

**PHYSICS, CHEMISTRY & MATHEMATICS****QP CODE: 100722****Paper – 2****Time Allotted: 3 Hours****Maximum Marks: 180**

- 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. All the section can be filled in **PART-A & B** of 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 **Blue/Black Ball Point Pen** 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 (01-04)** – Contains Four (04) 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-A (05–07)** contains (3) Multiple Choice Questions which have **One or More Than One Correct** answer.  
*Full Marks: +4* If only the bubble(s) corresponding to all the correct option(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.
- (iii) **Part-B (01-06)** This section contains **SIX (06)** questions. The answer to each question is a **NON-NEGATIVE INTEGER**. For each question, enter the correct integer corresponding to the answer. Each question carries **+4 marks** for correct answer. **There is no negative marking.**
- (iv) **Part-B (07-10)** This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places. Each question carries **+3 marks** for the correct answer. **There is no negative marking.**

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

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

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

**BATCH – NWCMPA425A1-PT-1**

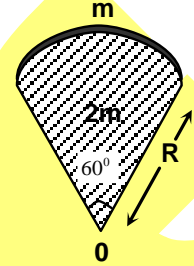
## **SECTION – I: PHYSICS**

### **(PART – A)**

**(Single Correct Answer Type)**

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. What is the distance of centre of mass of the combined system as shown in figure from 'O'. System consists of a uniform sector of mass  $2m$  and radius  $R$ , fixed with a uniform arc of mass  $m$  and radius  $R$  along the edge of the sector. (System is making an angle  $\theta = 60^\circ$  at their common centre)



- (A)  $\frac{5R}{3\pi}$  (B)  $\frac{4R}{3\pi}$   
 (C)  $\frac{7R}{3\pi}$  (D) none of these

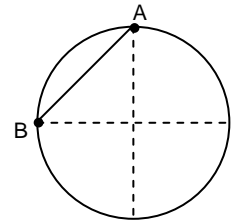
2. A stone is projected with a velocity  $20\sqrt{2}$  m/s at an angle of  $45^\circ$  to the horizontal. The average velocity of stone during its motion from starting point to its maximum height is (take  $g = 10$  m/s<sup>2</sup>)

- (A) 20 m/s (B)  $20\sqrt{5}$  m/s (C)  $5\sqrt{5}$  m/s (D)  $10\sqrt{5}$  m/s

3. If  $\vec{a}, \vec{b}, \vec{c}$  are unit vector then max value of  $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2$  is

- (A) 3 (B) 9 (C) 12 (D) 6

4. Two beads A and B of equal mass 'm' are connected by a light inextensible cord. They are constrained to move on a frictionless ring in vertical plane. The beads are released from rest as shown in figure. The tension in the cord just after the release is



- (A)  $\frac{mg}{4}$  (B)  $\sqrt{2} mg$   
 (C)  $\frac{mg}{2}$  (D)  $\frac{mg}{\sqrt{2}}$

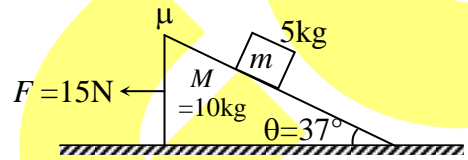
*Space For Rough Work*

**(One or More Than One Options Correct Type)**

This section contains **3 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE THAN ONE is correct**.

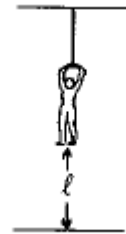
5. A projectile is thrown horizontally from top of a building of height 10 m with a certain speed  $u$ . At same time another projectile thrown from ground 10m away from the building with equal speed  $u$  in the same vertical plane at an angle  $\theta$  with horizontal. If they collide after 1s; then:
- (A) Angle of projection ( $\theta$ ) for second particle is  $45^\circ$   
 (B) Angle of projection ( $\theta$ ) for second particle is  $90^\circ$   
 (C) Initial speed,  $u = 10 \text{ m/s}$   
 (D) Initial speed,  $u = 5 \text{ m/s}$

6. A block of mass  $m = 5 \text{ kg}$  is placed on a rough wedge of mass  $M = 10 \text{ kg}$  and inclination  $\theta = 37^\circ$ . A force  $F = 15 \text{ N}$  is applied on the wedge  $M$  which is placed on the smooth ground as shown. The block  $m$  remains at rest relative to wedge. Choose the correct alternatives ( $g = 10 \text{ m/s}^2$ )



- (A) Co-efficient of friction between block  $m$  and wedge  $M$  is at least 0.92.  
 (B) Acceleration of wedge is  $1 \text{ m/s}^2$ .  
 (C) Normal reaction of block  $m$  on wedge  $M$  is 40 N  
 (D) The frictional force acting on the block  $m$  is 34 N

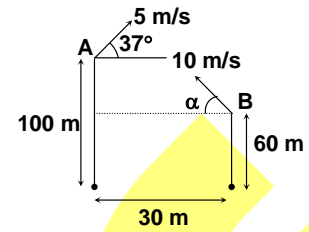
7. One end of a light rope is tied directly to the ceiling. A man of mass  $m$  initially at rest on the ground starts climbing the rope without slipping upto a height  $l$  which is quite large in comparison to the dimension of man. From the time he starts at rest on the ground to the time he is hanging at rest at a height  $l$ . Then
- (A) work done on man by rope is zero.  
 (B) work done by gravity is  $-mg/l$   
 (C) work done by man is  $+mg/l$   
 (D) work done by man is zero.



Space For Rough Work

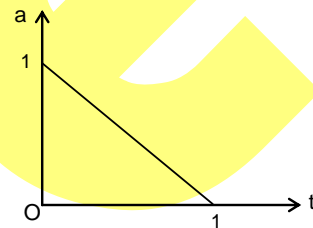
**(PART – B)**  
**(Non – Negative Integer)**

1. Two particles are projected simultaneously at point A and point B from two towers as shown in the figure. If they collide then the value of  $\alpha$  is  $(a \times 10 + b)$  in degree. Find the value of  $(a - b)$ . (Neglect any type of frictional force acting on the particles during motion. (take  $g = 10 \text{ m/s}^2$ ) (where  $a$  and  $b$  are positive integer,  $a < 10$  and  $b < 10$ )



2. Two blocks of masses 10 kg and 4 kg and are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of 14 m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is  $5K \text{ m/s}$ . Then find the value of  $K$ .
3. Two masses of 1 gm and 4 gm are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is  $m : n$ , then find the value of ' $m^n$ '.

4. A particle starting from rest moves in a straight line with acceleration as shown in the  $a-t$  graph. Find the distance travelled by the particle in the first four seconds from start of its motion.



5. A moving car encounters air resistance which is proportional to the square of the speed of the car. Find the value of  $\frac{24 \times \text{Power required at 40 kmph}}{\text{Power required at 80 kmph}}$ .

6. Power supplied to a particle of mass 2 kg varies with time as  $P = \frac{3t^2}{2} \text{ W}$ . Here  $t$  in second. If velocity of particle at  $t = 0$  is  $v=0$ . Find the velocity (in m/sec) of the particle at time  $t = 2 \text{ Sec}$ .

*Space For Rough Work*

**(PART – B)**

This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

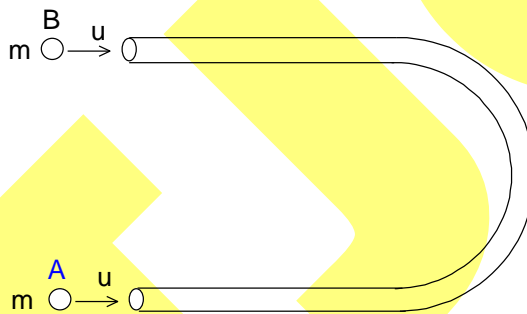
**Paragraph for Question no. 7 to 8**

If a man in a boat rows perpendicular to the bank, he is drifted to a distance of 120 m during crossing the river in 10 minutes. If he heads at an angle of  $\alpha$  from up stream he crosses the river by shortest path in 12.5 min.

7. Velocity of river with respect to ground will be (in m/min).
8. Width of River will be (in km).

**Paragraph for Question no. 9 to 10**

A U shaped tube of mass 2 m is placed on a smooth horizontal surface. Two identical spherical balls each of mass m and of diameter slightly less than the inner diameter of tube inters into the tube with a velocity v as shown in figure. (Assume no loss of energy anywhere and all collisions to be elastic).



Now answer the following questions:

9. Speed of each spherical ball just before their collision is  $ku$ . Find the value of 'k'.
10. All the time of collision, angle between direction of motion of spherical ball A and B is as observer in the ground frame is  $m \tan^{-1} \sqrt{n}$ . What is the value of  $m \times n$ ?

*Space For Rough Work*

## **SECTION – II: CHEMISTRY**

### (PART – A)

#### (Single Correct Answer Type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

- Calculate approximate pH of the resultant solution formed by titration of 25 mL of 0.04 M  $\text{Na}_2\text{CO}_3$  with 50 mL of 0.025 M HCl.  
[Given  $p^{K_{a1}} = 6.4$  and  $p^{K_{a2}} = 10.3$  for  $\text{H}_2\text{CO}_3$ ]  
[ $\log 3 = 0.4773$ ]  
(A) 4.09 (B) 5.98  
(C) 8.12 (D) 6.87
- For which of the following reversible reaction, the net rate is given by:  
$$\frac{dx}{dt} = k_1[A]^2[B]^1 - k_2[C]$$
  
(A)  $2A(s) + B(g) \rightleftharpoons C(g)$  (B)  $2A(g) + B(g) \rightleftharpoons C(g)$   
(C)  $C(g) \rightleftharpoons 2A(g) + B(g)$  (D)  $C(s) \rightleftharpoons 2A(g) + B(g)$
- What is the orbital angular momentum of the tenth electron of magnesium?  
(A) Greater than zero (B) Less than zero  
(C) Equal to zero (D) Undefined
- Which of the following molecule has see-saw shape?  
(A)  $\text{XeF}_4$  (B)  $\text{SF}_4$   
(C)  $\text{CF}_4$  (D)  $\text{BF}_4^-$

#### (One or More Than One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE THAN ONE is correct**.

- Which of the following species contain(s) pi( $\pi$ )-bonds?  
(A)  $\text{HCO}_3^-$  (B)  $\text{BO}_3^{3-}$   
(C)  $\text{BF}_4^-$  (D)  $\text{SO}_3^{2-}$

*Space For Rough Work*

6. The correct statement(s) regarding Arrhenius equation,  $k = Ae^{-E_a/RT}$  is/are  
 (A) the rate constant 'k' will have maximum value if  $E_a = 0$   
 (B) 'A' is equal to maximum rate constant  
 (C) the fraction of molecules having sufficient energy and properly orientation to form product is represented by  $e^{-E_a/RT}$   
 (D)  $E_a$  represents activation energy of the reaction
7. Which of the following ion(s) is/are larger than  $O^{2-}$ ?  
 (A)  $F^-$  (B)  $N^{3-}$   
 (C)  $C^{4-}$  (D)  $Na^+$

**(PART – B)**  
**(Non – Negative Integer)**

1. The complete wave function of an atomic orbital of hydrogen atom is expressed as:

$$\psi = \frac{1}{4(2\pi)^{1/2}} \left( \frac{Z}{a_0} \right)^{5/2} r e^{-Zr/2a_0} \cos \theta$$

If the angle between the plane containing the orbital and its nodal plane is  $x^\circ$ , what is the value of  $x$ ?

2. Consider  $PCl_5$  molecule  
 If  $x$  = the number of p-orbitals of phosphorus involved in hybridization  
 $y$  = the value of the smallest bond angle observed in the molecule in degree unit  
 $z$  = the number of all the possible ions (containing phosphorus) present in its solid state  
 then the value of  $(x + y + z)$  is
3. The threshold frequency of a metal is  $5 \times 10^{14} \text{ s}^{-1}$ . What should be the minimum energy in  $\text{kJ mol}^{-1}$  of the incident radiation which will just make the electrons free from the metal?  
 [Assume:  $N_A = 6 \times 10^{23}$ ] [ $h = 6.6 \times 10^{-34} \text{ JS}$ ]
4. The separation between two iodine atoms in  $BI_3$  molecule is  $3.6 \text{ \AA}$ . What is the bond length of  $BI_3$  in  $\text{\AA}$  unit? [Assume  $\cos 30^\circ = 0.9$ ]
5.  $N_2O_4(g) \rightleftharpoons 2NO_2(g)$   
 In the above reaction, the molecular mass of the equilibrium mixture is 85.18. What percentage of  $N_2O_4(g)$  undergoes dissociation at equilibrium?

*Space For Rough Work*

6. The heat change of a chemical reaction involving one reactant and one product is  $-4 \text{ kJ mol}^{-1}$ . If the activation energy of the forward reaction is  $5 \text{ kJ/mol}$ , what will be the activation energy of the backward reaction in  $\text{kJ mol}^{-1}$  unit?

**(PART – B)**

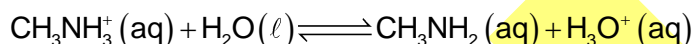
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**Paragraph for Question no. 7 to 8**

Aqueous solutions of salts of different types may be acidic, neutral or basic. It depends on the nature of salts which on hydrolysis produce acids and bases which may be strong or weak. Aqueous solutions of the salts of strong acids and strong bases and that of weak acids and weak bases have fixed pH which does not change on dilution. They are temperature dependent. Consider a base  $\text{CH}_3\text{NH}_2$  which ionization constant ( $K_b$ ) is  $10^{-4}$  and an acid  $\text{HCN}$  which ionization constant ( $K_a$ ) is  $10^{-10}$ .

Answer the following questions on the basis of above write up.

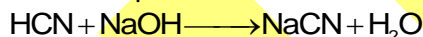
7. If the equilibrium constant  $K_c$  of the following reversible reaction is  $4x \times 10^{-10}$ ? What is the value of  $x$ ?



8. If the pH of  $10^{-2} \text{ M HCN}$  at  $25^\circ\text{C}$  is  $x$ . what is the value of  $x/4$   
[Assume  $1 - \alpha \approx \alpha$ ]

**Paragraph for Question no. 9 to 10**

A mixture of weak acid and strong base behaves as a buffer if they are mixed in certain proportions. Consider a weak acid  $\text{HCN}$  and strong base  $\text{NaOH}$ . We have  $0.1 \text{ M}$  solution of  $\text{NaOH}$  and  $0.2 \text{ M}$  solution of  $\text{HCN}$ .  $500 \text{ mL}$  of each of  $\text{HCN}$  and  $\text{NaOH}$  solutions are mixed in a vessel. The following reaction will take place.



[Given  $K_a$  of  $\text{HCN} = 10^{-10}$  and  $\log 0.25 = -0.6$ ]

Answer the following questions on the basis of above write up.

9. If the pH of the acid-base mixture after complete reaction is  $4x$ , what is the value of  $x$ ?
10. How many moles of  $\text{HCl}$  should be added to the reaction mixture of  $\text{HCN}$  and  $\text{NaOH}$  so that the pH becomes  $9.4$ ?

*Space For Rough Work*



## **SECTION – III: MATHEMATICS**

### **(PART – A)**

#### **(Single Correct Answer Type)**

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The solution set of inequality  $\frac{|x+2|-x}{x} < 2$  is  
 (A) (0, 1)                      (B) [0, 2)                      (C)  $(-\infty, 0) \cup (1, \infty)$                       (D)  $(-\infty, 0) \cup (2, \infty)$
2. If  $g(x) = [x] + \sum_{a=1}^{2012} \frac{x+a-[x+a]}{2012}$  then the value of  $g(100)$ ?  
 (Note:  $[.]$  denote greatest integer function)  
 (A) 89                      (B) 99                      (C) 90                      (D) 100
3. Identify the correct option  
 (A)  $\log_2 3 < \log_{1/4} 5$                       (B)  $\log_5 7 < \log_8 3$   
 (C)  $\log_{\sqrt[3]{2}} \sqrt{3} > \log_{\sqrt[3]{2}} \sqrt{5}$                       (D)  $2^{\frac{1}{4}} > \left(\frac{3}{2}\right)^{\frac{1}{3}}$
4. If  $\int \frac{3x+4}{x^3-2x-4} dx = \log|x-2| + k \log f(x) + c$ , and  $f(0) = 2$  then  $2k + f(1)$  equals  
 (A) 4                      (B) 2                      (C) -1                      (D) None of these

#### **(One or More Than One Options Correct Type)**

This section contains **3 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE THAN ONE is correct**.

5. The function  $f(x) = \frac{x}{1+|x|}$  is differentiable on  
 (A)  $(0, \infty)$                       (B)  $[0, \infty)$                       (C)  $(-\infty, 0)$                       (D)  $(-\infty, \infty)$
6. If  $\lim_{x \rightarrow 0} \frac{a \sin x - bx + cx^2 + x^3}{2x^2 \ln(1+x) - 2x^3 + x^4}$  exists and is finite, then  
 (A)  $a = 6$                       (B)  $b = 0$                       (C)  $c = 0$                       (D) The limit =  $\frac{3}{40}$
7. The value of integral  $\int_0^{\pi} x f(\sin x) dx$  is :  
 (A)  $\frac{\pi}{2} \int_0^{\pi} f(\sin x) dx$                       (B)  $\pi \int_0^{\pi/2} f(\sin x) dx$                       (C) 0                      (D) none of these

*Space For Rough Work*

**(PART – B)**  
**(Non – Negative Integer)**

1. The curve  $y = ax^3 + bx^2 + cx + 5$ , touches the  $x$  – axis at  $P(-2, 0)$  and cuts the  $y$  – axis at a point  $Q$ , where its gradient is 3, then find the value of  $4b - 2a + c$ .
2. Let  $f(x)$  and  $g(x)$  be differentiable for  $0 \leq x \leq 1$ , such that  $f(0) = 2, g(0) = 0, f(1) = 6$ . If there exist a real number  $c$  in  $[0, 1]$  such that  $f'(c) = 2g'(c)$ , then the value of  $g(1)$  must be
3. If  $f(x) = x^2 + kx + 1$  is monotonic increasing in  $[1, 2]$ , then the minimum values of  $k$  is  $\alpha$  then  $|\alpha|$  is
4. The sum of greatest and least values of  $f(x) = |x^2 - 5x + 6|$  in  $\left[0, \frac{5}{2}\right]$ , is
5. If  $\int \frac{\cos^5 x}{\sin^2 x} dx = A \sin^3 x + B \sin x + C \cot x + D$  then  $3A - 2B - C =$
6.  $\int_{-100}^{100} |x| dx = 100\lambda$  then  $\lambda$  is

**(PART – B)**

This section contains Two paragraphs. Each paragraph having TWO questions Numerical answer type with answer XXXX.XX. For each question, enter the correct numerical value. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

**Paragraph for Question no. 7 to 8**

$$\text{If } f(x) = |x-1| + |x-3| + |5-x|, \forall x \in \mathbb{R}$$

**On the basis of above information, answer the following questions:**

7. If  $f(x)$  is symmetrical about the line  $x = \lambda$ , then  $\lambda$  equals
8. The set of values of 'a' such that equation  $f(x) - a = 0$  has two solutions then the least possible integral value of a is

**Paragraph for Question no. 9 to 10**

$$\text{Consider a function } f(x) \text{ defined by } f(x) = \begin{cases} 1+x, & 0 \leq x \leq 2 \\ 3-x, & 2 < x \leq 3 \end{cases}$$

9. The number of points of discontinuous of  $f(f(x))$  is
10. The number of points of discontinuous of  $|f(x)| + f(|x|)$  is

*Space For Rough Work*

# FIITJEE INTERNAL TEST

BATCH: NWCMPA425A1-PT-1

Paper – 2

Code: 100722

JEE ADVANCED LEVEL

ANSWER KEY

ANSWER KEYS

## Physics

### PART – A

- |       |        |        |      |
|-------|--------|--------|------|
| 1. C  | 2. D   | 3. B   | 4. D |
| 5. BC | 6. ABD | 7. ABC |      |

### PART – B

- |                              |      |       |        |
|------------------------------|------|-------|--------|
| 1. 5                         | 2. 2 | 3. 1  | 4. 4   |
| 5. 3                         | 6. 2 | 7. 12 | 8. 0.2 |
| 9. 0.87 (range: 0.80 – 0.90) |      | 10. 4 |        |

## Chemistry

### PART – A

- |       |         |       |      |
|-------|---------|-------|------|
| 1. D  | 2. B    | 3. A  | 4. B |
| 5. AD | 6. ABCD | 7. BC |      |

### PART – B

- |                           |        |                                |         |
|---------------------------|--------|--------------------------------|---------|
| 1. 90                     | 2. 95  | 3. 198                         | 4. 2    |
| 5. 8 (range 7.89 to 8.13) |        | 6. 9                           | 7. 0.25 |
| 8. 1.5                    | 9. 2.5 | 10. 0.03 (range: 0.01 to 0.05) |         |

## Mathematics

### PART – A

- |         |        |       |      |
|---------|--------|-------|------|
| 1. C    | 2. D   | 3. D  | 4. A |
| 5. ABCD | 6. ACD | 7. AB |      |

### PART – B

- |      |        |      |      |
|------|--------|------|------|
| 1. 1 | 2. 2   | 3. 2 | 4. 6 |
| 5. 6 | 6. 100 | 7. 3 | 8. 5 |
| 9. 2 | 10. 1  |      |      |