

# KNOWLEDGE CHECK

30

## SUBSTITUTING INTO FORMULAS

A government agency uses the following formula for 'average points score' for monitoring the performance of about 3200 secondary schools in GCSE English:

$$\frac{57A + 51B + 45C + 39D + 33E + 27F + 21G}{A + B + C + D + E + F + G}$$

where A, B, C, D, E, F are the numbers of students achieving grades 9, 8, 7, 6, 5, 4 respectively and G is the number at level 3 or below

Using a calculator if necessary, find the average points score for a school where A = 3, B = 10, C = 15, D = 40, E = 30, F = 10 and G = 7.

## ANSWERS TO KNOWLEDGE CHECK 30

The average points score is 37.6, to one decimal place.

## DISCUSSION AND EXPLANATION OF KNOWLEDGE CHECK 30

To interpret this formula, remember that in algebra it is common practice to omit multiplication signs, because they can be confused with the letter X. So,  $57A$  means 57 multiplied by the value of the variable A. In this example,  $A = 3$ , so  $57A = 57 \times 3 = 171$ . It is also more usual to use fraction notation to represent division, rather than the division symbol. So, for example,  $P/Q$  would mean  $P \div Q$ . In this example, we have a long expression on the top of the fraction to be divided by another long expression on the bottom.

When substituting actual values for the variables in a formula, remember the algebraic rules about precedence of operators. In this example, we have to do the multiplications on the top first, before the additions. Because the fraction line runs under the whole of the expression on the top, it tells us to work all of that out first, before dividing. So, the division line also acts like a bracket. The addition on the bottom can be done mentally, to get the total of 115.

Using a basic four-function calculator with a memory, the key sequence for finding the value on the top would be: MRC, MRC (to clear the memory),  $57 \times 3 = M+$ ,  $51 \times 10 = M+$ ,  $45 \times 15 = M+$ ,  $39 \times 40 = M+$ ,  $33 \times 30 = M+$ ,  $27 \times 10 = M+$ ,  $21 \times 7 = M+$ . This calculates each product and successively adds the results into the memory. Now recall the total from the memory and divide by 115:  $MRC \div 115 =$ , giving the required value for the average points score.

What this formula is actually doing is simply to find the *mean* points score for Key Stage 3 English for all the pupils involved. The formula on the bottom gives the total number of pupils. The formula on the top gives the sum of all their points scores for English: 3 scores of 57 ( $57 \times 3$ ), 10 scores of 51 ( $51 \times 10$ ), and so on. Dividing the total points scored by the total number of pupils gives the mean.

Substituting specific values for the variables in a formula is straightforward provided you do the operations in the order prescribed by the formula, giving precedence to brackets, divisions and multiplications. Also, if the formula involves units, be careful that the values you substitute are in the right units. For example, a plumber's charges in pounds might be given by the formula  $0.4T + 35$ , where T is the time spent in minutes. You will get a nasty shock when the bill arrives for a 2-hour job if you had substituted  $T = 2$ , instead of  $T = 120$ !

## SUMMARY OF KEY IDEAS

- When substituting specific values for the variables in a formula, be careful to do the operations in the order prescribed by the formula, giving precedence to brackets, divisions and multiplications.
- In algebraic notation, the multiplication sign is usually omitted (e.g.  $7Q$  means  $7 \times Q$ ) and fraction notation is normally used for division (e.g.  $7/Q$  means  $7 \div Q$ ).



## FURTHER PRACTICE

30.1 The formula for converting temperatures from Celsius (centigrade) to Fahrenheit is  $F = 32 + 9C/5$ , where F is the temperature in degrees Fahrenheit and C is the corresponding temperature in degrees Celsius. To convert the other way the formula is  $C = 5(F - 32)/9$ .

- a) To the nearest whole number, what is F when  $C = 16$ ?
- b) To the nearest whole number, what is C when  $F = 82$ ?