

2021 NMOS Question

1. Study the following pattern:

$$1 + 2 + 1 = 4 = 2^2$$

$$1 + 2 + 3 + 2 + 1 = 9 = 3^2$$

$$1 + 2 + 3 + 4 + 3 + 2 + 1 = 16 = 4^2$$

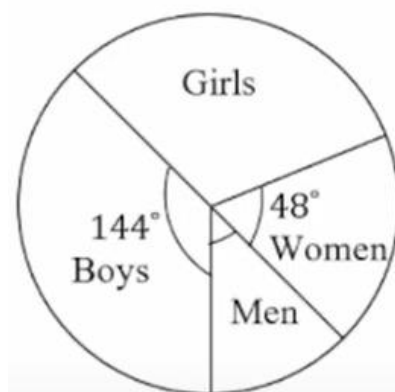
$$1 + 2 + 3 + 4 + 5 + 4 + 3 + 2 + 1 = 25 = 5^2$$

Find the value of

$$1 + 2 + 3 + 4 + \cdots + 48 + 49 + 50 + 49 + 48 + \cdots + 4 + 3 + 2 + 1.$$

2. The measures of angles A, B, C and D of a quadrilateral $ABCD$ are in the ratio $1:2:3:4$. Determine the smallest angle in degrees.

3. The composition of visitors to a certain zoo on a Sunday is shown in the pie chart below. There is an equal number of male visitors and female visitors. If the number of boys is 288, what is the total number of visitors who are not women?

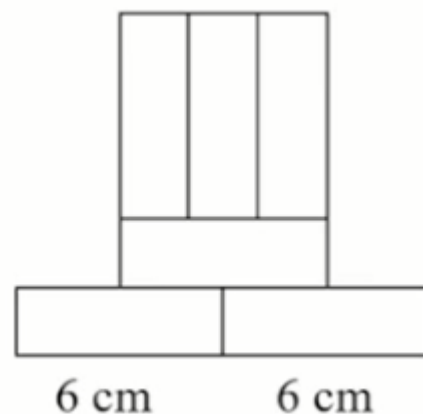


4. A rectangle is divided into four rectangles (not drawn to scale), and each area is shown in the following diagram. Determine the value of A .

| | |
|------------------|------------------|
| 48 m^2 | 80 m^2 |
| $A \text{ m}^2$ | 45 m^2 |

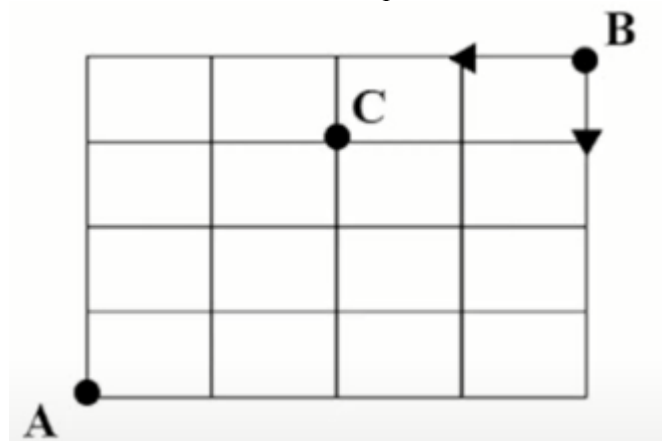
5. More than thirty students participated in a Math competition, the full score of which is 100 marks. It is known that Peter's score is not a multiple of 10. The teacher accidentally exchanges the tens digit and the unit digit of Peter's score, and the error decreases the average score of the class by 2 marks. What is Peter's actual score for the competition?

6. The figure below is composed of six identical rectangles. The length of each rectangle is 6 cm. Find the perimeter of the figure in centimetres.



7. In the year 2020, a total of 612 students participated in an annual mathematics contest. The organizer of the event observed that there is a 20% increase in the number of student participants every year over the previous year since the year 2018. How many students participated in the contest in the year 2018?

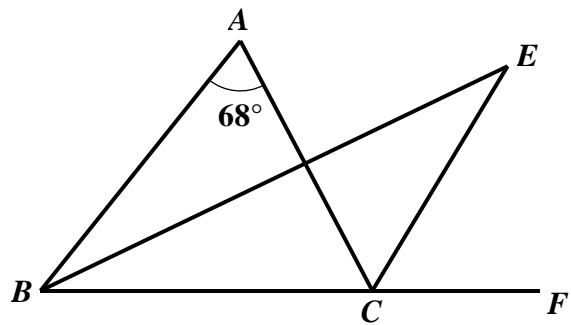
8. A bug is moving from B to A along the lines as shown below. It can only move downwards or to the left, and it must pass through C . What is the total number of different paths from B to A ?



9. Annie and Bonnie were running laps around a circular track. They started running together at the same point and in the same direction. Bonnie was running at a constant speed throughout. Initially, Annie's speed was 25% faster than Bonnie. After Annie ran for 1 km, she increased her speed by 20%, and ran for another 870 m. If they stopped running at the same time, how many metres did Bonnie run?

10. The first digit of the 5-digit number $\overline{1abcd}$ is 1. If this first digit is moved to the last place, we get a new 5-digit number $\overline{abcd1}$. Given that the average of both 5-digit numbers is 20219, find the value of \overline{abcd} .

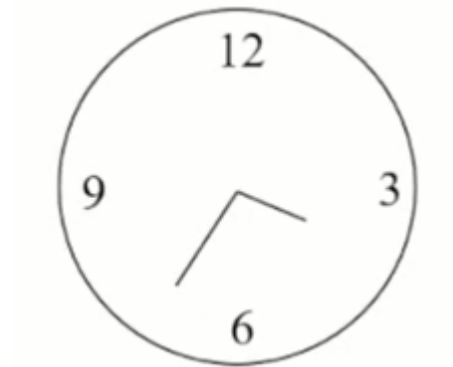
11. In the diagram below, BCF is a straight line. BE and CE intersect at point E . It is known that $\angle ABE = \angle EBC$, $\angle ACE = \angle ECF$, and $\angle BAC = 68^\circ$. Find $\angle BEC$ in degrees.



12. What is the average of all 4-digit number that can be formed by using the digits 2, 3, 5 and 6 exactly once?

13. Abel's father drives him from their home to school in 30 minutes, but his mother can drive him 24 km/h faster and gets him to school 8 minutes earlier. What is the distance (in kilometres) between Abel's school and his home?

14. The clock below shows 3:34 pm. Find the obtuse angle, in degrees, between the hour hand and the minute hand.

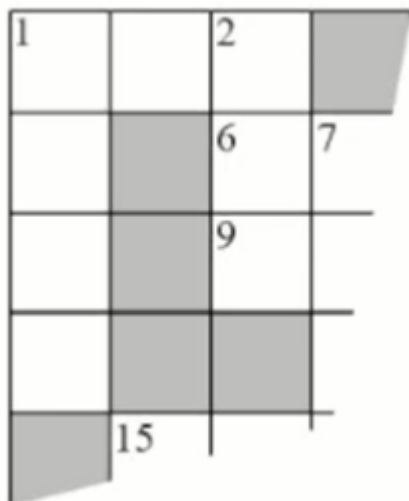


15. The sum of 2 different prime numbers is 90. Their product is a 4-digit number. Find the largest possible value of this product.

16. Joel participated in a Math contest which comprises two sections. In section A, each question is worth 3 marks, while in section B, each question is worth 5 marks. It is known that Joel answered 8 more questions correctly in section A than in section B, and his total score is 80 marks. There is no demerit for incorrect or blank answers. Find the total number of questions he answered correctly for the contest.

17. A boat travels 120 km downstream along a river in 6 hours at a constant speed and takes 10 hours to return upstream to the starting point at another constant speed. Find the speed (in km/h) of the boat in still water.

18. The diagram below shows a fragment of a cross-number puzzle.



The answer to each cross-number puzzle clue is a whole number. For example, 1 Across is a 3-digit number while 1 Down is a 4-digit number. Find the 3-digit number of 2 Down based on the following clues.

Across

1 Across is the square of 8 Down.

6 Across is half of 1 Across

Down

1 Down is twice of 2 Down

2 Down is a multiple of 9.

19. Each of the “ \square ” s below contains either an addition sign (+) or a subtraction sign (-).

$$1 \square 2 \square 3 \square 4 \square 5 \square 6 \square 7 \square 8 = 16$$

Find the number of ways the addition and subtraction signs can be assigned to the above “ \square ”s so that the equation is valid.

20. At a party, each person shakes hand with every other person exactly once. Given that there are 300 handshakes at the party, how many people are there at the party?

21. A , B and C are letters that represent different digits from 1 to 9 such that

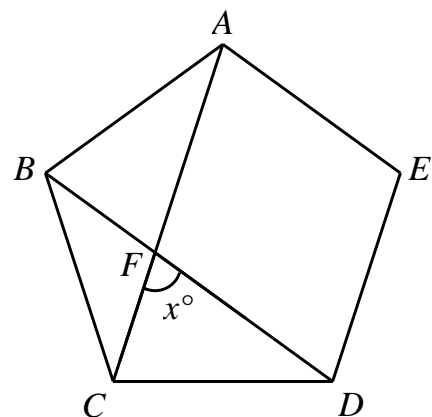
$$\begin{array}{r} A B A B \\ - A C A \\ \hline B A A C \end{array}$$

Find the 3-digit number \overline{ABC} .

22. A bag is filled with blue and red balls. At first, Audi draws 30 balls randomly from the bag and finds that 27 of them are red balls. He did not replace these ball into the bag. Thereafter, he will draw several rounds of 9 balls randomly without replacement, until the bag is empty. After each round, he realizes that exactly 5 of the 9 balls drawn in that round are red, and the total number of red balls that has been drawn so far from the beginning up till that round is always maintained at least 60% of the total number of balls drawn so far. Given that there are no leftover balls in the bag after the last round, what is the maximum number of balls in the bag at the beginning?

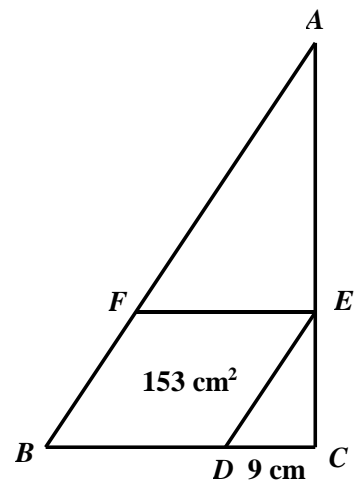
23. Find the value of $\frac{11}{\frac{1}{8} + \frac{1}{15} + \frac{1}{24} + \frac{1}{35}}$.

24. The figure below shows a regular pentagon $ABCDE$. The lines AC and BD intersect at the point F . Given that $\angle CFD = x^\circ$, find the value of x .

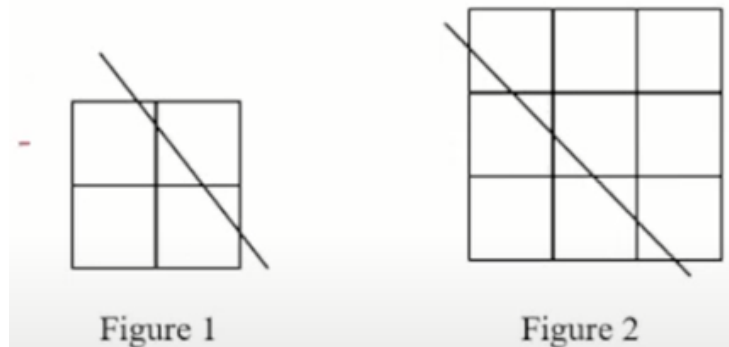


25. Let $N = 2^{2021} + 2021^2$. Find the remainder when N is divided by 7.

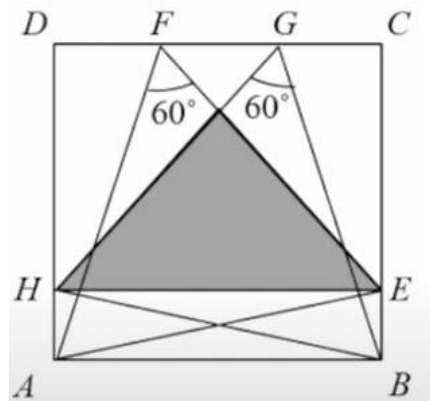
26. Shown below is a right-angled triangle ABC with $\angle ACB = 90^\circ$. Points D , E and F lie on sides BC , AC and AB respectively such that $BDEF$ is a parallelogram with an area of 153 cm^2 . Given that $DC = 9 \text{ cm}$, find the length of AE in cm.



27. In a 2×2 square grid, a random straight line will pass through at most 3 grid squares, as shown in Figure 1. In a 3×3 square grid, a random straight line will pass through at most 5 grid squares, as shown in Figure 2. Find the maximum number of grid squares that a random straight line will pass through in a 10×10 square grid.

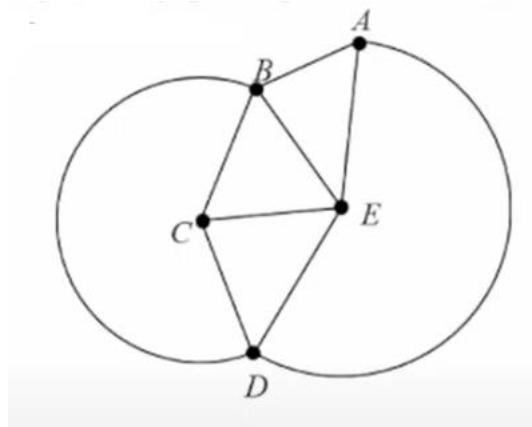


28. In the following square $ABCD$, the length of each side is 50 cm. The points E , F , G and H lie on the sides of the square. AEF and BGH are both equilateral triangles. Find the area of the shaded region in cm^2 .



29. A 6063-digit number N is $\overline{6ab6ab\dots 6ab}$, where a and b represent different digits. If N is a multiple of 77, find the sum of all possible 2-digit numbers \overline{ab} .

30. A railway network is set up among 5 cities. Refer to the diagram below. The network consists of seven straight paths which are two-directional, and two curved paths which are one-way in the anticlockwise direction only. Using the curved paths only, passengers can travel from B to D , or D to A , but not in the opposite direction.



The local tourism board wants to design a sightseeing route starting from city A , passing through each city exactly once and coming back to A . For example, $A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow A$ is one such route. How many such sightseeing routes are there in total.