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

 - (A) It is an endothermic reaction
 - (B) A catalyst may be used for the reaction
 - (C) It completes in a single step
 - (D) A reaction intermediate is formed

4. ABD
5. In Arrhenius equation : $k = Ae^{-E_a/RT}$
 - (A) The pre exponential factor has the units of rate of the reaction
 - (B) The pre exponential factor has the units of rate constant of the reaction
 - (C) The exponential factor is a dimensionless quantity
 - (D) The exponential factor has the units of reciprocal of temperatures

5. BC
6. Which of the following statement(s) is/are correct?
 - (A) The relaxation time ($t_{\text{average life}}$) is relevant only to first order kinetics
 - (B) Time for completion of 90% reaction of first order reaction is $2.303/K$
 - (C) Increase in the concentration of reactant increases the rate of zero order reaction
 - (D) The half-life of first order reaction is independent of initial concentration

6. ABD

7. The reaction $2\text{NO} + \text{Br}_2 \longrightarrow 2\text{NOBr}$ follows the mechanism
- (I) $\text{NO} + \text{Br}_2 \xrightleftharpoons{\text{Fast}} \text{NOBr}_2$
- (II) $\text{NOBr}_2 + \text{NO} \xrightarrow{\text{Slow}} 2\text{NOBr}$ which of the following is/are true regarding this
- (A) The order of the reaction with respect to NO is two
 (B) The molecularity of the steps (I) and (II) are two each
 (C) The molecularity of the overall reaction is three
 (D) The overall order of the reaction is three
7. ABD

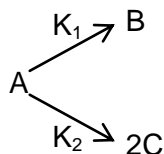
(Single Correct Choice Type)

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. A weak base (BOH) with $K_b = 10^{-5}$ is titrated with a strong acid, HCl. At $3/4^{\text{th}}$ of the equivalent point, pH of the solution is:
- (A) 5.823 (B) $5 - \log 3$
 (C) $14 - 5 + \log 3$ (D) 8.523
8. D
9. Let the solubilities of AgCl in H_2O , 0.01 M CaCl_2 ; 0.01 M NaCl and 0.05M AgNO_3 be S_1, S_2, S_3, S_4 respectively. What is the correct relationship between these quantities.
- (A) $S_1 > S_2 > S_3 > S_4$ (B) $S_1 > S_2 = S_3 > S_4$
 (C) $S_1 > S_3 > S_2 > S_4$ (D) $S_4 > S_2 > S_3 > S_1$
9. C
10. The rate constant, the activation energy and the Arrhenius parameter of a chemical reaction at 25°C are $3.0 \times 10^{-4} \text{ s}^{-1}$, $104.4 \text{ kJ mol}^{-1}$ and $6.0 \times 10^{14} \text{ s}^{-1}$ respectively the value of the rate constant as $T \rightarrow \infty$ is
- (A) $2.0 \times 10^{18} \text{ s}^{-1}$ (B) $6.0 \times 10^{14} \text{ s}^{-1}$
 (C) ∞ (D) $3.6 \times 10^{30} \text{ s}^{-1}$
10. B
11. The inversion of cane sugar proceeds with half-life of 500 minute at pH 5 for any concentration of sugar. However if pH = 6, the half-life changes to 50 minute. The rate law expression for the sugar inversion can be written as
- (A) $r = K[\text{sugar}]^2[\text{H}]^6$ (B) $r = K[\text{sugar}]^1[\text{H}]^0$
 (C) $r = K[\text{sugar}]^0[\text{H}^+]^6$ (D) $r = K[\text{sugar}]^0[\text{H}^+]^1$
11. B
12. Two substances A and B are present such that $[A_0] = 4[B_0]$ and half-life of A is 5 minute and that of B is 15 minute. If they start decaying at the same time following first order kinetics how much time later will the concentration of both of them would be same.
- (A) 15 minute (B) 10 minute
 (C) 5 minute (D) 12 minute
12. A
13. The concentration of hydroxyl ion in solution left after mixing 100 mL of 0.1 M MgCl_2 and 100 mL of 0.2 M NaOH (K_{sp} of $\text{Mg}(\text{OH})_2 = 1.2 \times 10^{-11}$) is
- (A) 2.8×10^{-3} (B) 2.8×10^{-2}
 (C) 2.8×10^{-4} (D) 2.8×10^{-5}
13. C

PART – B
(Numerical based)

1. Two parallel reactions of a substance A giving B and C, respectively, follows first order kinetics



Calculate the concentration of C after five hour of reaction if initial concentration of A is 0.25 M k_1 and k_2 are $1.5 \times 10^{-5} \text{ s}^{-1}$ and $5 \times 10^{-6} \text{ s}^{-1}$ respectively

1. 0.04
Range (0.03 to 0.04)
2. Two reactions proceed at 25°C at the same rate, the temperature coefficient of the rate of the first reaction is 2.0 and of the second, 2.5. Find the approximate ratio of rate of the first reaction to that of the second reaction at 95°C.
2. 0.2
Range (0.2 to 0.29)
3. The half time of first order decomposition of nitramide is 2.1 hour at 15°C
 $\text{NH}_2\text{NO}_2(\text{s}) \longrightarrow \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{l})$
 If 6.2 g of NH_2NO_2 is allowed to decompose, calculate the time taken in hour unit for NH_2NO_2 to decompose 99%?
3. 13.95
4. A buffer of pH 9.26 is made by dissolving x moles of ammonium sulphate and 0.1 mole of ammonia into 100 mL solution. If $\text{p}K_b$ of ammonia is 4.74, calculate value of x.
4. 0.05
5. The dissociation constants for aniline, acetic acid and water at 25°C are 3.83×10^{-10} , 1.75×10^{-5} and 1.008×10^{-14} respectively. Calculate the percentage of hydrolysis of aniline acetate in a deci normal solution?
5. 54.95

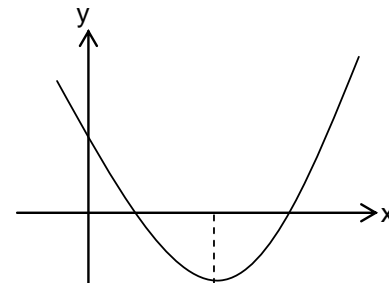
SECTION-3 : MATHEMATICS

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. If the quadratic function $y = ax^2 + bx + c$, $a \neq 0$ and $a, b, c \in \mathbb{R}$ has the following graph then which of the following is correct?
 (A) $a > 0$ (B) $b > 0$
 (C) $c > 0$ (D) $b^2 - 4ac > 0$



1. **ACD**

2. Which of the following are equal to 1?

- (A) $\frac{1}{2} \log_2 4$ (B) $\log_{30} 2 + \log_{30} 3 + \log_{30} 5$
 (C) $\log_2 (7^{\log_7 2})$ (D) $\log_{10} 200 - \log_{10} 20$

2. **ABCD**

3. The equations of tangents drawn to the ellipse $9x^2 + 16y^2 = 144$ from point $(2, 3)$ are

- (A) $y = 3$ (B) $x = 2$
 (C) $x + y = 5$ (D) $x - y + 1 = 0$

3. **AC**

4. Suppose $a, b \in \mathbb{R}$ and $a \neq 0, b \neq 0$. Let α, β be the roots of $x^2 + ax + b = 0$. Then:

- (A) $\frac{1}{\alpha}, \frac{1}{\beta}$ are roots of $bx^2 + ax + 1 = 0$
 (B) $-\alpha, -\beta$ are roots of $x^2 - ax + b = 0$
 (C) α^2, β^2 are roots of $x^2 + (2b - a^2)x + b^2 = 0$
 (D) $\frac{\alpha}{\beta}, \frac{\beta}{\alpha}$ are roots of $bx^2 + (2b - a^2)x + b = 0$

4. **ABCD**

5. If the equation of the ellipse is $3x^2 + 2y^2 + 6x - 8y + 5 = 0$, then which of the following is/are true?

- (A) $e = \frac{1}{\sqrt{3}}$ (B) Centre is $(-1, 2)$
 (C) Foci are $(-1, 1)$ and $(-1, 3)$ (D) Directrices are $y = 2 \pm 3$

5. **AC**

6. Equation of a tangent to the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ which cuts off equal intercepts on the axes is
- (A) $x + y - \sqrt{41} = 0$ (B) $x + y + \sqrt{41} = 0$
 (C) $x + y - 9 = 0$ (D) $x - y + 9 = 0$
6. **AB**
7. If one root of quadratic equation $x^2 - (a - 3)x + (a^2 - 6) = 0$ is smaller than 1 and the other root is greater than 1, then the value of a can be
- (A) 0 (B) 1
 (C) 2 (D) $\frac{1}{2}$
7. **ABD**

(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. If the roots of quadratic equation $ax^2 + bx + c = 0$ are equal in magnitude and opposite in sign then
- (A) $b^2 - 4ac = 0$ (B) $b = 0$
 (C) $c = 0$ (D) none of these
8. **B**
9. The value of 'a' for which the equation $(a^2 + 4a + 3)x^2 + (a^2 - a - 2)x + (a + 1) = 0$ is satisfied by more than two values of x is
- (A) 1 (B) 2
 (C) -2 (D) -1
9. **D**
10. Expression $x^2 + px + q$ will be a perfect square of linear expression if
- (A) $p^2 - 4q = 0$ (B) $p^2 + 4q = 0$
 (C) $q^2 = p^2$ (D) none of these
10. **A**
11. The roots of quadratic equation are always rational whenever
- (A) D is a perfect square of a rational number
 (B) D is a perfect square of a rational number and coefficients are rational
 (C) D is not a perfect square of a rational number
 (D) D is not a perfect square of a rational number and coefficients are irrational
11. **B**
12. Solution set of $\log_{1/2} x \geq \log_{1/4} 16$ is
- (A) $(-\infty, -4] \cup [4, \infty)$ (B) $[-4, 4]$
 (C) $(0, 4]$ (D) $[0, 4]$
12. **C**

13. An ellipse, with foci at $(0, 2)$ and $(0, -2)$ and minor axis of length 4, passes through which of the following points ?
- (A) $(2, \sqrt{2})$ (B) $(2, 2\sqrt{2})$
 (C) $(1, 2\sqrt{2})$ (D) $(\sqrt{2}, 2)$
13. D

PART – B
(Numerical based)

1. If the eccentricity of the ellipse $\frac{x^2}{25} + \frac{y^2}{9} = 1$ is e then the value of $5e$ is
1. **4**
2. The number of integral values of r for which the equation $\frac{x^2}{2-r} + \frac{y^2}{r-5} + 1 = 0$ represents an ellipse is
2. **2**
3. The number of solutions of $\log_4(x-1) = \log_2(x-3)$ is
3. **1**
4. Minimum area of the triangle formed by any tangent to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ with the coordinate axes is λab , then λ will be
4. **1**
5. Find the sum of all the integral roots of $(\log_5 x)^2 + \log_{5x} \left(\frac{5}{x} \right) = 1$
5. **6**

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B