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| **UNIT 1: Powers, decimals, HCF and LCM, positive and negative, roots, rounding, reciprocals, standard form, indices and surds** |

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**SPECIFICATION REFERENCES**

N2 apply the four operations, including formal written methods, to integers, decimals … both positive and negative; understand and use place value (e.g. working with very large or very small numbers, and when calculating with decimals)

N3 recognise and use relationships between operations, including inverse operations (e.g. cancellation to simplify calculations and expressions); use conventional notation for priority of operations, including brackets, powers, roots and reciprocals

N4 use the concepts and vocabulary of prime numbers, factors (divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation theorem

N5 apply systematic listing strategies **including use of the product rule for counting** **(i.e. if there are *m* ways of doing one task and for each of these, there are *n* ways of doing another task, then the total number of ways the two tasks can be done is *m* × *n* ways)**

N6 use positive integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5; **estimate powers and roots of any given positive number**

N7 calculate with roots and with integer **and fractional** indices

N8 calculate exactly with … **surds**; … **simplify surd expressions involving squares   
(e.g. √12 = √(4 × 3) = √4 × √3 = 2√3)**

N9 calculate with and interpret standard form *A* x 10*n*, where 1 ≤ *A* < 10 and *n* is an integer.

N14 estimate answers; check calculations using approximation and estimation, including answers obtained using technology

N15 round numbers and measures to an appropriate degree of accuracy (e.g. to a specified number of decimal places or significant figures); …

**PRIOR KNOWLEDGE**

It is essential that students have a firm grasp of place value and be able to order integers and decimals and use the four operations.

Students should have knowledge of integer complements to 10 and to 100, multiplication facts to 10 × 10, strategies for multiplying and dividing by 10, 100 and 1000.

Students will have encountered squares, square roots, cubes and cube roots and have knowledge of classifying integers.

**KEYWORDS**

Integer, number, digit, negative, decimal, addition, subtraction, multiplication, division, remainder, operation, estimate, power, roots, factor, multiple, primes, square, cube, even, odd, surd, rational, irrational standard form, simplify

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| **1b. Indices, roots, reciprocals and hierarchy of operations**  (N2, N3, N6, N7, N14) | **Teaching time**  3-5 hours |

**OBJECTIVES**

By the end of the sub-unit, students should be able to:

* Use index notation for integer powers of 10, including negative powers;
* Recognise powers of 2, 3, 4, 5;
* Use the square, cube and power keys on a calculator and estimate powers and roots of any given positive number, by considering the values it must lie between, e.g. the square root of 42 must be between 6 and 7;
* Find the value of calculations using indices including positive, fractional and negative indices;
* Recall that *n*0 = 1 and *n*–1 =  for positive integers n as well as,  = √*n* and  = 3√*n* for any positive number *n*;
* Understand that the inverse operation of raising a positive number to a power *n* is raising the result of this operation to the power ;
* Use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer powers, fractional and negative powers, and powers of a power;
* Solve problems using index laws;
* Use brackets and the hierarchy of operations up to and including with powers and roots inside the brackets, or raising brackets to powers or taking roots of brackets;
* Use an extended range of calculator functions, including +, –, ×, ÷, *x*², √*x*, memory, *x y*, , brackets;
* Use calculators for all calculations: positive and negative numbers, brackets, powers and roots, four operations.

**POSSIBLE SUCCESS CRITERIA**

What is the value of 25?

Prove that the square root of 45 lies between 6 and 7.

Evaluate (23 × 25) ÷ 24, 40, .

Work out the value of *n* in 40 = 5 × 2*n*.

**OPPORTUNITIES FOR REASONING/PROBLEM SOLVING**

Problems that use indices instead of integers will provide rich opportunities to apply the knowledge in this unit in other areas of Mathematics.

**COMMON MISCONCEPTIONS**

The order of operations is often not applied correctly when squaring negative numbers, and many calculators will reinforce this misconception.

**NOTES**

Students need to know how to enter negative numbers into their calculator.

Use negative number and not minus number to avoid confusion with calculations.