

## INTERNAL TEST for a SCHOLARSHIP

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### Instructions:

- **Do not open** this question paper until you are told to do so.
- Write your **name** and **date of birth** in the spaces provided below.
- **Read** the instructions for each part of the paper carefully.
- Answer **all** questions.
- Write your answers on this **booklet**. Use an **only blue/black ink pen**.
- You must finish the test within the time limit. The time for the test is **2 hours 30 minutes**.
- There are **3 parts** in this question paper. **English, Math and IQ**.
- The number of marks is given in **brackets [ ]**.
- Do not use staples, paper clips, glue or correction fluid.
- Please use the same booklet for all **scratch or draft work**. No extra paper will be provided for draft work.
- Shading MCQ answers:

Correct:



Wrong:



- To change your selection place a cross over the unwanted bubble:



Name:

Date of Birth:

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## LISTENING

### Questions 1-10

[Each correct answer will score 1 mark]

Complete the notes below.

Write **ONE WORD AND/OR A NUMBER** for each answer.

Cycle tour leader: Applicant enquiry
<i>Example</i> Name: Margaret ..... <i>Smith</i> .....
<b>About the applicant:</b> <ul style="list-style-type: none"><li>wants a <b>1</b> ..... job</li><li>will soon start work as a <b>2</b> .....</li><li>has led cycle trips in <b>3</b> .....</li><li>interested in being a leader of a cycling trip for families</li><li>is currently doing voluntary work with members of a <b>4</b> ..... club</li><li>available for five months from the 1<sup>st</sup> of <b>5</b> .....</li><li>can't eat <b>6</b> .....</li></ul>
<b>Contact details:</b> <ul style="list-style-type: none"><li>address: 27 <b>7</b> ..... Place, Dumfries</li><li>postcode: <b>8</b> .....</li></ul>
<b>Interview:</b> <ul style="list-style-type: none"><li>interview at 2.30 pm on <b>9</b> .....</li><li>will plan a short <b>10</b> ..... about being a tour guide</li></ul>

**Questions 11-20 (YOU WILL HEAR QUESTIONS 31 TO 40 IN THE AUDIO)**

**[Each correct answer will score 1 mark]**

Complete the notes below.

Write **ONE WORD ONLY** for each answer.

**Noise in Cities**

Past research focused on noise level (measured in decibels) and people's responses.

**Noise 'maps'**

- show that the highest noise levels are usually found on roads
- do not show other sources of noise, e.g. when windows are open or people's neighbours are in their **31** .....
- ignore variations in people's perceptions of noise
- have made people realize that the noise is a **32** ..... issue that must be dealt with

**Problems caused by noise**

- sleep disturbance
- increase in amount of stress
- effect on the **33** ..... of schoolchildren

**Different types of noise**

Some noises can be considered pleasant e.g. the sound of a **34** ..... in a town

To investigate this, researchers may use methods from **35** ..... sciences e.g. questionnaires

**What people want**

Plenty of activity in urban environments which are **36** ....., but also allow people to relax

But architects and town planners

- do not get much **37** ..... in acoustics
- regard sound as the responsibility of engineers

**Understanding sound as an art form**

We need to know

- how sound relates to **38** .....
- what can be learnt from psychology about the effects of sound
- whether physics can help us understand the **39** ..... of sound

**Virtual reality programs**

- advantage: predict the effect of buildings
- current disadvantage: they are **40** .....

## READING

You should spend about **20 minutes** on **Questions 21-33**, which are based on Reading.

### The History of Glass

From our earliest origins, man has been making use of glass. Historians have discovered that a type of natural glass - obsidian - formed in places such as the mouth of a volcano as a result of the intense heat of an eruption melting sand - was first used as tips for spears. Archaeologists have even found evidence of man-made glass which dates 'back to 4000 BC; this took the form of glazes used for coating stone beads. It was not until 1500 BC, however, that the first hollow glass container was made by covering a sand core with a layer of molten glass.

Glass blowing became the most common way to make glass containers from the first century BC. The glass made during this time was highly coloured due to the impurities of the raw material. In the first century AD, methods of creating colourless glass were developed, which was then tinted by the addition of colouring materials. The secret of glass making was taken across Europe by the Romans during this century. However, they guarded the skills and technology required to make glass very closely, and it was not until their empire collapsed in 476 AD that glass-making knowledge became widespread throughout Europe and the Middle East. From the 10th century onwards, the Venetians gained a reputation for technical skill and artistic

ability in the making of glass bottles, and many of the city's craftsmen left Italy to set up glassworks throughout Europe.

A major milestone in the history of glass occurred with the invention of lead crystal glass by the English glass manufacturer George Ravenscroft (1632-1683). He attempted to counter the effect of clouding that sometimes occurred in blown glass by introducing lead to the raw materials used in the process. The new glass he created was softer and easier to decorate, and had a higher refractive index, adding to its brilliance and beauty, and it proved invaluable to the optical industry. It is thanks to Ravenscroft's invention that optical lenses, astronomical telescopes, microscopes and the like became possible.

In Britain, the modern glass industry only really started to develop after the repeal of the Excise Act in 1845. Before that time, heavy taxes had been placed on the amount of glass melted in a glasshouse, and were levied continuously from 1745 to 1845. Joseph Paxton's Crystal Palace at London's Great Exhibition of 1851 marked the beginning of glass as a material used in the building industry. This revolutionary new building encouraged the use of glass in public, domestic and horticultural architecture.

Glass manufacturing techniques also improved with the advancement of science and the development of better technology.

From 1887 onwards, glass making developed from traditional mouth-blowing to a semi-automatic process, after factory – owner HM Ashley introduced a machine capable of producing 200 bottles per hour in Castleford, Yorkshire, England - more than three times quicker than any previous production method. Then in 1907, the first fully automated machine was developed in the USA by Michael Owens -founder of the Owens Bottle Machine Company (later the major manufacturers Owens - Illinois) - and installed in its factory. Owens' invention could produce an impressive 2,500 bottles per hour. Other developments followed rapidly, but it was not until the First World War; when Britain became cut off from essential glass suppliers, that glass became part of the scientific sector. Previous to this, glass had been seen as a craft rather than a precise science.

Today, glass making is big business. It has become a modern, hi-tech industry

operating in a fiercely competitive global market where quality, design and service levels are critical to maintaining market share. Modern glass plants are capable of making millions of glass containers a day in many different colours, with green, brown and clear remaining the most popular. Few of us can imagine modern life without glass. It features in almost every aspect of our lives - in our homes, our cars and whenever we sit down to eat or drink. Glass packaging is used for many products, many beverages are sold in glass, as are numerous foodstuffs, as well as medicines and cosmetics.

Glass is an ideal material for recycling, and with growing consumer concern for green issues, glass bottles and jars are becoming ever more popular. Glass recycling is good news for the environment. It saves used glass containers being sent to landfill. As less energy is needed to melt recycled glass than to melt down raw materials, this also saves fuel and production costs. Recycling also reduces the need for raw materials to be quarried, thus saving precious resources.

### Questions 21-28

[Each correct answer will score 1 mark]

Complete the notes below.

Choose **ONE WORD ONLY** from the passage for each answer.

### The History of Glass

- Early humans used a material called **21** ..... to make the sharp points of their **22** .....
- 4000 BC: **23** ..... made of stone were covered in a coating of man-made glass.
- First century BC: glass was coloured because of the **24** ..... in the material.
- Until 476 AD: Only the **25** ..... knew how to make glass.
- From 10th century: Venetians became famous for making bottles out of glass.
- 17th century: George Ravenscroft developed a process using **26** ..... to avoid the occurrence of **27** ..... in blown glass.
- Mid-19th century: British glass production developed after changes to laws concerning **28** .....

### Questions 29-33

[Each correct answer will score 1 mark]

In the boxes **29-33**, write

- TRUE** if the statement agrees with the information  
**FALSE** if the statement contradicts the information  
**NOT GIVEN** if there is no information on this

*Example:* The creation of lead crystal glass is attributed to George Ravenscroft.

- 29 .** In 1887, HM Ashley had the fastest bottle-producing machine that existed at the time.
- 30 .** Michael Owens was hired by a large US company to design a fully-automated bottle manufacturing machine for them.
- 31.** Nowadays, most glass is produced by large international manufacturers.
- 32.** Concern for the environment is leading to an increased demand for glass containers.
- 33.** It is more expensive to produce recycled glass than to manufacture new glass.

<b>Example:</b>	TRUE
<b>29.</b>	
<b>30.</b>	
<b>31.</b>	
<b>32.</b>	
<b>33.</b>	

## WRITING

[ This section is worth 12 marks in total ]

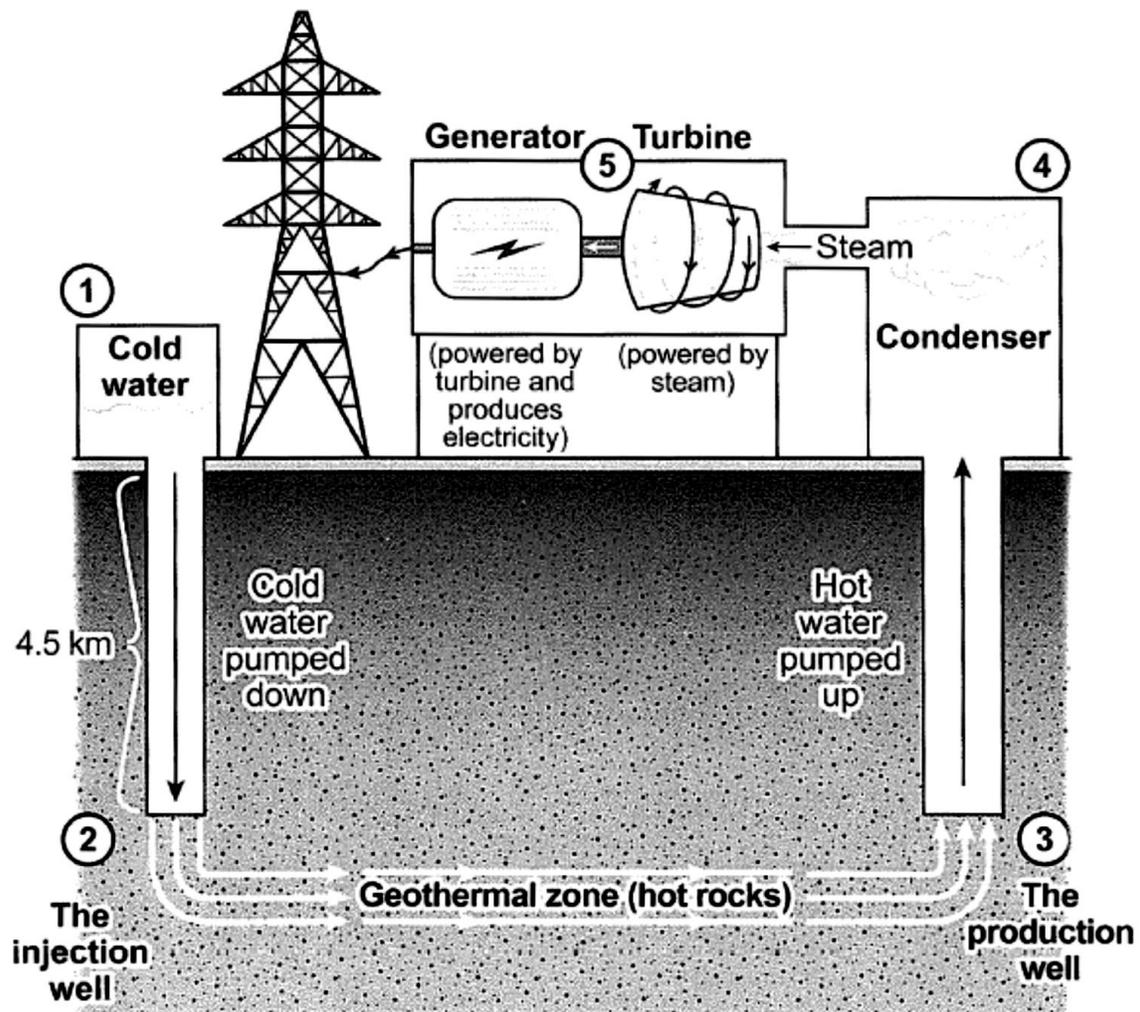
You should spend about **20 minutes** on this task.

*The diagram below shows how geothermal energy is used to produce electricity.*

*Summarise the information by selecting and reporting the main features, and make comparisons where relevant.*

Write at least 150 words in the provided boxes. You may use either one or both of the boxes to write your summary.

### Geothermal power plant





A blank sheet of lined paper with a solid top and bottom border and 25 horizontal dotted lines for writing.

**OR**

You should spend about 20 minutes on this task.

***You are unhappy about a plan to make your local airport bigger and increase the number of flights. You live near the airport.***

***Write a letter to your local newspaper. In your letter***

- ***explain where you live***
- ***describe the problem***
- ***give reasons why you do not want this development.***

You should write at **least 150 words** in the provided boxes.

You may use either one or both of the boxes to write your summary.

You do **NOT** need to write your own address.

Begin your letter as follows:

***Dear Sir/Madam,***

A blank sheet of lined paper with 25 horizontal dotted lines for writing, enclosed in a rectangular border.

A blank sheet of lined paper with a solid top and bottom border and 25 horizontal dotted lines for writing.

# MATHEMATICS

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[Each correct answer will score 1 mark]

**Problem 1:** Solve for  $x$ :  $3x^2 - 4x - 7 = 0$ .

- (a)  $\frac{4 \pm \sqrt{76}}{6}$
- (b)  $\frac{-4 \pm \sqrt{76}}{6}$
- (c)  $\frac{4 \pm \sqrt{28}}{6}$
- (d)  $\frac{-4 \pm \sqrt{28}}{6}$

**Problem 2** If  $a + b = 0$ , what is  $a^3 + b^3$ ?

- (a)  $ab$
- (b)  $0$
- (c)  $3ab$
- (d)  $-1$

**Problem 3** Simplify the expression:  $\frac{x^3 - 1}{x - 1}$ .

- (a)  $x^2 + 1$
- (b)  $x^2 - x + 1$
- (c)  $x^2 + x + 1$
- (d)  $x^2 - 1$

**Problem 4** Find the roots of the polynomial  $x^3 - 6x^2 + 11x - 6$ .

- (a)  $1, 2, 3$
- (b)  $-1, -2, -3$
- (c)  $1, -2, 3$
- (d)  $-1, 2, -3$

**Problem 5** What is the sum of the squares of the roots of  $x^2 + bx + c = 0$ ?

- (a)  $b^2 - 2c$
- (b)  $b^2 + 2c$
- (c)  $b^2 - 4c$
- (d)  $b^2 + 4c$

**Problem 6** Solve for  $x$  and  $y$ :  $x^2 + y^2 = 25$  and  $x - y = 1$ .

- (a)  $(3, 4)$
- (b)  $(4, 3)$
- (c)  $(5, 0)$
- (d)  $(0, 5)$

**Problem 7** Factor completely:  $x^4 - 16$ .

- (a)  $(x^2 + 4)(x^2 - 4)$
- (b)  $(x^2 + 4)(x + 2)(x - 2)$
- (c)  $(x^2 - 4)(x + 4)(x - 4)$
- (d)  $(x^2 - 4)(x^2 + 4)$

**Problem 8** Simplify:  $\sqrt{50} - \sqrt{18} + \sqrt{8}$ .

- (a)  $\sqrt{8}$
- (b)  $2\sqrt{5}$
- (c)  $\sqrt{8} + \sqrt{2}$

(d)  $4\sqrt{2}$

**Problem 9** Solve for  $x$  in the interval  $[0, 2\pi]$ :  $\sin(2x) = \sqrt{3}/2$ .

(a)  $\pi/3, 2\pi/3$

(b)  $\pi/6, 5\pi/6$

(c)  $\pi/4, 3\pi/4$

(d)  $\pi/2, 3\pi/2$

**Problem 10** Compute the value of  $\sin(75^\circ)$ .

(a)  $\frac{\sqrt{6}+\sqrt{2}}{4}$

(b)  $\frac{\sqrt{3}+\sqrt{5}}{4}$

(c)  $\frac{\sqrt{2}+\sqrt{6}}{4}$

(d)  $\frac{\sqrt{3}+\sqrt{2}}{4}$

**Problem 11** Find the exact value of  $\tan(15^\circ)$ .

(a)  $2 - \sqrt{3}$

(b)  $2 + \sqrt{3}$

(c)  $\sqrt{3} - 2$

(d)  $\sqrt{3} + 2$

**Problem 12** Differentiate:  $f(x) = x^2e^x$ .

(a)  $x^2e^x + 2xe^x$

(b)  $x^2e^x + xe^x$

(c)  $e^x(x^2 + 3x)$

(d)  $xe^x + 2e^x$

**Problem 13** Integrate:  $\int(3x^2 - 2x + 1) dx$ .

(a)  $x^3 - x^2 + x + C$

(b)  $x^3 - x^2 + x + 1 + C$

(c)  $x^3 - x^2 + \frac{x}{2} + C$

(d)  $x^3 - x^2 + x + C$

**Problem 14** Find the critical points of  $f(x) = x^3 - 3x^2 + 2x$  and determine their nature.

(a)  $x = 0, 1, 2$  with all being local maxima

(b)  $x = 0, 1, 2$  with  $x = 1$  and  $x = 2$  being local minima

(c)  $x = 1$  and  $x = 2$  with  $x = 1$  being a local minimum and  $x = 2$  being a local maximum

(d)  $x = 1$  and  $x = 2$  with both being local minima

**Problem 15** Differentiate:  $f(x) = \arctan(x)$ .

(a)  $\frac{1}{x^2+1}$

(b)  $\frac{1}{x^2-1}$

(c)  $\frac{1}{\sqrt{1-x^2}}$

(d)  $\frac{1}{\sqrt{1+x^2}}$

**Problem 16** Evaluate the limit:  $\lim_{x \rightarrow \infty} \frac{2x^3+3x}{4x^3-x^2+1}$ .

(a)  $\frac{1}{2}$

(b) 1

(c)  $\frac{2}{4}$

(d) 2

**Problem 17** If  $f(x) = x^2 - 2x + 1$ , find  $f(f(x))$ .

(a)  $x^4 - 4x^3 + 6x^2 - 4x + 1$

(b)  $x^4 - 4x^3 + 6x^2 - 4x$

(c)  $x^4 - 4x^3 + 4x^2 - 2x + 1$

(d)  $x^4 - 4x^3 + 4x^2 - 4x + 1$

**Problem 18** Evaluate the integral:  $\int_1^2 \frac{1}{x^2} dx$ .

(a)  $\frac{1}{2}$

(b)  $-\frac{1}{2}$

(c)  $-1$

(d)  $\frac{1}{3}$

**Problem 19** Solve the equation  $\sin(x) + \cos(x) = 1$  in the interval  $[0, 2\pi]$ .

(a)  $0, \frac{\pi}{4}$

(b)  $\frac{3\pi}{4}, \frac{\pi}{2}$

(c)  $0, \frac{\pi}{2}$

(d)  $0, \frac{5\pi}{4}$

**Problem 20** What is the area between the curve  $y = x^2$  and the x-axis, when x ranges from -1 to 1?

(a)  $\frac{2}{3}$

(b)  $\frac{1}{3}$

(c)  $\frac{1}{2}$

(d)  $\frac{3}{2}$

**Problem 21** Find the limit of  $\frac{\sin(x^2)}{x^2}$  as  $x \rightarrow 0$ .

(a) 1

(b) 0

(c)  $\infty$

(d)  $\frac{1}{2}$

**Problem 22** The numbers  $x, 3, y - 2$  form both an arithmetic and a geometric sequence. Find  $y - x$

(a) 2

(b) -2

(c) 3

(d) -3

**Problem 23** Solve the inequality  $\frac{(x^2-4x-5)\cdot(9-x^2)}{(x^2+7x)\cdot(x-9)} \leq 0$

(a)  $(-7, 3] \cup [1, 0) \cup [3, 5] \cup (9, \infty)$

(b)  $(-7, 3] \cup (1, 0) \cup [3, 7] \cup (9, \infty)$

(a)  $(-\infty, -7] \cup [1, 0) \cup [3, 5] \cup (9, \infty)$

(b)  $(-7, 3] \cup [1, 0) \cup [3, 5] \cup (7, 9]$

**Problem 24** The parabolas  $y = 3x^2 + 4x + m$  and  $y = 2x^2 + 5x + n$  intersect each other at two distinct points. Find the sum of the x-coordinates of the intersection points.

(a) -2

(b) 1

(c) 2

(d) 3

**Problem 25** Find the solution for the equation  $\log_x 2 + \log_x 4 + \log_x 8 + \dots + \log_x 256 = 72$ .

(a) 1

(b) 2

(c) 3

(d) 4

**Problem 26** Solve the equation  $2^x + 1 = \left(\frac{1}{2}\right)^{2x} + \left(\frac{1}{2}\right)^x$ .

- (a) -2
- (b) -1
- (c) 0
- (d) 1

**Problem 27** Evaluate  $\frac{3}{\pi}(\arccos\frac{\sqrt{3}}{2} + \arcsin\frac{\sqrt{3}}{2} + \arctan\sqrt{3})$

- (a) 2
- (b) 1/2
- (c) 3/2
- (d) 5/2

**Problem 28** Solve  $\tan^2x + \cos 2x = \frac{5}{2}$  for  $x$  in  $[0, \pi]$

- (a)  $\{\frac{\pi}{3}, \frac{2\pi}{3}\}$
- (b)  $\{\frac{\pi}{6}, \frac{\pi}{3}\}$
- (c) No solution
- (d) 0

**problem 29**  $8x^2 + (3a - 1)x + 45 = (4x - 5)(2x - 9)$  is given. Find the value of  $a$ .

- (a) -30
- (b) -20
- (c) -15
- (d) 25

**Problem 30** What is the number of positive divisors of 360?

- (a) 180
- (b) 30
- (c) 24
- (d) 18

# Single answer problems

Each question in this section is worth 2 points.

**Problem 1:** Two pedestrians leave the same destination at the same time with constant but different velocities. Their path is straight path in the same direction. After 2 hours distance between them is 1 kilometer. After that, pedestrians started walking faster and spend for each kilometer 10 minutes less amount of time. After another two hours the distance between them has become 3 kilometers. Find the initial velocity of the slower person. Write your answer inside the box

Answer

**Problem 2:** When a number is divided by 10, it leaves a remainder of 9, when divided by 9 it leaves a remainder of 9, when divided by 8 it leaves the remainder of 7, and so on until when divided by 2 it leaves a remainder of 1. What is the number?

Answer

**Problem 3:** Compute the definite integral  $\int_0^1 (x^2 + 1)^{\frac{3}{2}} \cdot x dx$ . Write your answer inside the box.

Answer

**Problem 4:** Solve the equation  $\log_2(x + 1) + \log_4(x + 3) = 2$  Write your answer inside the box.

Answer

**Problem 5:** What are the maximum and minimum values of the function  $f(x) = 5\sin x + 12\cos x$ . Write your answer inside the box?

Answer

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**[Each correct answer will score 1 mark]**

**Question 1:** If today is Monday, what day will it be 500 days from now?

- (a) Monday
- (b) Tuesday
- (c) Wednesday
- (d) Thursday correct

**Question 2:** If it takes 5 machines to make 5 widgets in 5 minutes, how long would it take 100 machines to make 100 widgets?

- (a) 5 minutes
- (b) 50 minutes
- (c) 1 hour
- (d) 30 minutes

**Question 3:** You have 27 balls, one of which is heavier. What is the minimum number of weighings is needed to find the heavier ball?

- (a) 2
- (b) 3
- (c) 4
- (d) 5

**Question 4:** What is the next number in the given a sequence of numbers 2, 17, 82, 257, ...?

- (a) 783
- (b) 496
- (c) 571
- (d) 626

**Question 5:** In a class every boy is friends with exactly three girls, and every girl is friends with exactly two boys. It is known that there are only 19 desks (each holding at most two students), and 31 of the students in the class study French. How many students are there?

- (a) 33
- (b) 35
- (c) 40
- (d) 30

**Question 6:** Two teams played each other in a decathlon. In each event the winning team gets 4 points, the losing team gets 1 point, and both teams get 2 points in case of a draw. After 10 events the two teams have 46 points together. How many draws were there?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

**Question 7:** The numbers  $2^{1989}$  and  $5^{1989}$  are written one after another. How many digits in all are there?

- (a) 1989
- (b) 1990
- (c) 2100
- (d) 1988

**Question 8:** The natural numbers 1 through 64 are written in squares of a chessboard, and each number is written exactly once. What is the maximum difference between two neighboring squares can be guaranteed?

- (a) 3
- (b) 4
- (c) 5
- (d) 7

**Question 9:** Find  $A \times B \times C$ , given the following operation.

$$\begin{array}{r}
 \text{ABC} \\
 \times \quad 43 \\
 \hline
 \text{37C} \\
 + \dots \\
 \hline
 \dots
 \end{array}$$

- (a) 14
- (b) 0
- (c) 9
- (d) 10

**Question 10:** What triplets is the answer for the question?

$$1 \blacktriangle 2 \rightarrow 1, 4, 4$$

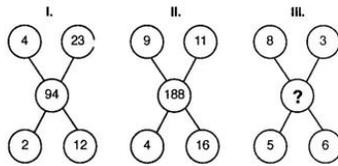
$$2 \blacktriangle 3 \rightarrow 4, 12, 9$$

$$1 \blacktriangle 5 \rightarrow 1, 10, 25$$

$$3 \blacktriangle 4 \rightarrow ?$$

- (a) 4,6,16
- (b) 9,25,16
- (c) 9,24,16
- (d) 9,16,16

**Question 11:** Find the missing number in the figure below.



- (a) 62
- (b) 63
- (c) 64
- (d) 65

**Question 12:** Find the result of the operations given below.

I.  $\square a + \triangle b + \text{pentagon } c = (a + 4) + (b - 3) + (c \cdot 5)$

II.  $\text{pentagon } 2 + \triangle 7 - \square 3 = 7$

III.  $\triangle 5 + \text{pentagon } 3 - \square 4 = ?$

- (a) 9
- (b) 10
- (c) 12
- (d) 14

**Question 13:** Calculate **a+c-b** for the following table.

+	a	b	c
a		c	
b	c		
c			

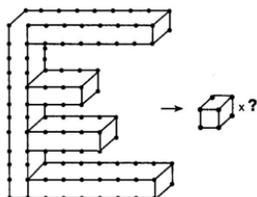
x	b	c
a		21
c	28	

- (a) 5
- (b) 6
- (c) 7
- (d) 8

**Question 14:** Which of the following figures differ from others?

- (a) 
- (b) 
- (c) 
- (d) 

**Question 15:** How many cubes are there in the figure below?



- (a) 30
- (b) 31
- (c) 32
- (d) 33