

# The Blitz-contest of IOM-2021

Nº 1

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A metal ball of radius 10 cm charged to a potential of 300 V. Later on it is surrounded by a thin conductive shell of radius 15 cm. What will the potential of the ball be if it is brought into contact with the inside of the shell? Give your number in Volts, rounded to integer.

Number

Nº 2

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For which of the following solid substances the mass of the solid increases when left on air?

lime stone

blue vitriol

potassium permanganate

gold

slaked lime

Nº 3

---

The police stopped a driver and sent him for blood sampling. The analysis showed that 10.0 mL of blood reacted with  $2.0 \cdot 10^{-5}$  mol of potassium dichromate. Calculate the mass concentration of ethanol (g/L) in the blood. Assume that only ethanol reacts with  $K_2Cr_2O_7$  and the only oxidation product is acetic acid.

Number

**Nº 4**

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Find all numbers of the form  $pq$ , where  $p$  and  $q$  are prime numbers and  $pq$  divides  $7^p + 7^q$ .

If there are multiple answers, they should be entered each in its own field; add more fields with the "+" button.

Number



**Nº 5**

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In the tetrahedron  $DABC$ , the edges  $DB$  and  $AC$  are perpendicular. Given  $AB = 5$ ,  $AD = 2\sqrt{22}$ , and  $DC = 12$ , find the length of  $BC$ .

If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.

Number or fraction

**Nº 6**

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If  $K_c$  for the reaction  $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$  is 6400, then what is  $K_c'$  for the reaction  $\text{SO}_2 + 1/2\text{O}_2 \rightleftharpoons \text{SO}_3$ ?

Number

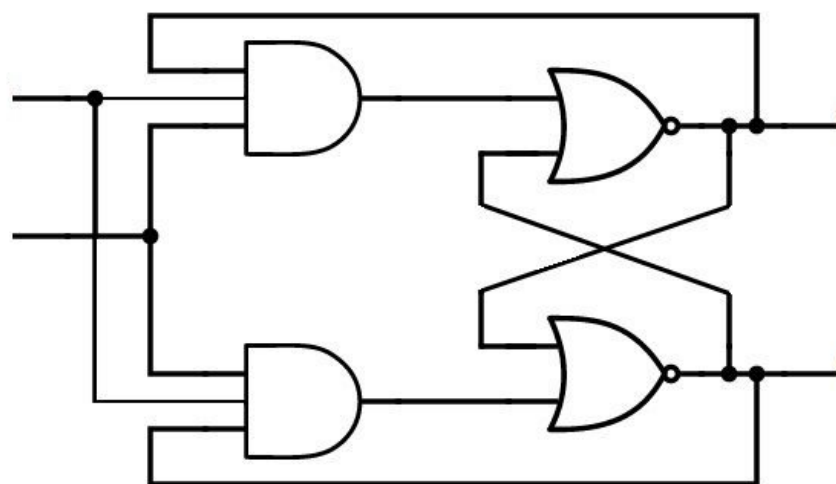
**Nº 7**

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The nuclear transformation  ${}^{237}_{93}\text{Np} \rightarrow {}^{209}_{81}\text{Tl}$  is a part of the neptunium decay chain. It includes a sequence of  $\alpha$ - and  $\beta$ -emissions. What is the number of  $\beta$ -emissions in this transformation?

Number

Nº 8



What is represented by the given circuit diagram?

- T flip-flop ("toggle")
- SR flip-flop ("set-reset")
- D flip-flop ("data" or "delay")
- JK flip-flop (some kind of the "set-reset")

Nº 9

What is the correct name of a molecule obtained by substituting one of the H atom of the first carbon of propene with the isopropyl group:

- 2,3-dimethylbut-1-ene
- 4-methylpent-1-ene
- 2-methylpent-4-ene
- 4-methylpent-2-ene
- 2-methylpent-3-ene

**Nº 10**

Consider a graph with vertices in all lattice points of a 3d space with  $x, y, z \in [-2000, 2000]$ , and edges between all pairs of vertices that have Euclidean distance 1 from each other. First, a breadth-first search is run to find the distance from  $(566, 566, 566)$  to  $(239, 239, 239)$ . Then, a breadth-first search with the meet-in-the-middle approach is run for the same task. What is the ratio of the number of vertices processed by the first BFS to the number of vertices processed by the second BFS?

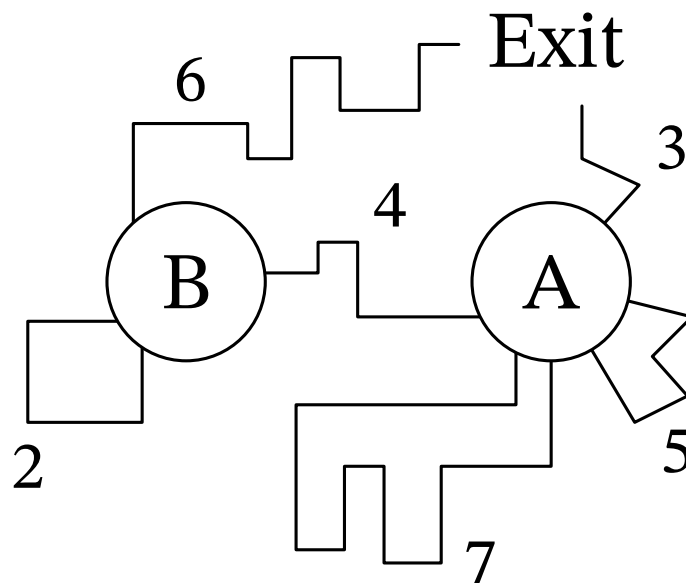
Give the answer rounded to the nearest integer.

(Both BFSs terminate when the desired distance is known.)

Number

**Nº 11**

Hazel the mouse wants to get out of a maze. His starting point is room A. Whenever he is in a room, he runs out into one of the outgoing passageways; each time he chooses each passageway with equal probability. (He has 6 options in room A and 4 options in room B.) On the map of the maze below, next to each passageway, it is written how long (in minutes) it takes for Hazel to run through it. What is the expected time in minutes for Hazel to get out of the maze?



If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.

Number or fraction

Nº 12

Which of the following statements **is not true** for hydrochloric and formic acids?

- Formic acid is weaker.
- During the dilution of their 0.1 mol/L solutions, the degree of dissociation of hydrogen chloride practically does not change, but that of formic acid increases.
- 100 mL of each solution with the same pH value are neutralized by the same volume of a 0.1 mol/L sodium hydroxide solution.
- pH of the 0.1 mol/L solution of formic acid is higher than that of the 0.1 mol/L solution of hydrochloric acid.
- Lime stone can be dissolved by both acids.

Nº 13

Which option best describes the following code?

```
for (int i = 0; i < n; i++) {  
    for (int j = i; j < n; j++) {  
        if (a[i] > a[j]) {  
            swap(a[i], a[j]);  
        }  
    }  
}
```

- Bubble Sort
- Selection Sort
- Insertion Sort
- Quick Sort
- Merge Sort

**Nº 14**

A narrow parallel beam of light falls from the air on a transparent ball of radius  $R = 20$  cm with a refractive index  $n = 2$  in the direction of one of the diameters. The distance from the center of the ball to a point where the rays are focused is equal to ... (give your number in cm, rounded to integer)

**Nº 15**

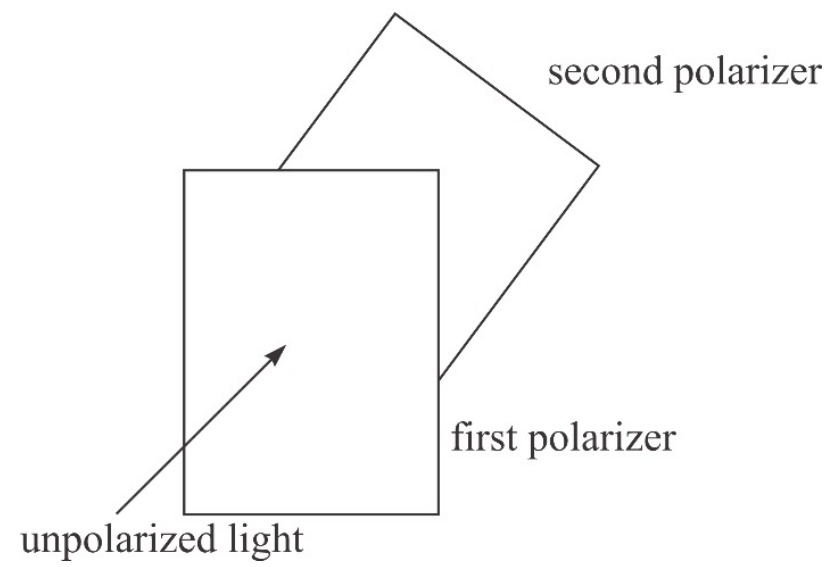
Which of the following is equivalent to **(A and B)** or **(A xor B)**?

 1 A B A and B A or B A xor B**Nº 16**

A dielectric plate with dielectric permeability  $\varepsilon = 1.5$  is placed in a uniform electric field so that its normal makes an angle  $\alpha_0 = 30^\circ$  with electric field lines. Strength of the electric field outside the plate is equal to  $E_0 = 1.0 \frac{\text{V}}{\text{m}}$ . Find the strength of the electric field inside the plate. Give your number in V/m, rounded to two decimal.

**Nº 17**

Unpolarized light of intensity  $I_0$  is incident on a polarizer. The transmitted light is then incident on a second polarizer. The axis of the second polarizer makes an angle of  $60^\circ$  to the axis of the first polarizer.



What is the intensity of the light transmitted through the second polarizer?

$I_0$

$\frac{I_0}{2}$

$\frac{I_0}{4}$

$\frac{I_0}{8}$

$\frac{I_0}{16}$

**Nº 18**

Find two's complement of the number  $-57$ , considering that one byte has been allocated to store it in the computer memory.

ОТВЕТ

Nº 19

Solve the equation  $\log_7(x) + 2\log_{49}(x) = \log_{1/7}(9)$ .

If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.  
If there are multiple answers, they should be entered each in its own field; add more fields with the "+" button.

Number or fraction



Nº 20

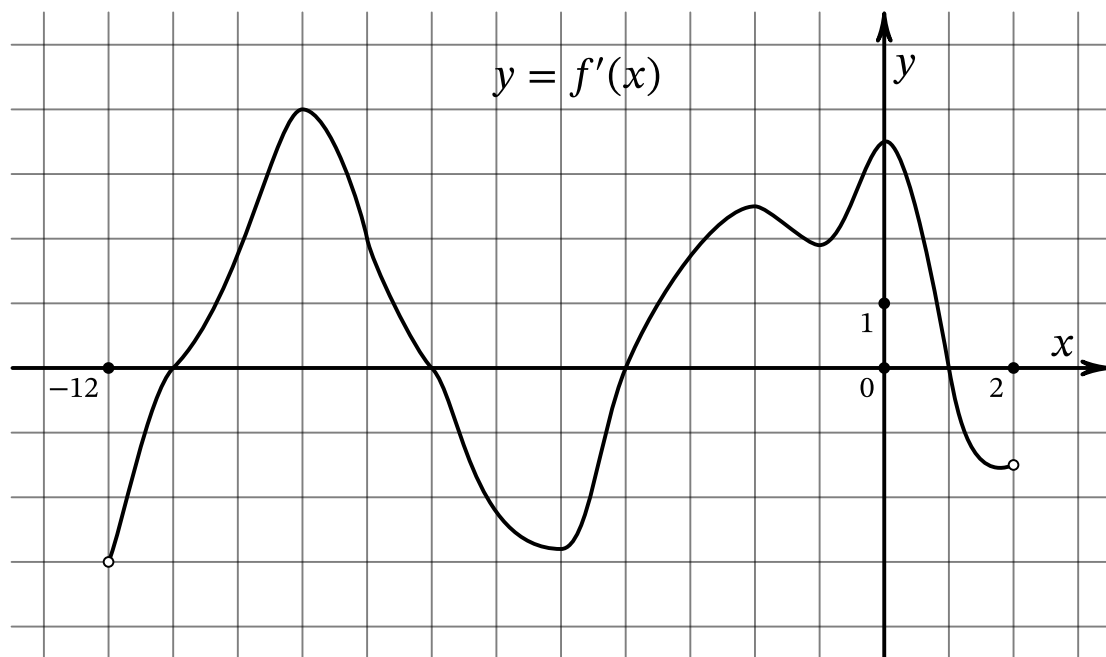
The hero has a magic sword. In one blow it is able to cut down the number of heads equal to the square of some positive integer. That is, it can cut down 1, 4, 9, 16, and so on heads. The hero chooses positive integer  $A$  and the Wizard tells the hero where the monster Serpent Gorynych is, with the number of heads  $(27 \oplus 29 \oplus 31 \oplus 33 \oplus A)$ . Here  $\oplus$  denotes bitwise xor, the exclusive or.

Help the hero find the smallest  $A$ , for which he can cut off all the heads of the Serpent Gorynych in one blow.

Number

Nº 21

The figure shows the graph of  $y = f'(x)$ , the derivative of some function  $f(x)$ , defined on the interval  $(-12, 2)$ .



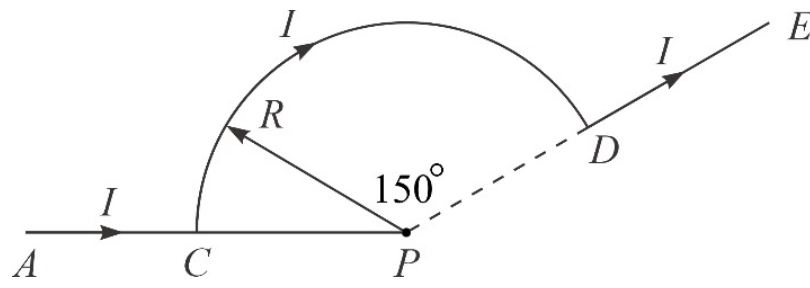
Consider the intervals of decrease of function  $f(x)$ . Find the length of the longest such interval.

Number



**Nº 22**

A steady current  $I = 0.2$  A is maintained in the conducting path  $ACDE$ . Find the strength of the magnetic field induction at  $P$  located at the center of the circular arc  $CD$  of radius  $R = 2$  cm subtending an angle of  $150^\circ$ . The number should be given in microTesla and rounded to two decimal places.



Number

**Nº 23**

Given the year 2021, what is the next year that has 2 more 1s in its binary representation than 2021 has in its binary representation?

Number

**Nº 24**

What is the best case time complexity of the bubble sort algorithm?

  $O(N)$   $O(N \log N)$   $O(N^2)$   $O(1)$

**Nº 25**

Real numbers  $a$  and  $b$  are the components of a 2-dimensional vector  $V$  and satisfy the following system of equations:

$$\begin{cases} 2a^2 - 2ab + b^2 = a; \\ 4a^2 - 5ab + 2b^2 = b. \end{cases}$$

Find all such vectors  $V$ . Give all different squares of their absolute values (i.e., values of  $|V|^2$ ) as answers.

*If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.*

*If there are multiple answers, they should be entered each in its own field; add more fields with the "+" button.*

Number or fraction

**Nº 26**

In a 0.5 M solution of a weak acid (HA),  $\text{pH} = 2.6$ . Calculate the value of  $\text{p}K_a$  for HA.

Number

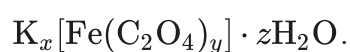
**Nº 27**

Hydrolysis of a natural tetrapeptide with the molar mass of 402 g/mol catalyzed by carboxypeptidase yields an amino acid that is optically inactive and a tripeptide. In the presence of trypsin, the tripeptide is further hydrolyzed into alanine and a dipeptide. The dipeptide is then fully hydrolyzed to form lysine, glutamic acid, and ammonia. Determine the correct amino acid sequence in the tetrapeptide (from the amino to the carboxyl end).

For each position in a sequence, choose one of the following amino acids: Ala, Gln, Glu, Gly, Lys.

**Nº 28**

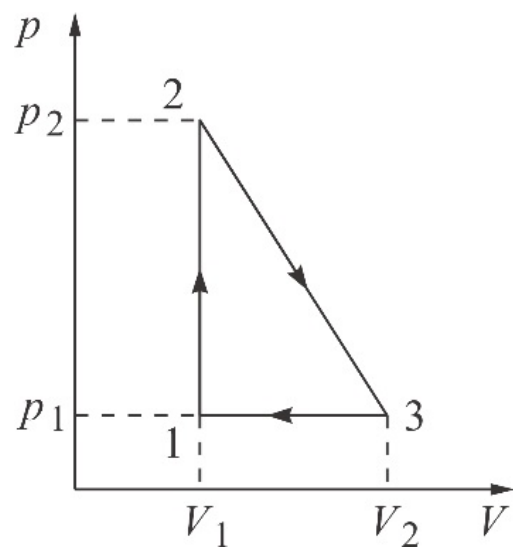
The solution containing 8.08 g of ferric nitrate nonahydrate was thoroughly mixed with the solution of 12.12 g of potassium oxalate dihydrate. The resulting solution was put into a fridge to cool it down. The mass of a green monocrystal precipitated from the cold solution was 7.856 g. Assume that the yield of an octahedral complex of Fe(III) is 80% and the monocrystal is uncontaminated. Determine the chemical formula of this monocrystal. Write down the indexes  $x$ ,  $y$ ,  $z$  in the formula



$x =$  ,  $y =$  ,  $z =$  .

Nº 29

Ideal gas passes through the cycle ( $p_2 = 2p_1, V_2 = 3.50V_1$ ). Find the the ratio of the maximum cycle temperature to the temperature at point 1.



3.50

3.55

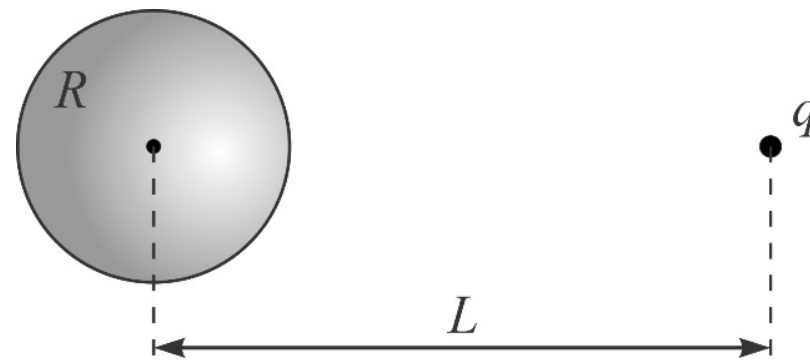
3.60

3.65

3.70

**Nº 30**

The point charge  $+q$  is located at a distance  $L = 3R$  from the center of the metallic sphere of radius  $R$ . At what values of the positive charge  $+Q$  of sphere the sphere and charge will attract?



$\frac{Q}{q} < \frac{15}{184}$

$\frac{Q}{q} < \frac{17}{192}$

$\frac{Q}{q} < \frac{19}{191}$

$\frac{Q}{q} < \frac{21}{197}$

$\frac{Q}{q} < \frac{23}{214}$

**Nº 31**

Consider the following recursive function  $\text{fun}(x, y)$ . What is the value of  $\text{fun}(47, 43)$ ?

```
int fun(int x, int y){  
    if (x == 1)  
        return y;  
    return y + fun(x - 1, y);  
}
```

Number

**Nº 32**

What is the output of the following code fragment?

```
n = 3
matrix = [[0 for i in range(n)] for j in range(n)]
cell, turn = 1, 0
while cell <= n * n:
    for i in range(turn, n - turn):
        matrix[turn][i], cell = cell, cell + 1
    for i in range(1 + turn, n - turn):
        matrix[i][n - 1 - turn], cell = cell, cell + 1
    for i in range(n - 2 - turn, turn - 1, -1):
        matrix[n - 1 - turn][i], cell = cell, cell + 1
    for i in range(n - 2 - turn, turn, -1):
        matrix[i][turn], cell = cell, cell + 1
    turn = turn + 1
for i in range(0, n):
    for j in range(0, n):
        print(matrix[i][j], end = ' ')
    print()
```

A)	B)	C)	D)	E)
1 2 3	1 2 3	1 2 3	1 1 1	1 2 3
8 0 4	1 2 3	2 0 4	2 2 2	8 9 4
7 6 5	1 2 3	3 4 5	3 3 3	7 6 5

A

B

C

D

E

**Nº 33**

A metallic equipment needs to be galvanized with a thin layer of silver on its surface. The equipment is put into a solution of sodium dicyanoargentate(I) and the electrolysis of the solution starts with the equipment attached to the cathode. How many seconds will it take to obtain the 20 $\mu$ m layer of silver with a current of 10 A and the surface area of the equipment of 50 cm<sup>2</sup>? The density of silver is 10.49 g/cm<sup>3</sup>, the Faraday constant is 96500 C/mol.

Number

**Nº 34**

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A bag contains the numbers 1, 2, 5, 7, 11. Two numbers are randomly pulled out of the bag. What is the probability that one of the numbers divides the other?

*If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.*

Number or fraction

**Nº 35**

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What is the value of the expression

$$1^2 - 2^2 + 3^2 - 4^2 + 5^2 - 6^2 + \dots - 2020^2 + 2021^2 \quad ?$$

Number

**Nº 36**

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Which of the following compounds has the second-highest boiling point?

acetic acid

tetrahydrofuran

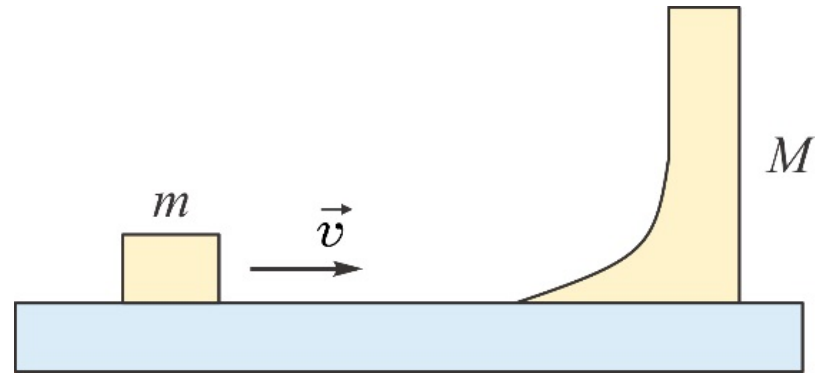
diethyl ether

butane

furan

**Nº 37**

A block of mass  $m$  is launched horizontally onto a curved wedge of mass  $M$  at a velocity  $v$ . What is the maximum height reached by the block after it shoots off the vertical segment of the wedge? Assume all surfaces are frictionless; both the block and the curved wedge are free to move.



$\frac{v^2}{2g}$

$\left(\frac{m}{m+M}\right)^2 \frac{v^2}{2g}$

$\left(\frac{M}{m+M}\right)^2 \frac{v^2}{2g}$

$\frac{m}{m+M} \frac{v^2}{2g}$

$\frac{M}{m+M} \frac{v^2}{2g}$

**Nº 38**

Numbers  $x_1$  and  $x_2$  are the roots of the equation  $4x^2 - 10x - 3 = 0$ . Find the value of the expression  $x_1^2 + 2.5x_2$ .

If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.

Number or fraction

**Nº 39**

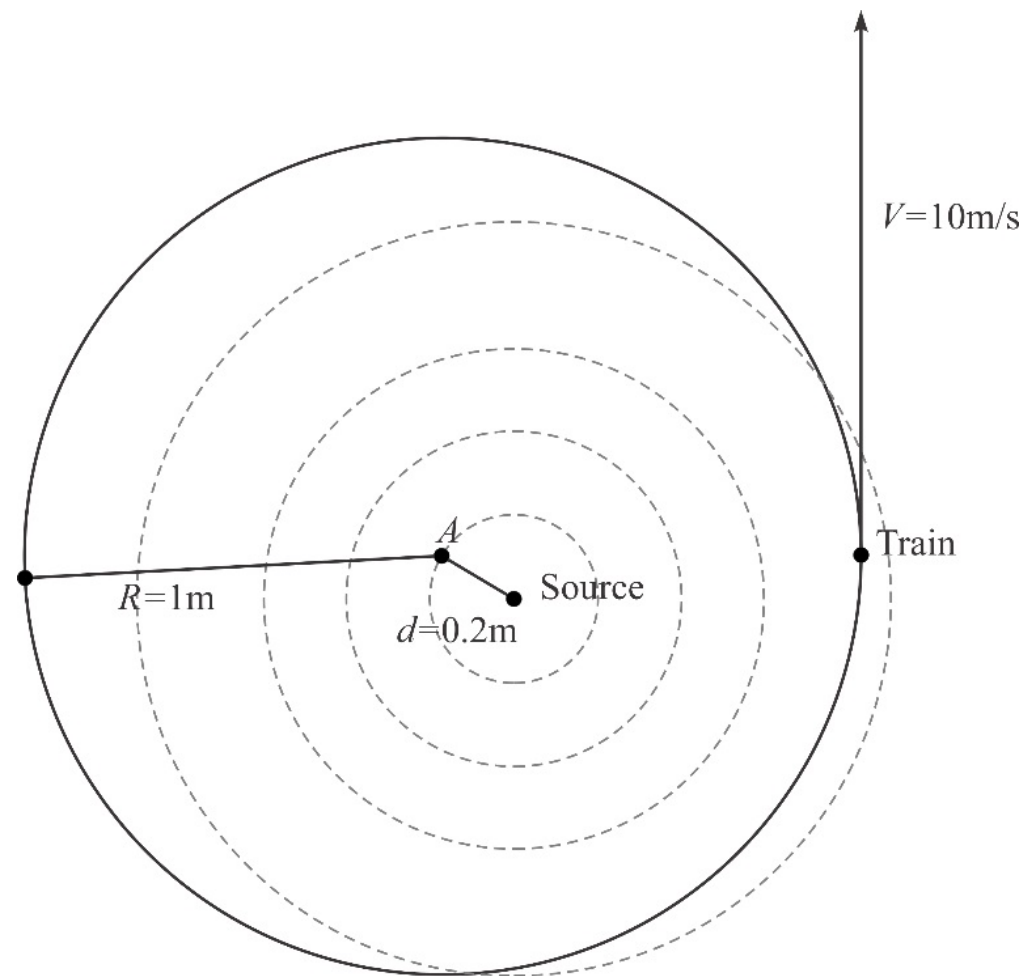
Determine the area of triangle  $ABC$  if point  $O$  is the origin of the coordinate system with basis unit vectors  $\vec{i}$  and  $\vec{j}$ , the vector  $\vec{OA} = -2\vec{i} + \vec{j}$ , the vector  $\vec{AB} = 5\vec{i} - 3\vec{j}$ , the vector  $\vec{AC}$  is parallel to the vector  $\vec{i}$ , and the scalar product  $\vec{AB} \cdot \vec{BC} = 0$ .

If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.

Number or fraction

**Nº 40**

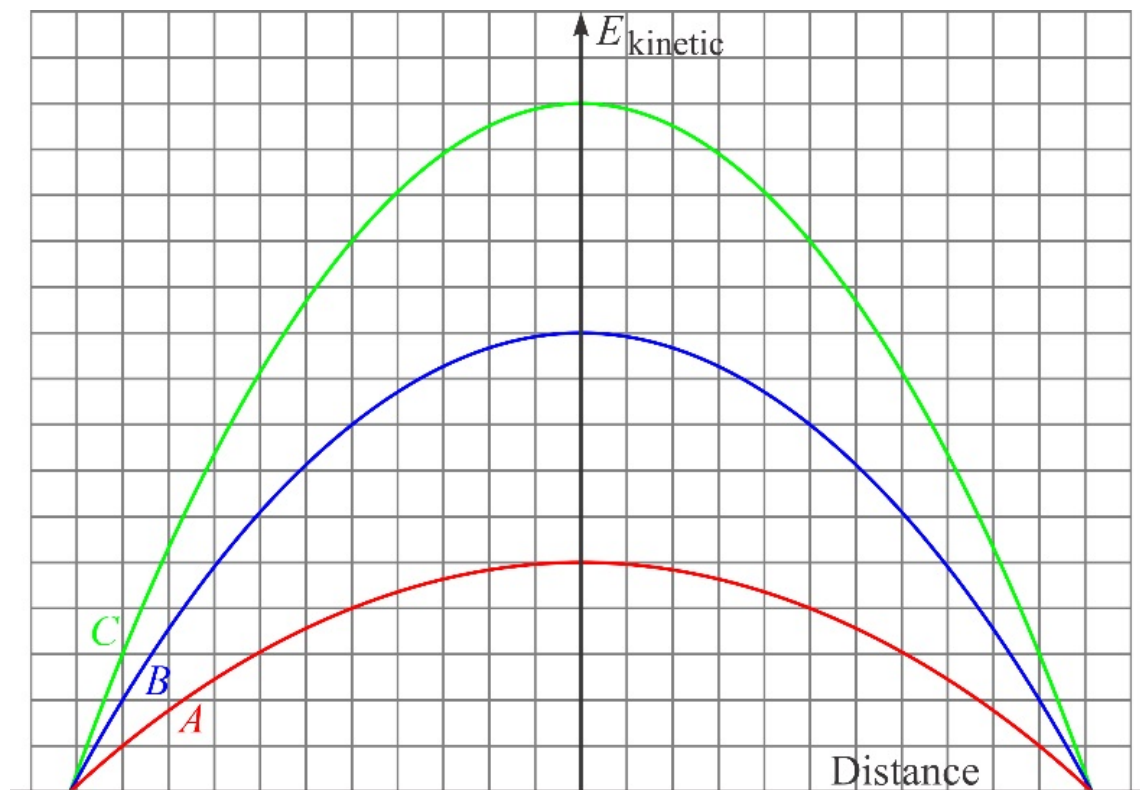
A toy train is moving in a circle with radius of 1 m and speed of 10 m/s. There is a source of sound at  $d = 0.2$  m from the center of the circle, which is playing a constant sound with the frequency of 10 kHz. There is a microphone in the train. What is the maximum frequency (in Hz, rounded to integer) of sound detected by the microphone? The speed of sound is 340 m/s.



Number



We put three bodies to three different springs and started an oscillation with the same amplitude. Here is the kinetic energy of the bodies based on the distance from the point of equilibrium. Which statement concerning the elasticity of the strings is correct? (*A* – red, *B* – blue, *C* – green).



- $K_A : K_B : K_C = 1 : 4 : 9$
- $K_A : K_B : K_C = 1 : 2 : 3$
- $K_A : K_B : K_C = 1 : \sqrt{2} : \sqrt{3}$
- $K_A : K_B : K_C = 3 : 2 : 1$
- $K_A : K_B : K_C = \sqrt{3} : \sqrt{2} : 1$

Nº 42

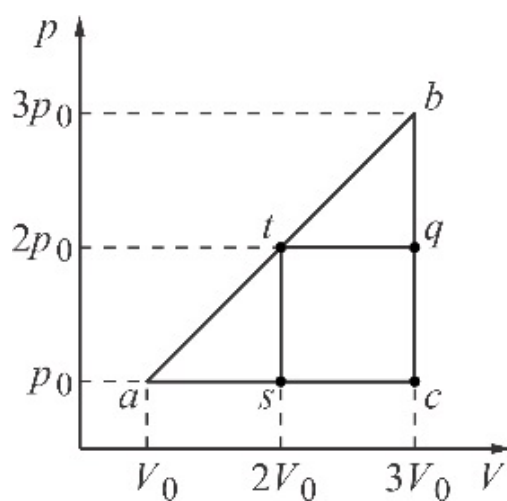
What does the following code do?

```
#include <bits/stdc++.h>
using namespace std;
map <int, int> mp;
int sum, res, m, x;
int main(){
    int n;
    cin >> n >> m;
    mp[0]=1;
    for(int i = 0 ; i < n ; i++){
        cin >> x;
        sum+=x;
        res+=mp[sum - m];
        mp[sum]++;
    }
    cout << res << endl;
    return 0;
}
```

- Count the number of distinct values in the list.
- Count the number of subarrays having sum  $m$ .
- Count the number of subarrays that have at most  $m$  distinct values.
- Maximum sum of values in a contiguous subarray with length between  $m$  and  $x$ .

Nº 43

A monoatomic ideal gas undergoes two thermodynamic cycles as shown below: Cycle 1:  $a-b-c-a$  Cycle 2:  $s-t-q-c-s$ . Find the ratio of the Energy Conversion Efficiency of two engines working with these cycles  $\eta_1/\eta_2$ . Give the number rounded to two decimal points.



Number

**Nº 44**

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64-bit CPU has a 64-bit address bus. If  $x$  is the maximum amount of memory CPU can address (in bytes), what is  $\lfloor \log_{10} x \rfloor$ ?

Number

**Nº 45**

---

For which initial nonnegative value of  $s$  does the following code output 0?

```
jump = [2, 3, 1, 4, 5, 9, 0, 6, 8, 7]
for _ in range(len(jump) - 1):
    for _ in range(4):
        s = jump[s]
        jump[s] = jump[jump[s]]
print(s)
```

Number

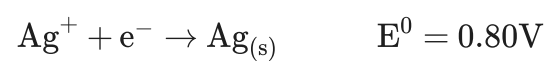
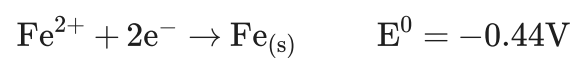
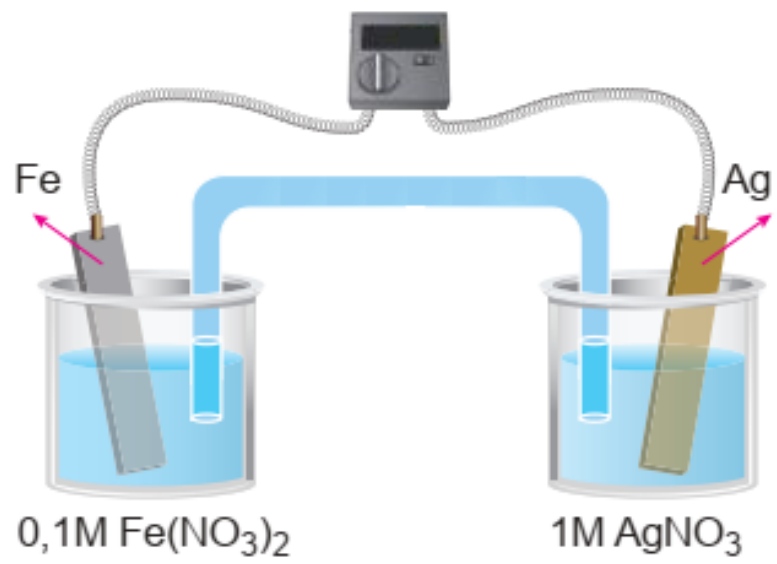
**Nº 46**

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A flat air capacitor consists of two horizontal plates. Each of the plates has an area  $S = 250 \text{ cm}^2$  and a distance between them  $d = 2.00 \text{ mm}$ . The capacitor is first charged by a battery with voltage  $U = 150 \text{ V}$ , then disconnected from the battery and a plate of dielectric is placed exactly in the middle between its plates. The plate has the same area, thickness  $l = 1.00 \text{ mm}$  and relative dielectric constant  $\varepsilon = 3.50$ . Calculate the charge on the upper surface of the dielectric plate. Give number in nC, round to first decimal.

Number

Nº 47



What is the potential (in volts) of the above system?

1.21

1.24

1.27

2.01

2.07

Nº 48

In how many ways can a group of 5 students be chosen from a class of 32?

Number

**Nº 49**

A cylindrical copper wire (length  $l = 1$  m, diameter  $d = 2$  cm,  $\rho_c = 0.017 \Omega \text{ mm}^2/\text{m}$ ) is moved into a region containing a homogenous magnetic field  $B = 0.3$  T with velocity  $v = 5$  m/s perpendicular to the B-field. Compute the ratio between the induced current inside the wire and the current in a DC circuit consisting of a battery with  $U = 1000$  V and a resistance of  $R = 2 \Omega$ . Round the answer to an integer.

Number

**Nº 50**

The organic substance **X** is a sulfur analogue of the oxygen-containing compound **Y**. 5.50 g of **X** is burned in an excess of oxygen. As a result,  $16.63 \text{ dm}^3$  of a gas mixture forms (400 K, 1 bar). When the mixture is cooled down to  $20^\circ\text{C}$ , a colorless, odorless liquid with the mass of 2.70 g condenses from this mixture. If the remaining gases are passed through a column with calcium hydroxide, a precipitate weighing 36.0 g forms. On air, the precipitate increases in weight by 0.80 g. Determine the formulas of **X** and **Y**. Write down the relative molecular mass of **Y** (as an integer number). Use the integer values of all atomic masses.

Number

**Nº 51**

Find the last digit of the number  $A = 2 \cdot 7^{2012^{2011}} + 5 \cdot 13^{12^{11}}$ .

(Notation  $a^{b^c}$  implies  $a^{(b^c)}$ .)

Number

**Nº 52**

During the interaction of 8 L of hydrogen with 6 L of oxygen, 100 kJ of heat was released under certain conditions. How much heat (in kJ) will be released during the interaction of 8 L of hydrogen with 3 L of oxygen under the same conditions?

Number

Nº 53

During the complete combustion of 50 L of a mixture of methane and ethane, 80 L of carbon dioxide were obtained. How many liters of oxygen have been consumed? Gas volumes are measured under the same conditions. Give the integer answer.

Number

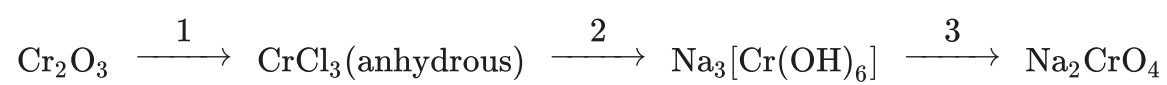
Nº 54

Triangle  $ABC$  has a side of length  $a = 8$ . The lengths of the other sides  $b$  and  $c$  are integers. Given  $b \cdot c = 84$ , determine the perimeter  $a + b + c$  of the triangle.

Number

Nº 55

Consider the reaction sequence.



Find the correspondence between the reaction number and the reaction conditions.

1

HCl/H<sub>2</sub>O

2

NH<sub>3</sub>/H<sub>2</sub>O

3

NaOH(excess)/H<sub>2</sub>O

Cl<sub>2</sub>/NaOH

C, Cl<sub>2</sub>,  $t$

**Nº 56**

---

You have 2000 bottles of wine and exactly 1 of them is poisonous. You also have  $x$  mice and you can make each of them drink from a subset of bottles. After 1 day if a mouse drinks from a poisonous bottle it dies. What is the smallest  $x$  for which you can be sure you can find the poisonous bottle in 2 days.

Number

**Nº 57**

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During an archeological excavation in Rom (Italy) a cryptic text was found. As clever participants of IOM VI help the excavation team to decrypt the message.

“znk hrozf ot ous corr hk lat”

the blitz in iom give us fun

fun blitz in iom will be six

the blitz in iom will be fun

the blitz in iom will be six

**Nº 58**

---

What should be the speed of a car on an icy road (no friction) in a roundabout? The road is inclined at an angle of  $5^\circ$  to the horizontal (towards the center of the roundabout). The diameter of the roundabout is 200 m,  $g = 10 \text{ m/s}^2$ . Give number in m/s, round the result to the first decimal.

Number

**Nº 59**

---

A circular sector is a portion of a disc enclosed by two radii and an arc. Among all circular sectors with a fixed area  $S$ , consider the one with the smallest perimeter. What is the central angle (in radians) of that circular sector?

*If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio “r/s”. Rounding is not allowed.*

Number or fraction

**Nº 60**

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Peter observes an image of the Moon on a screen after the light passes through a convex lens. What is the diameter of the image on the screen if the focal length of the lens is 200 mm? The apparent diameter of the Moon is  $0.50^\circ$ . Answer should be given in millimeters and rounded to the first decimal.

Number

**Nº 61**

---

A positive integer  $n$  is said to be *digitious* if it is a 9-digit number such that each digit 1, 2, ..., 9 appears exactly once. Find the largest digitious number such that the sum of any two adjacent digits is a multiple of either 5, 7 or 11.

Number

**Nº 62**

---

A gas was warmed by  $1^\circ\text{C}$  at constant pressure. Its volume increased by  $\frac{1}{300}$  of its original volume. What was the gas's original temperature? Give answer in Celsius, rounded to integer.

Number

**Nº 63**

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Let  $ABCD$  be a rectangle with area 1 and let point  $E$  lie on the side  $CD$ . What is the area of the triangle formed by the centroids of the triangles  $ABE$ ,  $BCE$  and  $ADE$ ?

*If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.*

Number or fraction



**Nº 64**

Five small spheres (whose masses are 2.00 kg, 2.05 kg, 2.10 kg, 2.15 kg and 2.20 kg) hang from a horizontal rigid tube. Each mass hangs from an identical fishing line that can withstand a maximum tension of 22.2 N. When this device is placed inside an elevator that accelerates upwards, the only threads that do not break are the ones holding the 2.00 kg and 2.05 kg masses. What could be the maximum acceleration of the elevator? Suppose  $g = 9.80 \text{ m/s}^2$ . Give answer in  $\text{m/s}^2$ , rounded to the second decimal.

Number

**Nº 65**

100 students came to a camp for 7 days. On each day, for each student, a bicycle was provided. Find the smallest possible number of bicycles in the camp, given that each bicycle has been used at most for 6 days.

Number

**Nº 66**

Let  $ABC$  be a triangle with  $\angle A \neq \angle B$  and  $\angle C = 45^\circ$ . On the internal angle bisector of  $\angle BCA$  consider the points  $D$  and  $E$  such that  $\angle CAD = \angle CBE = 45^\circ$ , and on the perpendicular bisector of  $AB$ , on the same side as  $C$  with respect to  $AB$ , consider the point  $F$  such that  $\angle AFB = 135^\circ$ . Find the degree measure of angles of the triangle  $DEF$ .

*If the answer is a fraction, it can be entered either as a decimal fraction or as a ratio "r/s". Rounding is not allowed.*

$\angle FDE =$    $^\circ$ ,  $\angle DEF =$    $^\circ$ ,  $\angle EFD =$    $^\circ$ .

**Nº 67**

The number of valence electrons in a metal atom is 6 times less than the total number of the inner electrons. Determine the element with the smallest atomic number which satisfies this condition. Write down the chemical symbol for this element.

ОТВЕТ

**№ 68**

Find a pair  $m, n$  of positive integers such that  $m < n$ ,  $\text{gcd}(m, n) = 1$  and  $\text{lcm}(m, n) = 15252$ . If there are several solutions, specify the one with the largest  $m$ .

(Here  $\text{gcd}$  denotes greatest common divisor and  $\text{lcm}$  denotes least common multiple.)

$m =$

Number

$n =$

Number

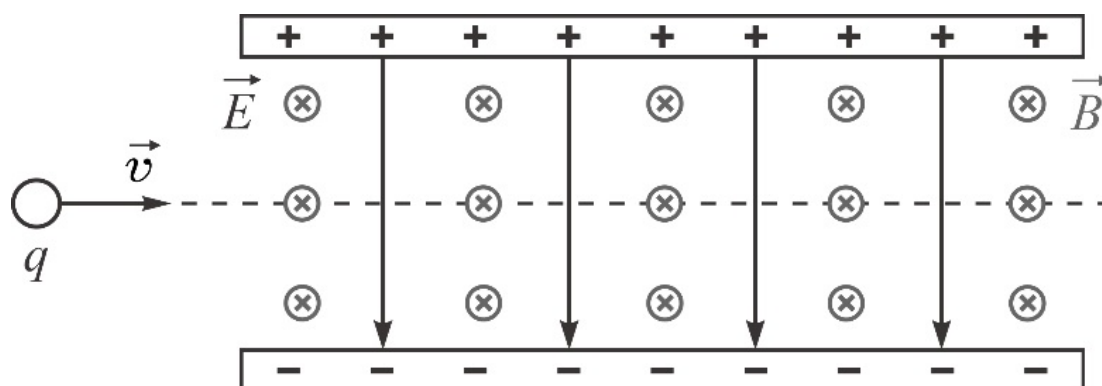
**№ 69**

A red substance consists of two elements. It is soluble in aqueous ammonia, concentrated hydrochloric acid, and concentrated nitric acid. In the latter case, a brown gas is released and a blue solution is formed. Determine the substance, write down its chemical formula.

ОТВЕТ

**№ 70**

Inside a given region in space there are two uniform fields: an electric field, with an intensity  $E = 0.01$  V/m, and a magnetic field, with an intensity  $B = 0.2$  T. These fields are placed in such a way that they are perpendicular to each other, just as shown in the figure. A charged particle  $q$  enters the region with a constant velocity  $v$ , which is perpendicular to both fields. The particle goes through the region without its velocity being altered. Find the speed of the particle. Give answer in mm/s, rounded to integer.



Number

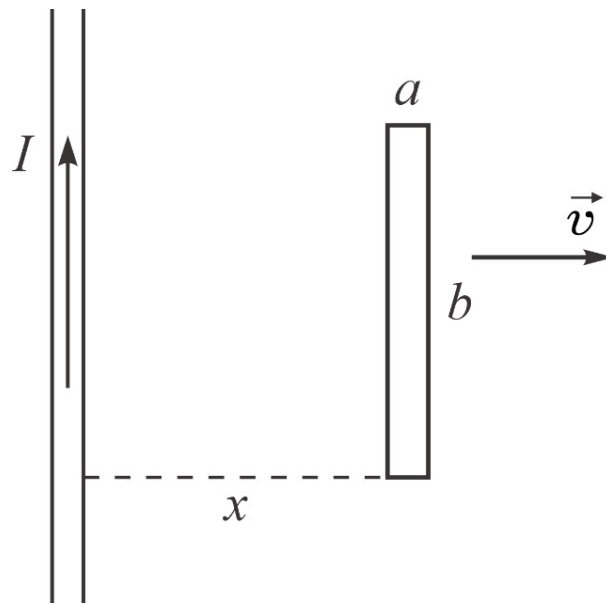
Nº 71

Given the array {831, 264, 856, 347, 474, 590, 640, 592, 548, 952} how many times would you have to rearrange the array to sort it using base 4 Radix sort?

Number

Nº 72

A very long uniform straight wire carrying constant electrical current  $I$  is located at a distance  $x$  from a thin rectangular frame (of metal) moving with constant speed  $v$  towards the right side in a direction perpendicular to the wire, as shown in the figure. The width of the frame is  $a$ , while its length is  $b$ . Suppose  $a$  is infinitely small compared to the distance between wire and frame. What is the emf induced in the frame?



$\frac{\mu_0 I a b v}{2\pi x^2}$

$\frac{\mu_0 I a x v}{b^2}$

$\frac{\mu_0 I a b v}{x^2}$

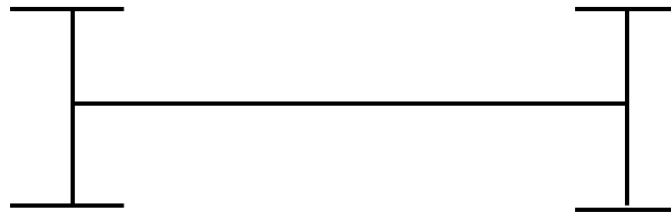
$\frac{\mu_0 I a x v}{2\pi b^2}$

$\frac{\mu_0 I a v}{2\pi x}$

**Nº 73**

Start with a segment 16 cm in length. At each end draw a segment half as long, perpendicular to the original segment and intersecting at the new segment's midpoint. If this process is continued infinitely, a fractal is created. Counting the original segment as stage 1, what is the total length of all segments after stage 6 is completed?

Stage 3:



Number

**Nº 74**

During the complete hydrolysis of a polysaccharide, glucose is formed as a single product. The average molecular mass of the polysaccharide is 1 million Da (1 Da = 1 amu). What is the average degree of polymerization of the polysaccharide?

Number

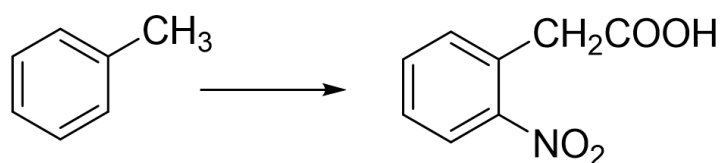
**Nº 75**

You represent the decimal integer 91 in the notation with base  $b$ . For which  $b$  it's representation has at least three equal digits?

Number

**Nº 76**

Arrange in the correct order the steps for the selective synthesis of *ortho*-nitrophenylacetic acid from toluene. Only one organic product should be obtained at each stage. Some stages may be used several times, and some may not be used at all. Enter the sequence of numbers without spaces, for example: 12344321.



- 1) NaCN
- 2) H<sub>2</sub>SO<sub>4</sub>(conc.), t°
- 3) HNO<sub>3</sub>(conc.), H<sub>2</sub>SO<sub>4</sub>(conc.), t°
- 4) Br<sub>2</sub>, hν
- 5) Br<sub>2</sub>, FeBr<sub>3</sub>, t°
- 6) H<sub>2</sub>SO<sub>4</sub>, H<sub>2</sub>O, t°

Number

**Nº 77**

How many different sets of values of boolean variables  $x_1, x_2, \dots, x_{10}$  satisfy all of the following conditions?

$$(x_1 \rightarrow x_2) \rightarrow (x_3 \rightarrow x_4) = 1$$

$$(x_3 \rightarrow x_4) \rightarrow (x_5 \rightarrow x_6) = 1$$

$$(x_5 \rightarrow x_6) \rightarrow (x_7 \rightarrow x_8) = 1$$

$$(x_7 \rightarrow x_8) \rightarrow (x_9 \rightarrow x_{10}) = 1$$

Number

**Nº 78**

Find the number of 13-tuples  $(x_1, x_2, \dots, x_{13})$  of nonnegative integers satisfying

$$x_1^2 + x_2^2 + \dots + x_{13}^2 = 2 + x_1x_2 + x_2x_3 + \dots + x_{12}x_{13}$$

Number

**№ 79**

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Messages that are transferred over a communication channel contain only four letters P, O, S, T; binary code is used for transferring, it allows unambiguous decoding. Code words for letters T, O and P are respectively T: 111, O: 0, P: 011. What is the shortest code word for the letter S if the code always allows the unambiguous decoding? If there are several codes, select the code with the smallest numerical value.

ОТВЕТ

**№ 80**

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The hydrogen isotopes protium, deuterium and tritium, which are all single positively charged, are separated from each other in a homogeneous magnetic field. They enter the magnetic field with the same initial velocity perpendicular to the field lines. Name the isotope which describes the largest circular path radius in the process.

Protium

Deuterium

Tritium