Question 3
Morse Code

The BIO has been receiving telegrams congratulating it on reaching its 10th anniversary. At least, we think it has. The telegrams have been sent in *Morse code* and, unfortunately, the gaps between letters have been left out.

In Morse code, each letter of the alphabet is replaced by a sequence of dots and dashes as follows:

a	`.-`	h	`....`	o	`---`	v	`...-`
b	`-...`	i	`..`	p	`.--.`	w	`.--`
c	`-.-.`	j	`.---`	q	`--.-`	x	`-..-`
d	`-..`	k	`-.-`	r	`.-.`	y	`-.--`
e	`.`	l	`.-..`	s	`...`	z	`--..`
f	`..-.`	m	`--`	t	`-`		
g	`--.`	n	`-.`	u	`..-`		

Every combination of between 1 and 4 dots and dashes is used, except for:

```
..--
.-.-
---.
----
```

Traditionally, dots were transmitted by a short note and dashes by a longer note, with pauses between different letters. This is why some mobile phones make the sound `... -- ...` when receiving a message, since this is the Morse code for SMS.

If the gaps between letters are missed out, messages can be ambiguous. For example, even if we know the message `-..-----.` is made up of three letters, it might mean **njg**, **dog**, **xmg** or **xon**.

3 (a)
[26 marks]

Write a program which reads in a message (between 1 and 10 letters inclusive) and determines how many messages, *with the same number of letters as the input*, it might represent.

Sample run

```
dog
4
```

3 (b)
[5 marks]

How many messages might `-----` represent, if we do not know the number of letters in the message? How about `-..-----.`?

3 (c)
[3 marks]

It is possible to come up with new ways of encoding the alphabet so that, even when the gaps between letters are missing, messages are unambiguous. The *size* of such an unambiguous encoding is the total number of dots and dashes in a message containing each letter once.

For example, we could encode each letter by some dots (indicating its position in the alphabet) followed by a dash; so `.-` would be **`a`**, `..-` would be **`b`**, and 26 dots followed by a dash would be **`z`**. This encoding has a size of 377 (2 + 3 + ... + 27).

What is the smallest size an unambiguous encoding can have?

Total marks: 100

End of BIO 2004 Round One paper