$4 = 2 \times 2$ so $\sqrt{4} = 2$
$9 = 3 \times 3$ so $\sqrt{9} = 3$
$16 = 4 \times 4$ so $\sqrt{16} = 4$
$25 = 5 \times 5$ so $\sqrt{25} = 5$
$36 = 6 \times 6$ so $\sqrt{36} = 6$
$81 = 9 \times 9$ so $\sqrt{81} = 9$
$144 = 12 \times 12$ so $\sqrt{144} = 12$
$225 = 15 \times 15$ so $\sqrt{225} = 15$
$625 = 25 \times 25$ so $\sqrt{625} = 25$

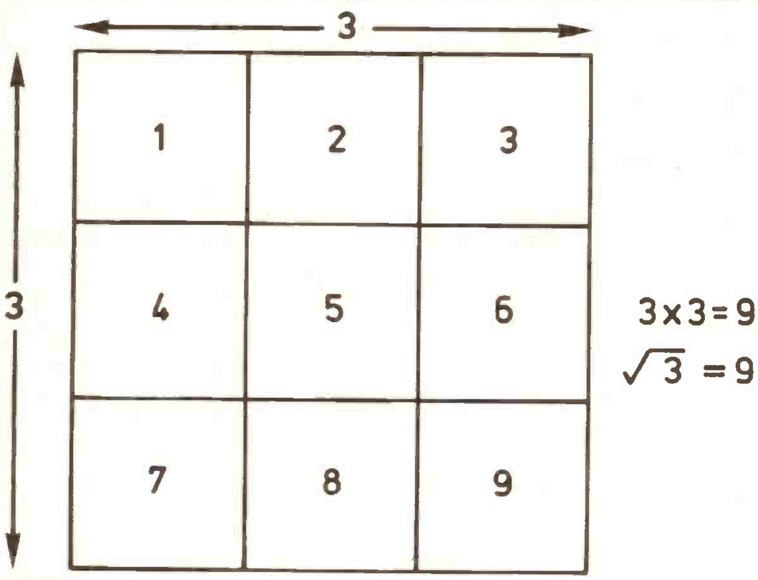

Fig.2.

$4 = 2 \times 2$ so $\sqrt{4} = 2$
$9 = 3 \times 3$ so $\sqrt{9} = 3$
$16 = 4 \times 4$ so $\sqrt{16} = 4$
$25 = 5 \times 5$ so $\sqrt{25} = 5$
$36 = 6 \times 6$ so $\sqrt{36} = 6$
$81 = 9 \times 9$ so $\sqrt{81} = 9$
$144 = 12 \times 12$ so $\sqrt{144} = 12$
$225 = 15 \times 15$ so $\sqrt{225} = 15$
$625 = 25 \times 25$ so $\sqrt{625} = 25$

and so on. Looking between numbers gives fractional square roots. The square root of 20 would have a value between $\sqrt{16}$ and $\sqrt{25}$ so its value would be between 4 and 5. Check it on your calculator.

In the case of indices we can obtain the square root very easily. If $10{,}000 = 100 \times 100$ then $10^4 = 10^2 \times 10^2$ so by dividing the index shown for 10,000 by 2 we have the index of the square root.

Another example would be 10^{12}, ie 1,000,000,000,000 which is 1 million × 1 million so the square root would be 1 million, 10^6 or $10^{12/2}$ ie. the index divided by 2.

In the case of negative indices, an example of say $\sqrt{10^{-18}}$ would be $= 10^{-9}$. Thus the answer would be 10^{-9}.

Nuts and bolts

This covers all the points necessary for the arithmetic side of the exam. The next stumbling block concerns the correct understanding of the simple algebraic notations used. Numbers can be manipulated just like a mechanic uses his tools. A mechanic uses a spanner the same way whether it is a 6mm open ended or a 45mm open ended spanner. The size of the spanner is not significant in the way he does the job. The significance is in the way he does the job and the significant thing is the *method* he uses. In our case the size of the numbers are not important. It's what we do with them that matters. Looking at the manipulating techniques rather than the numbers themselves, it's a lot easier to understand algebra. Substituting one number for another you can still use the same technique and get sensible answers.

Example: To say $3 \times 3 = 9$ is exactly the same technique as saying $5 \times 5 = 25$ so why not substitite a letter for the number? In this case we could say $a = 3$, $b = 5$

so $3 \times 3 = 9$
would be $a \times a = a^2$
or $5 \times 5 = 25$
would be $b \times b = b^2$

We could multiply $a \times b$ and get another group.

$3 \times 5 = 15$
$a \times b = ab$ where $ab = 15$

We could put any number we want against any letter we want providing that a record is kept of what has been done so that at the end of the calculation, conversion back to numbers is possible. The main use of the technique on the RAE course is to make up formulae: any letter can be substituted for any number.

For instance:

$ab = c$
then $a/c = b$
because if $a \times b = c$ then $c \div a = b$
and $c \div b = a$ so $c/a = b$
and $c/a = a$

Next month: Ohm's Law

"You may have got through the RAE, but you're not going on HF until you've passed the morse test."