1 1, 3, 13, 63, 313, ...
What is the eighth number in this pattern?

2 △ and ♦ stand for numbers. They are related by a rule. What is the rule?

| △	2	3	5	8
♦	7	16	34	61

A ♦ = 6 × △ − 5
B ♦ = 9 × △ − 11
C ♦ = △ × △ + 3
D ♦ = 2 × △ × △ − 1

3 Jo wants to draw a right-angled triangle. She has placed two points on the grid. Where could she place her third point?

A (2, 1) B (2, 4)
C (4, 1) D (1, 4)

4 Dylan used this rule to work out the next number in a pattern: 'Multiply the previous number by 8 and then add 3'.

The first 3 numbers in the pattern are 11, 91 and 731. What is the fifth number in the pattern?

Use this information to answer questions 5 and 6.
Ellie made a pattern with pentagons using pins. She drew up a table to show the number of pins needed for different numbers of pentagons.
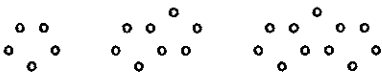
Number of pentagons	1	2	3
Number of pins	5	8	11

5 How many pins are needed for 7 pentagons?

6 How many pentagons can be made with 60 pins?

7 What is the next number in this pattern?
1, 2, 5, 26, 677, …

8 Callie started to draw up a table to show the number of matches needed to make different numbers of squares in a pattern.

Number of squares	1	2	3	4
Number of matches			8	

Which could **not** be the rule to give the number of matches?
A Double the number of squares and add 2.
B Multiply the number of squares by itself and then subtract 1.
C Add 5 to the number of squares.
D Multiply the number of squares by 4 and subtract 5.

9 Sergio wrote down the first seven numbers in a pattern: 1, 1, 2, 3, 5, 8, 13
What is the first number in this pattern that is greater than 100?

10 A rule to calculate the temperature in degrees Celsius (°C) when the temperature in degrees Fahrenheit (°F) is known is:
'First subtract 32, then divide by 1.8'.

An old recipe says to set the oven to 410°F. What is this temperature in °C? °C

11 The table shows the **total** number of bricks that can be stacked in different numbers of rows when following a particular pattern.

Number of rows	1	2	3	4	5
Number of bricks	1	3	6	10	15

What is the minimum number of rows needed to stack a total of 66 bricks?

12 The first two numbers in a pattern are 8 and 55. Ben knows that the rule for the pattern is to square the number and then either add or subtract (he can't remember which) a certain number. What is the third number in the pattern?

1 39063 **2** B **3** D **4** 46811 **5** 23 **6** 19 **7** 458330
8 D **9** 144 **10** 210°C **11** 11 **12** 3016

1 1, 3, 13, 63, 313, ...

The differences between the terms are 2, 10, 50 and 250. The differences are 5 times bigger each time.

So the rule might involve multiplying the previous number by 5.

Now $1 \times 5 = 5$

To get 3 you need to subtract 2.

Now $3 \times 5 - 2 = 13$

and $13 \times 5 - 2 = 63$

and $63 \times 5 - 2 = 313$.

The rule is to multiply by 5 and subtract 2.

Continue the pattern:

$313 \times 5 - 2 = 1563$

$1563 \times 5 - 2 = 7813$

$7813 \times 5 - 2 = 39063$

The eighth number is 39063.

2 Try each option:

△	2	3	5	8
◆	7	16	34	61

$◆ = 6 \times △ - 5$

When $△ = 2$,

$◆ = 6 \times 2 - 5$

$= 7$ ✓

When $△ = 3$,

$◆ = 6 \times 3 - 5$

$= 13$ ✗

The rule is not $◆ = 6 \times △ - 5$.

$◆ = 9 \times △ - 11$

When $△ = 2$,

$◆ = 9 \times 2 - 11$

$= 7$ ✓

When $△ = 3$,

$◆ = 9 \times 3 - 11$

$= 16$ ✓

When $△ = 5$,

$◆ = 9 \times 5 - 11$

$= 34$ ✓
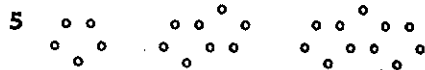
When $△ = 8$,

$◆ = 9 \times 8 - 11$

$= 61$ ✓

The rule is $◆ = 9 \times △ - 11$.

3 Jo could place her third point at $(1, 4)$ and make a right-angled triangle.
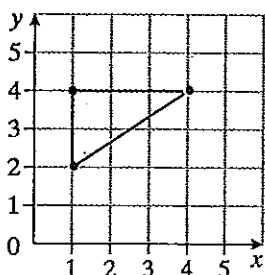
[She could also have placed a point at $(4, 2)$, but this was not one of the options.]

4 Fourth number $= 8 \times 731 + 3$

$= 5848 + 3$

$= 5851$

Fifth number $= 8 \times 5851 + 3$

$= 46808 + 3$

$= 46811$

5

Number of pentagons	1	2	3
Number of pins	5	8	11

The number of pins increases by 3 each time.

The rule is to multiply the number of pentagons by 3 and then add 2.

So for 7 pentagons,

Number of pins $= 3 \times 7 + 2$

$= 23$

6 Number of pins

$= 3 \times$ number of pentagons $+ 2$

Now $60 = 3 \times 20$

But 2 more pins would be required to make 20 pentagons.

There are only enough pins to make 19 pentagons.

7 1, 2, 5, 26, 677, ...

The rule is to multiply the number by itself (or square the number) and then add 1.

So $1 \times 1 + 1 = 2$

$2 \times 2 + 1 = 5$

$5 \times 5 + 1 = 26$

$26 \times 26 + 1 = 677$

Continuing the pattern:

$677 \times 677 + 1 = 458329 + 1$

$= 458330$

The next number is 458330.

8

Number of squares	1	2	3	4
Number of matches			8	

[The only information you have is that 8 matches are needed for 3 squares.]

Try each option:

'Double the number of squares and add 2.'

$2 \times 3 + 2 = 8$

The rule could be 'Double the number of squares and add 2.'

'Multiply the number of squares by itself and then subtract 1.'

$3 \times 3 - 1 = 8$

The rule could be 'Multiply the number of squares by itself and then subtract 1.'

'Add 5 to the number of squares.'

$3 + 5 = 8$

The rule could be 'Add 5 to the number of squares.'

'Multiply the number of squares by 4 and subtract 5.'

$4 \times 3 - 5 = 7$ (not 8)

The rule cannot be 'Multiply the number of squares by 4 and subtract 5.'

9 $1, 1, 2, 3, 5, 8, 13$

Each number is formed by adding the two previous numbers together.

$(1 + 1 = 2, 1 + 2 = 3, 2 + 3 = 5, 3 + 5 = 8$ and so on.)

Continue the pattern:

$8 + 13 = 21$

$13 + 21 = 34$

$21 + 34 = 55$

$34 + 55 = 89$

$55 + 89 = 144$

The first number greater than 100 is 144.

[The pattern of numbers in this question is known as Fibonacci's sequence.]

10 The temperature is 410°F.

First subtract 32:

$410 - 32 = 378$

Then divide by 1.8:

$378 \div 1.8 = 210$

The temperature is 210°C.

11

Number of rows	1	2	3	4	5
Number of bricks	1	3	6	10	15

The number of bricks increases by 2, then 3, then 4, then 5. It is increasing by 1 more each time.

Continue the pattern:

$1, 3, 6, 10, 15, 21, 28, 36, 45, 55, 66.$

66 is the 11th term of the pattern.

The minimum number of rows needed to stack 66 bricks is 11.

12 The first number is 8.

The first part of the rule is to square the number.

Now $8 \times 8 = 64$

But the second number is 55.

$64 - 9 = 55$

So the second part of the rule must be to subtract 9.

$$\begin{aligned} \text{Third number} &= 55 \times 55 - 9 \\ &= 3025 - 9 \\ &= 3016 \end{aligned}$$