

### ARITHMETIC

$73.65 - 28.19 = 45.46$   
 $26.17 + 9.45 = 35.62$   
 $43.05 \div 1.5 = 28.7$   
 $2.59 \times 370 = 958.3$

$6 \times 3 = 18$   
 $5 \times 5 = 25$   
 $18 + 25 = 43$   
 $43 \times 100 = 4300$   
 $4300 \div 100 = 43$

$2617 + 945 = 3562$   
 $259 \times 37 = 9583$

### NEGATIVE NUMBERS

$7 \times -5 = -35$   
 $-7 \times -5 = 35$   
 $-20 \div 5 = -4$   
 $-20 \div -5 = 4$

$+ \times + = +$   
 $+ \times - = -$   
 $- \times + = -$   
 $- \times - = +$

$-2 - +5 = -2 - 5 = -7$   
 $-2 + +5 = -2 + 5 = 3$   
 $-2 - -5 = -2 + 5 = 3$

SUBTRACTING THE NEGATIVE = ADDING THE POSITIVE AMOUNT

### APPROXIMATION

$3784 \times 72 \approx 4000 \times 70 = 280000$

$8792 - 958 \approx 9000 - 1000 = 8000$   
 $8000 \div 20 = 400$

$0.0782904 \approx 0.078$  (ROUND TO 3 D.P.)  
 $0.078$  (ROUND DOWN)  
 $0.078$  (ROUND UP)

$723608 \approx 724000$  (ROUND TO 3 S.F.)  
 $723608$  (ROUND DOWN)  
 $723608$  (ROUND UP)

### FRACTIONS

$2 \frac{3}{4} \times 1 \frac{2}{5} = \frac{11}{4} \times \frac{7}{5} = \frac{77}{20} = 3 \frac{17}{20}$

CONVERT TO IMPROPER FRACTIONS  
 CONVERT BACK TO A MIXED NUMBER

$2 \frac{3}{4} = \frac{11}{4}$   
 $1 \frac{2}{5} = \frac{7}{5}$

$11 \div 4 = 2r3$   
 $11 = 2 \times 4 + 3$

### FRACTIONS OF A QUANTITY

FIND  $\frac{3}{5}$  OF £60  
 $£60 \div 5 = £12$   
 $£12 \times 3 = £36$

$\frac{60}{90} = \frac{30}{45} = \frac{10}{15} = \frac{2}{3}$

CANCELLED TO ITS LOWEST TERMS

### COMPARING NUMBERS

$0.75 = \frac{3}{4}$   
 $3.5 \neq 3 \frac{1}{2}$

$-5 < -3$   
 $\frac{1}{3} > \frac{1}{5}$

$4 \div 5 = 0.8$   
 $0.8 \times 100 = 80\%$

$0.28 = \frac{28}{100} = \frac{7}{25}$   
 $0.28 \times 100 = 28\%$

$0.625 = \frac{625}{1000} = \frac{125}{200} = \frac{25}{40} = \frac{5}{8}$   
 $62.5 \div 100 = 0.625$

### PRIME NUMBERS

1 IS NOT A PRIME  
 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, ...

HAVE EXACTLY TWO FACTORS, THE NUMBER ITSELF AND 1

LOWEST COMMON MULTIPLE OF 12 AND 30 IS 60  
 12, 24, 36, 48, 60, ...  
 30, 60, 90, 120, 150, ...

MULTIPLES OF 12  
 MULTIPLES OF 30

FACTORS: INTEGERS WHICH DIVIDE EXACTLY INTO THE NUMBER WITH NO REMAINDER  
 FACTORS OF 12: 1, 2, 3, 4, 6, 12  
 FACTORS OF 30: 1, 2, 3, 5, 6, 10, 15, 30  
 HIGHEST COMMON FACTOR OF 12 AND 30 IS 6

### FRACTIONS

**FOUR OPERATIONS**

**MULTIPLY:** MULTIPLY NUMERATORS, MULTIPLY DENOMINATORS  
 $\frac{2}{3} \times \frac{4}{5} = \frac{2 \times 4}{3 \times 5} = \frac{8}{15}$

**FLIP THE SECOND FRACTION AND MULTIPLY**  
 $\frac{3}{7} \div \frac{5}{8} = \frac{3}{7} \times \frac{8}{5} = \frac{3 \times 8}{7 \times 5} = \frac{24}{35}$

**ADD:** FIND A COMMON DENOMINATOR  
 $\frac{2}{5} + \frac{3}{7} = \frac{2 \times 7}{5 \times 7} + \frac{3 \times 5}{7 \times 5} = \frac{14}{35} + \frac{15}{35} = \frac{29}{35}$

**SUBTRACT:** FIND A COMMON DENOMINATOR  
 $\frac{5}{6} - \frac{3}{8} = \frac{5 \times 4}{6 \times 4} - \frac{3 \times 3}{8 \times 3} = \frac{20}{24} - \frac{9}{24} = \frac{11}{24}$

USE EQUIVALENT FRACTIONS WITH A COMMON DENOMINATOR

### FRACTION, DECIMAL, PERCENTAGE

WRITE AS  $\frac{1}{10}, \frac{1}{100}, \frac{1}{1000}, \dots$  AND CANCEL TO LOWEST TERMS

FRACTION: NUMERATOR  $\div$  DENOMINATOR  
 DECIMAL:  $\div 100$   
 PERCENTAGE:  $\times 100$

**PRIME FACTORISATION**  
 EXPRESSING AN INTEGER AS A PRODUCT OF PRIME NUMBERS  
 THIS EXPRESSION IS UNIQUE TO ANY INTEGER

132:  $132 = 2 \times 2 \times 3 \times 11 = 2^2 \times 3 \times 11$   
 420:  $420 = 2 \times 2 \times 3 \times 5 \times 7 = 2^2 \times 3 \times 5 \times 7$

HIGHEST COMMON FACTOR OF 132 AND 420 IS 12  
 LOWEST COMMON MULTIPLE OF 132 AND 420 IS 4620

### UNITS OF MEASURE

**COMPOUND MEASURES**  
 VOLUME =  $642 \text{ cm}^3$   
 MASS =  $12400 \text{ g}$   
 DENSITY OF GOLD =  $\frac{12400}{642} = 19.3 \text{ g/cm}^3$

**EXCHANGE RATES**  
 $\$797.34 \div 1.37 = \$582.00$   
 $\pounds 1 = \$1.37$

**METRIC  $\leftrightarrow$  IMPERIAL**  
 $30.48 \text{ cm} \times 2.54 = 12 \text{ inches}$   
 $1 \text{ inch} = 2.54 \text{ cm}$

**METRIC  $\leftrightarrow$  METRIC**  
 LENGTH:  $\text{mm} \times 10 = \text{cm}$ ,  $\text{cm} \times 100 = \text{m}$ ,  $\text{m} \times 1000 = \text{km}$   
 AREA:  $\text{mm}^2 \times 100 = \text{cm}^2$ ,  $\text{cm}^2 \times 100 = \text{m}^2$   
 VOLUME:  $\text{mm}^3 \times 1000 = \text{cm}^3$ ,  $\text{cm}^3 \times 1000 = \text{m}^3$

### POWERS AND ROOTS

**THE LAWS OF INDICES (POWERS)**

**MULTIPLYING WITH THE SAME BASE:**  $a^x \times a^y = a^{x+y}$  (ADD THE POWERS)  
 $2^4 \times 2^3 = (2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2) = 2^7$

**DIVIDING WITH THE SAME BASE:**  $a^x \div a^y = a^{x-y}$  (SUBTRACT THE POWERS)  
 $2^5 \div 2^2 = \frac{2 \times 2 \times 2 \times 2 \times 2}{2 \times 2} = 2^3$

**POWER TO A POWER:**  $(a^x)^y = a^{x \times y}$  (MULTIPLY THE POWERS)  
 $(2^4)^3 = (2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) = 2^{12}$

**WITH ALGEBRA:**  $a^2 \div a^5 = a^{2-5} = a^{-3} = \frac{1}{a^3}$   
 $x^6 \times x^2 = x^{6+2} = x^8$   
 $(m^3)^4 = m^{3 \times 4} = m^{12}$   
 $\frac{12s^5t^2}{3s^2t} = \frac{12}{3} \times \frac{s^5}{s^2} \times \frac{t^2}{t} = 4s^3t$

**REPEATED MULTIPLICATION:**  $2^5 = 32$   
 $2^5 = 2 \times 2 \times 2 \times 2 \times 2$   
 $2 \times 2 \times 2 \times 2 \times 2 = 32$

**THE FIFTH ROOT:**  $\sqrt[5]{32} = 2$   
 $2^5 = 32$

**POWERS OF ZERO:**  $a^0 = 1$   
 $2^0 = 1$

**NEGATIVE POWERS:**  $a^{-x} = \frac{1}{a^x}$   
 $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$

**ONE DIVIDED BY THE BASE TO THE POSITIVE POWER:**  $\frac{1}{a^x} = a^{-x}$

**POWERS OF 2:**  $2^1=2, 2^2=4, 2^3=8, 2^4=16, 2^5=32$   
**POWERS OF 3:**  $3^1=3, 3^2=9, 3^3=27, 3^4=81, 3^5=243$   
**POWERS OF 4:**  $4^1=4, 4^2=16, 4^3=64, 4^4=256, 4^5=1024$   
**POWERS OF 5:**  $5^1=5, 5^2=25, 5^3=125, 5^4=625, 5^5=3125$

### FACTORS, MULTIPLES AND PRIMES

**FACTORS OF 12:** 1, 2, 3, 4, 6, 12  
**FACTORS OF 30:** 1, 2, 3, 5, 6, 10, 15, 30  
**HIGHEST COMMON FACTOR OF 12 AND 30 IS 6**

**PRIME FACTORISATION**  
 EXPRESSING AN INTEGER AS A PRODUCT OF PRIME NUMBERS  
 THIS EXPRESSION IS UNIQUE TO ANY INTEGER

**LOWEST COMMON MULTIPLE**  
 132:  $2 \times 2 \times 3 \times 11$   
 420:  $2 \times 2 \times 3 \times 5 \times 7$   
**LOWEST COMMON MULTIPLE IS 4620**

### STANDARD FORM

**FOR BIG NUMBERS:**  $8.2 \times 10^5 = 8.2 \times 10 \times 10 \times 10 \times 10 \times 10 = 820000$

**FOR SMALL NUMBERS:**  $3.72 \times 10^{-5}$

$5.39 \times 10^{-4} = 5.39 \times \frac{1}{10^4} = 0.000539$

**UPPER AND LOWER BOUNDS**  
 HEIGHT MEASURED TO THE NEAREST 10 cm: 1.7 to 1.8  
 HEIGHT MEASURED TO THE NEAREST 1 cm: 1.36 to 1.37

**COUNTING METHODS**  
 8 TIES, 5 SHIRTS, 6 TROUSERS  
**HOW MANY DIFFERENT OUTFITS?**  
 $8 \times 5 \times 6 = 240$

### ORDER OF OPERATIONS

**BRACKETS:**  $18 \div 2 + (7-3) \times 5^2 - 10$   
**INDICES:**  $18 \div 2 + 4 \times 5^2 - 10$   
**MULTIPLICATION:**  $18 \div 2 + 4 \times 25 - 10$   
**DIVISION:**  $9 + 100 - 10$   
**ADDITION:**  $99$   
**SUBTRACTION:**  $99$

**DECIMAL RECURRING DECIMALS**  
 LET THE RECURRING DECIMAL EQUAL  $x$ .  
 USE SUBTRACTION WITH  $10x, 100x, 1000x, \dots$  TO CANCEL THE DECIMAL PART AND THEN SIMPLIFY IF POSSIBLE.  
 $0.58\bar{3}$   
 $1000x = 583.28\bar{2}$   
 $-1000x = 58.28\bar{2}$   
 $990x = 325$   
 $x = \frac{325}{990} = \frac{65}{198}$

### SYSTEMATIC LISTING

**CHOOSE A STARTER, A MAIN AND A DESSERT**

**STARTER:** T TOMATO SOUP, P PRAWN COCKTAIL  
**MAIN:** C CHICKEN PASTA, F FISH + CHIPS, V VEGETABLE CURRY  
**DESSERT:** I ICE CREAM, L LEMON PIE

**HOW MANY DIFFERENT MENU CHOICES?**  
 12 POSSIBILITIES

### FRACTIONAL POWERS

**LAWS OF INDICES:**  $a^x \times a^y = a^{x+y}$   
 $a^{\frac{1}{2}} \times a^{\frac{1}{2}} = a^{\frac{1}{2} + \frac{1}{2}} = a^1 = a$   
 $a^{\frac{1}{3}} \times a^{\frac{1}{3}} \times a^{\frac{1}{3}} = a^{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}} = a^1 = a$   
 $a^{\frac{1}{4}} \times a^{\frac{1}{4}} \times a^{\frac{1}{4}} \times a^{\frac{1}{4}} = a^{\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}} = a^1 = a$

$a^{\frac{1}{2}} = \sqrt{a}$ ,  $a^{\frac{1}{3}} = \sqrt[3]{a}$ ,  $a^{\frac{1}{4}} = \sqrt[4]{a}$   
 $125^{\frac{1}{3}} = \sqrt[3]{125} = 5$   
 $125^{\frac{2}{3}} = \sqrt[3]{125^2} = \sqrt[3]{15625} = 25$

**LOOK FOR A FACTOR WHICH IS A SQUARE**  
 $\sqrt{75} = \sqrt{25 \times 3} = 5\sqrt{3}$

**RATIONALISE THE DENOMINATOR**  
 $\frac{8}{3+\sqrt{5}} = \frac{8}{(3+\sqrt{5})} \times \frac{(3-\sqrt{5})}{(3-\sqrt{5})} = \frac{24-8\sqrt{5}}{9-5} = \frac{24-8\sqrt{5}}{4} = 6-2\sqrt{5}$

### RECURRING DECIMALS

LET  $x = 0.32\bar{8}$   
 $1000x = 328.2\bar{8}$   
 $-1000x = 32.2\bar{8}$   
 $990x = 325$   
 $x = \frac{325}{990} = \frac{65}{198}$

**USE LONG DIVISION**  
 $7 \div 12 = 0.58\bar{3}$

### SURDS

**EXPAND:**  $(5+\sqrt{2})(4-\sqrt{3}) = 20 + 4\sqrt{2} - 5\sqrt{3} - \sqrt{6}$

**SIMPLIFY:**  $\sqrt{75} = \sqrt{25 \times 3} = 5\sqrt{3}$

**RATIONALISE THE DENOMINATOR:**  $\frac{8}{3+\sqrt{5}} = \frac{8(3-\sqrt{5})}{(3+\sqrt{5})(3-\sqrt{5})} = \frac{24-8\sqrt{5}}{9-5} = 6-2\sqrt{5}$

**SWAP THE + FOR -**  
 $\sqrt{5} \times \sqrt{5} = 5$

### UPPER AND LOWER BOUNDS

HEIGHT MEASURED TO THE NEAREST 10 cm: 1.7 to 1.8  
 HEIGHT MEASURED TO THE NEAREST 1 cm: 1.36 to 1.37

**LOWER BOUND:** 1.75, 1.365  
**UPPER BOUND:** 1.85, 1.375

**MAXIMUM DIFFERENCE IN HEIGHTS:**  $1.85 - 1.365 = 0.485 \text{ m}$