Question 3
Mops

A **mop expression** is way of producing a number using only multiplications, ones and pluses. The **length** of a mop is the number of ones it contains.

For example, 22 = 1+1+ ((1+1+1+1) × (1+1+1+1+1)), which has a length of 11.
Another mop of 22 is 1+ ((1+1+1) × (1+ ((1+1)×(1+1+1)))) which has a length of 10.
There are no shorter mops for 22.

3 (a)
[24 marks]

Write a program that inputs a single integer n ($1 \le n \le 10000$) and outputs the length of the shortest mop of n.

Sample run

```
22
10
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3 (b)
[3 marks]

Give a mop equal to 100, with length 16.

3 (c)
[3 marks]

If you have found a mop equal to n, with length l, is it always possible to find a longer mop that is also equal to n? Justify your answer.

3 (d)
[5 marks]

What is the highest value a mop of length 44 can have?

Total marks: 100.

End of BIO 2002 Round One paper