



# International Vedic Maths Olympiad 2023

Open

Time allowed - 1 Hour

Questions 1 - 25: Score 2 marks for each correct answer.

1.  $2(1 + 2(1 + 2(1 + 2(1 + 2(1 + 2(1 + 2))))))$

A 63

B 126

C 127

D 254

E 274

2. Which of the following is not a multiple of 9?

A 768321

B 224433

C 891548

D 243756

E 830106

3. A, B and C are three digits. B and C add up to 10.

What is the value of A?

$$\begin{array}{r} A \ B \\ \times A \ C \\ \hline 4216 \end{array}$$

A 2

B 3

C 4

D 5

E 6

4. What is the whole number remainder when 242871 is divided by 897?

A 487

B 851

C 475

D 206

E 681

5. The working below shows the division,  $259781 \div 11243 = 227$  remainder 320, using the Vedic Transpose and Apply method. What are the digits for ABC?

$$\begin{array}{r|l} 1143 & 259781 \\ \hline 143 & 286 \\ & ABC \\ & 429 \\ \hline & 23\bar{3}/320 \\ & 227/320 \end{array}$$

A  $\bar{4}\bar{2}\bar{9}$

B  $\bar{1}\bar{2}\bar{9}$

C  $\bar{1}\bar{4}\bar{3}$

D 286

E 081

6. 2023 has a square factor whose square root ends in 7. What is that square root?

A 7

B 17

C 27

D 37

E 47

7.  $992^2$

A 978464

B 987664

C 976764

D 984064

E 988264

8. What are the vinculum digits in the Nikhilam multiplication of  $524 \times 492$  when using a working base of 500 and a real base of 1000?

A  $\overline{144}$

B  $\overline{192}$

C  $\overline{326}$

D  $\overline{808}$

E  $\overline{162}$

9. What is the area of a rectangular floor measuring 15 ft 3 in. by 12 ft 9 in.? (1 foot = 12 inches)

A  $162 \text{ ft}^2 93 \text{ in}^2$

B  $178 \text{ ft}^2 23 \text{ in}^2$

C  $194 \text{ ft}^2 63 \text{ in}^2$

D  $180 \text{ ft}^2 27 \text{ in}^2$

E  $192 \text{ ft}^2 36 \text{ in}^2$

10. Using Flag Division (Straight division) what is the third step in the calculation of  $62995 \div 43$ ?

A  $(28 - 1 \times 3) \div 4$

B  $(29 - 1 \times 3) \div 4$

C  $(39 - 4 \times 3) \div 4$

D  $(32 - 2 \times 3) \div 4$

E  $(30 - 2 \times 3) \div 4$

11.  $79^3$

A 493039

B 627429

C 534149

D 467229

E 510239

12. What are the last five digits in the recurring pattern of the decimal equivalent of  $\frac{1}{49}$ ?

A ...25641

B ...77551

C ...20408

D ...16327

E ...02551

13. After the decimal point, how many non-recurring digits are there in the decimal equivalent for  $\frac{17}{384}$ ?

A 3

B 4

C 5

D 6

E 7

14. The digits 2, 3, 4, 5, 6 are placed in the grid to form two three-digit square numbers. Which number must be placed in the central square?

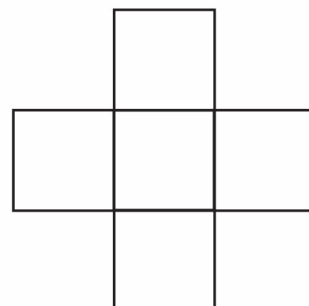
A 2

B 3

C 4

D 5

E 6



15. Images on a computer screen are made up of tiny dots called pixels. Each pixel is a square with edge length  $\frac{1}{96}$  of an inch. A certain screen has 2073600 pixels. What is its area in square inches?

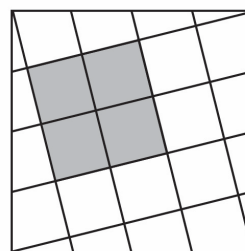
A 225 sq.in      B 216 sq.in      C 512 sq.in      D 256 sq.in      E 175 sq.in

16. Mr Elongate Musketeer owns 19 companies each with over ten thousand employees. Which of the following could be the total number of employees?

A 588728      B 290585      C 422121      D 540037      E 202101

17. What fraction of the square is shaded?

A  $\frac{1}{4}$       B  $\frac{1}{5}$       C  $\frac{2}{9}$       D  $\frac{4}{17}$       E  $\frac{4}{9}$

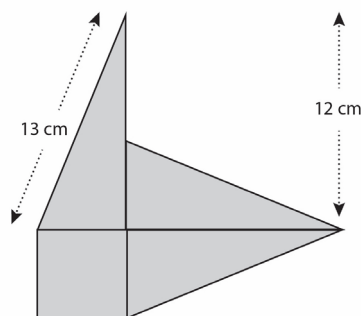


18. What is the simplified form of,  $(2x^2 + 3x + 1)^2 - (x^2 - 3x - 1)^2$ ?

A  $3x^2(x^2 + 6x + 2)$       B  $3x^2(x^2 + 6)$       C  $3x^4 + 20x^2 + 12x$       D  $3x^4 + 20x^2 - 1$       E  $3x^2(x^2 - 6x - 2)$

19. Three identical right-angled triangles and a square are placed together with measurements as shown. What is the outside perimeter of the whole shape?

A 43 cm      B 46 cm      C 49 cm  
D 51 cm      E 56 cm



20. Which of the following is an equation of the straight line which passes through the point  $(-3, 2)$  and also perpendicular to the line with equation,  $5x - 3y = 19$ ?

A  $3x + 5y = -9$       B  $3x + 5y = 1$       C  $y = -\frac{5}{3}x - 3$       D  $y = -\frac{3}{5}x - \frac{9}{5}$       E  $5y = 3x + 19$

21. A set of five different integers have a mean value of 6 and their median is 5. The smallest number is 3 and when all five are multiplied the result is 4800. What is the largest of the five numbers?

A 15      B 12      C 11      D 10      E 9

22. What is the value of  $x$  for which,  $2^{2x} \times 8^{x-1} = 16^{x+3}$  ?

A 0

B 9

C 15

D 16

E 48

23. A square has centre (3, 4) and one corner at (1, 5). Where is another corner?

A (1, 3)

B (5, 5)

C (4, 2)

D (2, 2)

E (5, 2)

24. Which of the following is a factor of  $3x^3 + 11x^2 + 30x + 72$  ?

A  $(x+1)$

B  $(x+2)$

C  $(x+3)$

D  $(x+4)$

E  $(x+6)$

25. What is the radius of the circle with equation,  $x^2 + y^2 + 2x - 4y + 1 = 0$  ?

A 1

B 2

C  $\sqrt{2}$

D  $\sqrt{5}$

E 5

**Questions 26 - 35: Score 3 marks for each correct answer.**

26. Triangle  $ABC$  has vertices with coordinates, (3, 5), (6, 9) and (11, 7).

In square units, what is the area of the triangle?

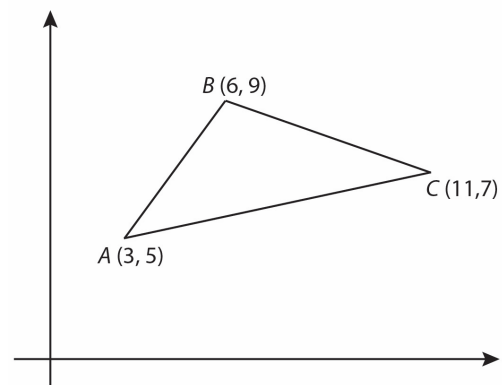
A 11

B 13

C 15

D 22

E 26



27. Two of the pyramids at Giza in Egypt are Khufu, with a height of 280 Royal Cubits, and Menkaure, with a height of 112 Royal Cubits. They can be treated as similar shapes. If the volume of Menkaure is  $1.2 \times 10^6$  Cubic Royal Cubits, what is the volume of Khufu, in the same units?

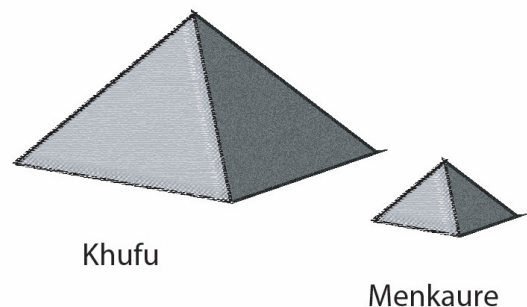
A  $3.125 \times 10^7$

B  $7.5 \times 10^6$

C  $1.875 \times 10^7$

D  $9 \times 10^6$

E  $1.625 \times 10^6$



28. Andria and Bertha both run 100 metres in times A and B seconds. The difference between the squares of their times is four times the sum of their times. The sum of their times is eight times the difference between their times. How long did it take for the slowest of the two runners?

A 15 s

B 16 s

C 17 s

D 18 s

E 19 s

29. Each square in this grid has side length one unit. Two circles, each with diameter one unit are placed in two opposite squares. What is the shortest distance between the two circles?

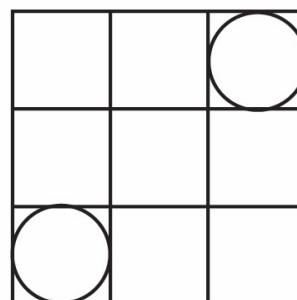
A 3

B 2

C  $2\sqrt{2}$

D  $\sqrt{2} + 1$

E  $2\sqrt{2} - 1$



30. In this magic square, the products of numbers in each row, each column and each diagonal are all the same. The missing numbers are 2, 4, 5, 10, 25, 50 and 100. Which number must be placed in the square labelled M?

A 2

B 4

C 5

D 10

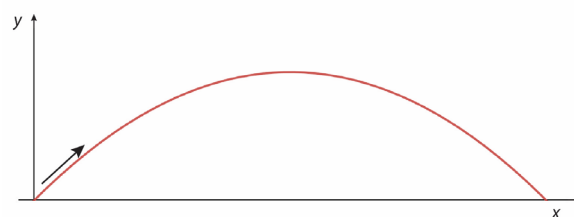
E 25

	1	20
M		

31. When a javelin is thrown it follows the path of a parabola and the maximum distance achieved is when the angle of throw is  $45^\circ$  to the horizontal. The graph of a record breaking throw is described by the equation,

$$y = x - \frac{x^2}{98}$$

where, x and y are measured in metres.



What is the maximum height of this throw?

A 24.5 m

B 49 m

C 28.5 m

D 98 m

E 12.5 m

32. How many three-digit numbers can be written as the sum of five different powers of 3, including  $3^0$ ?

A 6

B 7

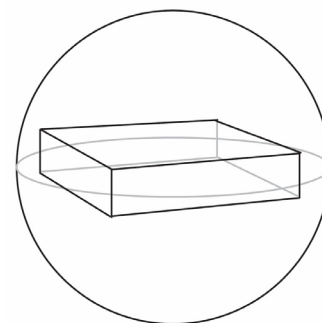
C 8

D 9

E 10

33. A cuboid, measuring 2 by 10 by 22 units, is placed inside a sphere with its eight vertices touching the surface. What is the edge length of the largest cube that can fit inside a sphere of the same size?

A 7                      B  $7\sqrt{3}$                       C 14  
D  $14\sqrt{3}$                       E  $3\sqrt{7}$



34. What is the value of  $p$ , given that,

$$(4x^2 - 3px + 2)(x^2 + px + 1) = 4x^4 + px^3 - 7px^2 - px + 2$$

A 1                      B 3                      C 5                      D 7                      E 9

35. What is the remainder when  $1 + 3x + 5x^2 + 7x^3 + \dots + 99x^{49}$  is divided by  $x - 1$ ?

A 1000                      B 2000                      C 2500                      D 5000                      E 5500

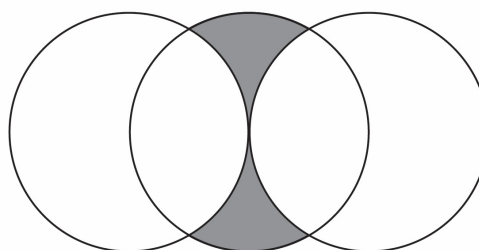
**Questions 36 - 40: Score 4 marks for each correct answer.**

36. Three circles, each with a radius of one unit, are set out as shown with the circumference of the middle circle passing through the centres of the outer two circles.

What is the area of the shaded region in terms of  $\pi$ ?

A  $2\sqrt{3} - \frac{2\pi}{3}$                       B  $\frac{2\sqrt{3} - \pi}{6}$                       C  $\frac{2\pi}{3} - \sqrt{3}$

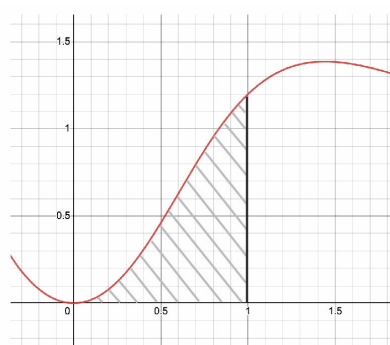
D  $\frac{4\pi}{3} - \sqrt{3}$                       E  $\sqrt{3} - \frac{\pi}{3}$



37. What is the area of the shaded region given by,

$$A = \int_0^1 \frac{6x^2}{2x^3 + 3} dx$$

A  $\ln 6$                       B  $\ln \frac{3}{4}$                       C  $\ln \frac{4}{3}$   
D  $\ln 3$                       E  $\ln \frac{5}{3}$



38. Given that  $|x| < \frac{1}{2}$ , which power series, to three terms, corresponds to the expansion of,

$$\frac{3x-1}{2x^2+3x-2} ?$$

- A**  $\frac{3}{2} + \frac{3}{4}x - \frac{9}{16}x^2 + \dots$ 
**B**  $\frac{1}{2} - \frac{9}{4}x + \frac{3}{8}x^2 + \dots$ 
**C**  $\frac{1}{2} - \frac{9}{4}x - \frac{31}{4}x^2 + \dots$   
**D**  $\frac{1}{2} - \frac{3}{4}x - \frac{5}{8}x^2 + \dots$ 
**E**  $\frac{1}{3} + \frac{1}{4}x - \frac{3}{8}x^2 + \dots$

39. The function,  $y = e^{kx}$  satisfies the equation,

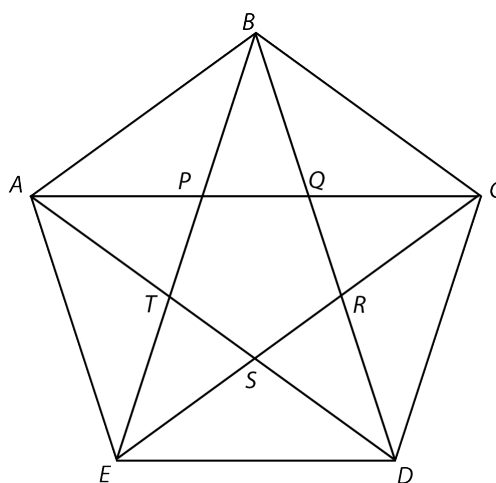
$$\left( \frac{d^2y}{dx^2} + \frac{dy}{dx} \right) \left( \frac{dy}{dx} - y \right) = y \frac{dy}{dx}$$

for

- A** no values of  $k$ 
**B** exactly one value of  $k$ 
**C** exactly two distinct values of  $k$   
**D** exactly three distinct values of  $k$ 
**E** infinitely many distinct values of  $k$

40. A pentagram is drawn within a regular pentagon. The area of the inner pentagon,  $PQRST$ , is one unit. Given that  $BC : BQ = BQ : PQ$ , what is the area of the large pentagon,  $ABCDE$ ?

- A**  $\frac{3\sqrt{5}+7}{2}$ 
**B**  $\frac{5+2\sqrt{5}}{4}$ 
**C**  $\frac{\sqrt{5}+1}{2}$   
**D**  $\frac{4\sqrt{5}+3}{4}$ 
**E**  $\frac{\sqrt{5}-1}{2}$



## Answer Key Open IVMO 2023

Questions 1 - 25: Score 2 marks for each correct answer.

Questions 26 - 35: Score 3 marks for each correct answer.

Questions 36 - 40: Score 4 marks for each correct answer.

1. D	11. A	21. D	31. A
2. C	12. B	22. C	32. E
3. E	13. E	23. D	33. C
4. E	14. A	24. C	34. B
5. A	15. A	25. B	35. C
6. B	16. D	26. B	36. E
7. D	17. D	27. C	37. E
8. B	18. A	28. D	38. D
9. C	19. E	29. E	39. C
10. C	20. B	30. B	40. A



## Answer Sheet Open IVMO 2023

Write your name in Block Capitals here

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Write yours answers, A, B, C, D or E in the boxes below.

1.		11.		21.		31.	
2.		12.		22.		32.	
3.		13.		23.		33.	
4.		14.		24.		34.	
5.		15.		25.		35.	
6.		16.		26.		36.	
7.		17.		27.		37.	
8.		18.		28.		38.	
9.		19.		29.		39.	
10.		20.		30.		40.	