ST. ANDREW'S COLLEGE
Cambridge

ENGINEERING FOUNDATION SPECIFICATIONS

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ABOUT ST ANDREW'S COLLEGE CAMBRIDGE

St. Andrew's College, Cambridge is a co-educational independent Sixth Form College providing boarding and day places for up to 157 students each academic year.

St Andrew's College is a member of the Dukes Education family. Dukes is a family of schools, teachers, learners, and parents connected by our pursuit of an extraordinary life for every member of our community.

Our philosophy is to support everyone to live with purpose, to encourage a love of learning, and to act as a team. All of this is underpinned by a quality standard that runs through everything we do.

St. Andrew's College, Cambridge is "international" in nature and is characterised by exceptional levels of academic and pastoral support at all stages. We accept students aged 15-22 years old.

We believe that education is a journey to be enjoyed and shared at every stage of life, unlocking extraordinary possibilities for every student.
St Andrew's College offers the following courses.

- Pre A-Level (September and January start)
- 2-year A-Level (September start)
- 3-year A-Level (September start)
- 2.5 -year A- Level (January start)
- 1-year University Foundation course (September start)
- 2-year university foundation courses (September start)
- 18-month university foundation course (January start)

Many of our applicants will commence courses in September, although we have up to 20 students each year who join the January intake. There are cases where students request to join the course as late joiners. These applications are reviewed on a case-by-case basis by the Principal and the Curriculum Manager. Where possible, late joiners are integrated into appropriate groups and receive additional tuition to make up for any time missed.

ADMISSIONS CRITERIA

Subject to real limits on student numbers imposed by boarding places, the availability of home stay hosts and resources, the college will admit applicants who have the potential to be successful on the course they've applied for.

Applicants must:

- Demonstrate a strong commitment to their studies
- Meet the entry requirements for the course applied for – Entrance exams & interview
- Agree to adhere to the college code of practice

The college aims to welcome students from all backgrounds, irrespective of nationality, race, religion, gender, sexual orientation, or disability.

SELECTION PROCESS AT A GLANCE

Our applicants go through a strict selection process based on three elements:

1. Application: in liaison with UKVI regulations (qualifications, Visa and language requirements)

2. Interview. Interviews are conducted by the Admissions Department with the purpose of:

- Explaining the academic, pastoral, and extracurricular provision available at the college and provide advice on courses appropriate to the student's age and academic ability
- Assess the suitability of the student for the course they have applied for (Entry criteria for courses are given at the end of this document)
- Provide an opportunity for a prospective student and parents / guardians / agents to look around the college.
- Provide advice about entry into Higher Education.
- Answer any questions about the college.

3. Testing and assessment. The college will request that prospective students take entry tests in Maths and English in order to determine if their proposed course for them.

REGISTRATION & ENROLMENT

OFFERS AND ENROLMENT

We will review a student's application once the stages above have been completed. If a student's application is successful a conditional or unconditional offer will be made.

ENGLISH REQUIREMENT

Those students enrolled on Foundation courses and for who English is not a first language, will be required to achieve a minimum IELTS score of 5 for September and 5.5 for January. Students who cannot provide satisfactory evidence of a pass at this level or proof of English level by means of an internal test and interview will not be allowed to join St. Andrew's College, Cambridge.

FOUNDATION COURSE REQUIREMENTS

ONE-YEAR MONTH FOUNDATION PROGRAMME

The one-year Foundation programme is an intensive, fast-track programme and is suitable for students who have already completed one or more years of A-Level study, or who have graduated with good grades from a high school system abroad. Applicants will have to demonstrate a good level of academic ability. A pass at Grade A*-C in GCSE/IGCSE English Language, IELTS 5.5 or a result of 5.5 or above on our internal English test is required for students whose first language is not English.

The Foundation program is accredited by the NCFE

ENGINEERING FOUNDATION

TYPICAL HOURS OF STUDY PER WEEK AND TOPICS

SUBJECT	NUMBER OF HOURS PER WEEK
	One-year course (34)
Chemistry	6
Physics	6
Mathematics	6
Tutor / UCAS	3
Total Hours	**21**
Hours over the duration of the course.	**714**

Please see the scheme of work at the end of the document for more details on areas covered by each subject.

THE ASSESSMENT STRUCTURE FOR THE COURSE

DECEMBER EXAM

All students will take an exam in each of the core subjects (Chemistry, Biology / Human Biology and Maths) in December of each course. This exam is to gather an understanding of the performance to date. On completion of the results transcript the student will be spoken to by his/her tutor and an Individual Learning Plan (ILP) will put together if applicable. The first exam is to monitor performance in the first term it will not be used for the overall results of the course.

PRACTICAL

Students will carry out 6 practical assessments during the spring term. The collated results of these tests will give them an overall result, which will count for 40% of the overall mark.

FINAL EXAM

The final assessment of the course will take place in the penultimate week. Each of the core subjects (Chemistry, Biology / Human Biology and Maths) will be examined twice (2 hours per paper). The final exams will carry 60% of the total grade.

ATTENDANCE

Students must have an attendance rate 95% or above in all subjects to pass the course.

COMPLETION OF WORK

Students must complete all work on time.

NCFE ACCREDITATION & CERTIFICATION

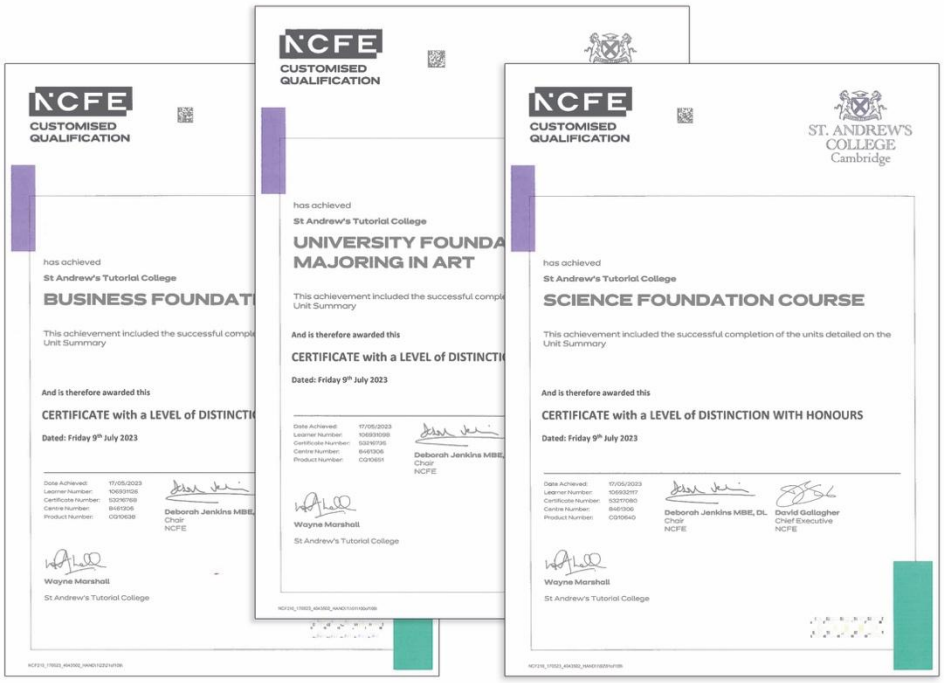
Our course has been accredited by NCFE, an awarding organisation recognised by the qualification regulators for England and Wales. NCFE's regulators are the Office of Qualifications and Examinations Regulation (Ofqual) in England, and the Welsh Government in Wales. This course isn't regulated by Ofqual but has been accredited by NCFE under our IIQ License.

St. Andrew's College provides the students with a Level 3 Diploma, and they will also receive a certificate and a transcript from the awarding body NCFE. (SEE SAMPLE BELOW)

Awards of Pass, Merit, Distinction and Distinction with Honours are only awarded when students meet the following criteria:

ACHIEVEMENT

Fail / Resubmit	**0-49%**
Pass	**50-59%**
Merit	**60-69%**
Distinction	**70-79%**
Distinction with Honours	**80% and above**



SUMMARY OF SYLLABUS CONTENT FOR EACH SUBJECT:

CHEMISTRY – SPECIFICATION SUMMARY

Term 1	Term 2	Term 3
Introduction Atomic Structure / Amount of Substance Bonding / Periodicity Redox Reactions / Group 7, the Halogens Redox Reactions / Group 2, the Alkaline Earth Metals / Metal Extraction Coursework reports	Redox Reactions / Group 2, the Alkaline Earth Metals / Metal Extraction Energetics / Kinetics / Equilibria Collision Theory, Maxwell-Boltzmann Distribution, Le Chatelier's Principle, etc. Introduction to Organic Chemistry / Alkanes Coursework reports	The Haloalkanes, Alkanes / Alcohols / Analytical Techniques Presentations

PART A

Physical Chemistry

- Atomic structure
- Understand the importance of fundamental particles in the structure of the atom
- Mass number and isotopes
- Know the electron configurations of atoms and ions

Amount of substance

- Be able to define relative atomic mass and relative molecular mass
- Understand the concept of a mole and Avogadro's constant
- Be able to recall the ideal gas equation
- Understand the concept and relationship between empirical and molecular formulae
- Balanced equations and associated calculations

Bonding

- Nature of ionic, covalent, metallic, and dative bonds
- Learn about bond polarity
- What are the forces acting between molecules?
- Recognise the different states of matter
- Shapes of molecules and ions

Energetics

- Learn about and calculate enthalpy change (calorimetry)
- Be able to apply Hess's Law
- Understand bond enthalpies and calculations

Kinetics

- Understand collision theory
- Qualitatively understand the Maxwell-Boltzmann distribution
- Effect of temperature, concentration, and particle size on reaction rate
- Understand how catalysts work

Equilibria

- Understand the dynamic nature of equilibria including effects of changes in pressure, temperature, and concentration on a system in equilibrium (Le Chatelier's principle)
- Importance of equilibria in industrial processes

Analytical techniques

- Understand the basic principles of mass spectrometry and infra-red spectroscopy

PART B

Inorganic Chemistry

Periodicity

- Be able to classify elements in s, p and d blocks
- Properties of Period 3 elements as an example of periodic trends
- Understand redox reactions, oxidation states and redox equations
- Group 2 (alkaline earth metals)
    - trends in physical and chemical properties
    - flame tests
- Group 7 (halogens)
    - trends in physical properties, and oxidizing and reducing abilities
    - identification of halide ions using AgNO3
    - uses of chlorine and chlorate (I)

Extraction of metals

- Principles of metal extraction and environmental aspects

PART C

Organic Chemistry

- Nomenclature
- Structural isomerism
- Alkanes
    - structure and properties
    - fractional distillation of crude oils

  - modification by cracking
  - combustion
- Alkenes
  - structure, bonding and reactivity
  - addition reactions
  - polymerization
- Haloalkanes
  - Synthesis
  - nucleophilic substitution
  - substitution reactions
- Alcohols
  - nomenclature
  - ethanol production
  - classification of reactions
  - elimination
- Organic mechanisms

PHYSICS – SPECIFICATION SUMMARY

Term 1	Term 2	Term 3
Safety Rules, Units, Indices, Graphs and Investigations Formulas and units Scalars and Vectors Equations of Motion and Travel Graphs Projectiles and Objects Falling Freely Newton's Laws and Momentum Balanced Forces and Work, Energy, etc. Waves Coursework reports	Current Electricity and DC Currents Atomic Structure, Isotopes, and Uses of Isotopes Waves and Diffraction Electricity and Capacitance Magnetic Fields, Electromagnetism, Motor Effect, Fields due to Current and Generator Effect Density, Pressure in Fluids, Molecular Structure, Specific Heat Capacity and Stretching Materials Photoelectric Effect, Wave / Particle Duality and Spectra Nuclear Equations and Radioactivity Coursework reports	Electric Fields and Gravitational Fields Thermodynamics Presentation

PART A

Radiation

- Understand the nature of Alpha, Beta and Gamma radiation
- Be able to complete balanced equations for radioactive decay
- Understand and be able to explain the inverse square law, decay constant and half life
- Complete calculations involving decay constant, half-lives, and the inverse square law

Photoelectric Effect

- Understand the concepts of the photoelectron work function energy levels and de Broglie wavelength
- Calculate kinetic energy, work function, energy level of de Broglie wavelength

Electrons, energy levels and photons

- Understand the nature of an electric field and charge
- Be able to interpret and calculate energy changes from energy level diagrams
- The nature of the wave-particle duality
- Complete calculations involving de Broglie theory

Electricity

- Understand and be able to define charge, current, Pd, resistance and power
- Be able to do calculations involving E, P, I, V, Q, and t.
- Understand and apply in calculations involving Ohm's Law
- Recognise the V/I characteristics of common electrical components
- Calculate resistivity from given data
- Calculate VT, RT and TT for series and parallel circuits
- Be able to apply Kirchhoff's Laws
- Be able to do calculations involving EMF and r
- Calculate R.M.S values for A.C.
- Interpret C.R.O. readings

PART B

Mechanics

- Understand momentum, elastic and inelastic collisions, conservation of momentum and explosions
- Calculate momentum and force from given data

Gravity fields

- Know what is meant by gravity field, field strength and mass point
- Calculate force, mass, and distance for gravitation attraction
- Understand how Newton's Laws of Gravitation are applied to Geostationary and Polar satellites

Electric fields

- Understand electric field, Coulomb's law, permittivity of free space, attraction, and repulsion
- Complete calculations involving Coulomb's Law
- Be able to calculate electric field strength from force and charge
- Calculate electric potential from given data
- Know similarities and differences between gravity and electric fields

PART C

Capacitors

- Recall the definitions of charge capacitance and the time constant

- Calculate capacitance from charge and voltage
- Understand how to calculate energy both graphically and from a formula

Magnetic fields

- Understand and be able to define flux, flux density and flux linkage
- Be able to use Fleming's left and right-hand rules
- Understand Faraday's and Lenz's Laws
- Use the equations $F = BIl$, $F=BQv$ and $E = IV\Delta\Phi / \Delta t$
- Explain how a transformer works

Calculate voltage and current given the N numbers

MATHEMATICS – SPECIFICATION SUMMARY

This mathematics programme has been reviewed to reflect and cater for the actual mathematical requirements of students as they progress towards their university courses. It's designed to lay the foundation for developing and consolidating effective reasoning and critical thinking while building a solid mathematical base essential for most engineering and further maths studies. The programme aim is to provide students with a valuable range of tools for analysing, modelling, formulating, and solving general mathematical problems including those arising from different fields of science and engineering.

Term 1	Term 2	Term3
Elementary Algebra, Polynomials and Algebraic Fractions Coordinate Geometry Functions and their graphs Differential Calculus Sequences and Series Integration Binomial Series Applications of differentiation Trigonometry	Exponential functions, Logarithm functions and Logarithm laws Composite functions Inverse function Further Trigonometry Further Differentiation Further Integration Numerical methods Vectors Matrix Algebra	Complex numbers Kinematics general concepts: displacement, position vector, velocity, and acceleration in vector form Kinematics of a particle moving in a straight line Motion of a particle under gravity Dynamics of a particle

NB: To keep the same standard for assessment purpose, effort should be made to cover the material for each term in the term indicated. However, within each term the content may be covered in any suitable order and some components may be exceptionally moved from one term to another to respond to the students' level of attainment or if required for use by other subjects.

Assessment

This course is assessed by examination (60%) and a portfolio (40%). The portfolio is made of two components:

1. a coursework consisting of a researched essay exploring the use of mathematics (10%)
2. a project consisting of investigating, analysing, modelling, and solving a real problem using both mathematical and computing tools (30%)

Pre-requisite

A medium or higher level in mathematics is suitable, equivalent to or above GCSE standard.

Specification content

Elementary Algebra, Polynomials and Algebraic Fractions

- Types of number: Natural, integer, decimal, rational, irrational, and real numbers
- Common sets of numbers N, Z, D, Q and R, together with the correct use of related set notations such as {}, ∈, ∪, ∩ …etc.
- Working with forms of number such as reciprocals, indices (or powers), fractions and surds. Students should learn properties of fractions, indices and surds including how to rationalise the denominator
- Algebraic expressions and related operations including determining the degree and coefficients of a polynomial, addition, subtraction, multiplication, simplification, expansion, factorisation and completing the square for trinomials
- Algebraic fractions and related operations including decomposition into proper and improper fractions, simplification, long division by a linear term, the remainder theorem, the factor theorem, and decomposition into partial fractions.
- Equations: distinction between, expressions, equations, identities, and functions. Solving quadratic and simple cubic equations using factorisation, completing the square or the discriminant method for quadratic equations. Solving simultaneous linear equations using elimination, substitution, or Cramer method where applicable. Solving simultaneous mixed equations (linear and non-linear)
- Inequalities: solving linear, quadratic, and simultaneous inequalities. For quadratic inequalities, the use of the curve is required along the sign inspection methods

Coordinate Geometry

- Recognising common 2D shapes and recalling their basic properties with focus on quadrilateral shapes including Trapeziums, Parallelograms, Rectangles, Squares, Rhombuses, Kites, and triangular shapes including Isosceles, Right-angled, and Equilateral triangles
- Determining and using the Cartesian equation of a straight line in a system of axes (Ox, Oy) in different forms such as Y= mX+c, aX+bY+c = 0 or Y – Y1 = m(X-X1)
- Parallel and perpendicular straight lines
- Intersection of 2 or more straight lines
- Coordinates of the midpoint of a segment AB
- Distance between two points A and B
- Geometric properties of a circle in a plane
- Cartesian equation of a circle
- Intersection of a circle and a straight line or of 2 or more circles
- Solving general problems involving circles, lines, and other shapes

Functions and their graphs

- Precise definition of a function and the related concepts of domain and range. One-to-one functions, piecewise functions, modulus functions, radical functions, and rational functions
- Basic combinations of 2 or more functions using addition, subtraction, multiplication, and division
- Sketching graphs of simple functions including linear, quadratic, cubic, homographic ($y = aX+b$) and Piecewise functions. The concepts of limits and continuity are not in the scope of $cX+d$ this part, but the vertical or horizontal asymptotes and infinite branches must be determined and used where required
- Transformation of curves: y = f(x + a), y= f(x) + a, y = f(ax) and y= af(x), y=-f(x), y =f(- x), y = |f(x)| and y = f(|x|). Students should be able to correctly describe each transformation and apply it to sketch the corresponding curve based on the curve y=f(x)

Differential calculus

- Differentiation from 1st principle
- Basic rules of differentiation for polynomials and algebraic functions with rational Indices
- Second and higher derivatives
- Equation of the tangent or the normal at a given point
- General problems involving differentiation and coordinate geometry

Sequences and Series

- General concepts of a sequence and series: 1st term, general term, recurrence relation, sum of first n terms, the use of Sigma notation
- Arithmetic sequence and series
- Geometric sequences and series including sum to infinity where defined
- General problems involving sequences and series

Integration

- Indefinite integration as the reverse process of differentiation
- Basic rules of integration for polynomials and algebraic functions with rational Indices
- Finding the constant of integration given the initial conditions
- Definite integral
- Area under a curve, area between a curve and a straight line
- Volume of a solid of revolution

Binomial Series

- Expansion of $(a + b)n \; where \; n \; is \; a \; positive \; integer$
- Pascal's Triangle, Combinatorial numbers: n! and nCr
- Using nCr to find the coefficients in the binomial expansion
- expanding $(1 + x)n \; where \; n \; is \; a \; positive \; integer$
- Use of the binomial series to find approximations such as in (2.02)9

Applications of differentiation

- Use of differentiation to determine the set of values for which a differentiable function is increasing or decreasing
- Use of differentiation to find stationary points and determine their nature
- Use differentiation to solve simple optimisation problems

Trigonometry

- Determining and working with the 3 trigonometric ratios sine, cosine, and tangent
- Trigonometric identities
- Properties involving complementary angles and supplementary angles
- Sign of trigonometric functions using the "CAST" rule
- Trigonometric ratios of special angles
- Reciprocals of the trigonometric ratios
- Converting between degrees and radians

- Sine rule and cosine rule
- Area of a triangle using 2 of its sides and the angle between them
- Curves of trigonometric functions: y = sinx, y = cosx and y= tanx
- Basic trigonometric equations: sinx = a, cosx = b, tanx= c and equations that can be expressed as a combination of these basic equations, including simple quadratic trigonometric equations
- Length of an arc and area of sector or a segment of a circle
- General problem involving trigonometry

Exponential functions, Logarithm functions and logarithm laws

- The function ax and its graph and properties
- Graph of logarithm function with base a
- Logarithm laws including the formula for changing the base
- Solving logarithm and exponential equations and simple inequalities

Composite functions and Inverse function

- Composite function of 2 or more functions where it's defined
- Domain and range of the composite function
- Properties of composite functions such as the associativity: fo(goh) = (fog)oh
- Expressing a given function as a composite of 2 or more functions
- Solving equations involving the composite function such as gf(x) = c where c is a given value
- Finding the inverse function of a one-to-one function
- Domain and range of the inverse function
- Properties of the inverse function
- Curve of the inverse function
- Inverse of common functions such as linear, quadratic, cubic, exponential, logarithm and trigonometric functions. The domain and range will have to be restricted as required to ensure the initial function is one-to-one

Further Trigonometry

- Compound angle formulae
- Double angle formulae
- Proof of trigonometric identities
- Application to finding the exact values of trigonometric ratios for angles that can be derived from special angles
- Solving more trigonometric equations (not to include AcosX +BsinX = C)

Further differentiation

- Differentiating the exponential function $f(x) = ex$
- Differentiating logarithm functions $f(x) = \ln(x)$ and $f(x) = loga(x)$
- Differentiating trigonometric functions
- The chain rule
- The product rule
- The quotient rule
- Differentiating $f(x) = ax$

Further integration

Integration using standard forms such as $nfn-1f'$ and f'
f

- Integration using partial fractions
- Integration by substitution
- Integration by parts
- Application of integration to finding area between two curves and volume of revolution

Numerical methods

- Investigating the conditions for the equation $f(x)$ = 0 $to\ have\ a\ solution\ in\ a\ given\ interval$ [a,b]
- Interval bisection method
- Linear interpolation
- Newton-Raphson method
- Problems of accuracy
- Finding an approximation to $\int b\ f(x)dx$ using the trapezium rule
- Percentage error when using the trapezium rule
- Over-estimate and under-estimate when using the trapezium rule

Vectors

- Definition and properties of a vector as mathematical object with a magnitude and a direction
- Elementary vector algebra: addition, subtracting and multiplication by a scalar
- Parallel vectors
- Using vectors to represent the position of a point in a 2 dimensional or 3-dimensional space
- Component form of a vector
- Operations with vectors using a basis ($\vec{i}$, $\vec{j}$, $\vec{k\rightarrow}$)
- The scalar product
- Vector equation of straight line in a 3D space
- Parametric equation of a straight line
- Relative positions of 2 straight lines in a 3D space

Matrix algebra

- nxm matrices
- Addition and subtractions of matrices with the same dimensions
- Multiplication of a matrix by a scalar
- Product of 2 matrices with compatible dimensions
- Determinant of a matrix
- Transpose of a matrix
- Singular matrices
- Inverse of a non-singular 2x2 matrix
- Solving systems of linear equations using matrix representation

Complex numbers

- Complex numbers in algebraic form: the real part, the imaginary part, the modulus, and the conjugate of a complex number
- Operations with complex numbers in algebraic form: addition, subtraction, multiplication by a scalar (real number), product of 2 complex numbers and division

- Trigonometric form of a complex number
- Properties of the modulus and the argument of a complex number
- Introduction to DeMoivre's theorem
- Representation of a complex number in Argand diagram
- Complex roots of polynomial equations

Kinematics general concepts

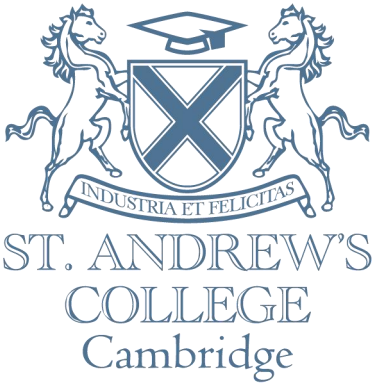
- Modelling objects as particles: commonly used assumptions
- Describing the motion of particle
- Position vector and displacement vector
- Velocity as a vector
- Acceleration as a vector

Kinematics of a particle moving in a straight line

- Equations to describe the motion of a particle in a straight line
- Particle moving with constant speed
- Particle moving with uniform acceleration (or deceleration)
- Distance-time, Speed-time, and acceleration-time graphs
- Motion of a particle in a vertical line under gravity

Dynamics of a particle

- Representation and characteristics of a force
- Newton's 1st law and 2nd law
- Friction forces
- Motion along a line of the greatest slope on an inclined plane
- Connected particles
- Momentum of a particle
- Impulse of a force
- Momentum-Impulse principle
- Conservation of momentum
- Application to the collision of 2 particles
- The moment of a force about a given point
- Using moments to solve equilibrium problems



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