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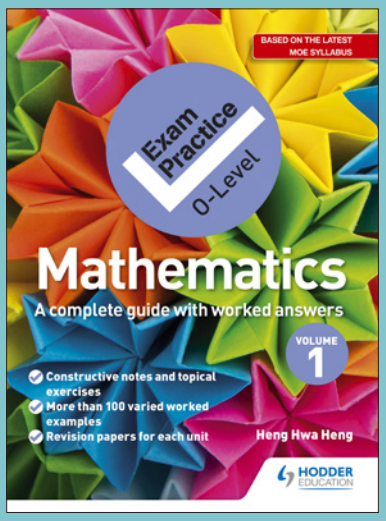

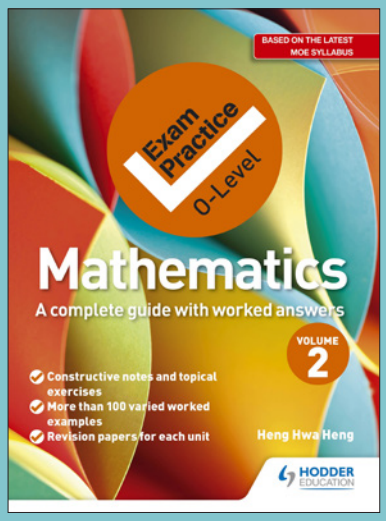

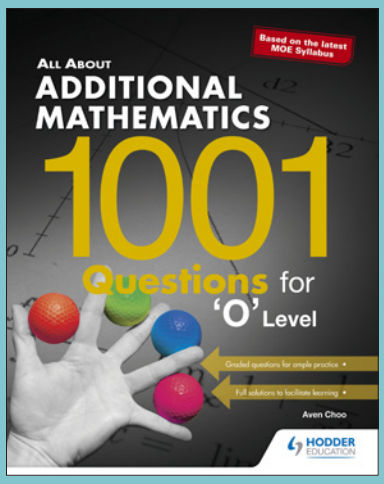

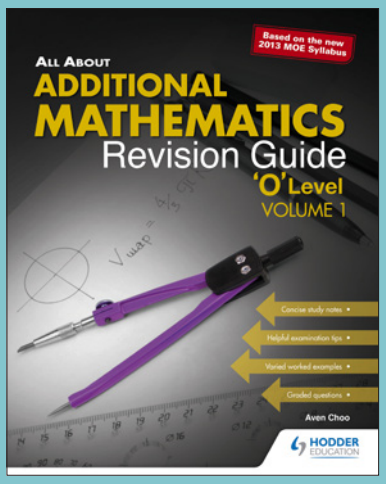

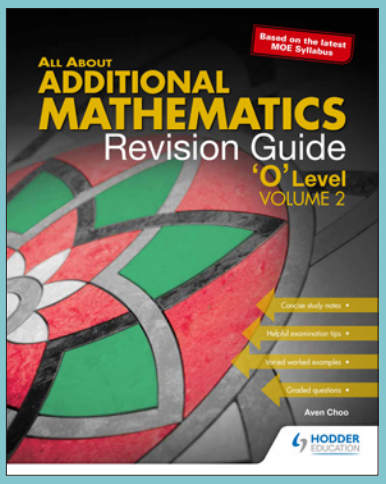

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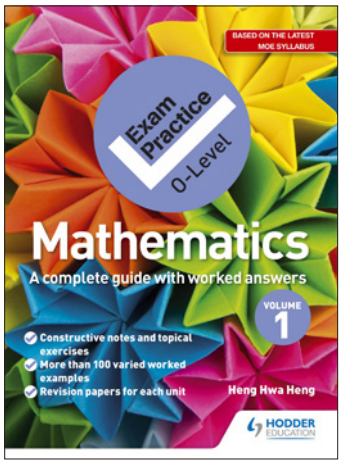

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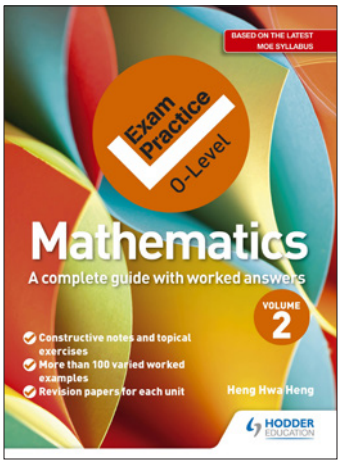

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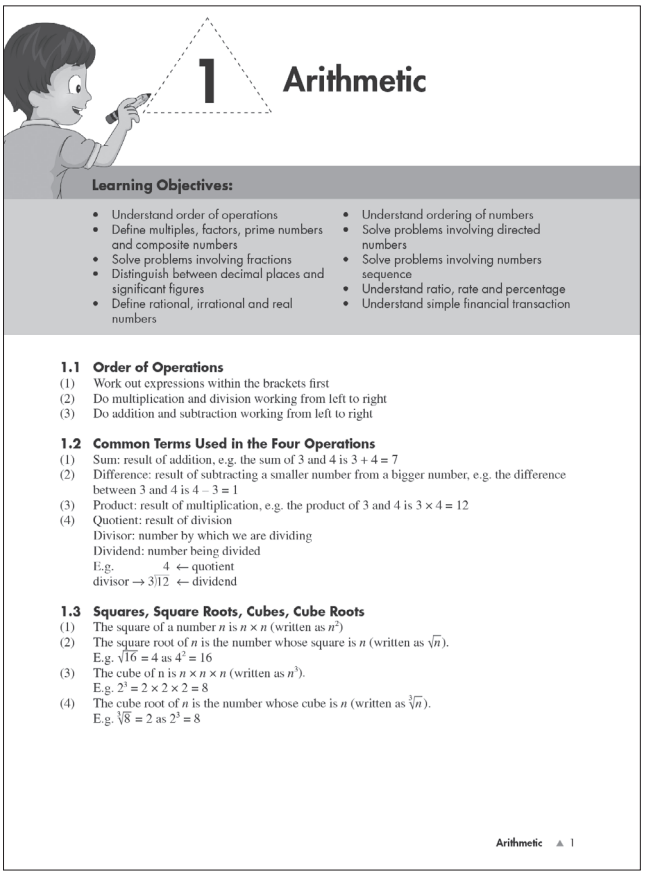


1 Arithmetic

Learning Objectives:

- Understand order of operations
- Define multiples, factors, prime numbers and composite numbers
- Solve problems involving fractions
- Distinguish between decimal places and significant figures
- Define rational, irrational and real numbers
- Understand ordering of numbers
- Solve problems involving directed numbers
- Solve problems involving numbers sequence
- Understand ratio, rate and percentage
- Understand simple financial transaction

1.1 Order of Operations

(1) Work out expressions within the brackets first
(2) Do multiplication and division working from left to right
(3) Do addition and subtraction working from left to right

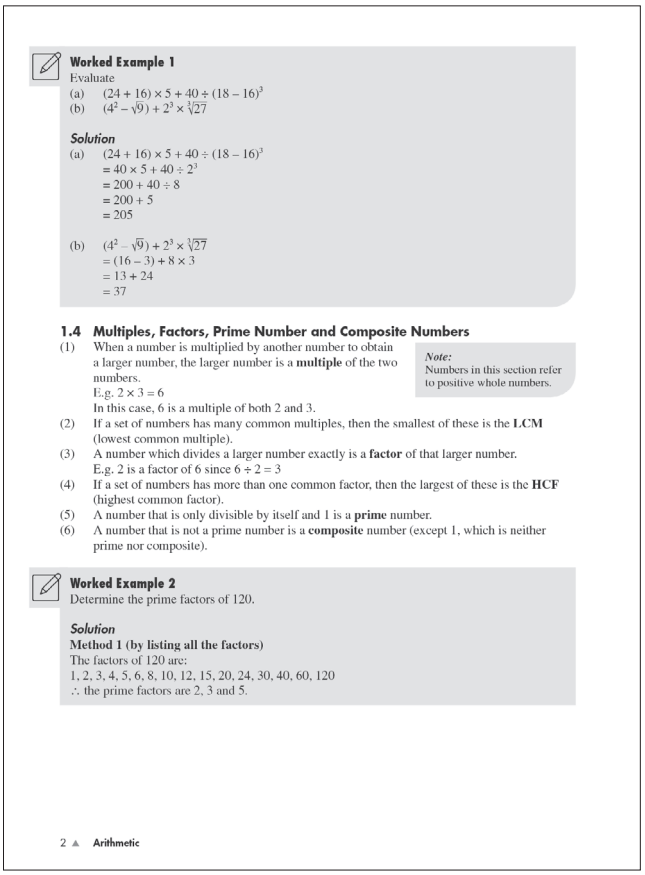
1.2 Common Terms Used in the Four Operations

(1) Sum: result of addition, e.g. the sum of 3 and 4 is $3 + 4 = 7$
(2) Difference: result of subtracting a smaller number from a bigger number, e.g. the difference between 3 and 4 is $4 - 3 = 1$
(3) Product: result of multiplication, e.g. the product of 3 and 4 is $3 \times 4 = 12$
(4) Quotient: result of division
Divisor: number by which we are dividing
Dividend: number being divided
E.g. 4 ← quotient
divisor → $3\overline{)12}$ ← dividend

1.3 Squares, Square Roots, Cubes, Cube Roots

(1) The square of a number n is $n \times n$ (written as n^2)
(2) The square root of n is the number whose square is n (written as $\sqrt{n}$).
E.g. $\sqrt{16} = 4$ as $4^2 = 16$
(3) The cube of n is $n \times n \times n$ (written as n^3).
E.g. $2^3 = 2 \times 2 \times 2 = 8$
(4) The cube root of n is the number whose cube is n (written as $\sqrt[3]{n}$).
E.g. $\sqrt[3]{8} = 2$ as $2^3 = 8$

Arithmetic ▲ 1



Worked Example 1
Evaluate
(a) $(24 + 16) \times 5 + 40 \div (18 - 16)^3$
(b) $(4^2 - \sqrt{9}) + 2^3 \times \sqrt[3]{27}$

Solution
(a) $(24 + 16) \times 5 + 40 \div (18 - 16)^3$
$= 40 \times 5 + 40 \div 2^3$
$= 200 + 40 \div 8$
$= 200 + 5$
$= 205$

(b) $(4^2 - \sqrt{9}) + 2^3 \times \sqrt[3]{27}$
$= (16 - 3) + 8 \times 3$
$= 13 + 24$
$= 37$

1.4 Multiples, Factors, Prime Number and Composite Numbers

(1) When a number is multiplied by another number to obtain a larger number, the larger number is a **multiple** of the two numbers.
E.g. $2 \times 3 = 6$
In this case, 6 is a multiple of both 2 and 3.
(2) If a set of numbers has many common multiples, then the smallest of these is the **LCM** (lowest common multiple).
(3) A number which divides a larger number exactly is a **factor** of that larger number.
E.g. 2 is a factor of 6 since $6 \div 2 = 3$
(4) If a set of numbers has more than one common factor, then the largest of these is the **HCF** (highest common factor).
(5) A number that is only divisible by itself and 1 is a **prime** number.
(6) A number that is not a prime number is a **composite** number (except 1, which is neither prime nor composite).

Note:
Numbers in this section refer to positive whole numbers.

Worked Example 2
Determine the prime factors of 120.

Solution
Method 1 (by listing all the factors)
The factors of 120 are:
1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 40, 60, 120
∴ the prime factors are 2, 3 and 5.

2 ▲ Arithmetic

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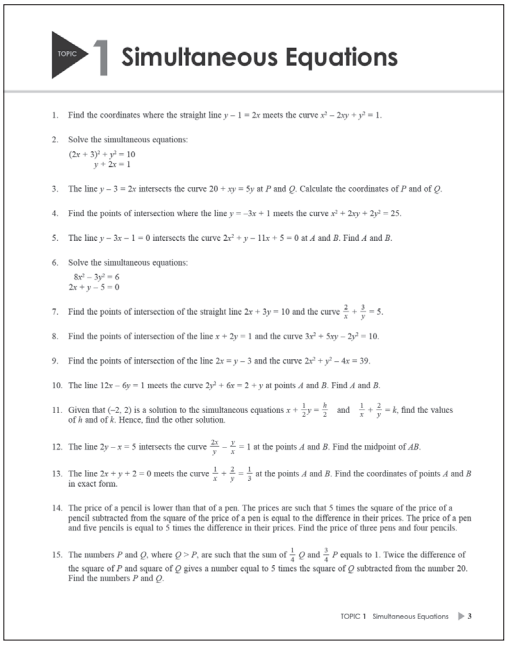
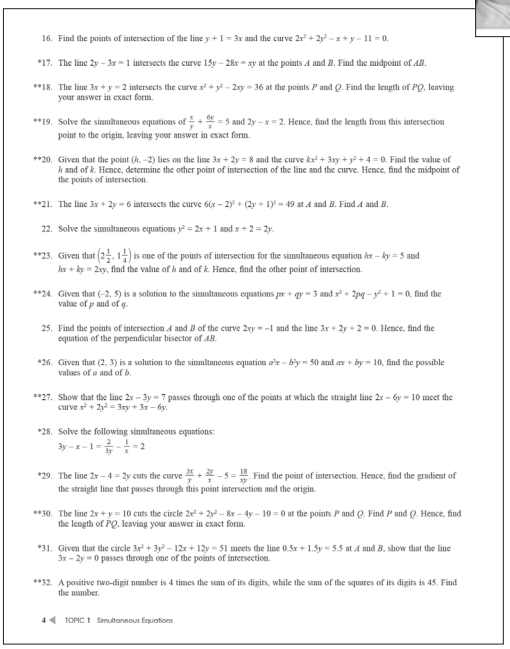


TOPIC 1 Simultaneous Equations

1. Find the coordinates where the straight line $y - 1 = 2x$ meets the curve $x^2 - 2xy + y^2 = 1$.
2. Solve the simultaneous equations:
   $(2x + 3)^2 + y^2 = 10$
   $y + 2x = 1$
3. The line $y - 3 = 2x$ intersects the curve $20 + xy = 5y$ at P and Q. Calculate the coordinates of P and of Q.
4. Find the points of intersection where the line $y = -3x + 1$ meets the curve $x^2 + 2xy + 2y^2 = 25$.
5. The line $y - 3x - 1 = 0$ intersects the curve $2x^2 + y - 11x + 5 = 0$ at A and B. Find A and B.
6. Solve the simultaneous equations:
   $8x^2 - 3y^2 = 6$
   $2x + y - 5 = 0$
7. Find the points of intersection of the straight line $2x + 3y = 10$ and the curve $\frac{2}{x} + \frac{3}{y} = 5$.
8. Find the points of intersection of the line $x + 2y = 1$ and the curve $3x^2 + 5xy - 2y^2 = 10$.
9. Find the points of intersection of the line $2x = y - 3$ and the curve $2x^2 + y^2 - 4x = 39$.
10. The line $12x - 6y = 1$ meets the curve $2y^2 + 6x = 2 + y$ at points A and B. Find A and B.
11. Given that $(-2, 2)$ is a solution to the simultaneous equations $x + \frac{1}{2}y = \frac{h}{2}$ and $\frac{1}{x} + \frac{2}{y} = k$, find the values of h and of k. Hence, find the other solution.
12. The line $2y - x = 5$ intersects the curve $\frac{2x}{y} - \frac{y}{x} = 1$ at the points A and B. Find the midpoint of AB.
13. The line $2x + y + 2 = 0$ meets the curve $\frac{1}{x} + \frac{2}{y} = \frac{1}{3}$ at the points A and B. Find the coordinates of points A and B in exact form.
14. The price of a pencil is lower than that of a pen. The prices are such that 5 times the square of the price of a pencil subtracted from the square of the price of a pen is equal to the difference in their prices. The price of a pen and five pencils is equal to 5 times the difference in their prices. Find the price of three pens and four pencils.
15. The numbers P and Q, where $Q > P$, are such that the sum of $\frac{1}{4}Q$ and $\frac{1}{4}P$ equals to 1. Twice the difference of the square of P and square of Q gives a number equal to 5 times the square of Q subtracted from the number 20. Find the numbers P and Q.

TOPIC 1 Simultaneous Equations 3



16. Find the points of intersection of the line $y + 1 = 3x$ and the curve $2x^2 + 2y^2 - x + y - 11 = 0$.

*17. The line $2y - 3x = 1$ intersects the curve $15y - 28x = xy$ at the points A and B. Find the midpoint of AB.

**18. The line $3x + y = 2$ intersects the curve $x^2 + y^2 - 2xy = 36$ at the points P and Q. Find the length of PQ, leaving your answer in exact form.

**19. Solve the simultaneous equations of $\frac{x}{y} + \frac{6y}{x} = 5$ and $2y - x = 2$. Hence, find the length from this intersection point to the origin, leaving your answer in exact form.

**20. Given that the point $(h, -2)$ lies on the line $3x + 2y = 8$ and the curve $kx^2 + 3xy + y^2 + 4 = 0$. Find the value of h and of k. Hence, determine the other point of intersection of the line and the curve. Hence, find the midpoint of the points of intersection.

**21. The line $3x + 2y = 6$ intersects the curve $6(x - 2)^2 + (2y + 1)^2 = 49$ at A and B. Find A and B.

22. Solve the simultaneous equations $y^2 = 2x + 1$ and $x + 2 = 2y$.

**23. Given that $\left(2\frac{1}{2}, 1\frac{1}{4}\right)$ is one of the points of intersection for the simultaneous equation $hx - ky = 5$ and $hx + ky = 2xy$, find the value of h and of k. Hence, find the other point of intersection.

**24. Given that $(-2, 5)$ is a solution to the simultaneous equations $px + qy = 3$ and $x^2 + 2pq - y^2 + 1 = 0$, find the value of p and of q.

25. Find the points of intersection A and B of the curve $2xy = -1$ and the line $3x + 2y + 2 = 0$. Hence, find the equation of the perpendicular bisector of AB.

*26. Given that $(2, 3)$ is a solution to the simultaneous equation $a^2x - b^2y = 50$ and $ax + by = 10$, find the possible values of a and of b.

**27. Show that the line $2x - 3y = 7$ passes through one of the points at which the straight line $2x - 6y = 10$ meet the curve $x^2 + 2y^2 = 3xy + 3x - 6y$.

*28. Solve the following simultaneous equations:
$3y - x - 1 = \frac{2}{3y} - \frac{1}{x} = 2$

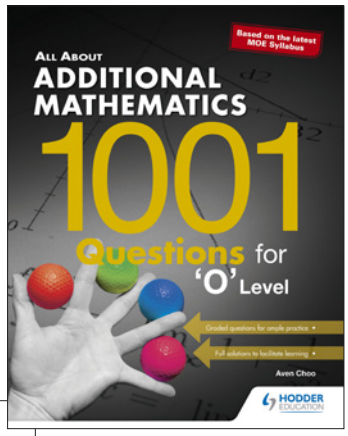
*29. The line $2x - 4 = 2y$ cuts the curve $\frac{3x}{y} + \frac{2y}{x} - 5 = \frac{18}{xy}$. Find the point of intersection. Hence, find the gradient of the straight line that passes through this point intersection and the origin.

**30. The line $2x + y = 10$ cuts the circle $2x^2 + 2y^2 - 8x - 4y - 10 = 0$ at the points P and Q. Find P and Q. Hence, find the length of PQ, leaving your answer in exact form.

*31. Given that the circle $3x^2 + 3y^2 - 12x + 12y = 51$ meets the line $0.5x + 1.5y = 5.5$ at A and B, show that the line $3x - 2y = 0$ passes through one of the points of intersection.

**32. A positive two-digit number is 4 times the sum of its digits, while the sum of the squares of its digits is 45. Find the number.

4 TOPIC 1 Simultaneous Equations



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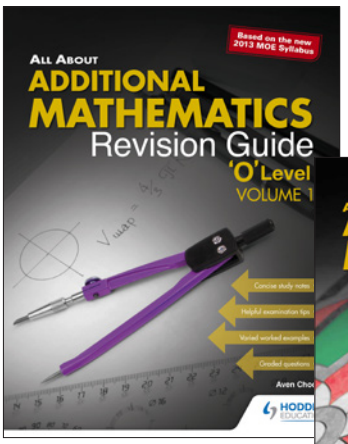

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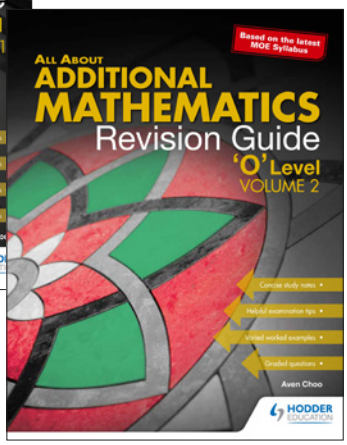

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