

## PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

Common  
Test- 4

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: –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.
- (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 : \_\_\_\_\_

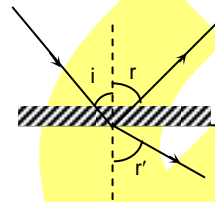
## SECTION-1 : PHYSICS

### 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 ray of light from a denser medium strike a rarer medium at an angle of incidence  $i$ . The reflected and refracted rays make an angle of  $90^\circ$  with each other. The angle of reflection and refraction are  $r$  and  $r'$ . The critical angle is (are)
- (A)  $\sin^{-1}(\tan r)$  (B)  $\sin^{-1}(\tan i)$   
 (C)  $\sin^{-1}(\tan r')$  (D)  $\tan^{-1}(\sin i)$



1. **AB**

2. A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence  $45^\circ$ . The ray undergoes total internal reflection. If  $n$  is the refractive index of the medium with respect to air, select the possible value(s) of  $n$  from the following
- (A) 1.3 (B) 1.4  
 (C) 1.5 (D) 1.6

2. **CD**

3. The threshold wavelength for photoelectric mission from a material is  $5200 \text{ \AA}$ . Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a:
- (A) 50 watt infrared lamp (B) 20 watt infrared lamp  
 (C) 50 watt ultraviolet lamp (D) 20 watt ultraviolet lamp

3. **CD**

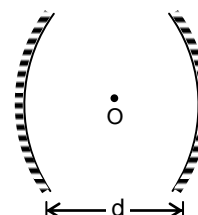
4. A nucleus with mass number 220 initially at rest emits an  $\alpha$ -particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the  $\alpha$ -particle
- (A) 4.4 MeV (B) 5.4 MeV  
 (C) 5.6 MeV (D) 6.5 MeV

4. **B**

5. Which of the following is/are correct regarding  $\alpha$ -rays?
- (A) Streak of doubly ionised helium atom.  
 (B) Ionisation power is more than  $\beta$ -rays.  
 (C) Penetration power is less compared  $\gamma$ -rays.  
 (D) Speed in more than  $\beta$ -rays.

5. **ABC**

6. The distance  $d$  between two identical concave mirrors of radius of curvature  $R$ . So, as to coincide the image I on the object O itself, which is placed at the mid point can be
- (A)  $R$  (B)  $2R$   
 (C)  $3R$  (D)  $R/2$



6. **AB**

## 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. A spherical surface of radius of curvature  $R$  separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object  $P$  placed in air on principle axis is found to have a real image  $Q$  in the glass. The line  $PQ$  cuts the surface at a point  $O$  and  $PO = OQ$ . Find the value of  $\frac{PO}{R}$ .

7. **5**

8. A bulb is placed at a depth of  $2\sqrt{7}$  m in water and a floating opaque disc is placed over the bulb so that the bulb is not visible from above the water surface. The radius (in meter) of the disc should be at least ( $\mu_{\text{water}} = 4/3$ )

8. **6**

9. A ray of light falls normally on a refracting face of a prism of refractive index 1.5. If the ray just fails to emerge from the prism. If the angle of prism is  $\sin^{-1} \frac{k}{3}$  then find the value of  $k$ .

9. **2**

10. For a concave mirror of focal length 20 cm, if the object is at a distance of 30 cm from the pole, find magnitude of magnification.

10. **2**

11. A hydrogen like atom (described by the Bohr model) is observed to emit ten wavelengths originating from all possible transitions between a group of two levels. The difference between principle quantum number of these two levels is :

11. **4**

12. If an object is placed unsymmetrically between two plane mirrors inclined at an angle of  $72^\circ$ , then the total number of images formed is

12. **5**

## PART – C

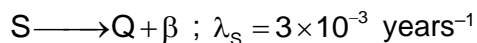
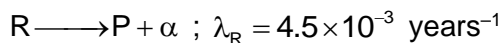
### (Numerical based)

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

13. The wavelength of  $K_\alpha$  line from an element of atomic number 51 is  $\lambda$ . For another element the wavelength of  $K_\alpha$  line is  $4\lambda$ . Find the atomic number of the second element.

13. **26**

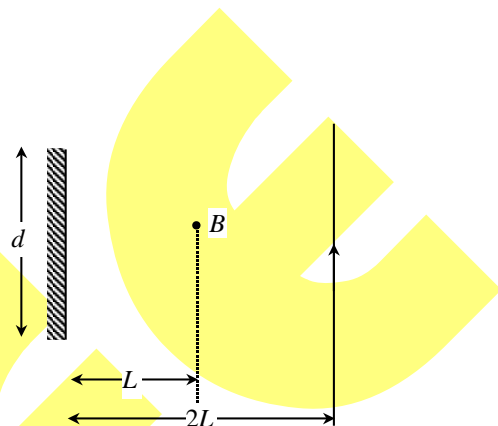
14. Two radioactive elements R and S disintegrate as



Starting with number of atoms of R and S in the ratio of 2 : 1, this ratio after the lapse of three half lives of R will be  $x/10$  where  $x$  is :

14. **10**

15. A point source of light B is placed at a distance  $L$  in front of the centre of a mirror of width  $d = 2.5$  metre hung vertically on a wall. A man walks in front of the mirror at a distance  $2L$  from it as shown. Find the greatest distance in meter over which he can see the image of the light source in the mirror.



15. **7.50**

16. If the maximum kinetic energy of emitted photo electrons from a metal surface of work function 2.5 eV, is 1.7 eV. If wavelength of incident radiation is halved, then find stopping potential in Volts.

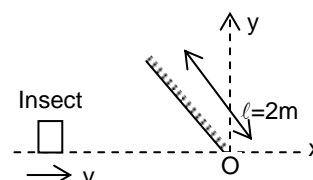
16. **5.90**

17. If doubly ionized lithium atom is hydrogen like with atomic number 3, find the wavelength (in Angstrom) of radiation required to excite the electron in  $\text{Li}^{++}$  from the first to the third Bohr orbit.

17. **113.64**

**Range: 112.50 to 114.50**

18. A plane mirror of length 2 m is kept along the line  $y = -x$  as shown in the figure. An insect having velocity of  $4\hat{i}$  cm/s is moving along the x-axis. The time span (in Sec) for which the insect can see its image is :



18. **70.7**

**Range: 70.0 to 71.0**

## **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 of the following factors will support the decomposition of  $\text{NO}_2$  into  $\text{NO}$  and  $\text{O}_2$ ?
- $$2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$$
- (A) increasing equilibrium pressure  
 (B) increasing volume of reaction container  
 (C) addition of inert gas at constant pressure  
 (D) addition of inert gas at constant volume

1. BC

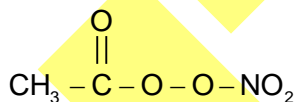
2.  $\text{Be}(\text{OH})_2(\text{s}) \rightleftharpoons \text{Be}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq})$   
 Which of the following substances can increase the solubility of  $\text{Be}(\text{OH})_2$ ?
- (A)  $\text{HCl}$  (B)  $\text{NH}_4\text{Cl}$   
 (C)  $\text{NaOH}$  (D)  $\text{K}_2\text{SO}_4$

2. AB

3. Which are non-viable particulates?
- (A) Mist (B) Smoke  
 (C) Dusts (D) Virus

3. ABC

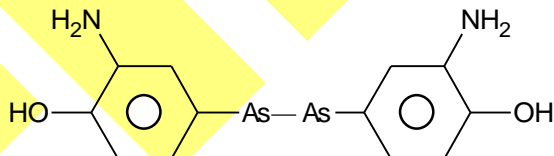
4. Choose correct statement regarding the following pollutant.



- (A) it is a secondary pollutant (B) it contribute to Los-Angeles smog  
 (C) it is formed by radical reactions (D) it is called PAN

4. ABCD

5. The structure of salvarsan is



Choose correct statements.

- (A) It is very effective against the protozoal disease syphilis  
 (B) It can form salt with  $\text{HCl}$   
 (C) It is dehydrogenated with  $\text{NaOH}$   
 (D) It undergoes 1, 2 and 1, 4-conjugate addition with  $\text{HBr}$

5. ABC

6.  $\text{CN}^- (\text{aq}) + \text{H}_2\text{O} (\ell) \rightleftharpoons \text{HCN} (\text{aq}) + \text{OH}^- (\text{aq})$   
 $[\text{K}_a \text{ of HCN} = 10^{-10}]$   
 Choose correct statement(s) from the following  
 (A) The equilibrium constant of the reaction is  $10^{-4}$   
 (B) The equilibrium constant  $K_c$  and  $K_b$  of  $\text{CN}^-$  ions are same  
 (C) The pH of the  $10^{-2}$  M  $\text{CN}^-$  solution is 11.  
 (D)  $p^{K_w}$  of water in the solution is more than 14

6. ABC

### PART – B

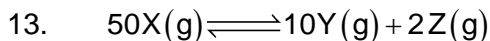
#### Integer Answer Type

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

7.  $\text{A} (\text{g}) + \text{B} (\text{g}) \rightleftharpoons \text{C} (\text{g})$   
 Equal moles of gases A, B and C are present at above equilibrium which is established at 40 K and 0.6 atm pressure. The equilibrium constant  $K_P$  in  $\text{atm}^{-1}$  unit is:
7. 5
8. One litre of a solution contains  $10^{-2}$  mole of NaCl and  $10^{-5}$  mole of NaOH. What is the pH of the solution?
8. 9
9.  $K_{a_1}$  and  $K_{a_2}$  of a dibasic acid  $\text{H}_2\text{XO}_3$  are respectively  $10^{-6}$  and  $10^{-10}$ . What is the pH of 0.1 M  $\text{NaHXO}_3$  solution?
9. 8
10.  $2\text{Ca} (\text{s}) + \text{O}_2 (\text{g}) \rightleftharpoons 2\text{CaO} (\text{s})$   
 The equilibrium constant  $K_P$  of the above reaction is  $0.2 \text{ atm}^{-1}$  at a certain temperature. What is the equilibrium pressure of the system in atm unit?
10. 5
11. What is the pH of a buffer solution which contains  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$  in the molar ratio of 10 : 1?  
 $(\text{K}_a \text{ of } \text{CH}_3\text{COOH} = 10^{-5})$
11. 4
12. One mole of each of gases  $\text{SO}_3$ , NO,  $\text{NO}_2$  and  $\text{SO}_2$  are taken in a one litre vessel for reaction.  
 $\text{SO}_3 (\text{g}) + \text{NO} (\text{g}) \rightleftharpoons \text{SO}_2 (\text{g}) + \text{NO}_2 (\text{g})$   
 The equilibrium state is attained after 50%(mole) of the reactants undergo reaction. What is the equilibrium constant  $K_C$  of the reaction.
12. 9

**PART – C**  
**(Numerical based)**

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



If the concentration of Y is doubled as equilibrium, the concentration of Z becomes  $\frac{1}{x}$  times of it's equilibrium concentration. What is the value of x?

13. 32

14. The pH of the saturated solution of a sparingly soluble base  $M(OH)_2$  is 12. If the solubility product of the base is expressed as  $y \times 10^{-9}$ . What is the value of 'y'?

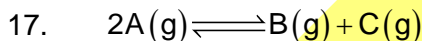
14. 500

15. For the decomposition reaction  $AB(g) \rightleftharpoons A(g) + B(g)$ , the molar mass of AB 100 g  $\text{mol}^{-1}$ . The molar mass of the reaction mixture at equilibrium is 80. What is the degree of dissociation of AB in decimal number?

15. 0.25

16. What is the pH of the aqueous solution of 0.01 M  $\text{NH}_4\text{Cl}$ ?  
[ $K_b$  of  $\text{NH}_4\text{OH} = 10^{-5}$ ]

16. 5.5



Initially three moles each of A, B and C gases are taken in a container and the mixture is heated to achieve the above equilibrium. What is the value of equilibrium constant  $K_c$  if the equilibrium concentration of B is 4.2 M?

17. 49



The equilibrium constant of the reaction is  $K_p$ . The slope of the graph between  $\ln K_p$  and  $\frac{1}{T}$  is -5. What is the enthalpy change  $\Delta H$  of the reaction in  $\text{J mol}^{-1}$  unit?

18. 41.57

## **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. Equation of a tangent passing through (2, 8) to the hyperbola  $5x^2 - y^2 = 5$  is:
 

(A) $3x - y + 2 = 0$	(B) $3x + 4y - 14 = 0$
(C) $23x - 3y - 22 = 0$	(D) $3x - 23y + 178 = 0$
  
1. **AC**
  
2. The co – ordinates of a focus of the hyperbola  $9x^2 - 16y^2 + 18x + 32y - 151 = 0$  is
 

(A) (-1, 1)	(B) (6, 1)
(C) (4, 1)	(D) (-6, 1)
  
2. **CD**
  
3. 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) $\log_{10} 200 - \log_{10} 20$
  
3. **ABCD**
  
4. Suppose  $a, b \in \mathbb{R}$  and  $a \neq 0, b \neq 0$ . Let  $\alpha, \beta$  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) $\alpha^2, \beta^2$ 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 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) $\frac{1}{2}$
  
5. **ABD**
  
6. If  $\frac{z+1}{z+i}$  is a purely imaginary number (where  $i = \sqrt{-1}$ ), then z lies on a
 

(A) straight line	(B) circle
(C) circle with radius $= \frac{1}{\sqrt{2}}$	(D) circle passing through the origin
  
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. The number of possible tangents which can be drawn to the curve  $4x^2 - 9y^2 = 36$ , which are perpendicular to the straight line  $5x + 2y - 10 = 0$  is:
7. **0**
8. If the hyperbolas,  $x^2 + 3xy + 2y^2 + 2x + 3y + 2 = 0$  and  $x^2 + 3xy + 2y^2 + 2x + 3y + c = 0$  are conjugate of each other, then the value of 'c' is equal to:
8. **0**
9. The number of solutions of  $\log_4(x-1) = \log_2(x-3)$  is
9. **1**
10. Find the sum of all the integral roots of  $(\log_5 x)^2 + \log_{5x}\left(\frac{5}{x}\right) = 1$
10. **6**
11. The quadratic equations  $x^2 - 6x + a = 0$  and  $x^2 - cx + 6 = 0$  have one root in common. The other roots of the first and second equations are integers in the ratio 4 : 3. Then the common root is:
11. **2**
12. 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
12. **1**

**PART – C**  
**(Numerical based)**

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

13. If z is a complex number which simultaneously satisfies the equation  $3|z - 12| = 5|z - 8i|$  and  $|z - 4| = |z - 8|$ , where  $i = \sqrt{-1}$ , then sum of all values of  $\text{Im}(z)$  be
13. **25.00**
14. The least integral value of k, for which  $(k - 2)x^2 + 8x + k + 4 > 0$  is true  $\forall x \in \mathbb{R}$ , is
14. **5.00**
15. If  $4^{\log_9 3} + 9^{\log_2 4} = 10^{\log_x 83}$ , then x is equal to
15. **10**

16. If  $\log_3 x \log_y 3 \log_2 y = 5$ , then  $x =$
16. 32
17. The eccentricity of the hyperbola  $9x^2 - 16y^2 + 72x - 32y - 16 = 0$  is:
17. 1.25
18. Let  $\alpha, \beta$  be the roots  $4x^2 - 16x + \lambda = 0, \lambda \in \mathbf{R}, 1 < \alpha < 2, 2 < \beta < 3$ . Then the sum of integral values of  $\lambda$  is:
18. 42

# ANSWERS

## **SECTION-1 : PHYSICS**

PART – A

PART – B

## **SECTION – 2 : CHEMISTRY**

PART – A

PART – B

## **SECTION – 3 : MATHEMATICS**

PART – A

PART – B