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AAQ Level 3 Cambridge Advanced Nationals Extended Certificate in Applied Science

Exam board: OCR **Course code: H151**

Student Handbook Year 2025-2027

Inspired **Confident** **Ambitious**

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At The John Roan Sixth Form, students will be ***inspired*** by our commitment to their destinations. They will feel ***confident*** in their abilities and prospects because of our teaching and curriculum and they will be ***ambitious*** because of the opportunities we provide.

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Welcome to Applied Science

Curriculum Aims (KS5)

The purpose of the Applied Science curriculum is to ensure that students develop their knowledge understanding and skills with respect to the practical subject that is Applied Science. The teaching takes a content led approach to the course. This is a flexible approach where the specification is divided into units, each covering different key concepts of all three sciences as well as the scientific method. As learners progress through the course, they'll build on their knowledge of science.

Here we explore the John Roan curriculum principles in the context of the Science curriculum:

- **Entitlement:** all pupils need to develop essential knowledge and understanding of different areas of the subject and how they relate to each other. Through their learning, they will develop and demonstrate a deep appreciation of the skills, knowledge and understanding of the scientific method. They will also develop competence and confidence in a variety of practical, mathematical and problem solving skills.

- **Coherence:** Our curriculum is carefully sequenced to maximise knowledge, skills and understanding. The course has 5 modules and there is a clear rationale for the order in which these are studied. The year 12 units build on work from GCSE and then the year 13 modules further develop and enhance these foundations.

- **Mastery:** regular testing (low and high tariff questions) is embedded within the curriculum. This enables teachers to ensure that foundational knowledge, skills and concepts are secure. To support mastery pupils revisit prior learning on a lesson-by-lesson basis, while feedback is at the heart of the teaching process.

- **Adaptability:** the core curriculum is in line with the demands of the specification and the focus is on success for all in both the examined units and the assignment-based units. In addition, we are seeking to develop their interest in further study and careers associated with the subject. Teachers adapt lesson to meet the needs of their classes.

- **Representation:** All pupils will be able to see themselves within the science curriculum. Our curriculum aspires to take all students beyond their immediate experience and to build an understanding of how society make decisions about scientific issues and how the sciences contribute to the success of the economy and society as exemplified in 'How Science Works'.

- **Education with character:** Through the curriculum pupils are given regular opportunities to discuss and reflect upon a wide variety of scientific issues. There are opportunities to look into subjects that affect their daily lives, as well as go into areas beyond the specification. Targets for improvement or comments should be acted upon.

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How we organise our work and learn in Applied Science

In year 12, you will be working in an exercise book, one each teacher. You will need to date handouts and make sure they are not loose. You should title and date each piece of work. Whenever you do practical work, you will need to reflect on the skills you have learnt. End of topic tests and evaluations should be kept in the back of the book.

In addition, you will be given a set of blank revision cards at the start of the year. You will work on these after each lesson to build up a set of revision notes for yourself, adding in information from lessons, homeworks and end of topic tests to support your learning.

When writing up assignments, your teacher will share a folder with you - this will be where you write up all the work against the assignment brief and your teacher will be able to monitor your work, adding comments to help you or providing feedback on your work. You will have until the hand in date to work on this, whereupon your teacher will print off the file and mark it. Completed assessments and other activities should be marked off in this booklet.

In lessons, the lesson will start with a Do Now, which is recall knowledge. You should try to answer this without using your notes. After this, your teacher will connect your learning objectives for the lesson with the curriculum, teach and then get you to do a range of activities to check, practice and consolidate your learning.

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Exam Specification

In year 12 we study two mandatory units.

• Unit F180: Fundamentals of science
This unit is assessed by an exam.
In this unit you will learn about the key topics that are important in biology, chemistry and physics. You will study two key practicals for each of those components to be assessed as part of section D of the exam. Topics include:
Section A (Biology)
o Topic Area 1 Cell structure and microscopy
o Topic Area 2 Bioenergetics
o Topic Area 3 Structure and function of biological molecules
o Topic Area 4 Biodiversity and ecosystems
Section B (Chemistry)
o Topic Area 1 Atomic structure and the Periodic Table
o Topic Area 2 Quantitative chemistry
o Topic Area 3 Structure and bonding
o Topic Area 4 Rates of reactions and enthalpy changes
Section C (Physics)
o Topic Area 1 Electricity
o Topic Area 2 Motion
o Topic Area 3 Medical Physics
Section D
o Practicals

• Unit F182: Investigating Science
This unit is assessed by an assignment.
In this unit you will learn about the role of a research scientist in industry by learning how to conduct your own scientific investigation. You will develop the skills to research, plan and risk assess your investigation before safely undertaking the practical tasks.
Topics include:
o Topic Area 1 Planning a scientific investigation
o Topic Area 2 Performing a scientific investigation
o Topic Area 3 Analysing and communicating results
o Topic Area 4 Evaluating a scientific investigation

In year 13 we study three more units.

• Unit F181: Science in Society
This unit is assessed by an exam sat in January of year 13.
In this unit you will learn about the skills scientists use and the roles they perform in an international scientific community. You will examine different types of scientific data and learn how scientists use them to draw conclusions that can contribute to scientific advancement. You will investigate what makes a scientific theory different to a scientific law by reviewing past scientific discoveries. You will explore current scientific developments and future challenges facing society that science will need to solve. You will consider ways that science is communicated in the scientific and wider communities, the implications of miscommunication and the importance of communication in driving future scientific advances. Topics include:
o Topic Area 1 What Scientists do
o Topic Area 2 Handling Scientific Data
o Topic Area 3 Scientific Developments
o Topic Area 4 Communicating Science

• Unit F183: Analytical Techniques in Chemistry
This unit is assessed by an assignment.
In this unit you will learn how to plan and perform practical investigations to separate substances and purify them. You will also learn how to categorise different types of substance according to their physical properties and determine amounts present in a substance or solution. You will develop the skills to use chemical tests to identify the presence of specific ions and molecules and interpret spectra to provide information about the structure of molecules. Studying this unit will help you develop analytical skills, make logical deductions and conclusions from observations and interpret results and data. You will gain planning and problem-solving skills by selecting and applying techniques as well as understanding the principles behind the tests and equipment used.
Topics include:
o Topic Area 1 Techniques to categorise and separate chemical substances
o Topic Area 2 Quantitative and qualitative analytical techniques to quantify and identify substances
o Topic Area 3 The principles of spectroscopic techniques and interpreting spectra for chemical substances

• Unit F184: Environmental Studies
This unit is assessed by an assignment.
In this unit you will learn to use primary and secondary data to study ecosystems. You will develop the skills to carry out in situ fieldwork investigations to survey an area using different sampling techniques. You will learn about the different surveys available for studying the environment and how in situ and ex situ conservation strategies are used to protect species and their environments. You will also learn how to use online information to learn about biodiversity and compare different ecosystems. Finally, you will be able to research some of the strategies used to monitor and treat waste products in places such as landfill sites and water courses. Topics include:
o Topic Area 1 Ecosystems and Biodiversity
o Topic Area 2 Impact of human activity and natural events
o Topic Area 3 Waste management
o Topic Area 4 Environmental management and conservation
o Topic Area 5 Fieldwork

Assessment

Methods of formal assessment in Applied Science are as follows:

1. **End of Unit Assessments**
2. **Mock Examinations**

You will receive further details about these during the year.

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Homework & Independent Work

Objectives of a Sixth Form Homework Policy

Objectives of a John Roan Sixth Form Homework policy are as follows:

- To enable our students to achieve the best grades that they are capable of at Post-16 through:
- The consolidation and revision of learned material
- The application of learned material
- Preparation for lessons to enable access to challenging subject content
- To reinforce high expectations of our students as independent learners
- To equip our students with the study skills required for University and other destinations

Expectation of subject homework

At The John Roan Sixth Form we aim to teach students to become independent learners who use their private study time effectively. Students will be given guidance and support with creating revision schedules, effective note taking, essay writing and academic literacy, but will also be expected to practise and demonstrate these in their home learning.

As a benchmark, students should expect to receive an amount of homework per subject that is equivalent to twice the number of contact hours that they receive in school: six hours per subject which amounts to 18 hours per week.

Deadlines

Failure to meet deadlines for homework will result in a detention after school the following day, while repeated failures to meet homework deadline will escalate to an academic support plan or school based exclusion. Students who are placed into detention will still be expected to complete missed homework. Students are encouraged to communicate with teachers about other deadlines in place so that they can be supportive of work set in other subjects.

Homework setting

All homework will be set for students using Show My Homework (Satchel One) which is available as an app which can be accessed via a mobile phone, or as a website that can be accessed via a computer. In some instances, homework will be set on software. However, instructions for any homework set on these platforms will be repeated on Show My Homework to ensure consistency.

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Homework & Independent Work

Examples of homework set at KS5 in BTEC Applied Science will typically include:

Revision Revision homework tasks will enable you to consolidate your learning and eliminate gaps in subject knowledge, helping you to prepare for your exams.	**Application** Application homework tasks test for understanding of recently-acquired subject knowledge and develop your technique for exams.	**Flipped-Learning** Flipped learning homework tasks ensure that you are able to access challenging subject material and allow you to progress quickly through your course.
• Standing Homework of producing revision notes from the lesson. • You can use your revision cards to do this. • Creating mind maps and flashcards • Creating / revising from check lists • Creating glossaries of terms • Creating flow charts • Creating a topic quiz • Revising for a topic quiz • Completing past papers •	• Standing homework of completing end of topic questions • Standing homework of completing practical skills reflection. • Completing write up • Completion of a practical follow up sheet. • Completing a calculation sheet. • Completing past papers questions • Preparing a presentation for a lesson • Completing coursework or another assignment for a deadline • Independent or guided research on a lesson topic • Completing a topic quiz	• Standing homework of pre-reading the next lesson's topic. • Preparation of notes in advance of a next lesson • Answering comprehension questions ahead of a new topic • Preparing a presentation for a lesson • Independent research in preparation for an experiment • Independent or guided research ahead of a lesson

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How to get a D* in Applied Science

- To get a D* grade in Applied Science you will need to demonstrate in your exams and in your assignments that you have a detailed and comprehensive knowledge and understanding of scientific ideas, processes, techniques and procedures from the range covered in the specification, applying them to familiar and new contexts. You should be aiming for distinction in all of the assignment units.
- In the examined unit F180, you will need to integrate relevant scientific knowledge and understanding from different areas to demonstrate a deeper understanding of how these apply to vocational and realistic situations. You will need to select relevant information and apply appropriate mathematical and technical skills to justify decisions or solve problems in context and be able to interpret and analyse information in order to make valid judgements that are supported by evidence, with awareness of limitations.
- In the coursework unit F182, you will demonstrate a thorough understanding of how scientific concepts, procedures, processes and techniques can be integrated and applied within a practical context. You will interpret, analyse and evaluate secondary data to support judgements and conclusions drawn. You use and integrate knowledge and understanding of scientific concepts, procedures, processes and techniques to make a hypothesis and plan an investigation that is fully supported by scientific reasoning. In addition, you will be able to provide rationalised evaluative judgements on scientific data, processes and procedures that are fully supported by scientific reasoning
- You will get at least 270 UMS points from the different units. The maximum points available is 300 across the whole course.

Unit	Maximum Marks	Maximum UMS	Distinction* UMS	Distinction UMS	Merit UMS	Pass UMS
F180 – Yr 12	70	70		56	42	28
F181 – Yr 13	50	50		40	30	20
Unit	Maximum Criteria	Maximum UMS	Distinction* UMS	Distinction UMS	Merit UMS	Pass UMS
F182 – Yr 12	28	70		56	42	28
F183/4 – Year 13 (2 units are completed)	22	55		44	33	22
FINAL GRADE	192	300	270	240	180	120

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Grade Descriptors

Level 3 Pass

At pass, students show adequate knowledge and understanding of the basic elements of much of the content being assessed. They can develop and apply their knowledge and understanding to some basic and familiar contexts, situations and problems.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are often limited.

Many of the most fundamental skills and processes relevant to the subject are executed effectively but lack refinement, producing functional outcomes. Demonstration and application of more advanced skills and processes might be attempted but not always executed successfully.

Level 3 Merit

At merit, students show good knowledge and understanding of many elements of the content being assessed. They can sometimes develop and apply their understanding to different contexts, situations and problems, including some which are more complex or less familiar.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are likely to be mixed, with some good examples at times and others which are less accomplished.

Skills and processes relevant to the subject, including more advanced ones, are developed in terms of range and quality. They generally lead to outcomes which are of good quality, as well as being functional.

Level 3 Distinction

At distinction, students show thorough knowledge and understanding of most elements of the content being assessed. They can consistently develop and apply their understanding to different contexts, situations and problems, including those which are more complex or less familiar.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are successful in most cases.

Most skills and processes relevant to the subject, including more advanced ones, are well developed and consistently executed, leading to high quality outcomes.

Coursework Units

The coursework units are known as NEA units. The work completed in these must be your own, and you will be under teacher supervision unless told otherwise. Group work is not allowed – you will have to work on your own. You will be required to use your own works when you produce final written pieces of work to show you have genuinely applied your knowledge, skills and understanding to the task. When you use your own words, ideas and opinions, it reduces the possibility of your work being identified as plagiarised.

Plagiarism is:

- the submission of someone else's work as your own.
- the failure to acknowledge a source correctly, including any use of written material, the internet or Artificial Intelligence (AI).

Plagiarised work will not be accepted as evidence, and is considered malpractice. Please consult with this document - https://www.ocr.org.uk/Images/570838-guide-to-referencing.pdf which gives a good overview of what you are allowed and not allowed to do. In terms of referencing, please look at pages 8, 9 and 10.

When doing research it is important to record the texts you refer to or quote from:

- Books – note the author or editors name, the publication date, the title, the city it was published in, the publishers name and the pages you have quoted or paraphrased from.
- Articles in Magazines or Newspapers – note the authors name, the year of publication, the title of the article, the title of the publication and the page numbers.
- Electronic sources – note the author the publication dates and the date you accessed the electronic text the website or email address and identify the form of the resource (WWW page, email, blog etc).
- For computer-generated sources (such as an AI chatbot) – not the date the content was generated and the AI bot used to generate it. You should also keep a copy of the computer-generated context for authentication purposes.

Teachers, as well as yourself, have to sign declarations that the work is your own. If the teachers think that malpractice has occurred, then we will need to report it to the exams officer and the Principle.

The evidence you need to produce needs to be submitted by the deadline set by your teacher. There will be areas of work that teachers will provide evidence that they have seen you do things, for example, that you carried out a preliminary experiment. You will receive a Teacher Observation Record (TOR) form when this occurs. This will need to be signed by you and the teacher and the form will be part of your evidence.

Grading the NEA (Units F182 to F186)

These units are assessed within the school, but are subject to external moderation by OCR. The assignments are set by the exam board each year. There are 4 to 5 practical tasks in each unit

that will be completed over about 20 hours of class time, along with about 5 hours of unsupervised time to complete.

Each unit has specific pass, merit and distinction assessment criteria. These are in section 5.3 of the specification. It is important that you maximise the number of statements that you achieve. You do not need to pass all the pass criteria in order to achieve a pass.

Unit	F182 (year 12)	F183-F186 (2 in year 13)
Total number of criteria for unit	28	22
Number at pass level	14	11
Number at merit level	8	6
Number of distinction criteria	6	5
Total Number achieved for a Pass	12	9
Total Number achieved for a Merit	17	13
Total Number achieved for a Distinction	23	18

The board will monitor this and may change the criteria.

Access Arrangements

If at any time you feel you would benefit from additional access arrangements in an exam, such as the use of a laptop, please speak with your subject teacher as soon as possible.

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Command Words- Exams

Command Word	Meaning
Analyse	• Separate or break down information into parts and identify their characteristics or elements • Explain the different elements of a topic or argument and make reasoned comments • Explain the impacts of actions using a logical chain of reasoning
Annotate	• Add information, for example, to a table, diagram or graph
Calculate	• Work out the numerical value. Show your working unless otherwise stated
Choose	• Select an answer from options given
Compare	• Give an account of the similarities and differences between two or more items or situations
Complete	• Add information, for example, to a table, diagram or graph to finish it
Describe	• Give an account that includes the relevant characteristics, qualities or events
Discuss (how/whether/etc)	• Present, analyse and evaluate relevant points (for example, for/against an argument) to make a reasoned judgement
Draw	• Produce a picture or diagram
Explain	• Give reasons for and/or causes of something • Make something clear by describing and/or giving information
Give examples	• Give relevant examples in the context of the question
Identify	• Name or provide factors or features from stimulus
Label	• Add information, for example, to a table, diagram or graph until it is final
Outline	• Give a short account or summary
State	• Give factors or features • Give short, factual answers

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Command Words- NEAs

Command Word	Meaning
Adapt	• Change to make suitable for a new use or purpose
Analyse	• Separate or break down information into parts and identify their characteristics or elements • Explain the different elements of a topic or argument and make reasoned comments • Explain the impacts of actions using a logical chain of reasoning
Assess	• Offer a reasoned judgement of the standard or quality of situations or skills. The reasoned judgement is informed by relevant facts
Calculate	• Work out the numerical value. Show your working unless otherwise stated
Classify	• Arrange in categories according to shared qualities or characteristics
Compare	• Give an account of the similarities and differences between two or more items, situations or actions
Conclude	• Judge or decide something
Describe	• Give an account that includes the relevant characteristics, qualities or events
Discuss (how/whether/etc)	• Present, analyse and evaluate relevant points (for example, for/against an argument) to make a reasoned judgement
Evaluate	• Make a reasoned qualitative judgement considering different factors and using available knowledge/experience
Examine	• To look at, inspect, or scrutinise carefully, or in detail
Explain	• Give reasons for and/or causes of something • Make something clear by describing and/or giving information
Interpret	• Translate information into recognisable form • Convey one's understanding to others, e.g. in a performance
Investigate	• Inquire into (a situation or problem)
Justify	• Give valid reasons for offering an opinion or reaching a conclusion
Research	• Do detailed study in order to discover (new) information or reach a (new) understanding
Summarise	• Express the most important facts or ideas about something in a short and clear form

Units in Science

It is expected that you will show and be able to apply understanding of physical quantities and corresponding units, and SI base units and derived units listed below.

These are the SI base units:

Physical quantity	Common symbol(s) (use of these symbols is optional)	SI base unit	Unit abbreviation
Length	d – diameter h – height (e.g. height raised above ground level to calculate gravitational potential energy) l – length (e.g. of a wire) s – displacement (e.g. displacement of a force) x – extension (e.g. of a spring) or distance travelled (e.g. for attenuation of X-rays through a medium) λ (lambda) – wavelength	metre	m
Mass	m	kilogram	kg
Time	t t_E – effective half-life $t_{1/2}$ – physical half-life t_B – biological half-life T – time period	second	s
Temperature	T – for Kelvin temperature ΔT – for change in Kelvin temperature	kelvin	K
Current	I	ampere	A
Amount of a substance	n	mole	mol

These are the SI derived units which you may come across:

Physical quantity	Common symbol(s) (use of these symbols is optional)	SI derived / accepted unit	Unit abbreviation
Angle	θ (theta)	degree	°
Area	A	squared metre	m^2
Acceleration	a	metre per squared second	$m\,s^{-2}$
Acoustic impedance	Z	kilogram per squared metre per second	$kg\,m^{-2}\,s^{-1}$
Activity	A	becquerel; per second	Bq; s^{-1}
Concentration	c	mole per cubic decimetre; gram per cubic decimetre	$mol\,dm^{-3}$; $g\,dm^{-3}$
Density	ρ (rho)	kilogram per cubic metre; kilogram per cubic centimetre	$kg\,m^{-3}$; $kg\,cm^{-3}$

/con't

Energy	E – energy W – work done Q – (thermal) energy	joule; electron volt	J; eV
Enthalpy change of combustion	$\Delta_c H$	kilojoule per mole	$kJ\,mol^{-1}$
Electric charge	Q	coulomb	C
Electric potential difference	V	volt	V
Electric resistance	R	ohm	Ω
Force	F	newton	N
Frequency	f	hertz	Hz
Gravitational field strength	g	newton per kilogram	$N\,kg^{-1}$
Intensity	I	watt per squared metre	$W\,m^{-2}$
Intensity reflection coefficient	α (alpha)	no units	no units
Linear attenuation coefficient	μ (mu)	per metre; per centimetre	m^{-1}; cm^{-1}
Magnification	M	no units	no units
Molar mass	M	grams per mole	$g\,mol^{-1}$
Mass attenuation coefficient	μ_m (mu)	squared metre per kilogram; squared centimetre per gram	$m^2\,kg^{-1}$; $cm^2\,g^{-1}$
Power	P	watt	W
Pressure	p	Pascal; newton per squared metre	Pa; $N\,m^{-2}$
Radioactive decay constant	λ	per second	s^{-1}
Specific heat capacity	c	Joule per kilogram per degree Celsius; Joule per kilogram per Kelvin	$J\,kg^{-1}\,°C^{-1}$; $J\,kg^{-1}\,K^{-1}$
Speed of sound	c	metre per second	$m\,s^{-1}$
Spring constant	k	newton per metre	$N\,m^{-1}$
Temperature	θ (theta) – for Celsius temperature $\Delta\theta$ (theta) – for change in Celsius temperature	degree Celsius	°C
Velocity	v – final velocity (also speed) u – initial velocity	metre per second	$m\,s^{-1}$
Volume	V	cubic metre; litre; cubic decimetre; cubic centimetre	m^3; L; dm^3;cm^3

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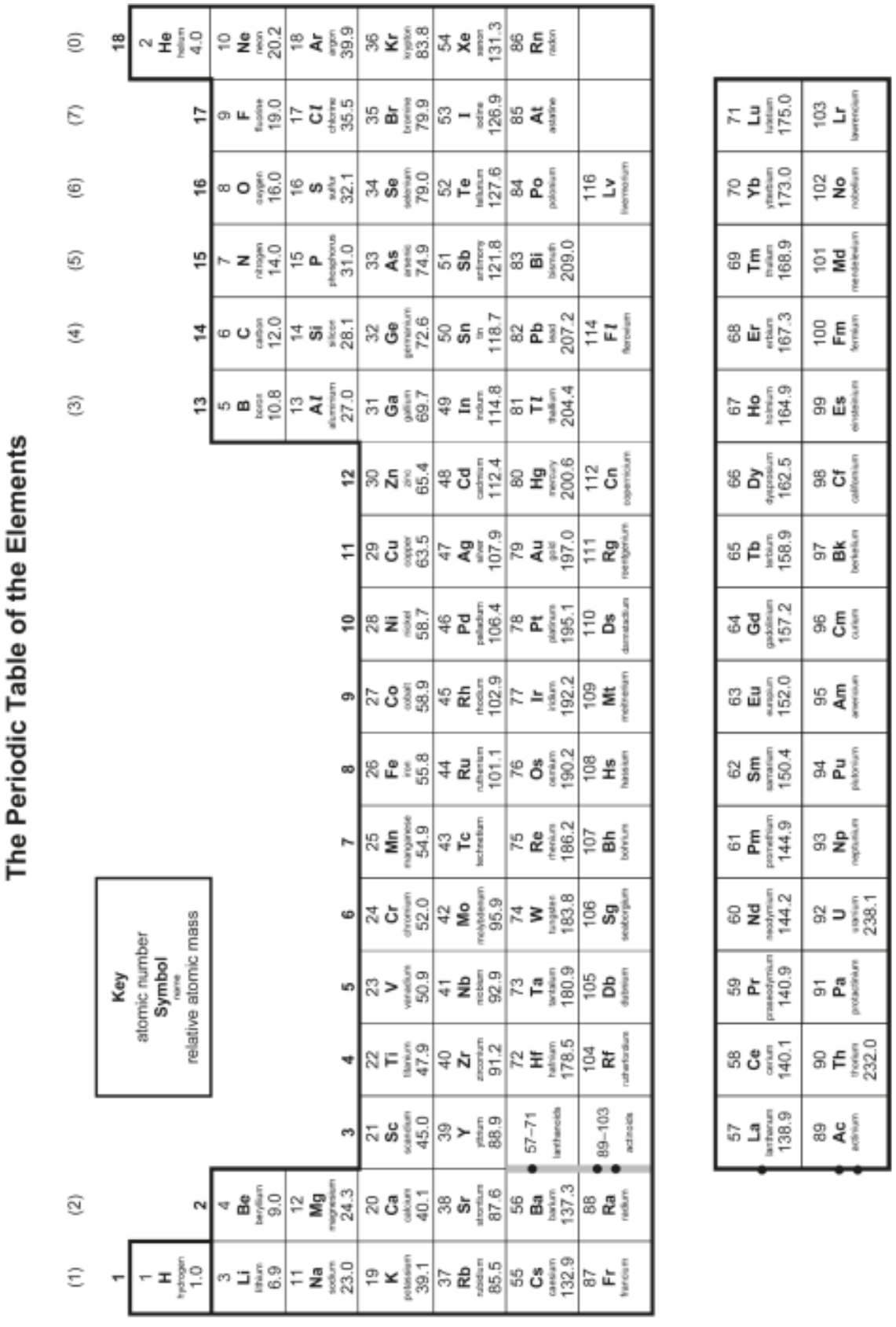
Data Sheet

You will be given this data-sheet for use in external exams.



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General information

Physical constant	Symbol	Value and units
Acceleration of free fall	g	$9.81\,m\,s^{-2}$
Avogadro constant	N_A	$6.02 \times 10^{23}\,mol^{-1}$
Elementary charge	e	$1.60 \times 10^{-19}\,C$
Electron rest mass	m_e	$9.11 \times 10^{-31}\,kg$
Neutron rest mass	m_n	$1.675 \times 10^{-27}\,kg$
Planck constant	h	$6.63 \times 10^{-34}\,J\,s$
Proton rest mass	m_p	$1.673 \times 10^{-27}\,kg$
Specific heat capacity of water	c	$4180\,J\,kg^{-1}\,°C^{-1}$
Speed of light in a vacuum	c	$3.00 \times 10^{8}\,m\,s^{-1}$
Molar gas volume (at room temperature and pressure, RTP)	V_m	$24.0\,dm^3\,mol^{-1}$
Euler's number	e	2.718

Conversion factors: $1\,eV = 1.60 \times 10^{-19}\,J$

Mathematical Equations

Circumference of circle = $2\pi r$

Area of circle = πr^2

Curved surface area of cylinder = $2\pi rh$

Surface area of sphere = $4\pi r^2$

Area of trapezium = $\frac{1}{2}(a + b)h$

Volume of cylinder = $\pi r^2 h$

Volume of sphere = $\frac{4}{3}\pi r^3$

Formulae and relationships for Unit F180

B1 Cell structure and microscopy	
Total magnification = magnification of objective lens × magnification of eyepiece lens	$M_T = M_O \times M_E$
Magnification = $\frac{\text{observed size}}{\text{actual size}}$	

B4 Biodiversity and ecosystems	
Percentage efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}} \times 100\%$	

C1 Atomic Structure and the Periodic Table	
Relative atomic mass = $\Sigma \frac{(\text{isotope mass} \times \text{isotope abundance})}{100}$	

C2 Amount of substance	
Amount of substance = $\frac{\text{mass of substance}}{\text{molar mass}}$	$n = \frac{m}{M}$
Concentration = $\frac{\text{amount of solute}}{\text{volume}}$	$c = \frac{n}{V}$
Concentration = $\frac{\text{mass of solute}}{\text{volume}}$	$c = \frac{m}{V}$
Amount of gas = $\frac{\text{volume of gas}}{24}$	$n = \frac{V}{24}$

C4 Rates of Reaction and Enthalpy Changes	
Thermal energy = mass × specific heat capacity × change in temperature	$Q = mc\Delta\theta$

P1 Electricity	
Charge = current × time	$Q = It$
Potential difference = current × resistance	$V = IR$
Power = current × potential difference	$P = IV$
Power = (current)^2 × resistance	$P = I^2R$
Power = $\frac{(\text{potential difference})^2}{\text{resistance}}$	$P = \frac{V^2}{R}$
Work done = potential difference × current × time	$W = VIt$
Work done = potential difference × charge	$W = VQ$
Total resistance in series = resistance of resistor 1 + resistance of resistor 2 + …	$R_T = R_1 + R_2 + \cdots$
$\frac{1}{\text{Total resistance in parallel}} = \frac{1}{\text{Resistance of resistor 1}} + \frac{1}{\text{Resistance of resistor 2}} + \cdots$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

P2 Forces & Motion	
Work done = force × displacement	$W = Fs$
Work done = force × displacement × $\cos\theta$	$W = Fs\cos\theta$
Kinetic energy = ½ × mass × (velocity)²	$E = \frac{1}{2}mv^2$
Gravitational potential energy = mass × acceleration of free fall × height	$E = mg\Delta h$
Elastic potential energy = ½ × force × extension = ½ × spring constant × (extension)²	$E = \frac{1}{2}Fx$ $= \frac{1}{2}kx^2$
Power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
Efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$	
Net force = mass × acceleration	$F = ma$
Average velocity = $\frac{\text{displacement}}{\text{time taken}}$	$v = \frac{s}{t}$
Acceleration = $\frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}}$	$a = \frac{v-u}{t}$
Final velocity = initial velocity + (acceleration × time taken)	$v = u + at$
Displacement = ½ (initial velocity + final velocity) × time taken	$s = \frac{1}{2}(u+v)t$
Displacement = (initial velocity × time taken) + (½ × acceleration × time taken²)	$s = ut + \frac{1}{2}at^2$
Final velocity² = initial velocity² + 2 × acceleration × displacement	$v^2 = u^2 + 2as$

P3.1 Medical Physics	
Energy of a photon = Planck constant × frequency	$E = hf$
Energy of a photon = $\frac{\text{Planck constant} \times \text{speed of light in a vacuum}}{\text{wavelength}}$	$E = \frac{hc}{\lambda}$
Intensity of emergent beam = intensity of incident beam × $e^{-\text{linear attenuation coefficient} \times \text{distance travelled through the medium}}$	$I = I_0 e^{-\mu x}$
Mass attenuation coefficient = $\frac{\text{linear attenuation coefficient}}{\text{density of medium}}$	$\mu_m = \frac{\mu}{\rho}$
Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$

Frequency = $\frac{1}{\text{time period}}$	$f = \frac{1}{T}$
Wave speed = frequency × wavelength	$v = f\lambda$
Intensity = $\frac{\text{power}}{\text{area}}$	$I = \frac{P}{A}$
Acoustic impedance = density of medium × speed of sound in the medium	$Z = \rho c$
Intensity reflection coefficient = $\frac{\text{intensity of reflected wave}}{\text{intensity of incident wave}}$ Intensity reflection coefficient = (acoustic impedance of second medium − $\frac{\text{acoustic impedance of initial medium}}{\text{acoustic impedance of second medium}}$ + acoustic impedance of initial medium)^2	$\alpha = \frac{I_r}{I_0}$ $\alpha = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$

P3.2 Radioactivity	
Physical half-life = $\frac{0.693}{\text{radioactive decay constant}}$	$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$
$^1/_{\text{effective half-life}} = {}^1/_{\text{physical half-life}} + {}^1/_{\text{biological half-life}}$	$\frac{1}{t_E} = \frac{1}{t_{\frac{1}{2}}} + \frac{1}{t_B}$
Activity = radioactive decay constant × number of undecayed nuclei	$A = \lambda N$
Number of undecayed nuclei = initial number of undecayed nuclei × $e^{-\text{radioactive decay constant} \times \text{time}}$	$N = N_0 e^{-\lambda t}$
Activity = initial activity × $e^{-\text{radioactive decay constant} \times \text{time}}$	$A = A_0 e^{-\lambda t}$

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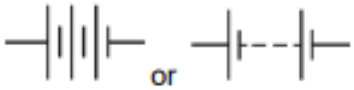
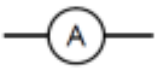
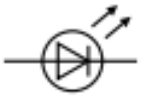
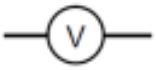
Electrical Circuit Symbols

You are also expected to be able to use these – they will not be supplied in the exam.

Cells and power supply symbols

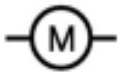
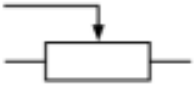
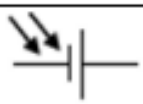
Component name	Symbol
Cell	
Battery of cells	
Open terminals	
d.c. power supply	
a.c. power supply	

General circuit symbols

Component name	Symbol	Component name	Symbol
Diode		Ammeter	
Light-emitting diode (LED)		Voltmeter	
Light dependent resistor (LDR)		Fixed resistor	
Thermistor		Variable resistor	
Indicator or light source		Switch	

Other circuit symbols that may be useful

These symbols may not be specified (please refer to the relevant specification) but may be useful in wider context.

Component name	Symbol	Component name	Symbol
Fuse		Wattmeter	
Heater		Thermocouple	
Junction		Microphone	
Motor		Earphone	
Loudspeaker		Electric bell	
Wire (showing current direction / energy or signal flow)		Buzzer	
Conductors crossing with no connection		Potentiometer (potential divider)	
Photovoltaic cell		Capacitor	
Photodiode		Oscilloscope	
Galvanometer