

## 10 Flanders Mathematics Olympiad 2002

### 10.1 First round: the problems

For this set of problems there is a working time of max. 3 hours allowed, and the scoring system is as follows: a correct answer amounts for 5 points, a wrong answer for 0 points, and a blank answer for 1 point.

1. The sum of 100 numbers is 1000. Each number is increased by 20, afterwards each number is multiplied by 5 and finally decreased by 20.

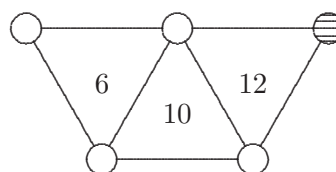
The sum of the 100 new numbers is

- |          |           |          |
|----------|-----------|----------|
| (A) 5000 | (B) 5080  | (C) 5800 |
| (D) 6500 | (E) 13000 |          |

2. If  $a^{0,123} = 5$ , then  $a^{0,369} =$

- |                 |                   |                   |        |         |
|-----------------|-------------------|-------------------|--------|---------|
| (A) $5^{0,246}$ | (B) $\frac{5}{3}$ | (C) $\sqrt[3]{5}$ | (D) 15 | (E) 125 |
|-----------------|-------------------|-------------------|--------|---------|

3. Fill in the numbers from 1 up to 5 in the five little circles, in such a way that in each triangle the given number is the sum of the numbers on the vertices. Which number appears in the shaded circle?

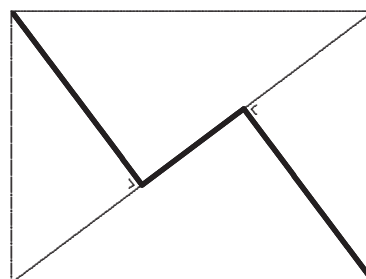


- |       |       |       |       |       |
|-------|-------|-------|-------|-------|
| (A) 1 | (B) 2 | (C) 3 | (D) 4 | (E) 5 |
|-------|-------|-------|-------|-------|

4. The number of “ending zero’s” of the product of  $15^6$ ,  $28^5$  and  $55^7$  is

- |        |        |        |
|--------|--------|--------|
| (A) 0  | (B) 5  | (C) 10 |
| (D) 13 | (E) 26 |        |

5. The length of the bold broken line in this rectangle with width 6 and length 8 is



- |        |          |          |
|--------|----------|----------|
| (A) 12 | (B) 12,4 | (C) 12,5 |
| (D) 14 | (E) 16   |          |

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6. In a cinema there is a room with 20 rows of chairs. The first row counts 30 chairs and each row has one chair more than the row in front of it. The number of chairs in the room is

(A) 790	(B) 800	(C) 810	(D) 820	(E) 830
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7. If  $f(x) = 1 + \frac{1}{x}$ , then  $f(f(f(x))) =$

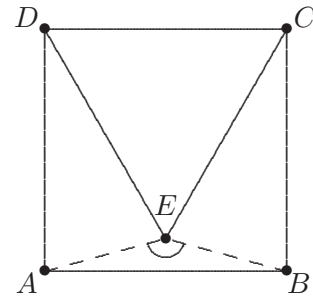
(A) $(1 + \frac{1}{x})^3$	(B) $3 + \frac{1}{x}$	(C) $1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{x}}}$
(D) $1 + \frac{3}{x}$	(E) $1 + \frac{1}{x^3}$	

- 8.

$$\frac{\frac{1}{2} - \frac{1}{3}}{\frac{1}{3} - \frac{1}{4}} \cdot \frac{\frac{1}{4} - \frac{1}{5}}{\frac{1}{5} - \frac{1}{6}} \cdot \frac{\frac{1}{6} - \frac{1}{7}}{\frac{1}{7} - \frac{1}{8}} \dots \frac{\frac{1}{48} - \frac{1}{49}}{\frac{1}{49} - \frac{1}{50}} =$$

(A) -50	(B) 0,04	(C) 1	(D) 25	(E) 46
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9. In the figure,  $ABCD$  is a square and  $DCE$  is an equilateral triangle. Determine the angle  $\widehat{AEB}$ ?

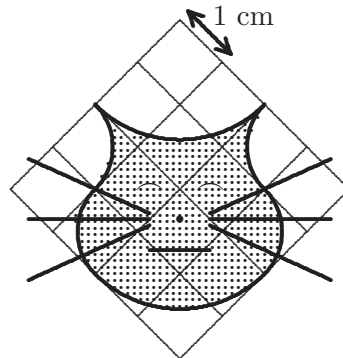


(A) $111^\circ$	(B) $120^\circ$	(C) $130^\circ$	(D) $140^\circ$	(E) $150^\circ$
-----------------	-----------------	-----------------	-----------------	-----------------

10. We know that a function  $f$  on  $\mathbb{N}$  is determined by  $f(mn) = mf(n) + nf(m)$  for each  $m, n \in \mathbb{N}$  and that  $f(12) = f(15) = f(20) = 60$ . Determine  $f(8)$ .

(A) 8	(B) 12	(C) 16	(D) 24	(E) 36
-------	--------	--------	--------	--------

11. The edge of the shaded region (see figure) consists of six quarter circles. The area of this region equals



- (A)  $5 \text{ cm}^2$       (B)  $6 \text{ cm}^2$       (C)  $7 \text{ cm}^2$       (D)  $8 \text{ cm}^2$       (E)  $9 \text{ cm}^2$

12. Which one of the following statements is correct?

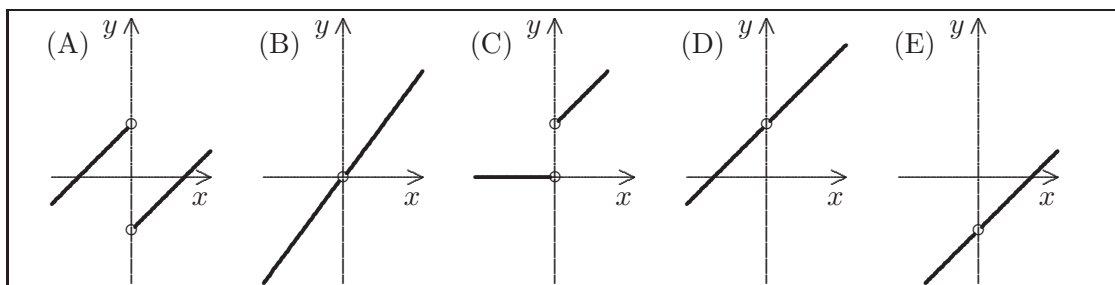
- I      This list contains exactly one wrong statement.  
 II     This list contains exactly two wrong statements.  
 III    This list contains exactly three wrong statements.  
 IV    This list contains exactly four wrong statements.  
 V     This list contains exactly five wrong statements.

- (A) I      (B) II      (C) III      (D) IV      (E) V

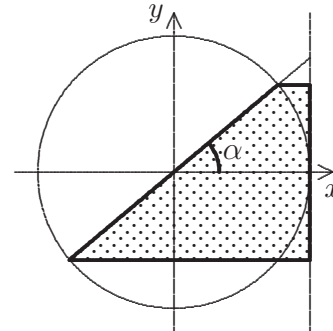
13. If  $49^x + 49^{-x} = 7$ , then  $7^x + 7^{-x}$  equals

- (A) 1      (B)  $\sqrt{5}$       (C)  $\sqrt{7}$       (D) 3      (E) 9

14. The graph of the function  $f(x) = x - \frac{x}{|x|}$  is given by



15. The figure shows a trigonometric circle and a quadrangle. One edge of the quadrangle is a diameter of the circle, the other edges are parallel to one of the axes, one of them is tangent to the circle. The angle formed by the diameter and the  $x$ -axis is  $\alpha$ . Determine the area of the quadrangle.

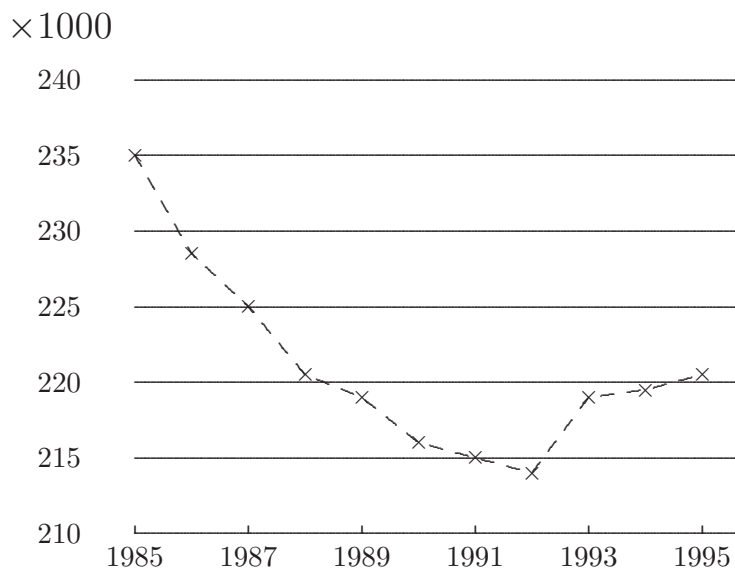


- |                                      |                       |                     |
|--------------------------------------|-----------------------|---------------------|
| (A) $2 \sin \alpha$                  | (B) $2 \sin^2 \alpha$ | (C) $2 \tan \alpha$ |
| (D) $2 \sin \alpha(2 + \cos \alpha)$ | (E) $\sin 2\alpha$    |                     |

16. Bob spends 40 % of his pocket money on a present for his dad. He uses 30 % of the rest to buy candy. Which percentage of his pocket money has he spent?

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| (A) 42% | (B) 52% | (C) 58% | (D) 65% | (E) 70% |
|---------|---------|---------|---------|---------|

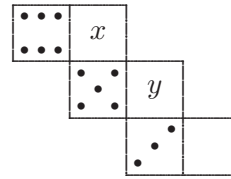
17. The following figure shows the number of girls in high school of Phantasia country between 1985 and 1995.



We can conclude that the number of female pupils between 1991 and 1995

- |                                |
|--------------------------------|
| (A) has about been halved.     |
| (B) has about been doubled.    |
| (C) increased with 6 pupils.   |
| (D) increased by about 5%.     |
| (E) increased by less than 3%. |

18. On a dice the sum of the number of eyes on opposite sides equals 7. The number of eyes on the sides  $x$  and  $y$  of the development of a dice (see figure) is respectively



(A) 1 and 4. (B) 2 and 1. (C) 2 and 4. (D) 4 and 1. (E) 4 and 2.

19. If  $2^x = 100$ , then

(A)  $4 \leq x < 5$  (B)  $5 \leq x < 6$  (C)  $6 \leq x < 7$   
(D)  $7 \leq x < 8$  (E)  $8 \leq x < 9$

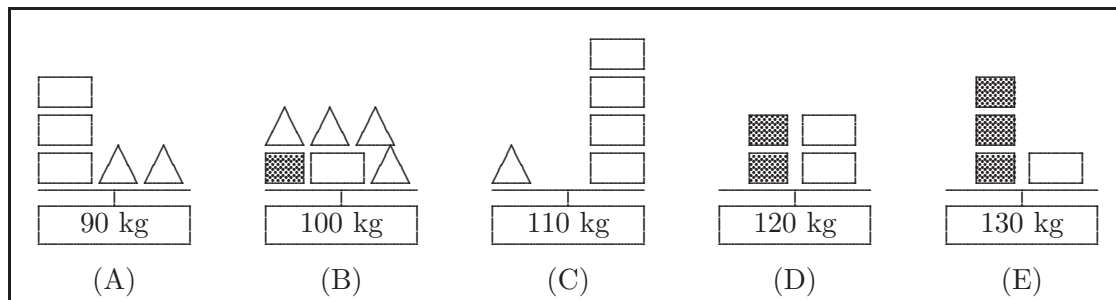
20. One edge of a triangle has length 8. The angle formed by this edge and a second edge is  $60^\circ$ . How many possibilities are there for this second edge to have a length that is a positive integer, smaller than 10 so that the length of the third edge is also a positive integer

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

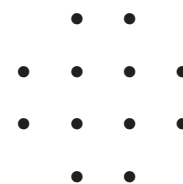
21. Female Plutionians have length  $n$  and male Plutionians have length  $m$ . There are  $m$  females and  $n$  males. Determine the average length of a Plutionian.

(A)  $\frac{2mn}{m+n}$  (B)  $\frac{m+n}{2}$  (C)  $\frac{m^2+n^2}{m+n}$  (D)  $\frac{|m-n|}{2}$  (E)  $\sqrt{mn}$

22. Exactly one of the following balances is broken. Which one?

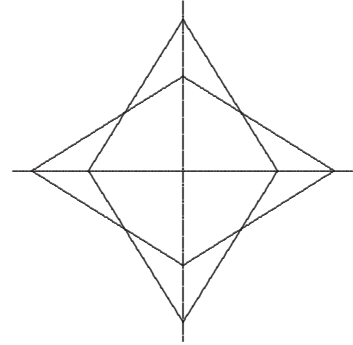


23. Given is a grid with 12 points (see figure). How many squares can be formed with four of these points as vertices?



(A) 5 (B) 7 (C) 9 (D) 11 (E) 13

24. Two congruent rhombi are placed one on top of the other, in such a way that the large diagonal of the first one is on the same line as the small diagonal of the second one and vice versa. The intersection of this two plane figures is a convex octagon with sides all of the same length. Determine the ratio of the large diagonal to the small diagonal so that this octagon is a regular octagon.



(A)  $\sqrt{2} - 1$  (B) 2 (C)  $\sqrt{2} + 1$  (D)  $2\sqrt{2}$  (E) 3

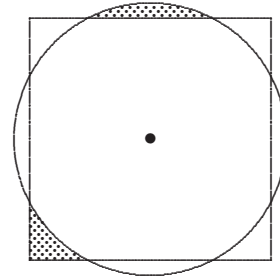
25. The lengths of the edges of a rectangular triangle are resp.  $x - y$ ,  $x$ ,  $x + y$  where  $x > y > 0$ .  
The ratio  $\frac{x}{y}$  equals

(A)  $\frac{4}{3}$  (B)  $\frac{3}{2}$  (C) 2 (D) 3 (E) 4

26. Consider the equation  $6x - 9y = k$  where  $k \in \mathbb{N}$ .  
For how many values of  $k$  ( $k < 90$ ) has this equation solutions  $x$  and  $y$  that are elements of  $\mathbb{Z}$ ?

(A) 5 (B) 10 (C) 15 (D) 30 (E) 90

27. A circle and a square have the same centre.  
If you know that the shaded regions have the same area, determine the ratio of the side of the square to the radius of the circle.



(A)  $\sqrt{2}$  (B)  $\sqrt{\pi}$  (C) 2 (D)  $\sqrt{2\pi}$  (E)  $\pi$

28. A number consists of 4 digits. The first two digits are the same and the last two digits are the same. The number is a perfect square.  
The sum of the digits of this number equals

(A) 12 (B) 16 (C) 18 (D) 20 (E) 22

29. The mass of 200 kg cucumbers consists for 99% of water. The cucumbers are drying out due to the sun, till the mass consists for 98% of water. Determine the weight of the cucumbers now.

(A) 100 kg	(B) 195 kg	(C) 197,97 kg	(D) 198 kg	(E) 199 kg
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30. The distance between the centres of the inscribed and the circumscribed circle of a triangle with sides of length 6, 8 and 10 is

(A) 0	(B) 2	(C) $\sqrt{5}$	(D) 2,4	(E) 2,5
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## 10.2 First round: the answer patterns

Flanders Mathematics Olympiad 2002 – First round Answer patterns (all participants)									
Problem	Correct	A	B	C	D	E	Correct	Wrong	Blank
1	E	5.78	8.87	4.66	1.09	67.08	67.08	20.40	12.51
2	E	3.33	2.09	6.63	7.53	70.48	70.48	19.58	9.93
3	D	0.09	0.21	2.24	92.16	4.00	92.16	6.54	1.30
4	C	31.92	8.11	6.95	4.89	8.17	6.95	53.11	39.94
5	B	6.66	34.65	10.68	7.64	3.74	34.65	28.72	36.62
6	A	84.66	6.13	5.44	0.92	0.90	84.66	13.44	1.91
7	C	6.37	1.93	68.08	0.66	3.32	68.08	12.29	19.63
8	D	1.21	6.72	10.18	42.60	9.78	42.60	27.91	29.49
9	E	1.26	10.57	3.45	7.64	57.04	57.04	22.93	20.03
10	D	1.57	2.87	3.73	14.83	3.80	14.83	11.98	73.19
11	D	1.02	2.33	4.56	79.27	3.78	79.27	11.70	9.02
12	D	4.71	0.66	0.73	71.67	4.87	71.67	10.99	17.33
13	D	7.79	2.72	48.36	4.84	1.16	4.84	60.03	35.14
14	A	57.73	13.21	4.14	3.22	7.73	57.73	28.31	13.96
15	A	23.83	4.77	4.87	9.16	3.79	23.83	22.60	53.57
16	C	17.74	5.50	68.27	1.04	4.45	68.27	28.73	3.00
17	E	0.48	1.63	9.20	8.58	75.91	75.91	19.91	4.18
18	D	4.41	3.42	4.27	82.13	1.52	82.13	13.64	4.23
19	C	1.51	4.64	88.63	1.55	0.63	88.63	8.34	3.03
20	D	6.36	21.48	11.52	14.69	5.68	14.69	45.05	40.26
21	A	66.25	13.20	8.78	0.49	0.54	66.25	23.02	10.74
22	A	48.78	7.01	4.96	2.90	2.52	48.78	17.39	33.83
23	D	22.72	2.32	39.03	30.65	2.34	30.65	66.43	2.92
24	C	5.74	11.36	9.19	6.19	3.08	9.19	26.37	64.45
25	E	3.07	3.90	5.07	2.95	58.09	58.09	15.00	26.91
26	D	2.49	2.95	4.88	19.23	16.90	19.23	27.23	53.54
27	B	5.22	33.49	5.21	8.94	5.15	33.49	24.54	41.98
28	E	5.62	6.98	5.23	4.16	6.81	6.81	22.02	71.17
29	A	16.66	4.76	16.87	45.89	2.26	16.66	69.79	13.55
30	C	12.31	10.10	14.96	7.62	4.30	14.96	34.34	50.70



## 10.4 Second round: the problems

For this set of problems there is a working time of max. 2 hours allowed, and the scoring system is as follows: a correct answer amounts for 5 points, a wrong answer for 0 points, and a blank answer for 1 point.

1.

$$\sqrt{0,111\dots} =$$

(A) 0,111...	(B) 0,222...	(C) 0,333...	(D) 0,444...	(E) 0,555...
--------------	--------------	--------------	--------------	--------------

2. Determine the smallest value of  $n$  so that  $n!$  is divisible by 2002.

( $n! = 1 \cdot 2 \cdot 3 \cdot \dots \cdot (n-2) \cdot (n-1) \cdot n$ ; p.e.  $6! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6$ )

(A) 7	(B) 9	(C) 11	(D) 13	(E) 1001
-------	-------	--------	--------	----------

3. Which sum of the following list remains if one removes the smallest two sums and the largest two sums?

(A) $\frac{1}{71} + \frac{1}{72} - \frac{1}{73} - \frac{1}{74}$ (C) $-\frac{1}{71} + \frac{1}{72} - \frac{1}{73} + \frac{1}{74}$	(B) $\frac{1}{71} - \frac{1}{72} - \frac{1}{73} + \frac{1}{74}$ (D) $-\frac{1}{71} + \frac{1}{72} + \frac{1}{73} - \frac{1}{74}$ (E) $\frac{1}{71} - \frac{1}{72} + \frac{1}{73} - \frac{1}{74}$
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4. The right most digit of

$$2^{\binom{2^{2002}}{2}} + 1$$

is

(A) 1	(B) 3	(C) 5	(D) 7	(E) 9
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5. If  $\Phi = \frac{1 + \sqrt{5}}{2}$ , the inverse of  $\Phi$  equals

(A) $-\Phi$	(B) $1 - \Phi$	(C) $\Phi - 1$
(D) $\Phi - \sqrt{5}$	(E) none of the previous	

6. How many natural numbers smaller than 999 are written using a digit 1?

(A) 243	(B) 244	(C) 253	(D) 271	(E) 276
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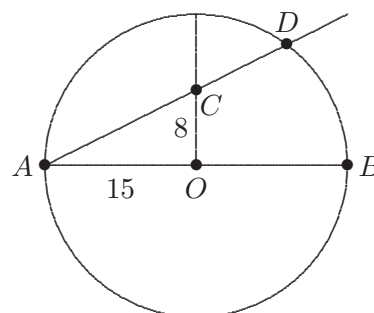
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7. Let  $A$  be the number consisting of 30 digits 9, and  $B$  be the number consisting of 20 digits 9. How many digits 8 are there in the product  $AB$ ?

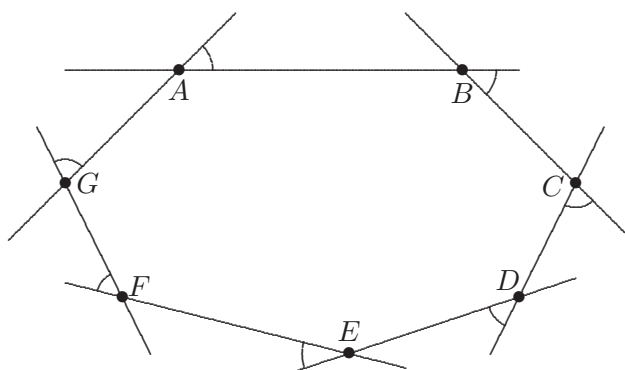
(A) none	(B) 1	(C) 20	(D) 29	(E) 30
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8. From the centre of a circle of radius 15, one draws a perpendicular line on the diameter  $[AB]$ .  $[OC]$  is a line segment of length 8 on this perpendicular line. The line  $AC$  intersects with the circle for a second time in  $D$ . The length of the line segment  $[CD]$  is closest to



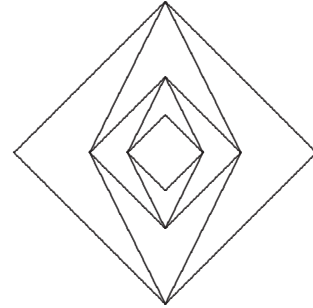
(A) 8,5	(B) 9	(C) 9,5	(D) 10	(E) 10,5
---------	-------	---------	--------	----------

9. The sum of the angles indicated on the figure equals



(A) $\pi$	(B) $\frac{3\pi}{2}$	(C) $2\pi$	(D) $\frac{5\pi}{2}$	(E) $3\pi$
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10. The figure shows the construction of a number of rhombi, which goes as follows: start with a rhombus having two diagonals of length 1. We double the vertical diagonal and obtain another rhombus. Now we double the horizontal diagonal of this new rhombus to construct a third one; keep repeating this procedure. The perimeters of the first three rhombi are now



$$2\sqrt{2}, 2\sqrt{5}, 2\sqrt{8}.$$

Determine the perimeter of the 6th rhombus.

- |                  |                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|------------------|
| (A) $2\sqrt{40}$ | (B) $2\sqrt{60}$ | (C) $2\sqrt{64}$ | (D) $2\sqrt{72}$ | (E) $2\sqrt{80}$ |
|------------------|------------------|------------------|------------------|------------------|

11. The total number of points that three spheres with different centres have in common, never equals

- |       |                     |       |
|-------|---------------------|-------|
| (A) 0 | (B) 1               | (C) 2 |
| (D) 3 | (E) infinitely many |       |

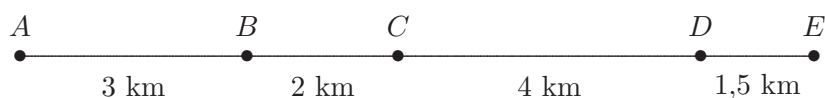
12. Jan and Mieke are in the supermarket in front of the shelves with chocolate. Jan remarks: "If I give you half of my money, you have exactly enough money to buy two bars of chocolate". Mieke replies: "If I give you half of my money, you have exactly enough money to buy one bar of chocolate."  
How much money does Jan have?

- |  |                                  |
|--|----------------------------------|
| (A) No money at all.                               | (B) Half of the amount of Mieke. |
| (C) The same amount of Mieke.                      | (D) Twice as much as Mieke.      |
| (E) This can't be determined using the given data. |                                  |

13. During a bingo evening one plays series of 6 games. In each series the amount of money which can be earned per winning game is multiplied by 7. In the first series one can win 1 eurocent a game; in the second series one can win 7 eurocent a game ... Zulma wins 100 euro. How many games did she win during that bingo evening?

- |       |        |        |        |        |
|-------|--------|--------|--------|--------|
| (A) 4 | (B) 10 | (C) 11 | (D) 12 | (E) 13 |
|-------|--------|--------|--------|--------|

14. Five friends, Axel, Bart, Chris, Dirk and Erwin live along the same road. The distances between the different houses are as shown in the figure.



To plan a joint trip, they decide to meet at a certain place  $P$  along that road. The place  $P$  is chosen so that the total distance from the five friends to  $P$  is minimal. What do you know about  $P$ ?

- |                                  |                                  |             |
|----------------------------------|----------------------------------|-------------|
| (A) $P = B$                      | (B) $P$ lies between $B$ and $C$ | (C) $P = C$ |
| (D) $P$ lies between $C$ and $D$ | (E) $P = D$                      |             |

15. Jan, Bob and Tom are brothers of Hilde and Inge. Inge is three years younger than Hilde. The age of Bob equals the average of the ages of Jan and Hilde. Jan and Tom together, and also Bob and Inge together, are 1 year younger than twice the age of Hilde. Jan and Inge together are 1 year older than twice the age of Hilde. Who is the eldest child?

- |           |          |         |         |         |
|-----------|----------|---------|---------|---------|
| (A) Hilde | (B) Inge | (C) Bob | (D) Jan | (E) Tom |
|-----------|----------|---------|---------|---------|

16. Given the real function  $f(x) = 1 - x$ . The inverse function of  $f$  is given by

- |             |             |             |                       |                       |
|-------------|-------------|-------------|-----------------------|-----------------------|
| (A) $1 - x$ | (B) $x - 1$ | (C) $x + 1$ | (D) $\frac{1}{1 - x}$ | (E) $\frac{1}{x - 1}$ |
|-------------|-------------|-------------|-----------------------|-----------------------|

17. If  $\sin x + \cos x = A$ , then  $\sin^3 x + \cos^3 x$  equals

- |                            |                            |                            |
|----------------------------|----------------------------|----------------------------|
| (A) $A^3$                  | (B) $\frac{A(A^2 - 3)}{4}$ | (C) $\frac{A(A^2 + 3)}{4}$ |
| (D) $\frac{A(3 - A^2)}{2}$ | (E) $\frac{A(A^2 + 1)}{2}$ |                            |

18. What is the effect on the graph of  $f$  if we replace the variable  $x$  by  $2 - x$  in  $y = f(x)$ ?

- |  |
|--|
| (A) The graph is translated to the right over a distance of 2. |
| (B) The graph is translated to the left over a distance of 2.  |
| (C) The graph is reflected with respect to the line $x = 2$ .  |
| (D) The graph is reflected with respect to the line $x = -2$ . |
| (E) The graph is reflected with respect to the line $x = 1$ .  |

19. Let  $f$  be an even function and  $g$  be an odd function, both with domain  $\mathbb{R}$  and not identically 0. The number of odd functions in the following set is

$$f \circ g, \quad g \circ f, \quad f \circ f, \quad g \circ g, \quad f + g$$

- |       |       |       |       |       |
|-------|-------|-------|-------|-------|
| (A) 1 | (B) 2 | (C) 3 | (D) 4 | (E) 5 |
|-------|-------|-------|-------|-------|

20. The number of integers  $x$  for which  $\log \frac{x(10-x)}{16} < 0$  is

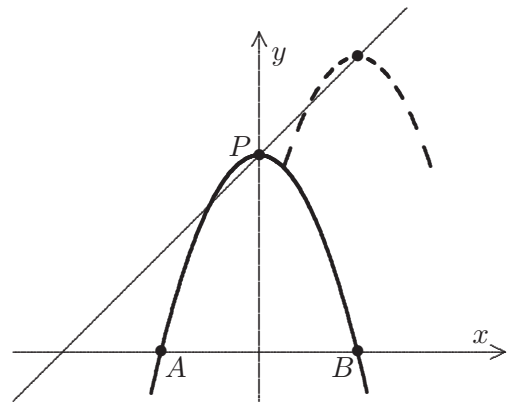
(A) 1	(B) 2	(C) 5
(D) 9	(E) infinitely many	

21. Which one of the following functions  $f: \mathbb{R} \rightarrow \mathbb{R}$  is strictly increasing?

(A) $\frac{1}{1+x^2}$	(B) $\frac{x}{1+x^2}$	(C) $\frac{x^2}{1+x^2}$	(D) $\frac{x^3}{1+x^2}$	(E) $\frac{x^4}{1+x^2}$
-----------------------	-----------------------	-------------------------	-------------------------	-------------------------

22. The parabola  $y = 4 - x^2$  has top  $P$  and intersects with the  $x$ -axis in the points  $A$  and  $B$ . The parabola is translated such that the top  $P$  moves along the line  $y = x + 4$  until the top is at the point  $Q$ . In this position, the parabola also intersects with the  $x$ -axis in point  $B$ .

The  $y$ -coordinate of point  $Q$  is



(A) 6	(B) 8	(C) 9	(D) 10	(E) 12
-------	-------	-------	--------	--------

23. Which one of the following inequalities is wrong if  $x > 2002$ ?

(A) $x^2 < 2^x$	(B) $100x^2 < x^4$	(C) $2^x < x^{10}$
(D) $x^{-4} < x^{-2}$	(E) $2^x < 10^x$	

24. The sum of the real roots of  $x^3 - 3x^2 + 3x + 1 = 0$  equals

(A) $-3$	(B) $1$	(C) $1 - \sqrt{2}$	(D) $3$	(E) $1 - \sqrt[3]{2}$
----------	---------	--------------------	---------	-----------------------

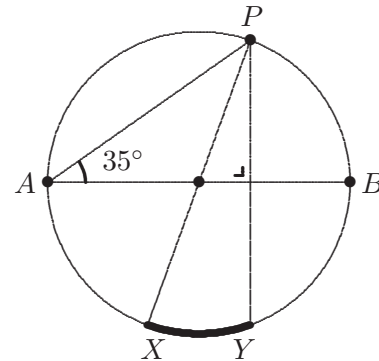
25. The interval of all the values of

$$\frac{6}{5} \sin^2 \alpha + \frac{7}{5} \cos^2 \alpha, \quad \alpha \in \mathbb{R}$$

has length

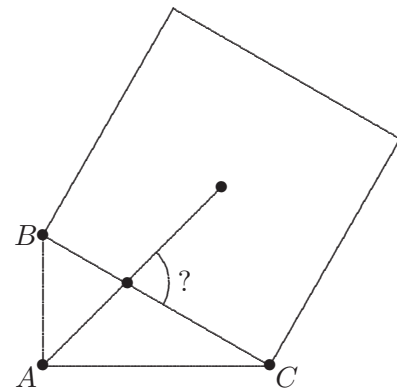
(A) $\frac{1}{5}$	(B) $\frac{2}{5}$	(C) $\frac{6}{5}$	(D) $\frac{7}{5}$	(E) $\frac{13}{5}$
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26. Through a point  $P$  on a circle with diameter  $[AB]$ , one draws the diameter  $[PX]$  and two chords  $[PA]$  and  $[PY]$  where  $PY \perp AB$ . If  $\widehat{PAB}$  equals  $35^\circ$ , then the arc  $\widehat{XY}$  equals



- |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
| (A) $20^\circ$ | (B) $35^\circ$ | (C) $40^\circ$ | (D) $55^\circ$ | (E) $70^\circ$ |
|----------------|----------------|----------------|----------------|----------------|

27. On the hypotenuse of a rectangular triangle  $ABC$  with angles  $\hat{A} = 90^\circ$ ,  $\hat{B} = 60^\circ$ ,  $\hat{C} = 30^\circ$ , one draws a square as shown in the picture. The midpoint of the square is linked to  $A$  by a straight line. The angle between this line and the hypotenuse measures



- |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
| (A) $60^\circ$ | (B) $70^\circ$ | (C) $75^\circ$ | (D) $80^\circ$ | (E) $90^\circ$ |
|----------------|----------------|----------------|----------------|----------------|

28. The midpoints of two circles are at a distance of 41 cm from each other. The radius of the smallest circle is 4 cm, the radius of the other one is 5 cm. The distance between the two tangent points on the inner tangent line equals

- |           |           |           |           |           |
|-----------|-----------|-----------|-----------|-----------|
| (A) 36 cm | (B) 38 cm | (C) 39 cm | (D) 40 cm | (E) 41 cm |
|-----------|-----------|-----------|-----------|-----------|

29. One drops an elastic ball on a wooden floor. The ball bounces up to half of the height from where it has been dropped. If we drop the ball from a height of 1 meter and we let the ball bounce, the total distance covered by the ball equals

- |         |              |                 |
|---------|--------------|-----------------|
| (A) 2 m | (B) 2,5 m    | (C) 2,6666... m |
| (D) 3 m | (E) infinity |                 |

30. Let  $p_1$  be the propability to have a 6 when throwing one dice,  $p_2$  the probability to have exactly one 6 when throwing two dices and  $p_3$  the propability to have exactly two 6's when throwing three dices. What is correct? (All dices are "fair".)

- |                       |                       |                       |
|-----------------------|-----------------------|-----------------------|
| (A) $p_1 < p_3 < p_2$ | (B) $p_3 < p_1 < p_2$ | (C) $p_2 < p_1 < p_3$ |
| (D) $p_2 < p_3 < p_1$ | (E) $p_3 < p_2 < p_1$ |                       |

## 10.5 Second round: the answer patterns

Flanders Mathematics Olympiad 2002 – Second round Answer patterns (all participants)									
Problem	Correct	A	B	C	D	E	Correct	Wrong	Blank
1	C	13.93	0.83	69.54	2.29	2.39	69.54	19.44	11.02
2	D	0.94	1.14	4.16	41.68	26.09	41.68	32.33	25.99
3	B	3.22	48.54	4.05	12.79	6.86	48.54	26.92	24.53
4	D	1.46	3.85	9.36	45.63	4.68	45.63	19.33	35.03
5	C	5.20	3.12	39.09	3.85	30.35	39.09	42.52	18.40
6	D	2.08	2.70	6.96	72.45	2.49	72.45	14.24	13.31
7	B	10.50	48.34	4.78	3.53	0.73	48.34	19.54	32.12
8	C	5.09	7.38	26.40	6.76	8.11	26.40	27.34	46.26
9	C	3.43	2.49	63.41	6.44	1.98	63.41	14.35	22.25
10	E	4.57	1.04	5.72	2.91	62.16	62.16	14.35	23.49
11	D	1.46	6.24	6.34	21.41	22.56	21.41	36.59	42.00
12	A	89.40	1.46	0.42	0.42	5.41	89.40	7.69	2.91
13	B	9.46	28.48	3.74	5.93	5.41	28.48	24.53	46.99
14	C	0.94	6.65	56.55	28.07	0.62	56.55	36.28	7.17
15	D	4.16	0.73	2.39	73.80	6.44	73.80	13.83	12.37
16	A	62.47	7.38	4.99	15.18	1.66	62.47	29.21	8.32
17	D	1.14	7.59	4.68	18.50	6.24	18.50	19.65	61.85
18	E	5.93	4.05	8.11	2.29	72.56	72.56	20.37	7.07
19	A	14.55	19.23	18.09	3.33	0.73	14.55	41.37	44.07
20	B	11.75	15.70	7.38	7.69	17.05	15.70	43.87	40.44
21	D	2.81	6.24	6.96	56.03	9.67	56.03	25.68	18.30
22	C	5.30	14.66	15.07	3.43	3.95	15.07	27.34	57.59
23	C	7.80	4.57	61.02	1.04	1.35	61.02	14.76	24.22
24	E	1.77	3.85	5.09	7.69	7.48	7.48	18.40	74.12
25	A	18.92	4.89	2.70	8.42	10.29	18.92	26.30	54.78
26	C	47.61	5.51	19.54	2.49	0.83	19.54	56.44	24.01
27	C	3.01	3.85	44.70	6.34	1.35	44.70	14.55	40.75
28	D	2.60	3.64	3.95	12.58	6.34	12.58	16.53	70.89
29	D	26.20	1.66	5.93	47.61	9.25	47.61	43.14	9.25
30	B	7.80	35.97	3.53	6.96	29.00	35.97	47.30	16.74

## 10.7 The final round

To solve these 4 problems, pupils are allowed a working time of 3 hours.

1. Is it possible to number the vertices of a cube from 1 to 8, in such a way that the sums of the numbers on each edge are different?

Proof your answer

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2. Determine all functions  $f : \mathbb{R}_0 \rightarrow \mathbb{R}$  so that for each  $x \in \mathbb{R}_0$ :

$$x \cdot f\left(\frac{x}{2}\right) - f\left(\frac{2}{x}\right) = 1$$

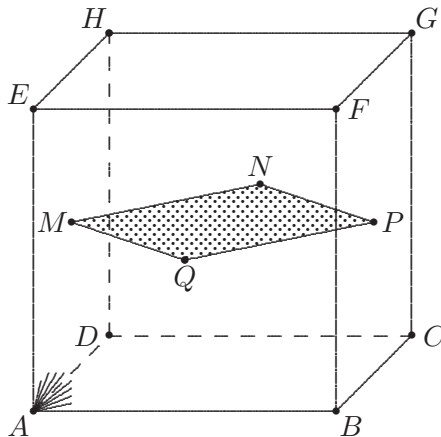

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3. Proof that

$$\frac{1}{15} < \frac{1}{2} \cdot \frac{3}{4} \cdot \frac{5}{6} \cdot \dots \cdot \frac{99}{100} < \frac{1}{10}$$


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4. In a cube-shaped room of edge  $a$ , there is a dark square board. The vertices of this board are at the centres of the upright sides of the cube. From vertex  $A$  a lamp is shining on the board, which throws a shadow on the sides of the cube.



- (a) Indicate the shadow on the figure.
  - (b) Determine the total area of the shadow.
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