OCR
Oxford Cambridge and RSA

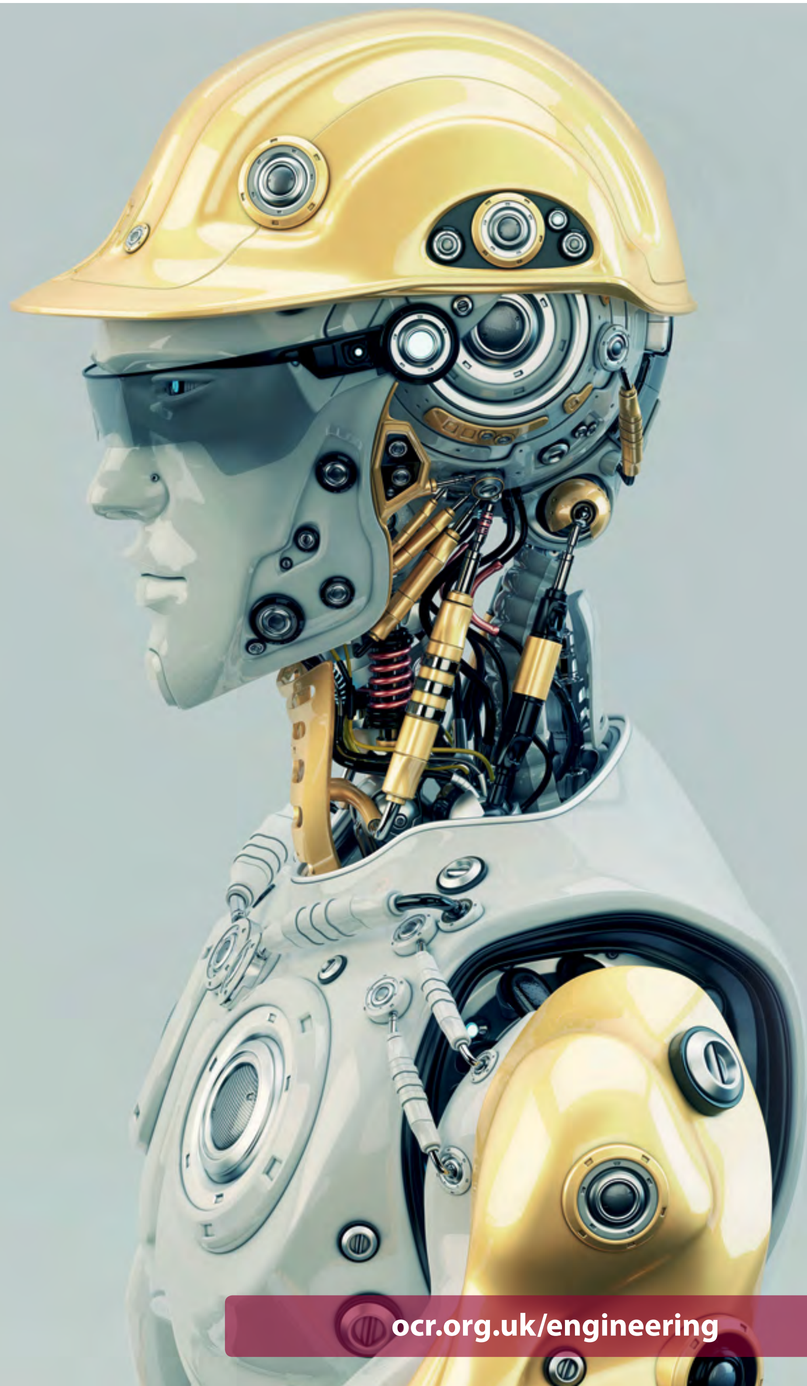
Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS 2016

MAPPING GUIDE TO A LEVELS IN PHYSICS

Version 1



ocr.org.uk/engineering

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INTRODUCTION

This document lists four of the Level 3 Cambridge Technicals in Engineering units (Units 1, 2, 3 and 4) and Learning Outcomes (LOs) which map to the relevant OCR Physics A Level units and LOs so that you can see where the LOs of the Cambridge Technicals in Engineering units align with OCR's A Levels in Physics. Links below to OCR's A Levels in Physics.

AS/A Level GCE Physics A - H156, H556 (from 2015)
http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h156-h556-from-2015/

AS/A Level GCE Physics A - H158, H558
http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-a-h158-h558/

AS/A Level GCE Physics B (Advancing Physics) - H157, H557 (from 2015)
http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-b-advancing-physics-h157-h557-from-2015/

AS/A Level GCE Physics B (Advancing Physics) - H159, H559
http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-b-advancing-physics-h159-h559/

The intention is that learners can be taught knowledge and skills within these Cambridge Technicals in Engineering units which they can apply to relevant activities either devised by the centre or using one of OCR's employed devised Project Approaches which are available for each engineering pathway http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/ (teaching and learning resources - pathway options). In either case, the activities (once successfully completed by the learner) will provide the required underpinning knowledge for their final assessment.

When considering a holistic approach to delivery and learning through projects and Project Approach, it is important to consider the overall structure a programme of learning which will be exciting and engaging for learners. This document can be used to help structure learning and curriculum so that the relevant knowledge of a Mathematics A Level can be applied to meaningful engineering skills development.

The range of sizes of the Level 3 Cambridge Technicals in Engineering has been developed to meet the changing needs of the sector and prepare your learners for the challenges they'll face in Higher Education or employment. Designed in collaboration with experts spanning the breadth of the sector, the Cambridge Technicals in Engineering focuses on the skills, knowledge and understanding that today's universities and employers demand. Your learners will practically apply their skills and knowledge in preparation for further study or the workplace.

When developing the Certificate and Extended Certificate qualifications, we worked with universities to design the content and assessment of these qualifications – ensuring that your learners are prepared and have the skills to progress to degree level. For the Tech Levels we worked with universities, industry experts and employers to design the content and assessment of these qualifications – ensuring that your learners are prepared and have the skills to progress to degree level, an apprenticeship, or work.

The three Diplomas have vocational pathways that can be followed (at least one pathway must be achieved). Each pathway focuses on industry sectors and job roles that your learners will actually be able to do having completed a Cambridge Technicals in Engineering. We've worked in partnership with industry to make sure your learners can progress directly into the sector in job roles that are appropriate for their age and experience.

TEACHING AND LEARNING RESOURCES

New resources are being developed to support your teaching of this new qualification. These will include Pathway Delivery Guides, a Qualifications Calculator and a Progress Tracker.

To find out more about this qualification please go to:

http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

This document covers the following Level 3 Cambridge Technicals in Engineering units, all of which are examined units.

OCR's Level 3 Cambridge Technical in Engineering – Unit aims

Unit 1 Mathematics for engineering

Mathematics is one of the fundamental tools of the engineer. It underpins every branch of engineering and the calculations involved are needed to apply almost every engineering skill.

This unit will develop learners' knowledge and understanding of the mathematical techniques commonly used to solve a range of engineering problems.

By completing this unit learners will develop an understanding of:

- algebra relevant to engineering problems
- the use of geometry and graphs in the context of engineering problems
- exponentials and logarithms related to engineering problems
- the use of trigonometry in the context of engineering problems
- calculus relevant to engineering problems
- how statistics and probability are applied in the context of engineering problems.

Link to unit document:

http://www.ocr.org.uk/Images/253332-unit-01-mathematics-for-engineering.pdf

Unit 2 Science for engineering

Different branches of science underpin the teaching and learning of a number of engineering disciplines. In this unit we focus on the science which supports mechanical engineering, electrical and electronic engineering, fluid dynamics, thermal physics and material science for engineering.

This unit will develop the learner's knowledge and understanding of principles of engineering science and consider how these can be applied to a range of engineering situations.

By completing this unit learners will:

- understand applications of SI units and measurement
- understand fundamental scientific principles of mechanical engineering
- understand fundamental scientific principles of electrical and electronic engineering
- understand properties of materials
- know the basic principles of fluid mechanics
- know the basic principles of thermal physics.

Link to unit document:

http://www.ocr.org.uk/Images/253338-unit-02-science-for-engineering.pdf

OCR's Level 3 Cambridge Technical in Engineering – Unit aims

Unit 3 Principles of mechanical engineering

All machines and structures are constructed using the principles of mechanical engineering. Machines are made up of components and mechanisms working in combination. Engineers need to understand the principles that govern the behaviour of these components and mechanisms. This unit explores these principles and how they are applied.

By completing this unit learners will develop an understanding of:

- systems of forces and types of loading on mechanical components
- the fundamental geometric properties relevant to mechanical engineering
- levers, pulleys and gearing
- the properties of beams
- the principles of dynamic systems.

Link to unit document:

http://www.ocr.org.uk/Images/253339-unit-03-principles-of-mechanical-engineering.pdf

Unit 4 Principles of electrical and electronic engineering

Electrical systems and electronic devices are present in almost every aspect of modern life – and it is electrical and electronic engineers who design, test and produce these systems and devices.

This unit will develop learners' knowledge and understanding of the fundamental principles that underpin electrical and electronic engineering.

By completing this unit learners will develop an understanding of:

- fundamental electrical principles
- alternating voltage and current
- electric motors and generators
- power supplies and power system protection
- analogue electronics
- digital electronics.

Link to unit document:

http://www.ocr.org.uk/Images/253341-unit-04-principles-of-electrical-and-electronic-engineering.pdf

MAPPING

Module 1 – Development of practical skills in physics

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
1.2.2 Use of apparatus and techniques 1.2.2 (a) use of apparatus and techniques, use of appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles and volume) and to interpolate between scale markings	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter
1.2.2 (b) use of appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance and mass)	**Unit 1 Mathematics for engineering** Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter
1.2.2 (c) use of methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line	**Unit 1 Mathematics for engineering** Use geometry and graphs in the context of engineering problems Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
1.2.2 (f) correctly constructing circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
1.2.2 (g) designing, constructing and checking circuits using DC power supplies, cells, and a range of circuit components	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
1.2.2 (h) use of a signal generator and oscilloscope, including volts/division and time-base	**Unit 1 Mathematics for engineering** Use geometry and graphs in the context of engineering problems Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions. **Unit 4 Principles of electrical and electronic engineering** Understand alternating voltage and current What is meant by a simple generator, alternating current (AC) and generated electromotive force (e.m.f.) including diagrammatic representations of a sine wave
1.2.2 (i) generating and measuring waves, using microphone and loudspeaker, or ripple tank, or vibration transducer, or microwave/radio wave source	**Unit 1 Mathematics for engineering** Use geometry and graphs in the context of engineering problems Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions. **Unit 4 Principles of electrical and electronic engineering** Understand alternating voltage and current What is meant by a simple generator, alternating current (AC) and generated electromotive force (e.m.f.) including diagrammatic representations of a sine wave

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Module 2 – Foundations of physics

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
2.1.1 Physical quantities 2.1.1 physical quantities have a numerical value and a unit	**Unit 2 Science for engineering** Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction
2.1.2 S.I. units (a) Système Internationale (S.I.) base quantities and their units – mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)	**Unit 2 Science for engineering** Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction
2.1.2 S.I. units (b) derived units of S.I. base units	**Unit 2 Science for engineering** Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction
2.1.2 S.I. units (d) checking the homogeneity of physical equations using S.I. base units	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions **Unit 2 Science for engineering** Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction
2.1.2 S.I. units (e) prefixes and their symbols to indicate decimal submultiples or multiples of units – pico (p), nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)	**Unit 2 Science for engineering** Understand applications of SI units and measurement, the formulae for relative and absolute error, absolute and relative correction

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
2.2.1 Measurements and uncertainties 2.2.1 (c) absolute and percentage uncertainties when data are combined by addition, subtraction, multiplication, division and raising to powers	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods
2.2.1 (d) graphical treatment of errors and uncertainties; line of best fit; worst line; absolute and percentage uncertainties; percentage difference.	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
2.3.1 (a) Scalars and vectors	**Unit 1 Mathematics for engineering** Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Force and motion, scalar and vector quantities, resultant of two coplanar vectors (vector triangle), resolve perpendicular vectors
2.3.1 (b) vector addition and subtraction	**Unit 1 Mathematics for engineering** Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems **Unit 2 Science for engineering** Force and motion, scalar and vector quantities, resultant of two coplanar vectors (vector triangle), resolve perpendicular vectors

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
2.3.1 (c) vector triangle to determine the resultant of any two coplanar vectors	**Unit 1 Mathematics for engineering** Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Force and motion, scalar and vector quantities, resultant of two coplanar vectors (vector triangle), resolve perpendicular vectors
2.3.1 (d) resolving a vector into two perpendicular components; $F_x = F \cos \theta$; $F_y = F \sin \theta$	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 2 Science for engineering** Force and motion, scalar and vector quantities, resultant of two coplanar vectors (vector triangle), resolve perpendicular vectors

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Module 3 – Forces and motion

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.1 3.1.1 (a) displacement, instantaneous speed, average speed, velocity and acceleration	**Unit 1 Mathematics for engineering** Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Displacement, speed, velocity and acceleration, use of graphical methods to represent distance travelled, displacement, speed, velocity and acceleration. Speed – time graph, velocity gradient (displacement – time graph)

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.1 (b) graphical representations of displacement, speed, velocity and acceleration	**Unit 1 Mathematics for engineering** Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Displacement, speed, velocity and acceleration, use of graphical methods to represent distance travelled, displacement, speed, velocity and acceleration. Speed – time graph, velocity gradient (displacement – time graph)
3.1.1 (c) Displacement–time graphs; velocity is gradient	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, In x = y and to use inverse function and log laws **Unit 2 Science for engineering** Displacement, speed, velocity and acceleration, use of graphical methods to represent distance travelled, displacement, speed, velocity and acceleration. Speed – time graph, velocity gradient (displacement – time graph)

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.1 (d) Velocity–time graphs; acceleration is gradient; displacement is area under graph.	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax, ey = x, ln x = y and to use inverse function and log laws **Unit 2 Science for engineering** Displacement, speed, velocity and acceleration, use of graphical methods to represent distance travelled, displacement, speed, velocity and acceleration. Speed – time graph, velocity gradient (displacement – time graph)
3.1.2 (a) (i) the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance V = u + at s = ½ (u+v)t S = ut + 1/2 at^2 $v^2 = u^2 + 2as$	**Unit 1 Mathematics for engineering** Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Acceleration, gradient of a velocity – time graph. Uniformly accelerated motion in a straight line. Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.2 (a) (ii) techniques and procedures used to investigate the motion and collisions of objects	**Unit 1 Mathematics for engineering** Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque
3.1.2 (b) (ii) techniques and procedures used to investigate the motion and collisions of objects	**Unit 1 Mathematics for engineering** Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.2 (c) reaction time and thinking distance; braking distance and stopping distance for a vehicle	**Unit 1 Mathematics for engineering** Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.3 Projectile motion	**Unit 1 Mathematics for engineering** Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax, ey = x, ln x = y and to use inverse function and log laws **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.1.3 (a) independence of the vertical and horizontal motion of a projectile	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.1.3 (b) two-dimensional motion of a projectile with constant velocity in one direction and constant acceleration in a perpendicular direction.	**Unit 1 Mathematics for engineering** Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.1 Dynamics	**Unit 1 Mathematics for engineering**
3.2.1 (a) net force = mass × acceleration; $F = ma$	Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Acceleration, gradient of a velocity – time graph. Uniformly accelerated motion in a straight line Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

OCR’s A Levels in Physics	OCR’s Level 3 Cambridge Technical in Engineering
3.2.1 (b) the newton as the unit of force	**Unit 1 Mathematics for engineering** Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Acceleration, gradient of a velocity – time graph. Uniformly accelerated motion in a straight line. Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.1 (c) weight of an object; W = mg	**Unit 1 Mathematics for engineering** Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Acceleration, gradient of a velocity – time graph. Uniformly accelerated motion in a straight line Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.1 (d) the terms tension, normal contact force, upthrust and friction	**Unit 1 Mathematics for engineering** Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.2.1 (e) free-body diagrams	**Unit 1 Mathematics for engineering** Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.1 (f) one- and two-dimensional motion under constant force	**Unit 1 Mathematics for engineering** Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.2.2 Motion with non-uniform acceleration	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x – a)^2 + (y – b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Force, work and power Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.2 (a) drag as the frictional force experienced by an object travelling through a fluid	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x – a)^2 + (y – b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Fluids at rest, pressure, gauge pressure, absolute pressure, pressure exerted on any point on a surface in a fluid is always at right angles to the surface, pressure at any point in a fluid is the same in all directions at that point, pressure due to a column of liquid
3.2.2 (b) factors affecting drag for an object travelling through air	**Unit 1 Mathematics for engineering** Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Fluids at rest, pressure, gauge pressure, absolute pressure, pressure exerted on any point on a surface in a fluid is always at right angles to the surface, pressure at any point in a fluid is the same in all directions at that point, pressure due to a column of liquid

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.2 (c) motion of objects falling in a uniform gravitational field in the presence of drag	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x – a)^2 + (y – b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Archimedes' principle, fluid flow, ideal fluid, streamline or laminar turbulent flow, boundary layers, definition of viscosity

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.2 (d) (i) terminal velocity 3.2.2 (d) (ii) techniques and procedures used to determine terminal velocity in fluids	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x – a)^2 + (y – b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Archimedes' principle, fluid flow, ideal fluid, streamline or laminar turbulent flow, boundary layers, definition of viscosity

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 Equilibrium 3.2.3 (a) moment of force	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems Application of algebra in engineering includes: Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 (b) couple; torque of a couple	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems Application of algebra in engineering includes: Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 (c) the principle of moments	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ • Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 (d) centre of mass; centre of gravity; experimental determination of centre of gravity	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ • Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 (e) equilibrium of an object under the action of forces and torques	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ • Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.3 (f) condition for equilibrium of three coplanar forces; triangle of forces.	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ • Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic **Unit 2 Science for engineering** Coupled pairs of equal parallel forces, rotation, moment of a force and the torque of a couple, equilibrium and resultant force and resultant torque

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.4 Density and pressure 3.2.4 (a) density; p = m/V	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Forces and Motion, the formula for force (F), definition of newton (N), application of the concept of weight as the effect of a gravitational field on mass, use of the formula for weight (W), centre of gravity
3.2.4 (b) pressure; p = F/A for solids, liquids and gases	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.2.4 (c) $p = h\rho g$ up thrust on an object in a fluid; Archimedes' principle	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Archimedes' principle, fluid flow, ideal fluid, streamline or laminar turbulent flow, boundary layers, definition of viscosity
3.3.1 Work and conservation of energy 3.3.1 (a) work done by a force; the unit joule	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.1 (b) W = Fx cos θ for work done by a force	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.3.1 (c) the principle of conservation of energy	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.1 (d) energy in different forms; transfer and conservation	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance
3.3.1 (e) transfer of energy is equal to work done	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.2 Kinetic and potential energies	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance
3.3.2 (a) kinetic energy of an object; $E_k = 1/2mv^2$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.2 (b) gravitational potential energy of an object in a uniform gravitational field; $E_p = mgh$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance
3.3.2 (c) the exchange between gravitational potential energy and kinetic energy	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.3 Power 3.3.3 (a) power; the unit watt; P t W	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.3.3 (b) P = Fv	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.3.3 (c) of a mechanical system; $$\text{Efficiency} = \frac{\text{useful output energy} \times 100\%}{\text{total input energy}}$$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Joules, the formula for work done (W), kinetic energy, gravitational potential energy, relationship between mechanical power, work done and time
3.4.1 Springs 3.4.1 (a) tensile and compressive deformation; extension and compression	**Unit 2 Science for engineering** Deformation is caused by a tensile or compressive force, Hooke's law, elastic limit, stress, strain
3.4.1 (b) Hooke's law	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Hooke's law, elastic limit, stress, strain

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.4.1 (c) force constant k of a spring or wire; *F* = *kx*	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, ln x = y and to use inverse function and log laws **Unit 2 Science for engineering** Hooke's law, elastic limit, stress, strain Young's modulus, elastic and plastic deformation of a material, calculate strain energy in a deformed material from a force – extension graph Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials
3.4.1 (d) (i) force–extension (or compression) graphs for springs and wires (ii) techniques and procedures used to investigate force–extension characteristics for arrangements which may include springs, rubber bands, polythene strips.	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, ln x = y and to use inverse function and log laws **Unit 2 Science for engineering** Young's modulus, elastic and plastic deformation of a material, calculate strain energy in a deformed material from a force – extension graph Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials
3.4.2 Mechanical properties of matter 3.4.2 (a) force–extension (or compression) graph; work done is area under graph	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, ln x = y and to use inverse function and log laws **Unit 2 Science for engineering** Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.4.2 (b) elastic potential energy; $E = ½Fx = ; E = 1/2kx^2$	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, In x = y and to use inverse function and log laws **Unit 2 Science for engineering** Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials
3.4.2 (c) stress, strain and ultimate tensile strength	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, In x = y and to use inverse function and log laws **Unit 2 Science for engineering** Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials
3.4.2 (d) (i) Young modulus = tensile strain tensile stress, $E = σ/ε$ (ii) techniques and procedures used to determine the Young modulus for a metal 3.4.2 (e) stress–strain graphs for typical ductile, brittle and polymeric materials 3.4.2 (f) elastic and plastic deformations of materials	**Unit 1 Mathematics for engineering** Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication Understand exponentials and logarithms related to engineering problems including y = eax, y = e-ax , ey = x, In x = y and to use inverse function and log laws **Unit 2 Science for engineering** Young's modulus, elastic and plastic deformation of a material, calculate strain energy in a deformed material from a force – extension graph Ultimate tensile stress, force-extension graphs for typical brittle, ductile and polymeric materials showing that there is a difference for various materials

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.5.1 Newton's laws of motion 3.5.1 (a) Newton's three laws of motion	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 3 Principles of mechanical engineering** How to apply Newton's Laws of Motion in a mechanical engineering context and the constant acceleration formulae to problems set in a mechanical engineering context to include $v^2 - u^2 = 2as$, $s = ut + ½ at^2$, $v = u + at$, $s= ½ (u+v)t$ and $s=vt - ½ at^2$ The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
3.5.1 (b) linear momentum; $p = mv$; vector nature of momentum	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 3 Principles of mechanical engineering** The principle of conservation of energy and how to apply this principle to problems involving kinetic and gravitational potential energy

Module 4 – Electrons, waves and photons

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.1.1 Charge 4.1.1 (b) electric current as rate of flow of charge	**Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy
4.1.1 (c) the elementary charge e equals 1.6 × 10–19 C	**Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy
4.1.1 (d) net charge on a particle or an object is quantised and a multiple of e	**Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter
4.1.1 (e) current as the movement of electrons in metals and movement of ions in electrolytes	**Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter
4.1.1 (f) conventional current and electron flow	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.1.1 (g) Kirchhoff's first law; conservation of charge	**Unit 1 Mathematics for engineering** Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn , ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.2.1 Circuit symbols 4.2.1 (a) circuit symbols	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.2.1 (b) circuit diagrams using these symbols	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.2.2 E.m.f. and p.d Power 4.2.2 (a) potential difference (p.d.); the unit volt 4.2.2 (b) electromotive force (e.m.f) of a source such as a cell or a power supply 4.2.2 (c) distinction between e.m.f. and p.d. in terms of energy transfer 4.2.2 (d) energy transfer; $W = VQ$; $W = \varepsilon Q$ 4.2.2 (e) energy transfer $eV = ½ mv^2$ for electrons and other charged particles	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter The difference between motors and generators and the application of the defining equation for a motor and generator The type of field winding and action of a separately excited DC generator ,series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.2.3 Resistance 4.2.3 (a) Resistance R =V/I the unit ohm	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy
4.2.3 (b) Ohm's law 4.2.3 (c) (i) I–V characteristics of resistor, filament lamp, thermistor, diode and light-emitting diode (LED) (ii) techniques and procedures used to investigate the electrical characteristics for a range of ohmic and non-ohmic components	**Unit 1 Mathematics for engineering** **Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.2.3 (d) light-dependent resistor (LDR); variation of resistance with light intensity	**Unit 1 Mathematics for engineering** **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.2.4 Resistivity 4.2.4 (a) (i) resistivity of a material; the equation $R = pL/A$ (ii) techniques and procedures used to determine the resistivity of a metal	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.2.4 (b) the variation of resistivity of metals and semiconductors with temperature	**Unit 1 Mathematics for engineering** **Unit 4 Principles of electrical and electronic engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.2.4 (c) negative temperature coefficient (NTC) thermistor; variation of resistance with temperature	**Unit 1 Mathematics for engineering** **Unit 2 Science for engineering** Use of graphs to show the variation with temperature of a pure resistor and of a negative temperature coefficient thermistor
4.2.5 Power 4.2.5 (a) the equations, P= VI, P = I2 and P= V2/R	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.2.5 (b) energy transfer; $W = VIt$	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy
4.2.5 (c) the kilowatt-hour (kW h) as a unit of energy; calculating the cost of energy	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.3.1 Series and parallel circuits	**Unit 1 Mathematics for engineering**
4.3.1 (a) Kirchhoff's second law; the conservation of energy	Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.3.1 (b) Kirchhoff's first and second laws applied to electrical circuits	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Understand calculus relevant to engineering problems involving differentiation such as determine gradients to a simple curve, algebraic functions, max/min turning points, differentiate trigonometric functions of the form and differential properties of exponential and logarithmic functions Solve problems involving indefinite integration using the rule to integrate simple algebraic functions i.e. y = a xn, ∫ axn dx = (xn + 1)/ n + 1 + constant C, integrate functions of the form, integrate sine and cosine function Problem solving involving definite integrals such as definite integral, integrate functions of the form, notation a∫ b fx = [F)x)]b a = F(b) – F(a) and the interpretation of a definite integral **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.3.1 (c) total resistance of two or more resistors in series; $R = R1 + R2 + \ldots\ldots$	**Unit 1 Mathematics for engineering** **Unit 2 Science for engineering** Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.3.1 (d) total resistance of two or more resistors in parallel; 1/R + 1/R + 1/ R + ……	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Application of the defining equations for, resistance, power, energy, resistors connected in series and parallel Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.3.1 (e) analysis of circuits with components, including both series and parallel	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.3.1 (f) analysis of circuits with more than one source of e.m.f.	**Unit 2 Science for engineering** Measurement of voltage, current and resistance in a circuit using a voltmeter, ammeter, ohmmeter and multi-meter **Unit 4 Principles of electrical and electronic engineering** DC motor starters to include a no-volt trip coil and an overload current trip coil
4.3.2 Internal resistance 4.3.2 (a) source of e.m.f.; internal resistance	**Unit 4 Principles of electrical and electronic engineering** DC motor starters to include a no-volt trip coil and an overload current trip coil

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.3.2 (b) terminal p.d.; 'lost volts'	**Unit 4 Principles of electrical and electronic engineering** The difference between motors and generators and the application of the defining equation for a motor and generator
4.3.2 (c) (i) the equations $\varepsilon = I(R+r)$ and $\varepsilon = V + Ir$	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 4 Principles of electrical and electronic engineering** The difference between motors and generators and the application of the defining equation for a motor and generator
4.3.2 (c) (ii) techniques and procedures used to determine the internal resistance of a chemical cell or other source of e.m.f.	**Unit 4 Principles of electrical and electronic engineering** The difference between motors and generators and the application of the defining equation for a motor and generator
4.3.3 Potential dividers 4.3.3 (a) potential divider circuit with components	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.3.3 (b) potential divider circuits with variable components e.g. LDR and thermistor	**Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem
4.3.3 (c) (i) potential divider equations e.g. $V_{out} = R_2/R_1 + R_2 \times V_{in}$ and $V_1/V_2 = R_1/R_2$	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
4.3.3 (c) (ii) techniques and procedures used to investigate potential divider circuits which may include a sensor such as a thermistor or an LDR	**Unit 2 Science for engineering** Calculate total resistance, current for a circuit that is a combination of resistors connected in series and parallel. The formulae for electrical power (P) and energy (W), kilowatt-hour unit of energy Efficiency, ratio of work output to work input, resistivity formula for resistivity (ρ), temperature coefficient of resistance **Unit 4 Principles of electrical and electronic engineering** Circuit theory including calculation of the total resistance and total current for a circuit that is a combination of resistors connected in series and parallel to explain and apply Kirchhoff's first and second law and the maximum power transfer theorem

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Module 5 – Newtonian world and astrophysics

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.1.1 Temperature 5.1.1 (a) thermal equilibrium	**Unit 2 Science for engineering** Know the basic principles of thermal physics, non-flow energy equation, the steady flow energy equatio
5.1.1 (b) absolute scale of temperature (i.e. the thermodynamic scale) that does not depend on property of any particular substance	**Unit 2 Science for engineering** What is meant by the term thermodynamic scale and state that on the Kelvin scale, absolute zero is the temperature at Which all substances have a minimum internal energy
5.1.1 (c) temperature measurements both in degrees Celsius (°C) and in kelvin (K)	**Unit 2 Science for engineering** What is meant by the term thermodynamic scale and state that on the Kelvin scale, absolute zero is the temperature at Which all substances have a minimum internal energy
5.1.1 (d) $T (K) \approx \theta(°C) + 273$	**Unit 1 Mathematics for engineering** Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** What is meant by the term thermodynamic scale and state that on the Kelvin scale, absolute zero is the temperature at Which all substances have a minimum internal energy
5.1.2 Solid, liquid and gas 5.1.2 (a) solids, liquids and gases in terms of the spacing, ordering and motion of atoms or molecules	**Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation
5.1.2 (b) simple kinetic model for solids, liquids and gases	**Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.1.3 Thermal properties of materials 5.1.3 (a) specific heat capacity of a substance; the equation $E = mc\Delta\theta$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers **Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation Specific heat capacity, formula heat energy or sensible heat (Q) and the efficiency equation. Sensible and latent heat application of formulae
5.1.3 (b) (i) an electrical experiment to determine the specific heat capacity of a metal or a liquid (ii) techniques and procedures used for an electrical method to determine the specific heat capacity of a metal block and a liquid	**Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation Specific heat capacity, formula heat energy or sensible heat (Q) and the efficiency equation. Sensible and latent heat application of formulae
5.1.3 (c) specific latent heat of fusion and specific latent heat of vaporisation; $E = mL$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers **Unit 2 Science for engineering** Specific heat capacity, formula heat energy or sensible heat (Q) and the efficiency equation. Sensible and latent heat application of formulae

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.1.3 (d) (i) an electrical experiment to determine the specific latent heat of fusion and vaporisation (ii) techniques and procedures used for an electrical method to determine the specific latent heat of a solid and a liquid	**Unit 2 Science for engineering** Specific heat capacity, formula heat energy or sensible heat (Q) and the efficiency equation. Sensible and latent heat application of formulae
5.1.4 Ideal gases 5.1.4 (a) amount of substance in moles; Avogadro constant *NA* equals 6.02×10^{23} mol^{-1}	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Know the basic principles of thermal physics, non-flow energy equation, the steady flow energy equation That the internal energy of a system is the sum of a random distribution of kinetic and potential energy concerned with the molecules of the system
5.1.4 (b) model of kinetic theory of gases	**Unit 2 Science for engineering** That the internal energy of a system is the sum of a random distribution of kinetic and potential energy concerned with the molecules of the system

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.1.4 (d) (i) the equation of state of an ideal gas $pV = nRT$, where n is the number of moles	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** That the internal energy of a system is the sum of a random distribution of kinetic and potential energy concerned with the molecules of the system What is meant by the term thermodynamic scale and state that on the Kelvin scale, absolute zero is the temperature at Which all substances have a minimum internal energy

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.1.4 (d) (ii) techniques and procedures used to investigate *PV* = constant (Boyle's law) and *T/P* = constant	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions **Unit 2 Science for engineering** Boyle's law, Charles' law, Pressure law, combined gas law, characteristic gas equation
5.2.1 Kinematics of circular motion 5.2.1 (a) the radian as a measure of angle	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** How to apply Newton's Laws of Motion in a mechanical engineering context and the constant acceleration formulae to problems set in a mechanical engineering context to include $v^2 - u^2 = 2as$, $s = ut + ½ at^2$, v = u + at, s= ½ (u+v)t and $s=vt - ½ at^2$ The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = $½ mv^2$ and work done = force × distance

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.2.1 (b) period and frequency of an object in circular motion	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = $\frac{1}{2}mv^2$ and work done = force × distance The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time
5.2.1 (c) angular velocity ω = 2∏/T or ω = 2∏*f*	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** How to apply Newton's Laws of Motion in a mechanical engineering context and the constant acceleration formulae to problems set in a mechanical engineering context to include $v^2 - u^2 = 2as$, $s = ut + \frac{1}{2}at^2$, $v = u + at$, $s = \frac{1}{2}(u+v)t$ and $s = vt - \frac{1}{2}at^2$ The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.2.2 Centripetal force 5.2.2 (a) a constant net force perpendicular to the velocity of an object causes it to travel in a circular path	**Unit 1 Mathematics for engineering** **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance
5.2.2 (b) constant speed in a circle; $v = \omega r$	**Unit 1 Mathematics for engineering** **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time
5.2.2 (c) centripetal acceleration; $a = V^2/r$ $a = \omega^2 r$	**Unit 1 Mathematics for engineering** **Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time
5.2.2 (d) (i) centripetal force; $F = mv^2/r$ $F=m\,\omega^2 r$ (ii) techniques and procedures used to investigate circular motion using a whirling bung	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.3.1 Simple harmonic oscillations 5.3.1 (a) displacement, amplitude, period, frequency, angular frequency and phase difference	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x-a)^2 + (y-b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation F≤ μN and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions
5.3.1 (b) angular frequency ω ; ω = 2∏/T or ω = 2∏f	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x-a)^2 + (y-b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation F≤ μN and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.3.1 (c) (i) simple harmonic motion; defining equation $a = -\omega^2 x$ (ii) techniques and procedures used to determine the period/frequency of simple harmonic oscillations	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation F≤ µN and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions
5.3.1 (f) the period of a simple harmonic oscillator is independent of its amplitude (isochronous oscillator)	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation F≤ µN and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
5.3.1 (g) graphical methods to relate the changes in displacement, velocity and acceleration during simple harmonic motion.	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ Solve problems for right-angled and non-right triangles, use Pythagoras' Theorem and sine, cosine and tangent rule and understand common trigonometric identities such as sin 60° = (√3)/2, cos 60° = ½, tan 60° = √3 **Unit 3 Principles of mechanical engineering** The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation $F \leq \mu N$ and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions
5.3.2 Energy of a simple harmonic oscillator 5.3.2 (a) interchange between kinetic and potential energy during simple harmonic motion	**Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time
5.3.2 (b) energy-displacement graphs for a simple harmonic oscillator	**Unit 3 Principles of mechanical engineering** The relationship between work done on a body and the change in energy of that body and the application of equations for energy and work done to problems set in a mechanical engineering context to include gravitational potential energy = mgh, kinetic energy = ½ mv^2 and work done = force × distance The use of the equations for power to solve problems set in a mechanical engineering context to include instantaneous power = force × velocity and average power = work done/time The action of a friction force between a body and a rough surface and how to apply the equation $F \leq \mu N$ and how to apply the principle of conservation of momentum to bodies experiencing elastic collisions

MAPPING

Module 6 – Particles and medical physics

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.1.1 Capacitors 6.1.1 (a) capacitance; $C = Q/V$ the unit farad	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.1.1 (b) charging and discharging of a capacitor or capacitor plates with reference to the flow of electrons	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc

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OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.1.1 (c) total capacitance of two or more capacitors in series; $1/C = 1/C_1 + 1/C_2 + \ldots\ldots$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.1.1 (d) total capacitance of two or more capacitors in parallel; $C = C1 + C2 + ...$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) **Unit 4 Principles of electrical and electronic engineering** Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc
6.1.1 (e) (i) analysis of circuits containing capacitors, including resistors (ii) techniques and procedures used to investigate capacitors in both series and parallel combinations using ammeters and voltmeters	**Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) **Unit 4 Principles of electrical and electronic engineering** Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.1.2 Energy 6.1.2 (a) p.d. – charge graph for a capacitor; energy stored is area under graph	**Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ)
6.1.2 (b) energy stored by capacitor	**Unit 1 Mathematics for engineering** **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ)
6.1.2 (c) uses of capacitors as storage of energy	**Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ)
6.1.3 Charging and discharging capacitors 6.1.3 (a) (i) charging and discharging capacitor through a resistor (ii) techniques and procedures to investigate the charge and the discharge of a capacitor using both meters and data-loggers	**Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ)
6.1.3 (b) time constant of a capacitor–resistor circuit; t = *CR*	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ)

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.2.1 Point and spherical charges 6.2.1 (a) electric fields are due to charges	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.2.1 (b) modelling a uniformly charged sphere as a point charge at its centre	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.2.1 (c) electric field lines to map electric fields	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.2.1 (d) electric field strength; $E = F/Q$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.2.2 Coulomb's law 6.2.2 (a) Coulomb's law; $F = Qq/4\pi\varepsilon_0 r^2$ for the force between two point charges	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Capacitance (C) farad (F), formula capacitance (C), energy (Wc) of a charged capacitor. Graph for a capacitor discharging through a resistor of (a) potential difference against time and (b) current against time. Capacitor time constant, discharge and charge (τ) Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.2.2 (b) electric field strength $E = Q/4\ \varepsilon_0 r^2$ for a point charge	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc The difference between motors and generators and the application of the defining equation for a motor and generator How the speed of a DC shunt motor and a series DC motor can be changed
6.2.2 (c) similarities and differences between the gravitational field of a point mass and the electric field of a point charge	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.2.2 (d) the concept of electric fields as being one of a number of forms of field giving rise to a force	**Unit 1 Mathematics for engineering** **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.2.3 Uniform electric field 6.2.3 (a) uniform electric field strength; $E = V/d$	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc The difference between motors and generators and the application of the defining equation for a motor and generator How the speed of a DC shunt motor and a series DC motor can be changed
6.3.1 Magnetic fields 6.3.1 (a) magnetic fields are due to moving charges or permanent magnets	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Circuit diagrams and phasor diagrams where a pure resistance, inductance and capacitance in series on AC when XL is greater than Xc, Xc is greater than XL and XL is equal to Xc Application of the defining equation for RLC series circuit when XL is greater than Xc, RLC series circuit when Xc is greater than XL and RLC series circuit when XL is equal to Xc

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.1 (b) magnetic field lines to map magnetic fields	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.3.1 (c) magnetic field patterns for a long straight current-carrying conductor, a flat coil and a long solenoid	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Applications for a separately excited DC generator, series wound self-excited DC generator ,shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor How the speed of a DC shunt motor and a series DC motor can be changed

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.1 (d) Fleming's left-hand rule	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) • Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Applications for a separately excited DC generator, series wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor How the speed of a DC shunt motor and a series DC motor can be changed

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.2 Motion of charged particles 6.3.2 (a) force on a charged particle travelling at right angles to a uniform magnetic field; $F = BQv$	**Unit 1 Mathematics for engineering** Use trigonometry in engineering problems such as angles and radians (x radians = 1800x/π degrees: x degrees = πx/180 radians) Solve problems with arcs, circles and sectors using formula for length of an arc, circle, area and use $(x - a)^2 + (y - b)^2 = r^2$ **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Application of the defining equations for a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Applications for a separately excited DC generator, series wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor How the speed of a DC shunt motor and a series DC motor can be changed
6.3.2 (b) charged particles moving in a uniform magnetic field; circular orbits of charged particles in a uniform magnetic field	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Applications for a separately excited DC generator, series wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Application of the defining equations for a separately excited DC generator, series-wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor Applications for a separately excited DC generator, series wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor How the speed of a DC shunt motor and a series DC motor can be changed
6.3.2 (c) charged particles moving in a region occupied by both electric and magnetic fields; velocity selector	**Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field **Unit 4 Principles of electrical and electronic engineering** Applications for a separately excited DC generator, series wound self-excited DC generator, shunt-wound self-excited DC generator, series-wound DC motor and a shunt-wound DC motor

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.3 Electromagnetism	**Unit 1 Mathematics for engineering**
6.3.3 (a) magnetic flux Ø the unit weber Ǿ = BAcosθ	Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.3 (b) magnetic flux linkage	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self-inductance, energy (WL) stored in the magnetic field

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.3 (c) Faraday's law of electromagnetic induction and Lenz's law	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorem • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field

MAPPING

OCR's A Levels in Physics	OCR's Level 3 Cambridge Technical in Engineering
6.3.3 (d) (i) e.m.f. = – rate of change of magnetic flux linkage; ε = -Δ(NØ)/Δt (ii) techniques and procedures used to investigate magnetic flux using search coils	**Unit 1 Mathematics for engineering** Understand the application of algebra relevant to engineering problems. Application of algebra in engineering includes: • Multiplication by constant, binomial expressions, removing a common factor, factorisation, use of the lowest common multiple (LCM) • Simplification of polynomials by factorising a cubic, algebraic division, remainder and factor theorems • Method used to simplify and solve equations, transpose formulae containing two like terms, roots and powers • Solving linear simultaneous equations with two unknowns by graphical interpretation and algebraic methods • Methods used to solve quadratic equations by quadratic graphs, factorisation, completing the squares and using the formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Use geometry and graphs in the context of engineering problems How to use co-ordinate geometry such as straight line equations (equation of a line through two points, gradient of parallel and perpendicular lines, mid-point of a line, distance between two points, composite and inverse functions Understand curve sketching such as graphs of y = kxn and graphical solution of cubic functions Know how to apply graphical transformations such as translation by addition and multiplication **Unit 2 Science for engineering** Inductance (L) henry (H), formula for inductance (L), coil self- inductance, energy (WL) stored in the magnetic field
6.3.3 (e) simple a.c. generator	**Unit 4 Principles of electrical and electronic engineering** What is meant by a simple generator, alternating current (AC) and generated electromotive force (e.m.f.) including diagrammatic representations of a sine wave The distribution of electrical energy to consumers by a single-phase 2-wire system, single phase 3-wire system, three phase 3-wire Delta connected system and a three phase 4-wire Star connected system How an alternating current can be rectified to a half wave direct current using a single diode and full wave rectification can be obtained by using two diodes but full wave rectification can be obtained by using four diodes in a bridge configuration

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