3. The little engine that could… read (15 marks)

Professor Monotone's "Astounding Linguistic Knowledge Engine for Making Inferences" (ALKEMI) can, when given a list of true statements, deduce further true statements from it. For example, if it knows that "Professor Monotone can read Russian", it can deduce that "Professor Monotone can read". We represent this as:

Professor Monotone can read Russian $\Rightarrow$ Professor Monotone can read

This means that whenever the first statement is true, the second has to be true, too; there's no way for the first to be true while the second is false. We call this a legitimate inference.

The Professor's machine can go through statements and, by making particular sorts of changes, generate further statements that follow from them. However, it's not as easy as replacing "can read Russian" with "can read" anywhere you find it. For example, funny things happen when the statement contains one of a set of words called "quantifiers", including *every*, *some*, *no*, *a*, *few*, *many*, *three*, and so on.

No student can read Russian $\Rightarrow$ No student can read   WRONG!

The inference is not legitimate: even if no student can read Russian, it is entirely possible that students can read Japanese, English or Spanish.

Each of the quantifiers allows a different pattern of legitimate inferences, so the professor's machine keeps a special table of patterns and uses it to derive new statements from given ones. We've reproduced it below. It may look mysterious, but given the information in this table and a list of inferences produced by the machine shown on the next page, you can work out what each part means and how the machine works.

	Quantifier	Side	Direction
A	Every	Left	Downward
B	Every	Right	Upward
C	No	Left	Upward
D	No	Right	Downward
E	Some	Left	Upward
F	Some	Right	Upward

Unfortunately, however, there is one error in the table above that is causing the professor's machine to make some illegitimate inferences!

Here are some examples of inferences declared legitimate by the professor's machine:

- Every teacher can read English ⇒ Every English teacher can read English
- Some English students can read English ⇒ Some English students can read
- No English student can read Russian ⇒ No student can read Russian
- Every teacher can read English and Russian ⇒ Every teacher can read Russian
- No student can read Russian ⇒ No student can read English and Russian
- Every teacher can read English ⇒ Every Russian teacher can read English
- Some Russian students can read English ⇒ Some students can read English
- No English student can read ⇒ No English student can read English

Q3.1. Which table row (A-F) contains a mistake and caused the machine to draw one or more illegitimate inferences? (2 points)

Q3.2. The list of inferences isn't complete. The professor's machine could draw additional inferences as well. Using only words that appear in the list of valid inferences above, generate another legitimate inference that the machine could have drawn from "Every teacher can read English". (4 points)

Q3.3. The professor's machine doesn't yet understand every quantifier. Help it learn the quantifiers *at least three, at most three*, and *not all* by completing the table below in your answer book: put "Upward" or "Downward" in the appropriate cells. (9 points)

	Quantifier	Side	Direction
G	At least three	Left	
H	At least three	Right	
I	At most three	Left	
J	At most three	Right	
K	Not all	Left	
L	Not all	Right	

Q3. The little engine that could .... read

1			
2			
3	G.		
	H.		
	I.		
	J.		
	K.		
	L.		

Q3. The little engine that could .... read

1	C		1
2	Every teacher can read.		2
3	G.	Upward	2
	H.	Upward	2
	I.	Downward	2
	J.	Downward	2
	K.	Upward	2
	L.	Downward	2

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