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| **UNIT 14: Multiplicative reasoning:** **more percentages, rates of change, compound measures** | **Teaching time**  6–8 hours |

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**SPECIFICATION REFERENCES**

N12 interpret fractions and percentages as operators

N13 use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate

A5 understand and use standard mathematical formulae; rearrange formulae to change the subject

R1 change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts

R9 … express one quantity as a percentage of another; … solve problems involving percentage change, … and original value problems … including in financial mathematics

R10 solve problems involving direct and inverse proportion …

R11 use compound units such as speed, rates of pay, unit pricing, density and pressure

R13 understand that *X* is inversely proportional to *Y* is equivalent to *X* is proportional to ; interpret equations that describe direct and inverse proportion

R16 set up, solve and interpret the answers in growth and decay problems, including compound interest

G14 use standard units of measure and related concepts (length, area, volume/capacity, mass, time, money, etc)

**PRIOR KNOWLEDGE**

Students should be able to interpret scales on a range of measuring instruments.

Students should be able to find a percentage of an amount and relate percentages to decimals.

Students should be able to rearrange equations and use these to solve problems.

Students should know speed = distance/time, density = mass/volume.

**KEYWORDS**

Ratio, proportion, best value, proportional change, compound measure, density, mass, volume, speed, distance, time, density, mass, volume, pressure, acceleration, velocity, inverse, direct

**OBJECTIVES**

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

* Understand and use compound measures:
* density;
* pressure;
* speed:
* convert between metric speed measures;
* read values in km/h and mph from a speedometer;
* calculate average speed, distance, time – in miles per hour as well as metric measures;
* use kinematics formulae to calculate speed, acceleration (with formula provided and variables defined in the question);
* change d/t in m/s to a formula in km/h, i.e. d/t × (60 × 60)/1000 – with support;
* Express a given number as a percentage of another number in more complex situations;
* Calculate percentage profit or loss;
* Make calculations involving repeated percentage change, not using the formula;
* Find the original amount given the final amount after a percentage increase or decrease;
* Use compound interest;
* Use a variety of measures in ratio and proportion problems:
* currency conversion;
* rates of pay;
* best value;
* Set up, solve and interpret the answers in growth and decay problems;
* Understand that *X* is inversely proportional to *Y* is equivalent to *X* is proportional to ;
* Interpret equations that describe direct and inverse proportion.

**POSSIBLE SUCCESS CRITERIA**

Know that measurements using real numbers depend upon the choice of unit, with speedometers and rates of change.

Change m/s to km/h.

Understand direct proportion as: as *x* increase, *y* increases.

Understand inverse proportion as: as *x* increases, *y* decreases.

**OPPORTUNITIES FOR REASONING/PROBLEM SOLVING**

Speed/distance type problems that involve students justifying their reasons why one vehicle is faster than another.

Calculations involving value for money are a good reasoning opportunity that utilise different skills.

Working out best value of items using different currencies given an exchange rate.

**COMMON MISCONCEPTIONS**

Some students may think that compound interest and simple interest are the same method of calculating interest.

Incomplete methods when using multipliers, i.e. reduce £80 by 15% = 80 × 0.15.

**NOTES**

Encourage students to use a single multiplier.

Include simple fractional percentages of amounts with compound interest and encourage use of single multipliers.

Amounts of money should be rounded to the nearest penny, but emphasise the importance of not rounding until the end of the calculation if doing in stages.

Use a formula triangle to help students see the relationship for compound measures – this will help them evaluate which inverse operations to use.

Help students to recognise the problem they are trying to solve by the unit measurement given, e.g. km/h is a unit of speed as it is speed divided by a time.