0.1 Section A: Analytical / Coordinate Geometry

Consider two points $P_1\,(x_1, y_1)$ and $P_2\,(x_2, y_2)$.

1. **Distance Formula:** $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

2. **Midpoint Formula:** $M(\bar{x}, \bar{y}) = \left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

3. **Gradient of a Line:** $m = \frac{\Delta y}{\Delta x} = \frac{y_2-y_1}{x_2-x_1}$

4. **Inclination of a Line:** $\tan\theta = m = \frac{y_2-y_1}{x_2-x_1} \implies \theta = \tan^{-1}\left(\frac{y_2-y_1}{x_2-x_1}\right)$

5. **Parallel Lines:** Have the same gradient. This means that $m_1 = m_2$

6. **Perpendicular Lines:** The product of their gradients is -1, i.e. $m_1 \times m_2 = -1$

7. **Equation of a Straight Line:** $y - y_1 = m(x - x_1) \implies y - y_1 = \frac{y_2-y_1}{x_2-x_1}(x - x_1)$

8. **Circle Centred at the Origin** $(0, 0)$**:** $x^2 + y^2 = r^2$

9. **Cirlce Centred at** (a, b) **of Radius** r**:** $(x - a)^2 + (y - b)^2 = r^2$

0.2 Section B: General Properties of Shapes

0.2.1 One-dimensional Shapes

1. Straight Line / Ray:

- Extends from one point to another, oftentimes used to join two points
- The sum of angles on a straight line add up to 180°

0.2.2 Two-dimensional Shapes

1. Square:

- All sides are equal in length
- Sides intersect at right angles / perpendicularly (90°)
- Diagonals are equal in length
- Diagonals intersect at right angles
- Area:

$$A = s \times s = s^2$$

- Perimeter:

$$P = s + s + s + s = 4s$$

† The sum of interior angles of trianlge add up to 180°

†† The exterior angle of a triangle equals the sum of the interior opposite angles

††† **Theorem of Pythagoras:** In any right-angled triangle, the square of the hypotenuse equals the sum of the squares of the other two sides

2.1. Equlateral Triangle:

- All sides are equal in length
- All internal angles are equal and have a value of 60°

- Area:

$$A = \frac{1}{2}bh_{\perp} = \frac{\sqrt{3}}{4}s^2$$

- Perimeter:

$$P = s + s + s = 3s$$

2.2. Isosceles Trianlge:

- Two sides of the triangle are equal in length
- The base angles are equal
- Area:

$$A = \frac{1}{2}bh_{\perp} = \frac{1}{2}b\sqrt{\ell^2 - \frac{b^2}{4}}$$

- Perimeter:

$$P = \ell + \ell + b = 2\ell + b$$

2.3. Scalene Triangle

- None of the sides are equal in length
- None of the internal angles are equal
- Area:

$$A = \frac{1}{2}bh_{\perp}$$

- Perimeter:

$$P = a + b + c$$

3. Parallelogram / Parm

4. Rhombus

5. Trapezium (US) / Trapezoid (UK)

6. Kite

7. Circle

0.2.3 Three-dimensional Shapes

1. Cube

• Volume:

$$V = s \times s \times s = s^3$$

• Surface Area:

$$SA = \underbrace{s^2 + s^2 + \cdots + s^2}_{\text{6 sides}} = 6s^2$$

2. Rectangular Prism

• Volume:

$$V = \ell \times b \times h$$

• Surface Area:

$$SA = \underbrace{(bh + bh)}_{\text{Front+Back}} + \underbrace{(\ell h + \ell h)}_{\text{Left Side+Right Side}} + \underbrace{(\ell b + \ell b)}_{\text{Bottom+Top}} = 2\,(bh + \ell h + \ell b)$$

3. Triangular Prism:

4. Cylinder

- Volume:

$$V = \pi r^2 h$$

- Surface Area:

$$SA = \underbrace{2\pi r^2}_{\text{Top+Bottom}} + \underbrace{2\pi r h}_{\text{Circular wall}} = 2\pi r\left(r + h\right)$$

4. Sphere

- Volume:

$$V = \frac{4}{3}\pi r^3$$