

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code:

RIT – 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: –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 : _____

BATCHES – NWCM82201S, NWCM2022S1W, NWCM2022A1R, NWCM2022A2R + DEHRADUN-2022R, NWCM2022A3R, NWCM2022B1R, NWCM2022B1W, NWCM2022G1, NWCM2022A1W, NWCM2022A2W, NWCM2022A3W, NWCM2022A4W, NWCM2022A5W, NWCM2022A6W, NWCM2022A7W, NWCM2022A8W, PANINI2022-G1, PANINI2022-XII 1, PANINI2022-XII 2, PANINI2022-XII 3, NWCM2022E1R+NWCMM2022E1W, NWCM2022EW, RCM2022B1R, RCM2022B1W, PANINI2022B01

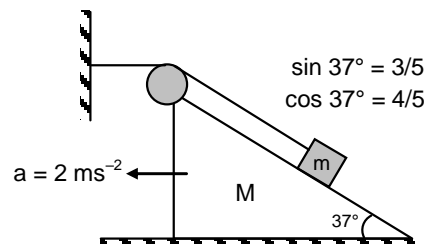
SECTION-1 : PHYSICS

PART – A

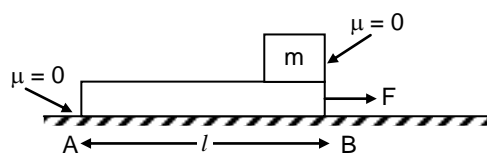
(Multi Correct Choice Type)

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.

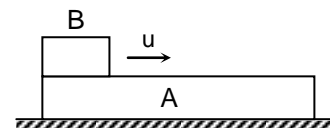
1. As shown in the figure, if acceleration of M with respect to ground is 2 ms^{-2} , then
- (A) Acceleration of m with respect to M is 5 ms^{-2}
- (B) Acceleration of m with respect to ground is 3 ms^{-2}
- (C) Acceleration of m with respect to M is 2 ms^{-2}
- (D) Acceleration of m with respect to ground is 10 ms^{-2}



1. **C**
2. In the figure, a small block is kept on M, then
- (A) The acceleration of m w.r.t. ground is $\frac{F}{m}$
- (B) The acceleration of m w.r.t. ground is zero
- (C) The time taken by m to separate from M is $\sqrt{\frac{2\ell m}{F}}$
- (D) The time taken by m to separate from M is $\sqrt{\frac{2\ell M}{F}}$

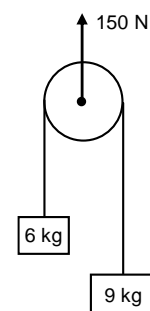


2. **BD**
3. A long block A is at rest on a smooth horizontal surface. A small block B, whose mass is half of A, is placed on A at one end and projected along A with velocity u . The coefficient of friction between the blocks is μ .



- (A) the blocks will reach a final common velocity $\frac{u}{3}$.
- (B) the time in which blocks reach a common velocity from just after projection is $\frac{2u}{3\mu g}$.
- (C) before the blocks reach a common velocity, the acceleration of A relative to B is $\frac{2}{3}\mu g$.
- (D) before the blocks reach a common velocity, the acceleration of A relative to B is $\frac{3}{2}\mu g$.

3. **ABD**
4. As situation shown in figure, choose the correct option(s) (take $g = 10 \text{ m/s}^2$ downward)
- (A) the acceleration of pulley is $\frac{5}{6} \text{ m/s}^2$ upward.
- (B) the acceleration of pulley is $\frac{5}{12} \text{ m/s}^2$ upward.
- (C) the acceleration of pulley is 0.
- (D) tension in the string which connects the masses is 75 N.



4. **BD**

5. The potential energy of a particle is given by $U = \frac{a}{r^2} - \frac{b}{r}$ where a and b are positive constants, r is the distance from the centre of the field. The equilibrium position of the particle corresponds to the distance r_0 and the type of equilibrium is given by

(A) $r_0 = \frac{2a}{b}$

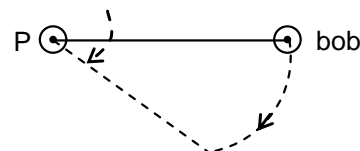
(B) $r_0 = -\frac{a}{b}$

(C) Stable equilibrium

(D) Unstable equilibrium

5. **AC**

6. Initial position of bob in simple pendulum is in the horizontal level of point of suspension P as shown in figure when it is released, for what angle with vertical the acceleration of bob directed horizontally.



(A) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$

(B) $\cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$

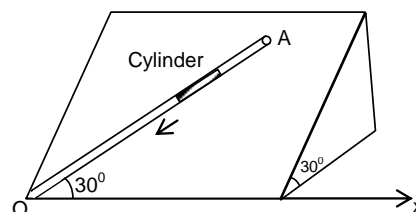
(C) 30° (D) 45° 6. **A**

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**.

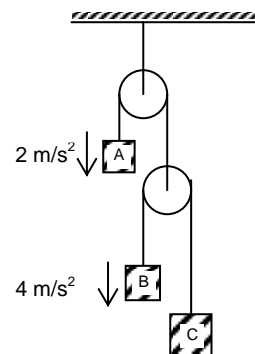
7. An inclined plane makes an angle 30° with the horizontal. A groove (OA) of length = 5m cut in the plane makes an angle 30° with OX. A short smooth cylinder is free to slide down under the influence of gravity. The time taken by the cylinder to reach from A to O in seconds is ($g = 10 \text{ m/s}^2$)

7. **2**

8. An object is displaced from point $A(1\text{m}, 2\text{m}, 3\text{m})$ to a point $B(2\text{m}, 3\text{m}, 4\text{m})$ under a constant force $\vec{F} = (2\hat{i} + 3\hat{j} + 4\hat{k})\text{N}$. Find the work done by this force in this process. (in joule)

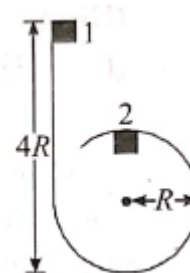
8. **9**

9. In the figure shown acceleration of blocks A and B are as shown. The acceleration of block C in S.I. units is



9. **8**

10. A cube of mass 100 gm starts at rest from point 1 at a height $4R$, where R is the radius of the circular track. The cube slides down the frictionless track and around the loop. The force which the track exerts on the cube at point 2 in Newton is:

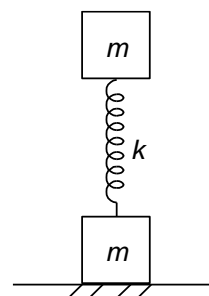


10. **3**

11. A locomotive of mass m starts moving so that its speed varies according to the law $v = a\sqrt{S}$ where a is a constant and S is the distance covered. If the total work performed by all the forces, which are acting on the locomotive during the first t seconds after the beginning of motion is $\frac{ma^4t^2}{x}$, then find the value 'x'.

11. **8**

12. A system consists of two identical slabs each of mass m linked by compressed weightless spring of stiffness k as shown in Figure. The slabs are also connected by a thread, which is burnt at a certain moment. If the value of Δl the initial compression of spring, the lower slab will bounce up after the thread is burned through is $\frac{xmg}{k}$, then find the value of 'x'.

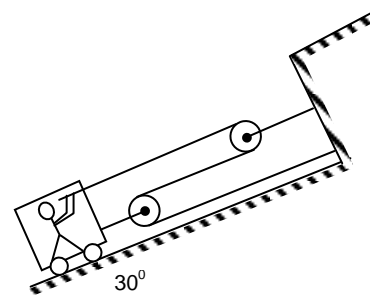


12. **3**

PART – C (Numerical based)

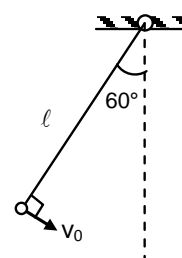
This section contains **6 questions**, numerical based questions, (answer of which maybe positive or negative numbers or decimals).

13. A man pulls himself up the 30° incline by the method shown. If the combined mass of the man and cart is 100 kg, determine the acceleration of the cart in S.I. units if the man exerts a pull of 250 N on the rope. Neglect all friction and the mass of the rope, pulleys and wheels.



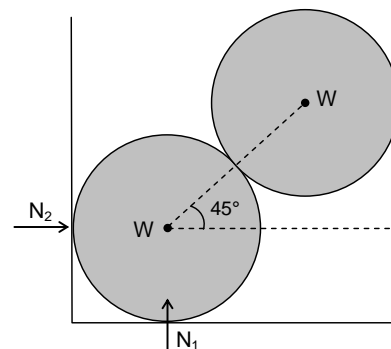
13. **2.5**

14. A small size ball is suspended from a massless string of length $\ell = 0.2$ m. Initial position of it is making angle 60° from vertical as shown in figure. What minimum initial velocity v should be imparted to it so that it just complete circular motion in vertical plane ($g = 9.8$ m/sec²)



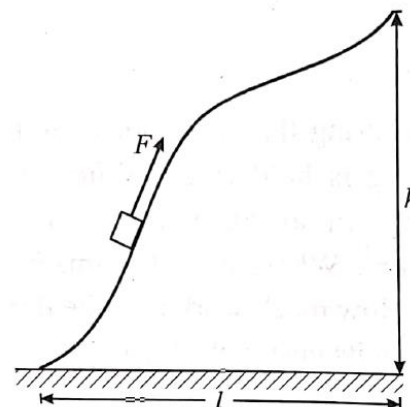
14. **2.80**

15. Two identical, uniform, frictionless spheres, each of weight W , rest in a rigid rectangular container as shown in figure. Ratio of normal reaction on left sphere $\frac{N_2}{N_1}$ is



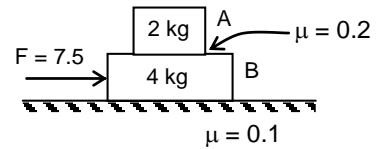
15. **0.50**

16. A body of mass m was slowly hauled up the hill by a force F which at each point was directed along a tangent to the trajectory as shown in figure. Height of the hill $h = 100$ m, the length of its base $\ell = 100$ m and coefficient of friction $\mu = 1.25$. Mass of body $m = 10^{-3}$ kg and consider $g = 10$ m/sec², then work performed by this force (in Joules) in shifting body from bottom to top of track of hill is



16. **2.25**

17. Frictional force between block A and block B is ($g = 10 \text{ m/sec}^2$)



17. **0.50**

18. A small body start sliding down an inclined plane of inclination θ whose base length is equal to ℓ . The coefficient of friction between the body and the surface is equal to $\sqrt{3}$. If the angle θ is varied keeping ℓ constant, then at what angle of inclination of inclined plane (in degrees), time of sliding will be minimum

18. **75**

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 molecules has zero dipole moment?
 (A) $\begin{array}{c} \text{F} & & \text{F} \\ & \diagdown & / \\ & \text{C} = \text{C} = & \text{C} \\ & / & \diagdown \\ \text{F} & & \text{F} \end{array}$ (B) PCl_2F_3
 (C) PCl_3F_2 (D) CCl_4

1. ACD

2. Which statement is/are correct about HCHO ?
 (A) It has sp^2 hybridised carbon
 (B) The bond angular $\angle\text{HCH}$ and $\angle\text{HCO}$ are 116° and 122° respectively
 (C) It involves lone-pair- bond pair repulsion
 (D) All of the above

2. AB

3. Which of the following is the correct order of average bond energy?
 (A) $\text{C} = \text{O} > \text{C} = \text{N} > \text{C} = \text{C} > \text{N} = \text{N}$ (B) $\text{C} \equiv \text{O} > \text{N} \equiv \text{N} > \text{C} \equiv \text{N} > \text{C} \equiv \text{C}$
 (C) $\text{C} - \text{C} > \text{C} - \text{O} > \text{C} - \text{N} > \text{N} - \text{N}$ (D) $\text{C} - \text{C} > \text{N} - \text{N} > \text{F} - \text{F} > \text{O} - \text{O}$

3. ABCD

4. Which of the following have same bond order as N_2 ?
 (A) CN^- (B) NO
 (C) NO^+ (D) C_2^-

4. AC

5. Select the correct statements
 (A) Li_2CO_3 is unstable due to small size of Li^+ and large CO_3^{2-} ion
 (B) LiF and CsI are water insoluble due to high lattice enthalpy of LiF and low hydration enthalpy of CsI
 (C) BeSO_4 is water soluble while BaSO_4 is insoluble
 (D) All group-II elements impart characteristic colour to flame

5. ABC

6. The metal hydroxide(s) soluble in excess of sodium hydroxide solution is/are
 (A) Cr^{3+} (B) Fe^{3+}
 (C) Al^{3+} (D) Zn^{2+}

6. CD

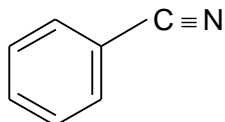
PART – B
Integer Answer Type

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

7. Among He_2 , He_2^+ , Li_2 , Be_2 , C_2^{2-} , N_2 , O_2^- and F_2 , the number of diamagnetic species is

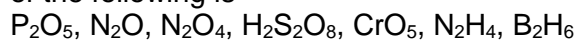
7. 6

8. The number of π -bonds in the following molecule is



8. 5

9. The total number of molecules containing covalent bond between two atoms of same kind of the following is



9. 5

10. The number of unpaired electrons in super oxide ion O_2^- is

10. 1

11. The volume strength of a given sample of H_2O_2 is 5.6 V. Its normality is

11. 1

12. The number of water molecule of crystallisation in Lithium Chloride is

12. 2

PART – C
(Numerical based)

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

13. The amount of NaOH needed to dissolve 5g of aluminium be x gm. Then x will be

13. 7.4

14. The % strength of '20V' hydrogen peroxide will be

14. 6.07

15. The I.E and EA of an element are 13 eV and 3.8 eV respectively. The electronegativity of this element on Mulliken scale will be

15. 8.4

16. The observed dipole moment of HCl is 1.03 D. if bond length of HCl is 1.275 \AA . The % ionic character in HCl will be
16. 16.82% (Range 16.80 – 16.83)
17. The change in bond order when N_2 changes to N_2^+ is x. Then x is
17. 0.5
18. The number of resonance structures of ClO_4^- be 'a' and no. of π bonds in ClO_4^- be 'b'. Then $\frac{a}{b}$ will be
18. 1.33

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. Given the following two statements:
 $S_1 : (q \vee p) \rightarrow (p \leftrightarrow \sim q)$ is a tautology
 $S_2 : \sim q \wedge (\sim p \leftrightarrow q)$ is a Fallacy. Then:
 (A) S_1 is incorrect (B) Both (S_1) and (S_2) are correct
 (C) S_2 is incorrect (D) both (S_1) and (S_2) are incorrect

1. ACD

2. The statement $(p \rightarrow (q \rightarrow p)) \rightarrow (p \rightarrow (p \vee q))$ is not:
 (A) equivalent to $(p \vee q) \wedge (\sim p)$ (B) equivalent to $(p \wedge q) \vee (\sim p)$
 (C) a contradiction (D) a tautology

2. ABC

3. Which one of the following, statements is a tautology:
 (A) $(p \vee q) \Rightarrow (p \vee (\sim q))$ (B) $(p \vee q) \Rightarrow p$
 (C) $p \Rightarrow (p \vee q)$ (D) $(p \wedge q) \Rightarrow (\sim p) \vee q$

3. BCD

4. The lines $x + y = 1, (\mu - 1)x + (\mu^2 - 7)y - 5 = 0, (\mu - 2)x + (2\mu - 5)y = 0$ are:
 (A) concurrent for three distinct real values of μ
 (B) concurrent for no real value of μ
 (C) parallel for one real value of μ
 (D) parallel for two real value of μ

4. BC

5. Perpendicular is drawn from a fixed point (3, 4) to a variable line having x – intercept unity. $P(x, y) = 0$ represents the locus of the foot of perpendicular drawn from (3, 4) to the variable line, which is a circle. Which of the following statement9s) is (are) correct?
 (A) Radius of circle is $\sqrt{3}$
 (B) Radius of circle is $\sqrt{5}$
 (C) If tangent is drawn to $P(x, y) = 0$ from the origin, then the length of tangent is $\sqrt{3}$
 (D) If tangent is drawn to $P(x, y) = 0$ from the origin, then the length of tangent is $\sqrt{5}$

5. BC

6. Consider $|x - 2e^{\ln 3}| + |x + 2e^{\ln 3}| = 12$, then identify which of the following statement(s) is (are) correct?
 (A) The number of integral solutions of the equation is 7
 (B) The number of integral solutions of the equation is 13
 (C) The sum of all the integral solutions of the equation is 0
 (D) The sum of all the integral solutions of the equation is 28
6. BC

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 $x = \alpha$ is the solution of the equation $|2 + \log_2 7x| - \log_2(x - 1) = 5$, then find the value of $(65)^{\frac{1}{3} \log_{\alpha^2+1} \alpha}$
7. 2
8. If $x = \log_2 3 - 4 \log_{\left(\frac{\ln 5}{4}\right)} 3$, $y = \log_{\sqrt{3}} \left(\frac{\ln 5}{4}\right)$ and $z = \log_2 \left(\log_{(5/4)} e\right)$ then find the absolute value of $(xy + 2z)$.
8. 8
9. Let PT be a tangent from the point $P(5, 3 + \sqrt{3})$ to the circle $x^2 + y^2 + 4x - 6y - 3 = 0$ with correct C at T and AB is secant which passes through P such that BT is the normal at T. If $\text{Ar}(\triangle CAB) + \text{Ar}(\triangle CAT) = \frac{\lambda}{25}$, then find the value of $([\sqrt{\lambda}] - 15)$.
 [Note : $[k]$ denotes greatest integral value less than or equal to k and $\text{Ar}(\triangle PQR)$ denotes area of triangle PQR.]
9. 4
10. Line L touches circle C_1 , C and C_2 which pair wise touch each other externally (as shown in figure). If $r_1 = 36$ and $r_2 = 900$ then find the value of \sqrt{r} .
-
10. 5
11. Consider a family of lines $(2\lambda + 1)x - (\lambda + 1)y + 1 - 2\lambda = 0$, if the minimum area of triangle which a member of this family with negative gradient can make with the positive semi axes is A, find $\frac{A}{6}$.
11. 4

12. If the point (α, α^4) lies on or inside the triangle formed by lines $x^2y + xy^2 - 2xy = 0$, then find the largest possible value of $\alpha^2 + \alpha + 1$
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. The sum $\sum_{K=1}^{99} \log_3 \sqrt{\frac{K}{K+1}}$ is equal to
(Assume base of logarithm is 10)
13. – 0.66
14. If the value of the product $P = 3 \cdot 3^{\log_4 3} \cdot 3^{\log_4 3^{\log_4 3}} \cdot 3^{\log_4 3^{\log_4 3^{\log_4 3}}} \dots \dots \infty$ is $a^{\log_b c}$ where $a, b, c \in \mathbb{Q}$, then b equals:
14. 1.33
15. If centroid of a triangle be (1, 4) and the co – ordinates of its any two vertices are (4, –8) and (–9, 7), then twice the area of the triangle is:
15. 333
16. The x – intercept of angle bisector of angle between the lines $2x + y - 2 = 0$ and $2x + 4y + 7 = 0$ which contains the fixed point on the family of lines $(2\cos\alpha + 3\sin\alpha)x + (3\cos\alpha - 5\sin\alpha)y = 5\cos\alpha - 2\sin\alpha$ for different values of α , is equal to
16. 5.5
17. The radius of the circle which touches the line $x + y = 0$ at M (–1, 1) and cuts the circle $x^2 + y^2 + 6x - 4y + 18 = 0$ orthogonally, is
17. 7.05 (range 7.04 to 7.08)
18. One circle has a radius of 5 and its center at (0, 5). A second circle has a radius of 12 and its centre at (12, 0). The length of a radius of a third circle which passes through the center of the second circle and both points of intersection of the first 2 circles, is equal to:
18. 6.5

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B