Programme
Guide

Undergraduate Foundation Programme
Engineering & Physical Sciences

ONCAMPUS
Achieve more.

Programme Details

Who is this programme designed for?

This programme is designed to prepare international students, who have completed senior secondary education, for entry to undergraduate studies at the top universities across the UK.

The Undergraduate Foundation Programme (UFP) is set at level 3.

How long will I study for?

This programme lasts one academic year (nine months). The year is divided into three terms of approximately 10 weeks. On average, students will undertake between 16 and (up to) 22 hours of classroom-based study per week.

Please note: Minimum and maximum hours are estimated, hours may vary depending on the student's academic and English level and may be adjusted throughout their course.

English Language forms up to six hours of a students timetable, is compulsory for students who are below the required level for progression, and will be integrated into the teaching of academic subjects as well as being taught separately if students need additional support. Students who are at or above the required English level for progression are likely to follow a reduced timetable.

Students will be expected to timetable self-study hours in addition to the classroom-based hours.

What will I study?

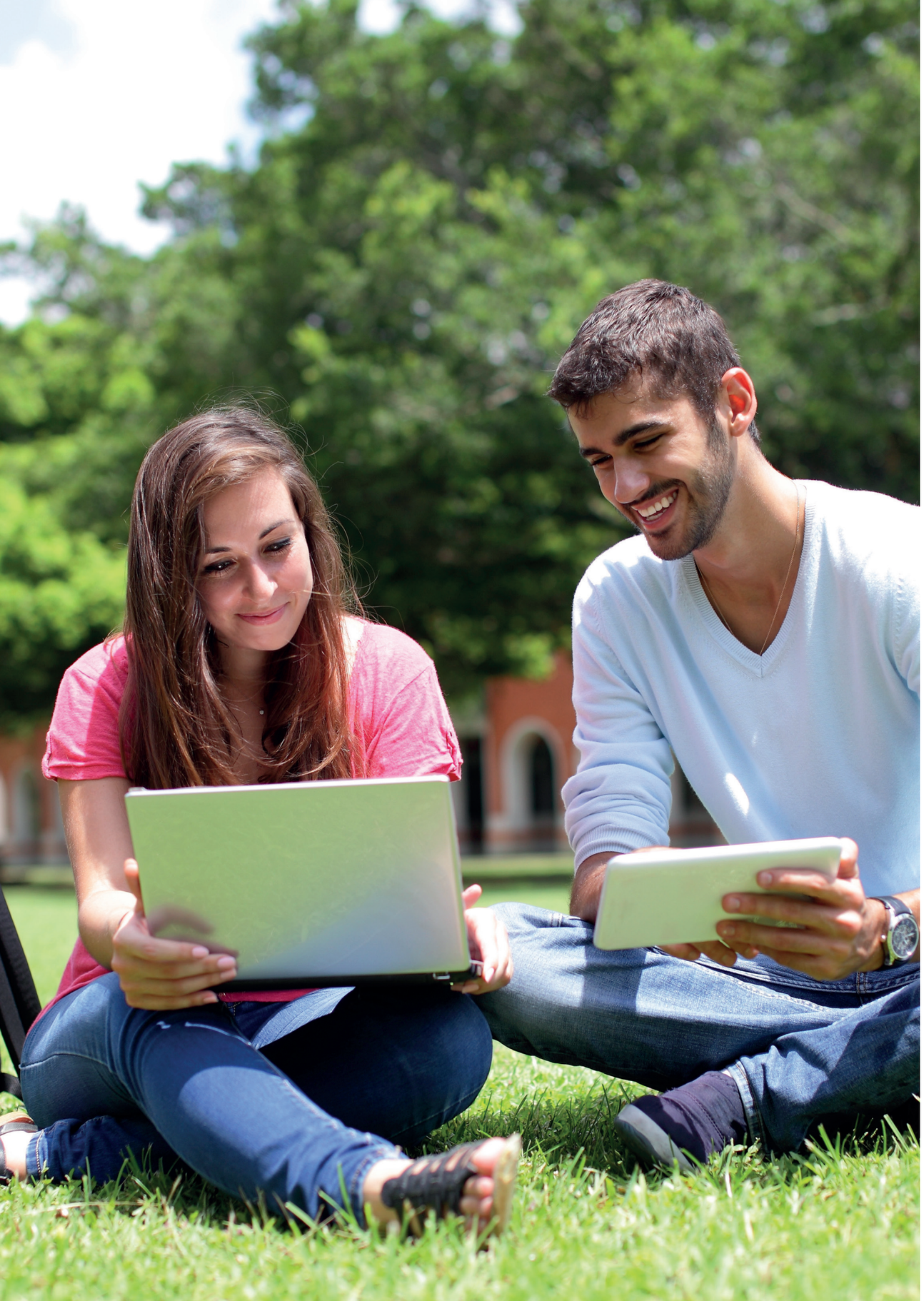
This programme includes English and three academic subject modules. English will be integrated into the teaching of academic subjects, as well as being taught separately if students need additional support to develop their English language.

How will I be assessed?

Students will be assessed at regular intervals throughout the programme to ensure they are making the progress required to successfully complete the programme.

Final assessments for each module will be spread across the academic year.

Assessment methodologies are aligned to those that will be experienced in the University environment, and include project work, essays, presentations and unseen examinations.



Modules

Modules vary by ONCAMPUS centre as shown in the table below and may change depending on progression degree. All students will have English incorporated into their study plan.

Centre	Pure Mathematics	Physics	Skills for Science	Chemistry
ONCAMPUS LONDON	✔	✔	✔	
ONCAMPUS UK NORTH	✔	✔	✔	
ONCAMPUS ASTON	✔	✔	✔	✔ *
ONCAMPUS HULL	✔	✔	✔	✔ *
ONCAMPUS LONDON SOUTH BANK	✔	✔	✔	✔ *
ONCAMPUS** READING	✔	✔	✔	
ONCAMPUS SUNDERLAND	✔	✔	✔	
ONCAMPUS*** SOUTHAMPTON	✔	✔	✔	✔ *

* Chemistry may be studied as an alternative module to Physics dependent on progression degree.

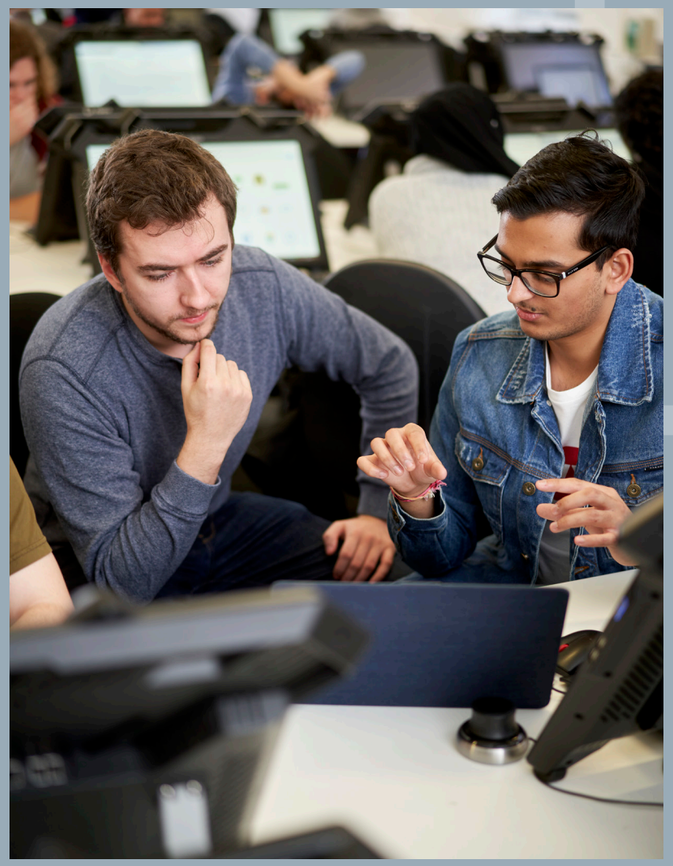
** The Engineering and Physical Sciences pathway at ONCAMPUS Reading will be delivered at ONCAMPUS London.

*** The Engineering and Physical Sciences pathway at ONCAMPUS Southampton will run from September 2022.

Pure Mathematics Module

The aim of the module is to enable you to develop your understanding of mathematics using a variety of techniques and methods to solve given problems. It gives you the opportunity to apply your knowledge to real life contexts and prepares you for future undergraduate studies across multiple disciplines.

It is adapted from the Edexcel AS and A level Pure Mathematics course with appropriate modifications. Statistical methods and mechanics will be covered in the 'Skills for Science' element of the pathway.



Key Topics

01 Review of prior learning

1. To be able to successfully apply basic operations to calculations
2. To be able to identify prime numbers and prime factors of a number
3. To be able to perform simple operations on fractions and decimals
4. To be able to write a number to a given number of significant figures
5. To be able to perform calculations involving percentages
6. To be able to perform calculations involving ratio

02 Algebra and functions

1. Simplify expressions by collecting like terms
2. To apply the rules of indices
3. Expand expressions
4. Factorise expression
5. Factorise quadratic equations
6. Extend the rules of indices to all rational exponents
7. To use and manipulate surds
8. To rationalise the denominator of a fraction when it is a surd

03 Economics: national economic performance, economic growth and welfare

1. Understand national economic performance indicators such as current balance, inflation, economic growth, unemployment and government objectives relating to these indicators
2. Understand and illustrate the business cycle characteristics
3. Understand and distinguish between GDP, GNI and GDP per capita
4. Understand the term HDI and explain the components
5. Explain and analyse causes of economic growth and their implications
6. Explain and assess alternative ways of measuring welfare – e.g. Political Freedom, Social and Cultural Freedoms, Pollution, Crime levels, the working environment
7. Explain the difference between exclusive and inclusive economic growth

04 Equations and inequalities

1. Solve simultaneous linear equations by both elimination and substitution
2. Solve simultaneous equations involving one quadratic and one linear
3. Solve both linear and quadratic inequalities

05
Sketching curves

1. Sketch and interpret cubic functions
2. Sketch the reciprocal function
3. Use the intersection points of functions to solve equations
4. Perform transformations of on curves using the rules
5. Discuss factors that may lead to an increase in unemployment, factors can be: government policies: minimum wages unemployment benefits and business cycles

06
Co-ordinate geometry in the X and Y plane

1. Interpret straight lines in the forms y=mx+c and ax+by+cy=0
2. Calculate both the gradient and equation of a line using the form y–y1 =m(x – x1)
3. Find the equation of a straight line given 2 co-ordinates
4. Understand the conditions for parallel and perpendicular lines and be able to determine the equation of perpendicular and parallel lines
5. Find the mid–point of a line
6. Find the distance between two points on a line

07
Basic complex numbers

1. Solve quadratic equations with complex roots

08
Differentiation

1. Differentiate a function (simplifying first if necessary) of the form axn and find the gradient at a point
2. Find the second derivative
3. Find the rate of change of a function at a particular point
4. Find the equation of the tangent and normal to a curve at a point

09
Integration

1. Integrate a function(simplifying first if necessary) of the form axn
2. Use the integral sign
3. Find the constant of integration

10
Algebra and functions

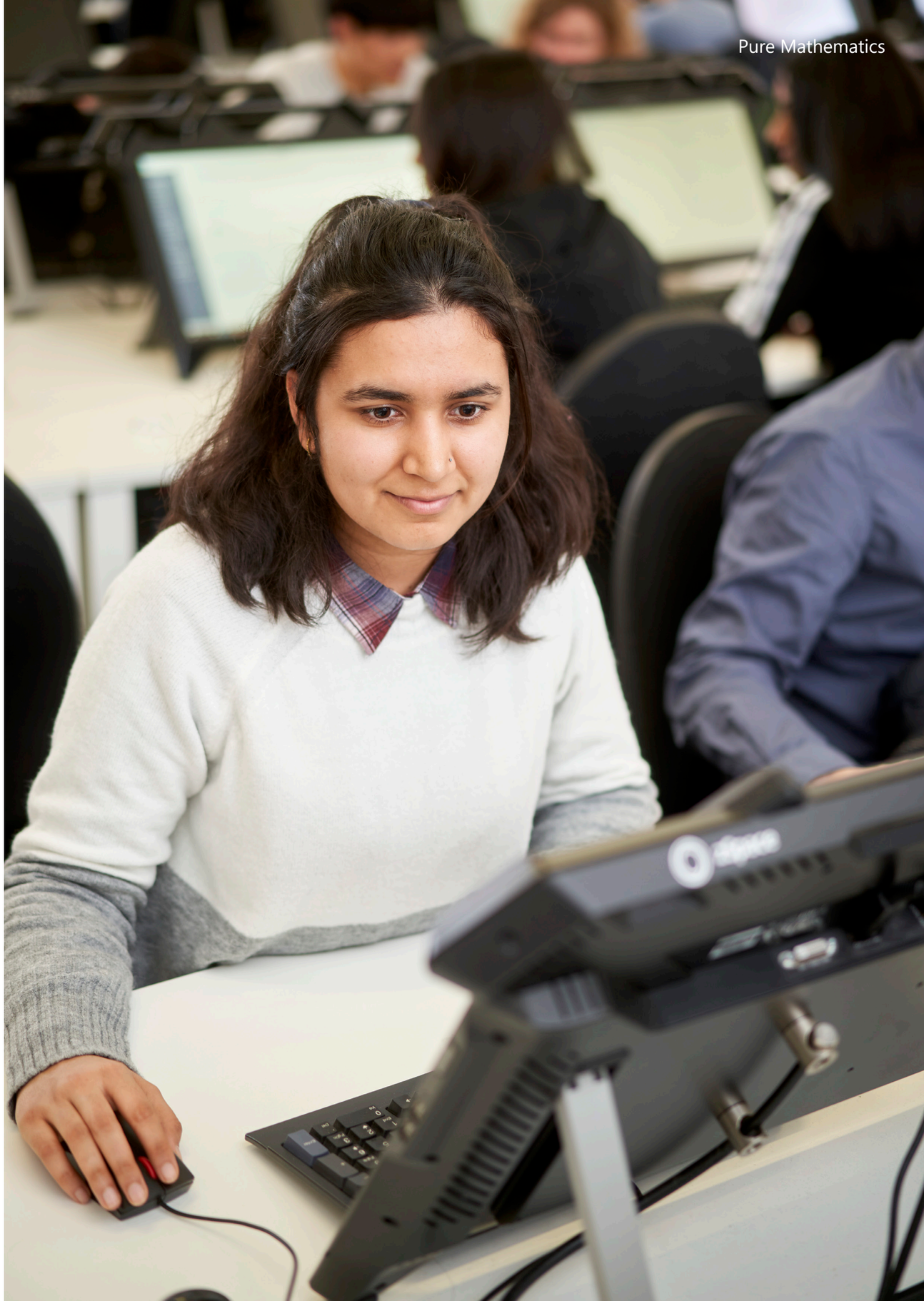
1. Simplify algebraic fractions by division
2. Divide a polynomial by (x+p) or (x–p)
3. Factorise a polynomial using the factor theorem
4. Use the Remainder Theorem

11
Basic trig ratios and pythagoras

1. Use Pythagoras to find the length of a right angled triangle, given 2 sides
2. Use the trig ratios to find the length of a side and an angle in a right angled triangle
3. Use both the Sine Rule and cosine rule to find missing sides/angles of triangles
4. Apply the formula: A=0.5absinC to find the area of a triangle

12
The Binomial Expansion

1. Use Pascal's Triangle to expand expressions
2. Use combinations factorial notation to help expand expressions
3. Use (n /r) to determine the coefficients in the binomial expansion
4. Expand (ax + b)n using the Binomial expansion
5. Find approximations using the binomial expansion



13

Radian measure and applications

1. Convert Degrees to Radians and vice-versa
2. Use the arc length and Area of a Sector formula
3. Find the area of a Segment

14

Further differentiation

1. Use Differentiation to calculate when a function is increasing or decreasing, where the stationary points are and be able to determine their nature
2. Use Differentiation to Solve practical problems involving maximum and minimum

15

Trigonometrical identities and simple equations

1. Simplify trigonometric identities
2. Solve trigonometric equations
3. Solve more complicated trigonometric equations, including quadratics, double angles

16

Further integration

1. Solve problems involving definite integrals
2. Use integration to calculate the area under a curve and between two curves
3. Use the Trapezium Rule to estimate an area under a curve

17

Further calculus 1

1. Differentiate a function using the chain rule and product rule
2. Differentiate a function using the quotient rule
3. Differentiate the exponential function, the logarithmic function, sin x, cos x and tan x
4. Differentiate combinations of the above, as well as sec x, cosec x and cot x

18

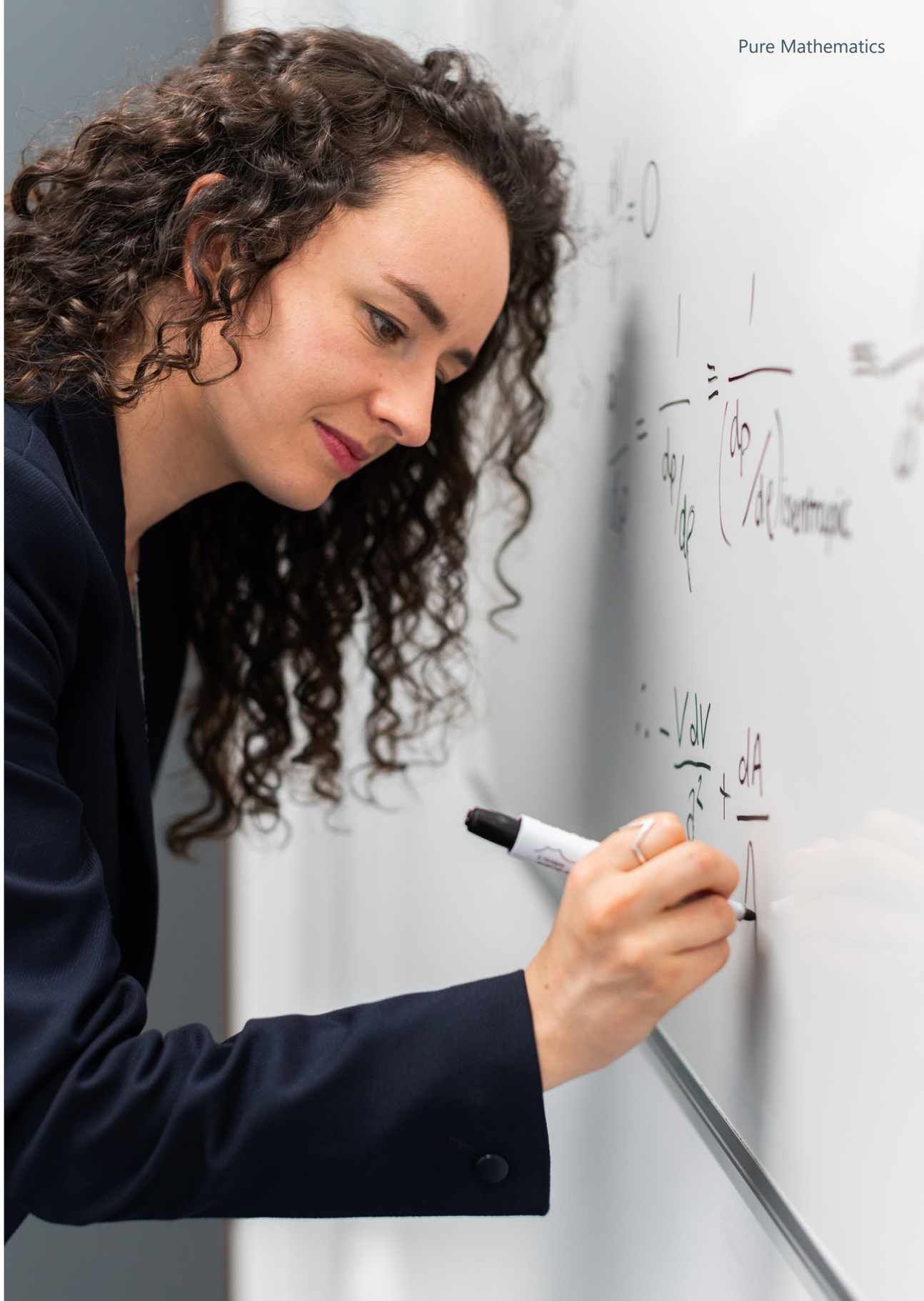
Further calculus 2

1. Integrate by using standard functions
2. Integrate by using the reverse chain rule
3. Integrate by using trigonometric functions
4. Use integration to solve differential equations that arise out of a context

19

Vectors

1. Use Vector Definitions and diagrams
2. Use Vector Arithmetic and the Unit Vector
3. Understand points in 2 or 3 dimensions
4. Use Cartesian components of a vector in 2D
5. Use Cartesian components of a vector in 3D
6. Be able to extend 2D results to 3D
7. Find the Scalar Product of Vectors
8. Use and find the Vector Equation of a straight Line
9. Find the Intersection point of straight line vector equations
10. Find the angle between 2 straight line vectors

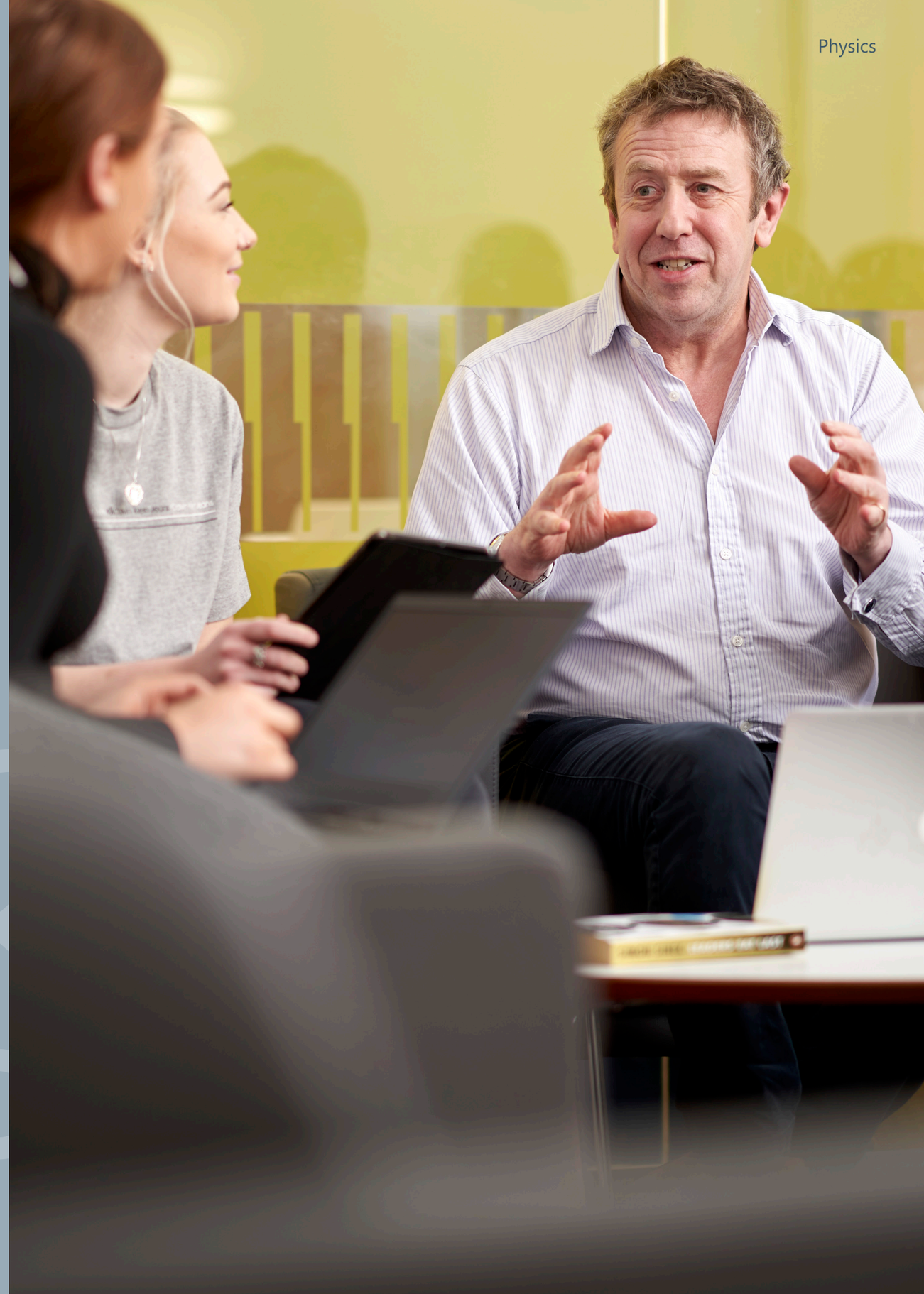


Physics Module

Physics is the study of nature; it aims to understand particles, energy, forces and fields on both the smallest and largest scales, from the interaction of the smallest particles yet discovered to the way the Universe has evolved since the beginning of time. You will cover topics more relevant to your daily life and see how Physics underpins much of the technology we have come to rely on in the modern world, and has inspired the digital revolution.

This course is an excellent foundation (and indeed essential) for further study of a whole range of engineering degrees.

The problem solving skills you will develop in Physics are essential for future undergraduate courses.



01

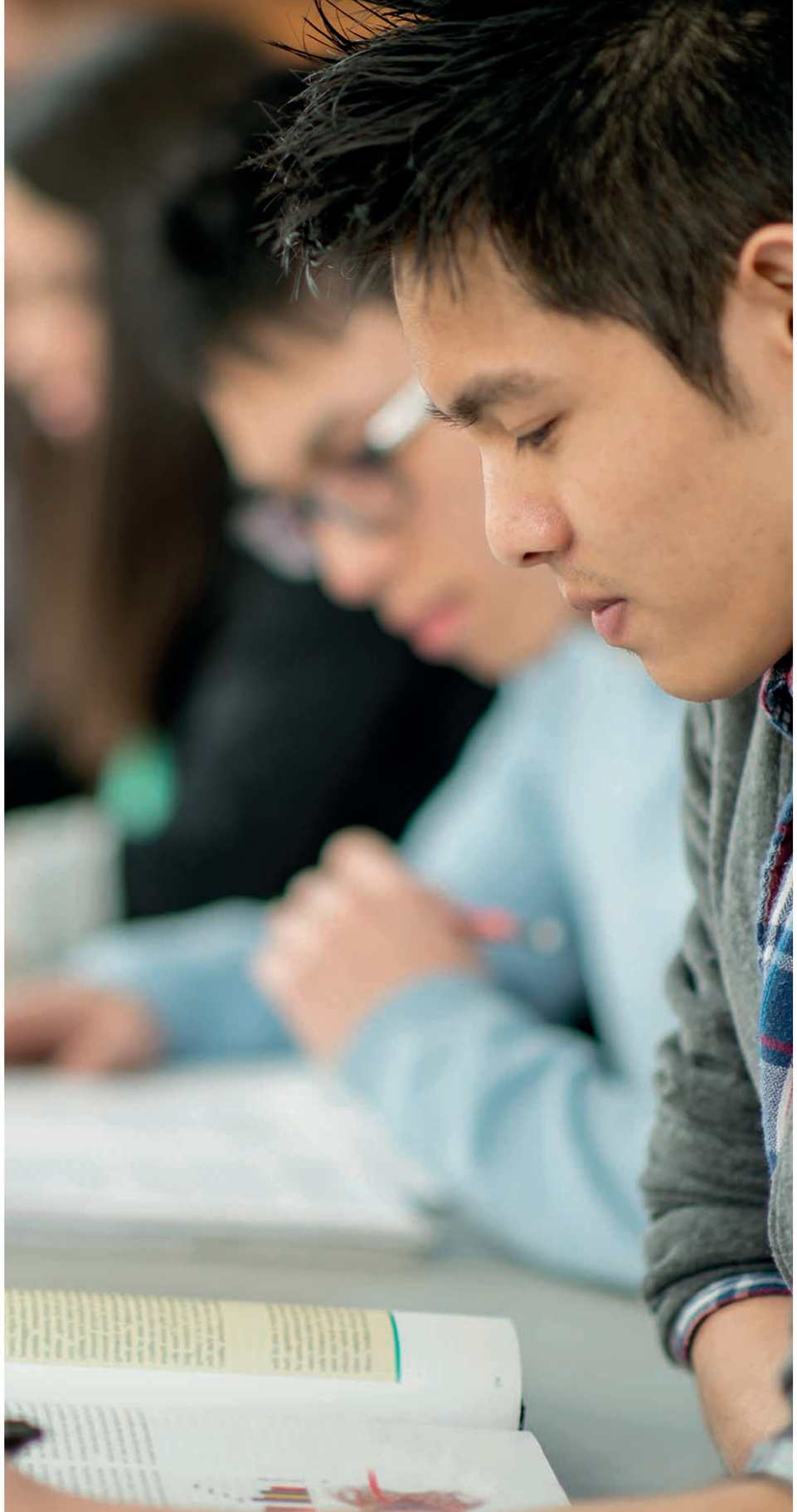
Vector and scalars

1. Distinguish between vector and scalar quantities and give examples of each
2. Determine the sum or difference of two vectors mathematically or by scale drawing
3. Resolve vectors into perpendicular components along chosen axes. For example, resolving parallel and perpendicular to an inclined plane

02

Force

1. Description of what a force is
2. Determine the resultant force in different situations
3. Demonstrate and apply knowledge and understanding of: net / resultant force = ma unit of force – Newton
4. Examples of forces – tension, normal contact force N, weight W, up thrust, friction
5. Weight: Students must be able to demonstrate their knowledge and understanding of the existence of gravitational fields due to the object's mass
6. Friction force: Students should be able to: define friction; Use of the equation F = μR; drag as the frictional force experienced by an object travelling through a fluid; factors affecting drag for an object travelling through a fluid; motion of objects falling in uniform gravitational field in the presence of drag; terminal velocity – questions may be set on objects falling under gravity or through any fluid
7. Upthrust: students should be able to demonstrate their knowledge and understanding of upthrust and Archimedes' Principle
8. Identify the forces acting on a body and draw free body force diagrams representing the forces acting



03

Newton's laws and momentum

1. State Newton's 1st Law of Motion
2. Describe examples of Newton's 1st Law
3. State the conditions for equilibrium and be able to solve problems involving equilibrium.
4. State Newton's 2nd Law of motion
5. Students should be familiar with the law expressed as F=ma and F=Δp / Δt
6. Solve problems involving Newton's 2nd Law
7. Define Linear momentum and impulse
8. Determine the impulse due to a time varying force by interpreting a force-time graph
9. State the law of conservation of linear momentum
10. Solve problems involving momentum and impulse
11. State the law of conservation of momentum
12. Solve problems involving collisions / explosions and the interaction of bodies
13. Define elastic and inelastic collisions
14. State Newton's 3rd Law of Motion

04

Kinematics and projectile motion

1. Define displacement, velocity, speed and acceleration .Students should be able to define which are vectors and scalars
2. Explain the difference between instantaneous and average values of speed, velocity and acceleration
3. Outline the conditions under which the equations for uniformly accelerated motion may be applied
4. Identify the acceleration of a body falling in a vacuum near the Earth's surface with the acceleration g of free fall
5. Solve problems involving the equations of uniformly accelerated motion
6. Describe the effects of air resistance on falling objects. Only qualitatively. Students should understand the concept of Terminal velocity/speed
7. Draw and analyse distance-time, displacement – time, velocity – time and acceleration – time graphs. Students should be able to sketch and label these graphs for various situations and should be able to write descriptions of the motions represented by these graphs
8. Calculate and interpret the gradients of displacement - time graphs and velocity - time graphs, and the areas under

velocity time graphs and acceleration – time graphs

9. State the independence of the vertical and horizontal components of velocity for a projectile

10. Describe and sketch the trajectory of projectile motion as parabolic in the absence of air resistance.

11. Poof of the parabolic nature of the trajectory is not required

12. Describe qualitatively the effect of air resistance on the trajectory of a projectile

13. Solve problems on projectile motion

05

Work, energy and power

1. Outline what is meant by work

2. Determine the work done by non-constant force by interpreting a force – displacement graph

3. Solve problems involving the work done by a force

4. Outline what is meant by kinetic energy

5. Outline what is meant by a change in gravitational potential energy

6. State the principal of conservation of energy

7. List the different forms of energy and describe examples of the transformation of energy from one form to another

8. Distinguish between elastic and inelastic collisions

9. Define power

10. Define and apply the concept of efficiency

11. Solve problems involving momentum, work, energy and power

06

Materials/ mechanical properties of matter

1. Understand the concept of density ρ, use the equation ρ = m/V and to calculate mass, density and volume

2. State what is meant by tensile and compressive deformation, extension and compression

3. State Hooke's Law, elastic limit. F = kΔl where k is the spring constant/ force constant / stiffness constant of a spring or wire. Determine k both graphically and through calculation

4. Draw force / extension graphs and identify the characteristics

5. Determine elastic strain energy both from a force/ extension graph (area under graph) and by calculation E = ½ FΔl or E = ½ kΔl2

6. Define tensile stress, tensile strain, breaking stress, ultimate tensile strength

7. Describe plastic and elastic behaviour

8. Define the Young Modulus

9. Use stress-strain graphs to determine the Young modulus

10. Distinguish between stress-strain graphs for typical brittle, ductile and polymeric materials

07

Electrical potential difference, current and resistance

1. Define electric potential difference, V

2. Solve problems involving electric potential difference

3. Draw circuit symbols. Students should be able to recognise and use the accepted circuit symbols

4. Define electric current

5. Understand that electrical charges can move easily through some substances e.g. metals

6. Apply the relationship between current, I, charge, Q, and time, t

7. Define resistance

8. Students should be aware that R=V/|I is a general definition of resistance, NOT statement of Ohm's Law. Students should understand what is meant by a resistor

9. Apply the equation for resistance in the form R = ρl /A where ρ is the resistivity of the material

10. Use I = nAve to find currents and explain range of resistivity's of different materials

11. State Ohm's Law

12. Compare Ohmic and Non-Ohmic behaviour

13. For example students should be able to sketch and explain the I-V characteristics for a resistor, filament lamp and diode

14. Understand the relationship between potential difference V, energy transferred E and charge Q is: V=E/Q

15. Use E=ItV, $P=IV = I^2R = V^2/R$ to calculate power and energy in a circuit

16. Solve problems involving potential difference, current and resistance

08

Electrical circuits

1. Define electromotive force
2. Describe the concept of internal resistance
3. Apply the equations for resistors in series and parallel .This includes combinations of resistors and also complete circuits involving internal resistance
4. Describe the use of ideal ammeters and voltmeters
5. Describe a potential divider
6. Explain the use of sensors in potential divider circuits (sensors should include LDR's and NTC thermistors)
7. Solve problems involving electrical circuits. Students should appreciate that many circuit problems may be solved by regarding the potential divider. Students should be aware that ammeters and voltmeters have their own resistance

09

Capacitance

1. Define capacitance as C=Q/V and know its unit
2. Describe the charging and discharging of a capacitor or capacitor plates with reference to the flow of electrons. Appreciate that a capacitor stores energy by transferring charge from one plate to the other, so that the plates carry equal but opposite charges (the net charge being zero)
3. Know that the capacitance of a parallel plate capacitor depends on the geometry of the capacitor and the dielectric material between two plates $C= \varepsilon 0 \varepsilon A/d$
4. Understand the role of the dielectric as something that increases the capacitance
5. Determine the total capacitance of two or more capacitors connected in series or in parallel or a mixed combination
6. Analyse circuits containing both capacitors and resistors
7. Know that the area under a p.d.-charge graph for a capacitor is equal to the energy stored
8. Calculate using appropriate equations the energy stored by a capacitor
9. Understand the process by which a capacitor discharges through a resistor
10. Know Time Constant =RC
11. Calculate time constants including their determination from graphical data

10

Fields: electric charge and electric fields

1. State that there are two types of electric charge
2. State and apply the law of conservation of charge
3. Describe and explain the difference in the electrical properties of conductors and insulators
4. State and apply Coulomb's Law. Students should be aware that the charges in the force law are point charges
5. Define electric field strength E as force per unit charge defined by E = F/Q Students should understand the concept of a test charge
6. Draw the electric field patterns for different charge configurations
7. Include fields due to the following charge configurations: a point charge, a charged sphere, two point charges, and oppositely charged plates The latter should include the edge effect
8. Understand and being able to apply the formula to determine E in both a radial field and a uniform field
9. Understand the definition of absolute electric potential, including zero
10. Understand the value at infinity and of electrical potential difference
11. Work done moving a charge Q is given by $\Delta W = Q\Delta V$ and the magnitude of V in a radial field given by $V=Q / 4\pi\varepsilon or$
12. Be able to represent graphically variations of E with V and r

11

Fields: gravitational

1. Understand that gravity is a universal attractive force acting between all matter, Students should be able to use the equation
2. $F = G m^1 m^2 / r^2$ where G is the gravitational constant and appreciate that the gravitational field outside spherical bodies, such as the Earth is essentially the same as if the whole mass were concentrated at the centre
3. Define Gravitational field strength
4. Understand the concept of a force field as a region in which a body experiences a force and can be represented by gravitational field lines
5. Define g as the force per unit mass: g = F/m and so the magnitude of g in a radial field is given by g = GM/r2
6. Understand the definition of gravitational potential, including zero value at infinity and gravitational potential difference
7. Understand and be able to apple the appropriate equations relating work done moving a mass m is given by $\Delta W = m\Delta V$ and gravitational potential V in a radial field given by V=-GM/r
8. Be able to draw graphical representations of variations of g with V and r
9. Comparison of electric and gravitational fields Similarities: inverse square law fields having many characteristics in common Differences: masses always attract but charges may attract or repel

12

Thermal concepts

1. State that temperature determines the direction of thermal energy transfer between two objects. Students should be familiar with the concept of thermal equilibrium
2. State the relationship between Kelvin and Celsius scales of temperature - T / K = t / 0C + 273 is sufficient
3. Explain the physical differences between solid, liquid and gaseous phases in terms of molecular structure and particle motion.
4. Describe and explain the process of phase changes in terms of molecular behaviour. Students should be familiar with the terms melting, freezing, evaporating, boiling and condensing and should be able to describe each in terms of the changes in molecular potential and random kinetic energies of molecules
5. Explain in terms of molecular behaviour why temperature does not change during a phase change
6. Distinguish between evaporation and boiling
7. State that the internal energy of a substance is the total potential energy of a substance is the total potential energy and the random kinetic energy of the molecules of the substance
8. Students should know that the kinetic energy of the molecules comes from their random translational and rotational motion and that the potential energy of the molecules arises from the forces between the molecules
9. Explain and distinguish between the macroscopic concepts of temperature, internal energy and thermal energy (heat)
10. Students should understand that the term thermal energy refers to the non-mechanical transfer of energy between a system and its surroundings

13

Gas laws

1. State the three gas laws, describing the relationships between p,V,T and mass
2. Define a mole and molar mass
3. Define the Avogadro Constant
4. Calculate the number of moles in a gas using N=nNA
5. Perform calculations using the ideal gas equation pV=nRT or pV = NkT
6. Describe the conditions for which a real gas behaves like an ideal gas
7. Explain the increase of pressure of a gas when it is compressed or heated
8. Describe the distribution of molecular speeds
9. Apply the kinetic theory equation. E = 3/2kT

Skills for Science Module

Progress in the sciences is made through scientific experimentation and interpretation of the results. In order to complete this accurately and safely it is important to understand experimental design and methodology and how to analyse results.

This module aims to prepare you for laboratory work, develop your data analysis skills and teach you how to report and critique your findings. It will also introduce you to regulation of scientific and medical research and medical ethics.

You should, having completed the course, being able to draw conclusions from data, organise facts and figures in a logical way, test hypotheses in logical ways to find answers, and see the how a larger situation can be affected by smaller activities.

Key Topics

01 Basic mathematical skills

1. Express data in decimal and standard form
2. Analyse and express appropriate units used in calculations
3. Convert between different types of units
4. Rearrange equations to change the subject
5. Perform calculations using equations
6. Calculate and convert percentages, fractions, and ratios
7. Identify the limits of the least accurate measurements
8. Identify appropriate numbers of significant figures and decimal places

02 Statistical tests

1. Calculate the mean, median and mode of a range of data, including from experimental data, frequency tables
2. Evaluate measures of dispersion including standard deviation
3. Perform a simple scientific investigation and perform statistical tests on the data recorded

03 Drawing tables and graphs

1. Represent data in a variety of appropriate forms, including tables, bar charts, histograms, line graphs, pie charts, log graphs
2. Analyse data in a variety of forms, including tables, bar charts, histograms, line graphs, pie charts, log graphs

04 Scientific communication

1. Demonstrate skills for reading
2. Demonstrate skills for writing
3. bar charts, histograms, line graphs, pie charts, log graphs
4. Analyse data in a variety of forms, including tables, bar charts, histograms, line graphs, pie charts, log graphs

05
Handling data

1. Explain how to make and record observations
2. Collect and present raw data in a suitable table
3. Plot two variables from experimental or other data on a suitable graph
4. Construct and interpret frequency tables and diagrams, bar charts and histograms
5. Discuss which style of graph fits different types of data

06
Laboratory reports

1. Construct laboratory reports with the following sections:
   - Introduction
   - Materials
   - Methods
   - Diagram
   - Results
   - Discussion
   - Conclusion

07
Selecting and using a statistical test

1. Construct an appropriate null hypothesis
2. Calculate the test statistic given a standard scientific calculator and understand how to use probability for acceptance or rejection of the null hypothesis

08
Chi-squared calculation

1. The chi-squared test to test the significance of the difference between observed and expected phenotypic ratios
2. Calculate and analyse students t-test

09
Review of graphing

1. Understand that y = mx+ c represents a linear relationship
2. Determine the slope and intercept of a linear graph
3. Determine the appropriate graph to plot from a given equation in order to find an unknown
4. Including equations with exponentials
5. Students need to draw and use the slope of a tangent to a curve as a measure of rate of change

10
Evaluation of errors

1. Qualitative and quantitative treatment of errors/ uncertainties.
2. Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined by addition, subtraction, multiplication, division and raising to powers

11
Vernier Calliper and micrometer

1. Use of a Micrometer and Vernier Callipers for measuring
2. Reading Vernier and micrometer scales and their precision

Chemistry Module

Studying the different aspects of Chemistry enables you to comprehend the combinations of physical, inorganic and organic principles.

Practical work aims to complement theory and develop observational, analytical and skills required for future scientific study.

Key Topics

01 An introduction to the periodic table

1. Explain how and why elements are generally arranged on the Periodic Table
2. Name the family of elements in groups 1, 2, 7 and 8
3. Describe the difference between metals and non-metals

02 Atoms

1. Describe the structure of atoms in terms of protons, neutrons and electrons
2. Describe the relative mass and relative charge of protons, neutrons and electrons
3. Draw Bohr's simple model of an atom for elements with atomic numbers 1-20
4. Define atomic number, mass number, isotopes, relative atomic mass, relative molecular mass
5. Calculate number of protons, electrons, neutrons in an atom, isotope or ion
6. Calculate mass number of an element

03 Electrons in shells

1. Describe and explain the trends and properties (chemical and physical) of elements in the same group or period (radii across a period, first ionisation energies, melting point, including groups 1, 2 and 7 and period 3)
2. Write balanced equations for reactions of group 1 with water, oxygen and halogens
3. Write balanced equations for reactions of group 2 metals with oxygen, chlorine and water, group 2 oxides and hydroxides with water and acids
4. Write balanced chemical equations for reactions of group 7 halogens with groups 1 and 2
5. Write electron configurations in terms of sub shell notation
6. Show how electrons fill sub shell orbitals
7. Classify an element as an s, p,d or f block element using its electron structure
8. Define Ionisation and Successive Ionisation Energies
9. Explain how ionisation energy data provides evidence for electron structure

04 Relative atomic & molecular masses

1. Define relative atomic mass (Ar)
2. Define relative molecular mass (Mr)
3. Determine relative molecular mass (Mr) of a substance using relative atomic mass (Ar) values
4. Describe and explain the difference between empirical and molecular formulae
5. Complete calculations to find empirical formula from data giving composition by mass or percentage by mass
6. Deduce molecular formula from empirical formula and relative molecular mass

05 The mole, equations, gas volumes, concentrations and volumes of solutions

1. Define Avogadros constant
2. Complete calculations using the Avogadro constant
3. Calculate and write balanced equations
4. Calculate and write ionic equations
5. Complete calculations involving moles
6. Complete calculations using mass, concentration, volume and amount of substance in a solution/gases
7. Use and transpose the ideal gas equation pV = nRT with the variables in SI units

05

Bonding: Ionic, Covalent, Metallic

1. Define an ionic bond
2. Describe the structure of ionic compounds
3. Draw dot and cross diagrams to represent ionic bond formation.
4. Explain the properties of ionic compounds
5. Predict the formula of simple ions based on the position of the element in the Periodic Table and knowledge of common compound ions
6. Define a covalent bond
7. Describe the nature of covalent bonds
8. Draw annotated diagrams to represent covalent bond formation
9. Describe the structure of molecular substances
10. Explain the properties of molecular substances
11. Describe the nature of metallic bonding
12. Describe the structure of metals
13. Explain the properties of metals
14. Compare and contrast metallic, ionic and covalent bonding
15. Describe and explain the properties of ionic, molecular, giant covalent and metallic substances, in terms of bond types, interaction forces, boiling/melting points, conductivity and physical states at stp (including water)
16. Draw, describe and explain the structures of diamond and graphite
17. Compare the properties and uses of diamond and graphite

06

Bond polarity and intermolecular forces

1. Define the concept of electronegativity
2. Predict and explain the trend in electronegativity down groups and across periods
3. Describe why some covalent bonds are polar and deduce whether a bond is polar
4. Explain why some molecules are polar and deduce whether a molecule has a permanent dipole
5. Describe intermolecular forces, van der walls forces, dipole- dipole forces and hydrogen bonding
6. Explain how each of the intermolecular forces arise
7. Explain how the melting points are influenced by these intermolecular forces
8. Explain trends in the relative strength of the three types of force
9. Explain the anomalous nature of ice and how its low density can be explained through a knowledge of hydrogen bonding

07

Molecular shapes

1. Use VSEPR theory to deduce , name and sketch the shape of molecules and ions with up to six electron pairs surrounding the central atom, including bond angles (e.g. BeCl2, BCl3, CH4, HCl, NH3, NH4+, H2O, CO2, SO2, SO32-, SO42-, CO32-, NO3-, NO2-, PCl3, PCl5, SF6)
2. Explain using VSEPR theory (Valence Shell Electron Pair Repulsion Theory) why molecules and ions have the shapes that they do, including the effect on the bond angles of the great repulsion by lone (non-bonding) pairs

08

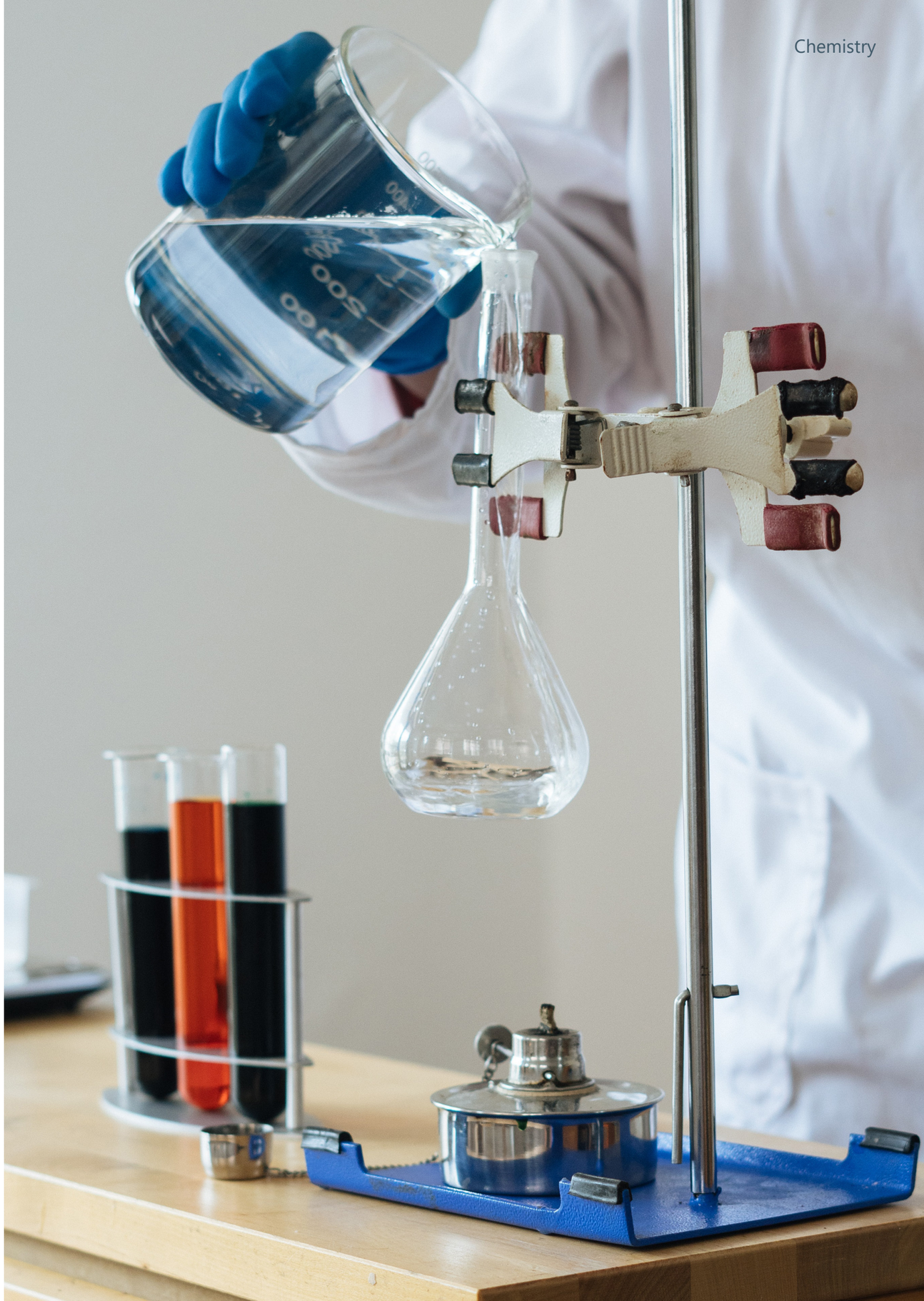
Oxidation states

1. Define oxidation, reduction, oxidising agent and reducing agent in terms of electron transfer.
2. Recall the oxidation state of an element is zero
3. Determine oxidation states of each element in substances and ions
4. Write redox half equations
5. Combine redox half equations to produce full equations
6. Identify reduction and oxidation processes
7. Identify strong and weak oxidising agents
8. Identify strong and weak reducing agents
9. Define a spectator ion

09

Collision theory

1. Explain Collision Theory
2. Describe activation energy (EA)
3. Interpret energy profile diagrams
4. Explain that reactions can only take place when particles collide with energy greater than or equal to the activation energy
5. Perform calculations for reactions involving percentage yields and atom economies
6. Describe economic, ethical and environmental advantages for society and industry of processes with a high atom economy



10

Factors affecting rates

1. Describe and explain how factors affect rates of reaction
2. Define a Catalyst
3. Explain how and why a catalyst affects the rate of reactions
4. Sketch and interpret Maxwell–Boltzmann distribution curves - at different temperatures, pressures, number of particles and with/without catalysts.
5. Describe Homogeneous and Heterogeneous catalysts

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The Arrhenius equation

1. Calculate the initial rate of a reaction from graphs
2. Define the rate constant (k) as a number that links the rate of reaction to the concentration of reactants.
3. Define the components of Arrhenius equation as
   - k as the rate constant
   - Ea as the activation energy
   - T as the temperature in Kelvin
   - R as the gas constant (value 8.31 JK-1.mol-1 will be provided)
4. A as the Arrhenius constant
5. Describe how the rate constant changes with temperature and activation energy
6. Perform calculations using the Arrhenius equation

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Bond enthalpies

1. Define the terms exothermic and endothermic
2. Define enthalpy change
3. Define mean bond enthalpy
4. Calculate enthalpy change (ΔH) using mean bond enthalpies
5. Explain why most bond enthalpies are mean values
6. Define standard enthalpy changes of combustion and formation
7. Recall and apply the equation for heat change $q = mc\Delta T$
8. Calculate ΔH using calorimetry data

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Hess's Law

1. Define Hess' Law including standard conditions
2. Use Hess's law to calculate enthalpy changes using enthalpies of formation and combustion
3. Explain why values from mean bond enthalpy calculations differ from those determined using Hess's law

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Chemical equilibria

1. Define Le Chatelier's principle
2. Define the term dynamic equilibrium
3. Describe and explain how changes in temperature, pressure and concentration affect the position of a system at equilibrium
4. Explain why compromise conditions of temperature and pressure may be used for a reversible reaction in an industrial process
5. Construct an expression for Kc for a homogeneous system in equilibrium
6. Calculate a value for Kc from the equilibrium concentrations for a homogeneous system at constant temperature
7. Perform calculations involving Kc
8. Predict the qualitative effects of changes of temperature on the value of Kc

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Acids and bases

1. Define Brønsted–Lowry acids and bases
2. Identify species as Brønsted–Lowry acids or bases in proton transfer reactions
3. Define a strong acid
4. Define a strong base
5. Define pH
6. Define Kw
7. Calculate pH of a strong acid/base from its hydrogen ion concentration ($pH = -\lg[H^+]$, $pOH = -\lg[OH^-]$)
8. Calculate the concentration of a strong acid/base from its pH ($[H^+] = 10^{-pH}$)
9. Use Kw to calculate the pH of strong bases ($Kw = [H^+]^* [OH^-]$)

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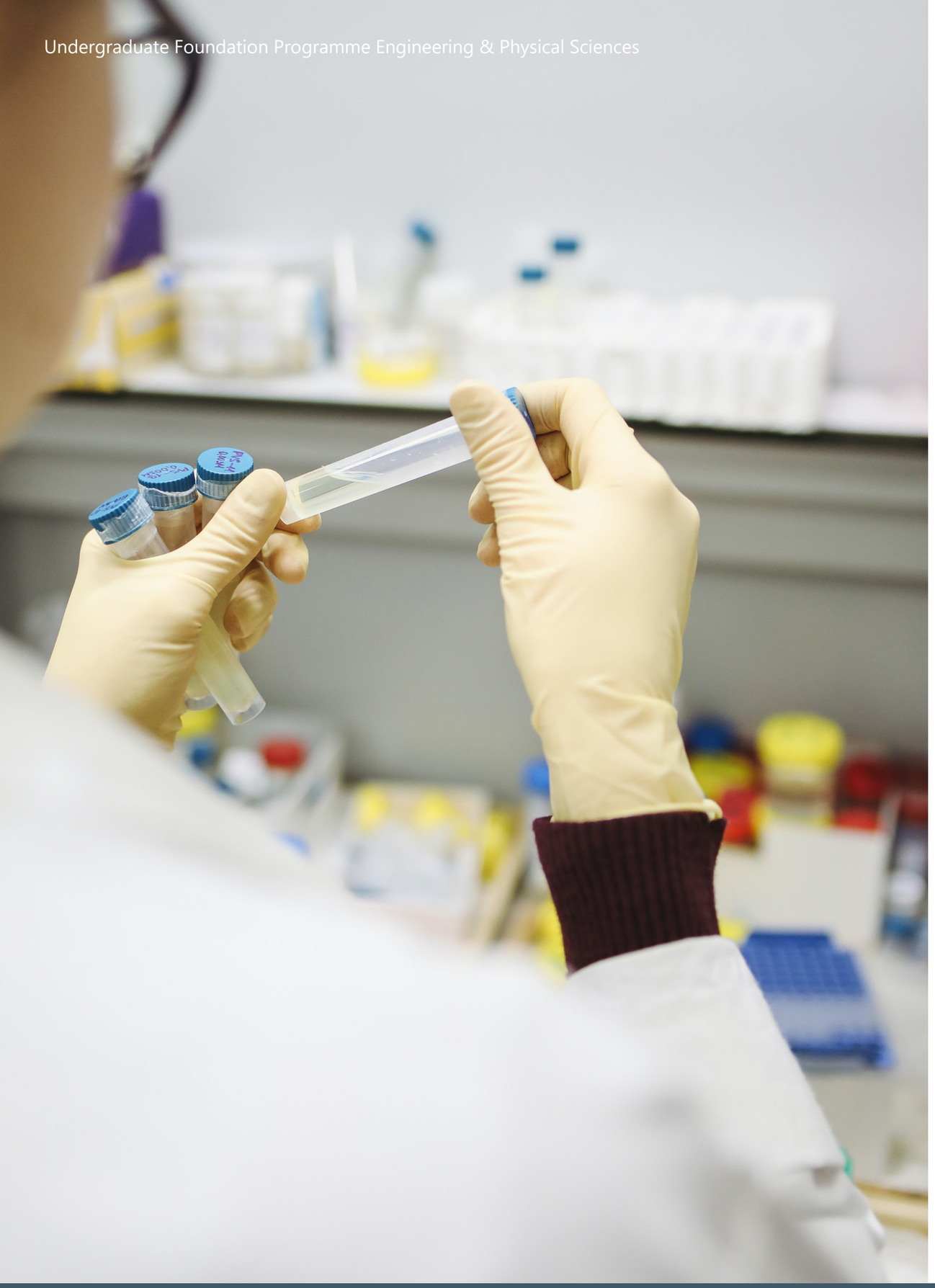
Weak acids and bases and Ka

1. Define a weak acid
2. Define a weak base
3. Write expressions for Ka including units
4. Perform calculations linking Ka to concentration and pH ($[H^+] = \sqrt{Ka*[HA]}$, and then $pH = -\lg[H^+]$)
5. Draw, describe and explain pH curves pH against volume of acid or base
6. Use pH curves to decide which indicator to use in titrations
7. Deduce a suitable indicator for acid-base titrations
8. Calculate concentrations from titration results to include diprotic acids

17

Nonmenclature

1. Describe the characteristics of a homologous series
2. Define and identify functional groups
3. Describe positive chemical tests for Alkenes, Halogenoalkanes, Alcohols (primary and secondary), Aldehydes, Ketones and Carboxylic acids
4. Represent organic compounds using
   - empirical formula
   - molecular formula
   - general formula
   - structural formula
   - displayed formula
   - skeletal formula
5. Draw the structure of, and name aliphatic organic molecules using IUPAC rules
6. Describe alkanes as saturated hydrocarbons
7. Describe alkenes as unsaturated hydrocarbons
8. Write balanced equations for the complete and incomplete combustion of alkanes
9. Describe why pollutants may be formed when fuels are burned and how these can be reduced (eg NOx, CO, C SO2)
10. Draw and name alkenes
11. Describe how the double bond is an area of high electron density
12. Describe the test for the C=C bond using bromine water
13. Write equations and mechanisms for reactions of alkenes with HBr, Br2 and H2SO4



18

Isomerism

1. Define the term isomerism
2. Define the term structural isomer
3. Define the term stereoisomer
4. Draw the structure of and name chain, position and functional group isomers
5. Explain the cause of E–Z isomerism
6. Draw the structure of and name E–Z isomers (using Cahn–Ingold–Prelog priority rules)
7. Define an electrophile
8. Define a nucleophile
9. Define a free radical
10. Describe bond breaking (homolytic & heterolytic) through diagrams

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Halogenoalkanes

1. Draw and name halogenoalkanes
2. Write balanced equations for the reaction of halogens with alkanes
3. Write equations to show the mechanism for the reaction of halogens with alkanes
4. Explain the reaction of methane and chlorine as a free radical substitution mechanism involving initiation, propagation and termination steps
5. Represent the unpaired electron in a radical using a dot
6. Construct equations and mechanisms for reactions of halogenoalkanes (eg with OH-, CN– and NH3) to show nucleophilic substitution
7. Draw mechanisms with curly arrow diagrams
8. Construct equations and mechanisms for elimination reaction of halogenoalkanes (eg using OH–, such as 2-bromopropane with potassium hydroxide)

20

Alcohols

1. Draw and identify alcohols and classify them as primary, secondary or tertiary
2. Construct balanced equations to show oxidation reactions of alcohols (to aldehydes, carboxylic acids and ketones)
3. Describe oxidation of tertiary alcohols using potassium dichromate (unsuccessfully)and burning
4. Describe chemical tests to distinguish between aldehydes and ketones

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Revision

1. Development of practical skills
2. To become competent in the use of practical equipment

Resources and reading list

Pure Mathematics

Edexcel AS and A level Mathematics Pure Mathematics Year 1/AS Textbook
Published by Pearson ISBN: 978–1292183398

Physics

A-Level Physics Exam Board: Edexcel Complete Revision and Practice (CGP)- ISBN: 9871782943051
Published by CGP
Advanced Physics For You (APFY) (Second Edition) - ISBN: 9781408527375
Published by Oxford University Press
AQA A-Level Physics For A –level Year 1 and AS (AQAP1) - ISBN: 9871471807732
Published by Hodder Education By Nick England, Carol Davenport, Jeremy Pollard, Nicky Thomas
AQA A-Level Physics 2 (AQAP2) - ISBN: 9781471807763
Published by Hodder Education by Nick England, Carol Davenport, Jeremy Pollard, Nicky Thomas

Chemistry

New A-Level Chemistry: AQA Year 1 & 2 Complete Revision & Practice with Online Edition -
ISBN: 9781789080292
OCR A Level Chemistry 1 by John Older & Mike Smith - ISBN 9781471827068
CGP Books (2018)
A-Level Chemistry for AQA: Year 1 & 2 Student Book with Online Edition - ISBN: 9781789080476 CGP Books
New A-Level Chemistry: AQA Year 1 & 2 Exam Practice Workbook
ISBN: 9781782949138
OCR Chemistry 1 by John Older and Mike Smith - ISBN: 9781471827068
Revise Edexcel AS/A Level Chemistry Revision Workbook Publisher: Pearson. Author: Nigel Saunders -
ISBN: 9781447989943
Revise Edexcel AS/A Level Chemistry Revision Guide. Publisher: Pearson. Author: Nigel Saunders -
ISBN: 9781447989974
Edexcel A Level Chemistry Student Book 2 by Graham Curtis and Andrew Hunt - ISBN: 9781471807497
Calculations for A-level Chemistry by E.N.Ramsden - ISBN 978074875839

Skills for Science

Science Skills - A Level Chemistry: Science, Maths and Quality of Written Communication
Paperback by Chris Conoley
Science Skills - A Level Physics: Science, Maths and Quality of Written Communication Paperback 21 Mar 2014 by Ian Galloway
Science Skills - A Level Biology: Science, Maths and Quality of Written Communication Paperback 3 Feb 2014 by Mike Boyle
Essential Maths Skills for A level Physics. Study notes, Examples and Practice questions
Published by CGP ISBN: 9781782944713

Example Timetable

Please note this is an example timetable and will vary for every student. Students should anticipate lessons starting earlier than 9am or later than 5pm. Students will be expected to allocate self study and revision hours within their timetable which will be given at the start of the academic term.

	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5
Mon	English	English		Lunch	Pure Mathematics	Pure Mathematics		
Tues		Physics	Physics	Lunch	English	English		Personal Tutorial
Wed	Pure Mathematics	English	English	Lunch	Skills for Science			
Thur		Physics	Physics	Lunch	Pure Mathematics	Pure Mathematics		
Fri	Skills for Science	Skills for Science	Pure Mathematics	Lunch	Physics	Physics		

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