Parameters

- **The parabola $x^2 = 4ay$**
  Can be written as $x = 2at$ and $y = at^2$ where t is the parameter

- **The Chord**
  Joining the points P($2ap$, ap^2) and Q($2aq$, aq^2) on the parabola $x^2 = 4ay$ has:
  - gradient = $\frac{p+q}{2}$
  - equation $y - ½(p+q)x + aqp = 0$
  - $pq = -1$ if it is a focal chord
  - parameters of the endpoints are p, $\frac{-1}{p}$ if it is a focal chord

- **Parametric Differentiation**
  Given that $y = f(t)$ and $x = f(t)$ then:
  $\frac{dy}{dx} = \frac{dy}{dt} \cdot \frac{dt}{dx}$

- **Equation of tangent and normal to the parabola**
  - equation of tangent at (x_1, y_1) is: $xx_1 = 2ay + 2ay_1$
  - equation of the tangent at t: $y - tx + at^2 = 0$
  - equation of the normal at (x_1, y_1) is: $y - y_1 = \frac{-2a}{x_1}(x - x_1)$
  - equation of the normal at 't' is: $x + ty = at^3 + 2at$
  - gradient of the tangent at the point where $x = t$ is: t
  - gradient of the normal at the point where $x = t$ is: $-\frac{1}{t}$

- **Further points on the parabola $x^2 = 4ay$ [P($2ap$, ap^2) and Q($2aq$, aq^2)]**
  - **Chord PQ;**
    - gradient = $\frac{p+q}{2}$
    - equation is $y - ½(p+q)x + apq = 0$
  - **Tangent at P;**
    - gradient = p
    - equation is $y - px + ap^2 = 0$
    - tangents at P and Q meet at $[a(p+q), apq]$
    - equation of the tangent at (x_1, y_1) is: $x_1x = 2a(y + y_1)$
  - **Normal at P;**
    - gradient = $\frac{-1}{p}$
    - equation is $x + py = ap^3 + 2aq$
    - normals at P and Q meet at $[-apq(p+q), a(p^2 + pq^2 + q^2 + 2)]$
    - equation of the normal at (x_1, y_1) is: $x_1x = y - y_1 = \frac{-2a}{x_1}(x - x_1)$
  - **Focal chord;**
    - endpoints have parameters p and $\frac{-1}{p}$
    - tangents at endpoints intersect at right angles on the directrix

- **Equation of the chord of contact**
  $x_1x = 2a(y + y_1)$