SPECIFICATION

For exams January, May and November onwards
For teaching from September 2021 onwards

Learning Resource Network

LRN INTERNATIONAL GCSE
PHYSICS (6321)

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2020

Contents

BACKGROUND TO LRN

Learning Resource Network (LRN) is a recognised Awarding Organisation that offers a range of qualifications to candidates, educational institutes, training providers, schools and employers.

LRN is recognised for its high quality qualifications that enable candidates to progress to other areas of study and employment in their designated fields.

In producing its qualifications, LRN uses the experience and expertise of academics, professionals working in the pertinent industries and assessment practitioners with a wealth of best practice and knowledge of validation, verification, delivery and assessment.

ACCOLADES

Queen's Award

In April 2020, LRN received the Queen's Award for Enterprise for International Trade. LRN is one of 220 organisations in the UK to be recognised with this prestigious accolade. This was in recognition of the expansion LRN brought to the overseas qualification market.

MANAGEMENT SYSTEMS

LRN has been awarded international accreditation as part of its quality controls, policies, systems and overall approach to its management systems. These awards are externally validated by the British Assessment Bureau. LRN has achieved accreditation in the form of ISO 9001: Quality Management Systems, ISO 14001: Environment Management Systems and ISO 27001: Information Security Management Systems.

CUSTOMER SERVICE EXCELLENCE

LRN has achieved the prestigious award of Customer Service Excellence. This is in recognition of its customer service practices, approach to managing and dealing with UK and Overseas customer needs, including the diverse needs of its centres.

LRN was the first UK Awarding Organisation to achieve Customer Service Excellence. Following reaccreditation in 2019, LRN received an award for Customer Service Excellence: Compliance Plus, demonstrating that LRN went above and beyond the delivery of its customer service principles.

INTRODUCTION

This specification provides an overview to the LRN International GCSE Physics[1]. This document is suitable for various users, including candidates, centres, administrators, employers, parents/guardians, teachers (and other related staff) and examiners. The specification outlines the key features and administrative procedures required for this international qualification.

OBJECTIVE

The LRN International GCSE Physics is designed to enable international candidates to demonstrate their ability, to work scientifically in both practical and theoretical terms across a range of general skills, motion, forces, energy, waves, electricity, magnetism, thermal physics, nuclear and space.

MODE OF DELIVERY

This qualification has been constructed to be delivered within centres. Centres will need to demonstrate to LRN, through the centre recognition processes, that they have the resources, facilities and competence to deliver. However, centres must be able to demonstrate, in line with LRN's criteria, that they have the means, capability, capacity and resources (including suitably qualified centre staff) to deliver by the method chosen by the centre.

PROGRESSION

The LRN International GCSE Physics has been designed to reflect the wide variation in candidates' origins, levels of education and career aims. Progression opportunities may, therefore, take a variety of paths. Depending on the level of qualification achieved, it may be appropriate for the candidate to progress to:

1. Similar level 2 qualification in Physics;
2. LRN Level 2 Certificate or Diploma in Pre-A Foundation Studies;
3. LRN Level 3 Diploma in Pre-U Foundation Studies;
4. A higher level of any qualification – e.g. A-Level, Diploma
5. Vocationally Related Qualifications

[1] LRN International GCSEs are globally recognised qualifications designed specifically for international candidates and are available outside the United Kingdom. Candidates based in England refer to the Ofqual register.

QUALIFICATION OVERVIEW

<table>
<tr><th>Number</th><th>Subject Content</th><th>AO</th><th>Exam</th></tr>
<tr><td>1</td><td>General Skills</td><td>1, 2 and 3</td><td rowspan="10">Combination of written exam papers (externally set and marked) and a practical demonstration of skills.

Paper 1:
Multiple Choice, Extended Theory and practical based skills.

Duration: 2 hours

Paper 2:

Multiple Choice, Extended Theory and practical based skills.

Duration: 2 hours</td></tr>
<tr><td>2</td><td>Motion</td><td>1, 2 and 3</td></tr>
<tr><td>3</td><td>Forces</td><td>1, 2 and 3</td></tr>
<tr><td>4</td><td>Energy</td><td>1, 2 and 3</td></tr>
<tr><td>5</td><td>Waves</td><td>1, 2 and 3</td></tr>
<tr><td>6</td><td>Electricity</td><td>1, 2 and 3</td></tr>
<tr><td>7</td><td>Magnetism</td><td>1, 2 and 3</td></tr>
<tr><td>8</td><td>Thermal Physics</td><td>1, 2 and 3</td></tr>
<tr><td>9</td><td>Nuclear</td><td>1, 2 and 3</td></tr>
<tr><td>10</td><td>Space</td><td>1, 2 and 3</td></tr>
</table>

BREAKDOWN OF ASSESSMENT OBJECTIVES

AO1 - demonstrate knowledge and understanding of:

- scientific ideas
- scientific techniques and procedures

AO2 – apply knowledge and understanding of:

- scientific ideas
- scientific enquiry, techniques and procedures l

AO3 – analyse information and ideas to:

- interpret and evaluate
- make judgements and draw conclusions
- develop and improve experimental procedures

ASSESSMENT

The assessment for this qualification consists of (i) written exam papers, and (ii) practical demonstration of skills, set and marked by the LRN.

Assessment objectives (AOs)	Weighting	
	Paper 1	Paper 2
AO1	30%	30%
AO2	40%	40%
AO3	30%	30%

GUIDED LEARNING HOURS

The guided learning hours (GLH) for this qualification are 130. Please note the hours stated are indicative.

ENTRIES CODES

One entry per qualification is sufficient and will cover all the question papers including certification.

PRIVATE CANDIDATES

Centres are advised that private candidates are only to be enrolled with prior agreement and confirmation from LRN.

GRADING

Results are reported, as 9 to 1.

RESULTS

Exam series are in:

- January (results released in March)
- June (results released in August)
- November (results released in January)

RE-TAKES

Whereas candidates can re-take the whole qualification as often as they wish, individual components cannot be re-taken as it is a traditional linear specification.

Please remember, one entry per qualification is sufficient and will cover all the question papers including certification.

CUSTOMER SERVICE STATEMENT

Learning Resource Network (LRN) is committed to ensuring all customers are dealt with promptly and in a professional and helpful manner. In order to guarantee this, we commit to ensuring the following in our day to day interactions with candidates, assessment centres and our stakeholder network:

- All customers will be treated equally and with respect;
- All customer information will only be used in a way which has been agreed in advance, unless we are informed of something that places them or others at risk of harm;
- All customers will be treated by staff in a professional manner.

LRN has arrangements in place to provide a telephone and e-mail helpdesk which will be staffed from 09:00 to 17:00 from Monday to Friday. Furthermore, it will respond to each e-mail, letter or telephone message it receives regarding feedback on its qualifications, centre approvals process or other matters relating to its products and/or services. The timetable for responding is as follows:

- E-mail: 5 working days
- Letter: 5 working days
- Telephone message: 5 working days

DIVERSITY AND EQUALITY

Learning Resource Network (LRN) is committed to ensuring fair and equal access to its qualifications, examinations and support materials. Our Diversity and Equality policy seeks to eliminate unjustifiable discrimination, harassment and/or victimisation and to advance equality of opportunity, thereby ensuring all candidates are treated fairly, in accordance with the protected characteristics of the Equality Act 2010. Specifically, we comply fully with the requirements laid out in the Equality Act 2010. In addition, and within the constraints of this policy, LRN will have due regard for the General data Protection Regulations (GDPR) in the retention of information which is unnecessary.

1- **General Skills**			
Aim Learners will be expected to use the following skills throughout the course and will be assessed on them across all the units.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand units.	1.1	**State** the correct SI units (name and symbol) for physical quantities.
		1.2	**Recall** and make use of the SI unit prefixes (names and symbols) nano [n], micro [µ], milli [m], kilo [k], mega [M] and giga [G].
		1.3	**Convert** between units as part of a calculation.
		1.4	**State** calculation answers to an appropriate number of significant figures. Usually 2 or 3sf is sufficient. 1sf is usually not enough to gain correct answer marks. A question that states “Show that” requires a value to be seen to at least one more significant figure than the value asked for.
		1.5	**State** the correct symbols for physical quantities.
2	Understand how to plot graphs.	2.1	**Draw** axes using a ruler.
		2.2	**Label** axes with descriptions and units.
		2.3	**Label** axes with correct scales. They should be continuous with equal increments, and the increments should be factors of 1, 2, 5 and 10 (e.g. 0.05, but not 30). The scale does not need to start at zero, but it should be clearly labelled.
		2.4	**Plot** data points using a cross. The centre of the cross should be within half a grid square of the correct point.
		2.5	**Draw** a line of best fit using a ruler. The line should go through the middle of the data, so there should be about the same number of points above and below the line. The line does not need to pass through any of the points and should not simply connect the first and last points.
		2.6	**Label** different data sets clearly if they are plotted on the same axes.
		2.7	**Draw** a triangle at least half the size of one of the graph dimensions when finding a gradient.
		2.8	**Draw** and shade in the area under a graph when using it to calculate a value.

		2.9	**Draw** sketch graph axes with a ruler.
		2.10	**Label** sketch graph axes with descriptions but not units.
		2.11	**Sketch** the general shape of a sketch graph.
3	Understand how to make measurements.	3.1	**Calculate** the mean of a data set.
		3.2	**Describe** measurements of length using an appropriate device. <3cm micrometer (or Vernier callipers), 3cm-1m metre rule, 1m-10m tape measure, 10m+ trundle wheel.
		3.3	**Describe** how to measure the volume/diameter of a cylinder. e.g. Measure a wire by measuring its diameter (usually with a micrometer) at different points along it and at different orientations, then take an average.
		3.4	**Describe** how to measure small dimensions by measuring multiple objects. e.g. Measuring the thickness of paper by measuring a large number of identical sheets stacked next to each other and finding the average.
		3.5	**Describe** how to measure vertical distances, including making sure the measurement is actually vertical. Use set-squares or plumb-line to check.
		3.6	**Describe** measurements of time using an appropriate device. Stop-watch/stop-clock, or timer are acceptable. Clocks and watches are not accurate enough for times less that several hours.
		3.7	**Describe** how to measure a small-time interval by measuring multiple consecutive events. e.g., Timing a pendulum swing by timing a large number of repetitions and finding the average.
		3.8	**Describe** measurements of mass using an appropriate device. (Electronic) balance is acceptable. Scales are not accurate enough for masses less that about 100kg.
		3.9	**Describe** how to measure a small mass by measuring a large number of identical objects.
		3.10	**Describe** how to measure volumes using appropriate equipment. A measuring cylinder for liquids, a displacement can and measuring cylinder for oddly shaped objects, measurements and calculations for regular objects.
		3.11	**Describe** how to measure current and potential difference.

		3.12	**Describe** how to use a thermometer to find the temperature of a solid, liquid or gas. Ensuring thermal contact with the solid, not in contact with a fluids container, ensuring that the fluid is stirred, and waiting for the thermometer to reach the same temperature as the material it is measuring.
		3.13	**Describe** measurements of angle using an appropriate device.
		3.14	**Define** an 'Anomaly' as a measurement result that is significantly far away from the other results (compared to the uncertainty in the measurements).
4	Understand how to conduct an experiment.	4.1	**Identify** the independent, dependent variables and control variables in an experiment.
		4.2	**Describe** how variables are measured and/or controlled.
		4.3	**Draw** a labelled diagram of the apparatus and/or circuit.
		4.4	**State** safety precautions.
		4.5	**Describe** how to conduct the experiment. A student who is just starting International GCSE should be able to follow your description and obtain usable results.
		4.6	**State** which parts are to be repeated for accuracy, which results are ignored as anomalies, and that you will take an average.
		4.7	**State** what changes you would make to the independent variable before repeating the whole process.
		4.8	**State** the equations you would use to calculate the results.
		4.9	**Describe** the graph you would plot and how you would obtain results from it.

2	Motion		
Aim Physics is all about how things move and change. The aim of this subject content is to describe, depict, calculate and predict the motion of objects.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1		1.1	**List** examples of scalar quantities.
		1.2	**List** examples of vector quantities.
		1.3	**State** an appropriate direction along with a magnitude for vector quantities.
		1.4	**Draw** vector diagrams.
		1.5	D**etermine** the sum of two vectors using vector diagrams.
2	Understand displacement, velocity and acceleration.	2.1	**Define** 'Displacement' as the distance travelled in a given direction and use distance and displacement correctly in descriptions.
		2.2	**Define** 'Speed' as the distance travelled per unit time.
		2.3	**Solve** problems using $v = \frac{s}{t}$ and $\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$.
		2.4	**Define** 'Velocity' as the speed in a given direction and use speed and velocity correctly in descriptions.
		2.5	**Outline** an experiment to find the average speed of a given object moving in a straight line.
		2.6	**Define** 'Acceleration' as the rate of change of velocity.
		2.7	**State** that acceleration can cause the velocity to increase or decrease, and/or change direction.
		2.8	**Understand** that 'Deceleration' is the 'Rate of decrease of velocity'.
		2.9	**Solve** problems using $a = \frac{\Delta v}{\Delta t}$, and $\text{Average Acceleration} = \frac{\text{Change in Velocity}}{\text{Time Taken}}$.

		2.10	**Outline** an experiment to find the average acceleration of a given object moving in a straight line.
3	Understand motion graphs.	3.1	**Draw** distance-time and velocity-time graphs.
		3.2	**Interpret** distance-time and velocity-time graphs.
		3.3	**Calculate** speed from the gradient of a distance-time graph.
		3.4	**Calculate** acceleration from the gradient of a velocity-time graph.
		3.5	**Calculate** distance travelled from the area under a velocity-time graph.
		3.6	**Identify** key points on a distance-time or velocity-time graph.
4	Understand the equations of motion.	4.1	**State** that the 'SUVAT' equations of motion describe the movement of objects under constant acceleration.
		4.2	**Recognise** situations where velocity or acceleration are constant, or where acceleration is changing (from descriptions, data or graphs).
		4.3	**Solve** problems using $s = ut + \frac{1}{2}at^2$.
		4.4	**Solve** problems using $v = u + at$.
		4.5	**Solve** problems using $s = \frac{u+v}{2}t$.
		4.6	**Solve** problems using $v^2 = u^2 + 2as$ (equation given).
		4.7	**Calculate** the average velocity of an object using $\text{Average Velocity} = \frac{u+v}{2}$.
		4.8	**Estimate** typical speeds and the magnitude of common accelerations.
5.	Understand momentum.	5.1	**Define** 'Momentum' as the product of an objects (inertial) mass and its velocity.
		5.2	**Solve** problems using $p = mv$.

		5.3	**State** that momentum is conserved unless an external force acts.
		5.4	**Explain** how a moving object can lose momentum.
		5.5	**Use** Total Momentum Before = Total Momentum After to **solve** problems involving the collision of two objects (assuming no external forces) in one dimension.
		5.6	**Explain** why momentum is conserved during a collision.
		5.7	**Outline** an experiment to test the conservation of momentum.

3	Forces		
Aim Forces mediate the interactions between objects. The aim of this subject content is to explain the interaction of objects through forces and how those forces can balance out to produce a system in equilibrium.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand forces.	1.1	**Define** a 'Force' as an interaction that tries to change an objects momentum.
		1.2	**List** examples of forces.
		1.3	**Draw** force vectors as arrows with length proportional to the magnitude of the force.
		1.4	**Describe** how multiple forces can be represented by a single resultant force.
		1.5	**Calculate** the resultant of several parallel forces.
		1.6	**Use** vector diagrams to find the resultant force in an unbalanced (non-equilibrium) system, or to find the unknown force in a balanced (equilibrium) system.
		1.7	**Draw** free-body diagrams for simple systems.
		1.8	**Explain** why stretching, compressing or bending an object requires more than one force to be acting on the object.
		1.9	**Distinguish** between internal (acting between two objects inside the system) forces and external (acting on an object in the system from outside it) forces.
		1.10	**Describe** resistance forces as forces that oppose motion, and give examples.
		1.11	**State** that friction and air resistance increase as the speed of an object increases.
		1.12	**State** that the force due to gravity/gravitational field strength/acceleration due to gravity is constant near the Earth's surface.
		1.13	**Explain** the motion of a body falling in a constant gravitational field in terms of the forces acting on it.
		1.14	**Describe** 'Terminal Velocity' as the velocity reached when the accelerating force is balanced by the resistance forces, so that the resultant force/acceleration is zero, and therefore the velocity does not change.

2	Understand Newton's Laws.	2.1	**State and use** Newton's First Law – An object maintains its state of motion unless acted upon by an external resultant force.
		2.2	**State and use** Newton's Second Law – An object accelerates when acted upon by an external resultant force.
		2.3	**Solve** problems using $F = ma$, where *m* is the inertial mass.
		2.4	**Define** the 'Inertial Mass' as the resistance to changing the velocity of an object, given by $m = \frac{F}{a}$. {The distinction between inertial and gravitational mass will not be examined, and use of the term 'inertial' will not be expected by the student}
		2.5	**Define** 'Weight' as the force exerted on an object (with mass) by gravity.
		2.6	**Recall** that the gravitational field strength, *g*, is 10 m/s at the Earth's surface, and that it will be different on other planets/moons/etc.
		2.7	**Solve** problems using $\text{Weight} = mg$, where *g* is given if the object is not on the Earth's surface.
		2.8	**Explain** why motion in a circle at a constant speed requires a constant force (towards the centre of the circle).
		2.9	**State and use** Newton's Third Law – When an object exerts a force on a second object, the second object exerts an equal and opposite force on the first.
		2.10	**Identify** Newton's Third Law force pairs.
		2.11	**Explain** why two forces are/aren't Third Law pairs.
		2.12	**Outline** an experiment to estimate human reaction times.
		2.13	**Recall** typical human reaction times (~0.1-0.2 seconds).
		2.14	**Explain** factors that affect the stopping distance [thinking distance + braking distance] of a car in an emergency.
		2.15	**Explain** the dangers of high deceleration and **estimate** the forces involved in normal traffic situations and during crashes.
		2.16	**Explain**, using Newton's Laws and the equations of motion, how car safety systems reduce the force, and therefore the damage, on passengers in a crash. {Answers involving the force being proportional to the rate of change of momentum will be accepted, but not expected}

3	Understand forces acting on springs.	3.1	**State** that a force can change the shape of an object.
		3.2	**State** that if an object returns to its original shape when the force deforming it is removed then the change was elastic, otherwise the change is inelastic.
		3.3	**State** Hooke's Law as the extension of a spring is directly proportional to the force causing the extension.
		3.4	**Solve** problems using $F = kx$.
		3.5	**Outline** an experiment to find the spring constant of a metal spring.
		3.6	**Define** the 'Limit of Proportionality' as the point beyond which Hooke's law no longer applies.
		3.7	**Define** the 'Elastic Limit' as the point beyond which a stretched object will not return to its original length when the force is removed.
		3.8	**Identify** the limit of proportionality and the elastic limit on a Force-Extension graph.
		3.9	**Interpret** Force-Extension graphs and use them to calculate a spring constant, and the energy stored, below the limit of proportionality.
4	Understand pressure.	4.1	**Define** 'Pressure' as the force per unit area.
		4.2	**State** that the pressure on a surface is at right angles (normal) to the surface.
		4.3	**Solve** problems using $P = \frac{F}{A}$.
		4.4	**Explain** why pressure in a fluid varies with height or depth.
		4.5	**State** that the pressure at a point in a fluid is the same in all directions.
		4.6	**Define** 'Density' as the mass per unit volume of a material.
		4.7	**Solve** problems using $\rho = \frac{m}{V}$.
		4.8	**Explain** why the pressure in a fluid depends in the density of the fluid.
		4.9	**Solve** problems using $P = \rho g h$ (equation given).

		4.10	**Explain** how the difference in pressure above and below a partially submerged object leads to an upwards force (buoyancy) on the object.
		4.11	**Describe** factors that affect whether an object sinks or floats.
		4.12	**Explain** why one object floats while the other sinks even though they have the same mass and are made from the same material.
5.	Understand moments.	5.1	**Define** a 'Moment' as the turning effect of a force.
		5.2	**Describe** everyday examples where forces cause rotation.
		5.3	**Solve** problems using Moment = Force x (Perpendicular) Distance to Pivot.
		5.4	**State** the 'Principle of Moments': In a balanced system the sum of the clockwise moments is equal to the sum of the anti-clockwise moments (about a single point).
		5.5	**Outline** an experiment to test the principle of moments.
		5.6	**Solve** problems using the principle of moments.
		5.7	**Explain** how a lever can be used to lift a heavy object.
		5.8	**Explain** how gears transmit and change a rotational force.
		5.9	**Define** the 'Centre of Mass' as the point in an object where all the mass appears to act from.
		5.10	**Explain** why an object does not rotate if its centre of mass is directly above a fulcrum.
		5.11	**Explain** what effect the position of the centre of mass (vertically or horizontally) has on the stability of an object.
		5.12	**Outline** a method to find the centre of mass of an object.

4	Energy		
Aim Energy is the driving force behind changes in the physical world. The Aim of this subject content is to explain what the quantity called ‘Energy’ is, how it can cause motion, and how it can be moved between different stores in order to produce useful effects.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand energy stores and changes.	1.1	**Define** ‘Work’ as the energy transferred when a force causes an object to move a distance.
		1.2	**Solve** problems using $W = Fd$.
		1.3	**Define** ‘Energy’ as the capacity to do Work.
		1.4	**List** examples of ‘Energy Stores’.
		1.5	**Describe** the energy transfers that take place in common devices or situations.
		1.6	**Define** ‘Power’ as the rate at which energy is transferred.
		1.7	**Solve** problems using $P = \frac{W}{t}$.
2	Understand energy conservation and efficiency.	2.1	**State** that energy is conserved.
		2.2	**Define** ‘Useful’ energy as the energy output in the forms a device was intended to produce, and ‘Wasted’ energy as the energy output in the forms a device was not intended to produce.
		2.3	**Identify** useful and wasted energies in common devices or situations.
		2.4	**Calculate** an unknown energy using $\text{Total Energy In} = \text{Total Energy Out}$.
		2.5	**Explain** how energy tends to dissipate/spread out among objects in a system, and that system’s surroundings, so that it is stored in less useful ways.
		2.6	**Draw** Sankey diagrams from data.
		2.7	**Calculate** the efficiency of a system using $\text{Efficiency} = \frac{\text{Useful Energy}}{\text{Total Energy}}$.
		2.8	**Explain** ways of improving the efficiency of a system

		2.9	**Explain** how parts of a building reduce the amount of heat lost to the environment.
3	Understand energy calculations	3.1	**Solve** problems using $K.E. = \frac{1}{2}mv^2$.
		3.2	**Solve** problems using $G.P.E. = mgh$.
		3.3	**Solve** problems using $\text{Energy Stored in a Spring (E.P.E.)} = \frac{1}{2}kx^2$ (equation given).
		3.4	**Solve** problems involving the transfer of energy between K.E., G.P.E. and E.P.E.
		3.5	**Outline** an experiment to test the conservation of energy using a falling object.
		3.6	**Solve** problems involving the work done on a system and the K.E., G.P.E. and E.P.E. gained.
		3.7	**Solve** problems involving the power put into a system and the K.E., G.P.E. and E.P.E. gained.
4.	Understand energy resources.	4.1	**Explain** how the main energy sources available on Earth are used to generate electricity.
		4.2	**Define** 'Renewable Energy Sources' as sources which replenish themselves faster than they can be used.
		4.3	**Compare and Contrast** the main energy sources in terms of renewability, reliability, cost to set-up, cost to run, environmental impact and limitations.
		4.4	**Explain** why an energy source would or would not be suitable in a given situation.

5	Waves		
Aim Waves are a class of phenomena across many different areas of physics. The aim of this subject content is to understand the similarities and differences of different types of wave, and how wave properties and the way they interact with materials can be used to our advantage.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the characteristics of waves.	1.1	**Describe** waves as oscillations that transfer energy without transferring matter.
		1.2	**Define** the term 'Amplitude' as the difference between the maximum value of the wave and the equilibrium value.
		1.3	**Define** the term 'Wavelength' as the distance between two adjacent maxima (or minima).
		1.4	**Define** the term 'Frequency' as the number of wavelengths passing a point per second.
		1.5	**Define** the term 'Period' as the time taken for one whole wavelength to pass a point.
		1.6	**Label** diagrams of waves with: amplitude, wavelength or period, crest and trough.
		1.7	**Solve** problems using $v = f\lambda$
		1.8	**Compare and Contrast** transverse and longitudinal waves and give examples of each type.
2	Understand the interaction of waves with a boundary.	2.1	**Define** the term 'Reflection' as an abrupt change in direction of a wave when it meets a boundary, such that it remains in the original material.
		2.2	**Define** the term 'Refraction' as an abrupt change in direction of a wave when it meets a boundary, such that it passes into the second material.
		2.3	**Define** the term 'Diffraction' as the spreading out of a wave as it passes through a gap, or travels past an object.
		2.4	**Define** the term 'Transmission' as the passing of all or part of a wave completely through an object or region.
		2.5	**Define** the term 'Absorption' as the transfer of energy from a wave into the medium it is passing through.
		2.6	**Identify** angles of 'Incidence', 'Reflection' and 'Refraction'.

		2.7	**Describe** reflection at a plane surface and relate it the effect of reflections from smooth (specular reflection) and rough surfaces (diffuse reflection).
		2.8	**State and use** the law of reflection *angle of incidence = angle of reflection.*
		2.9	**Outline** an experiment to test the law of reflection.
		2.10	**Explain** refraction at a boundary in terms of the change in wavelength due a change in speed at constant frequency.
		2.11	**Solve** problems using $n_1 \sin\theta_1 = n_2 \sin\theta_2$ where a light wave passes between air and a transparent material.
		2.12	**Outline** an experiment to find the refractive index of an unknown material.
		2.13	**Describe** the effect on a wave passing through a gap that is either much larger than the wavelength or approximately the same size as the wavelength.
		2.14	**State** real world examples of reflection, refraction and diffraction.
3	Understand electromagnetic waves.	3.1	**State** that light is an electromagnetic wave.
		3.2	**Recall** that the speed of light in a vacuum, *c*, is $3\text{x}10^8$ m/s, and that it is approximately the same in air.
		3.3	**State** the properties of electromagnetic waves. EM waves: transverse, same velocity, travel through a vacuum, and exhibit wave behaviour (e.g., refraction).
		3.4	**List** the different parts of the electromagnetic spectrum in order of increasing/decreasing wavelength/frequency.
		3.5	**Describe** means of producing and detecting each of the parts of the electromagnetic spectrum.
		3.6	**Describe** uses and dangers for each of the parts of the electromagnetic spectrum.
		3.7	**List** the colours in the visible part of the electromagnetic spectrum in order of increasing/decreasing wavelength/frequency.

		3.8	**Describe** how the relative amounts of absorption, transmission and reflection of light by a substance depends on the wavelength of light.
		3.9	**Explain** how colour depends on the differences in absorption, transmission, specular reflection and scattering for different wavelengths.
4.	Understand how to construct ray diagrams.	4.1	**Construct** a ray diagram to show reflection in a plane mirror.
		4.2	**Construct** a ray diagram to show the refraction of light passing through a rectangular glass block.
		4.3	**Sketch** a ray diagram of visible light passing through a prism (dispersion).
		4.4	**Define** the terms 'Converging', 'Diverging', and 'Focal point'.
		4.5	**Construct** ray diagrams for convex and concave lenses.
5	Understand sound waves.	5.1	**State** that sound is a longitudinal wave.
		5.2	**Define,** and relate to the equivalent wave terms, the terms 'Loudness' [Amplitude], 'Pitch' [Frequency], and 'Echo' [Reflection].
		5.3	**Describe** sound waves as a series of compressions and rarefactions in a medium.
		5.4	**Explain** how sound travels through air and solids.
		5.5	**Explain** why sound travels better and faster through a solid than a gas.
		5.6	**State** that the range of audible frequencies for humans is about 20Hz to 20kHz.
		5.7	**Identify** sound waves as 'Ultrasound', 'Infrasound' or 'Audible'.
		5.8	**Describe** how the frequency dependence of absorption/reflection of a wave incident upon a solid limits the frequency range of detection by a device.
		5.9	**Explain** why the human hearing range is limited.
		5.10	**Outline** an experiment to find the speed of sound in air.

6	Understand applications of waves.	6.1	**Describe** how the interaction of waves with different media can be used to investigate internal/hidden structures.
		6.2	**Explain** how ultrasound can be used to 'look' inside our bodies, how earthquakes can be used to 'look' inside the Earth, and how sonar can be used to 'look' through deep water.
		6.3	**Explain** how refraction of light from glass into air leads to Total Internal Reflection.
		6.4	**Solve** problems using $n = \frac{1}{\sin c}$ where *c* is the critical angle and **define** what the critical angle is.
		6.5	**Explain** how optical fibres use total internal reflection to allow long distance communication (fibre optic cables) and medical diagnosis (endoscopes).
		6.6	**Describe** how the relative motion of the source and observer leads to a change in observed frequency – Doppler Effect.

6	Electricity		
Aim Electricity is the most diversely used energy source in our modern world. The aim of this subject content is to explain the difference between current and static electricity, how each can be used to produce beneficial effects, and how the dangers of each can be prevented.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand current, potential difference and resistance.	1.1	**Define** 'Current' as the rate of flow of charge (through a point in a circuit).
		1.2	**Solve** problems using $I = \frac{Q}{t}$.
		1.3	**State** that the current in metals is due to the flow of electrons.
		1.4	**Recall** that electrons flow in the opposite direction to 'Conventional Current'.
		1.5	**Define** 'Potential Difference' at the energy transferred per unit charge (moving across a component in a circuit). {use of the term 'e.m.f.' will not be expected}
		1.6	**solve** problems using $V = \frac{W}{Q}$.
		1.7	**State** that for current to flow a closed circuit and a source of potential difference is required.
		1.8	**Define** 'Resistance' as the ratio of the potential difference across a component and the current through it.
		1.9	**Solve** problems using $R = \frac{V}{I}$.
		1.10	**State** that a component with constant resistance is called an 'Ohmic Conductor'.

		1.11	**Identify** an ohmic conductor from a graph or data table.
		1.12	**Calculate** the resistance of an ohmic conductor from a graph or data table.
		1.13	**Sketch and identify** I-V graphs for fixed resistors, bulbs/lamps, and diodes/LED's.
		1.14	**Sketch** the I-V graph for a (negative coefficient) thermistor or LDR when the conditions change, given the original curve.
		1.15	**Explain** I-V graphs for fixed resistors, bulbs/lamps, and diodes/LED's.
		1.16	**Explain** the changes in the I-V graph for a thermistor or LDR when the conditions change.
		1.17	**Calculate** the resistance of a component at a specified potential difference given its I-V graph.
		1.18	**Solve** problems using $P = IV$ (components and devices).
2	Understand series and parallel circuits.	2.1	**Draw and identify** common component symbols. (wire, cell, battery, switch, fixed resistor, variable resistor, LDR, thermistor, lamp, diode, ammeter, voltmeter)
		2.2	**Describe** the difference between series and parallel circuits.
		2.3	**Draw and interpret** simple circuit diagrams using common component symbols.
		2.4	**Explain** why the resistance of two identical resistors in series is higher than one of the resistors (qualitative only).
		2.5	**Calculate** the total resistance of two resistors in series using $R_T = R_1 + R_2$.
		2.6	**Explain** why the resistance of two identical resistors in parallel is lower than one of the resistors (qualitative only).
		2.7	**Calculate** the total resistance of two resistors in parallel using $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$.
		2.8	**Calculate** currents, potential differences and resistances in series and parallel circuits using the circuit rules.
		2.9	**Outline** an experiment to determine the resistance of a fixed resistor using an ammeter and a voltmeter.
		2.10	**Outline** an experiment to determine how the resistance of an LDR/Thermistor depends on the light level/temperature using an ammeter and a voltmeter.

		2.11	**Describe** advantages and disadvantages of series and parallel circuits.
3	Understand the mains (domestic) electricity supply.	3.1	**Recall** that the domestic supply in the UK is A.C. at 50 Hz, and that the voltage is equivalent to D.C. at 230V. {rms is a useful term but is not required}
		3.2	**Describe** the functions of the 'Live', 'Neutral' and 'Earth' wires in a mains cable or electrical appliance.
		3.3	**Identify** 'Live', 'Neutral' and 'Earth' wires by their colour codes. {Only the current UK colour codes will be examined, but an appreciation of the existence of past codes and variation across countries should be encouraged}
		3.4	**Describe** how to safely wire a mains plug. {The position of wires will not be examined}
		3.5	**Identify** common faults from mains plug diagrams.
		3.6	**Explain** common electrical hazards in the home.
		3.7	**Explain** how 'Earth Wires', 'Fuses' and 'Circuit Breakers' protect us from harm.
		3.8	**Explain** the advantages and disadvantages of 'Earth Wires', 'Fuses' and 'Circuit Breakers'.
		3.9	**Explain** how a live wire is dangerous even when a plug socket is switched off.
4.	Understand static electricity.	4.1	**State** that charges are either positive or negative.
		4.2	**Describe** the direction of the force between two like charges and between two unlike/opposite charges.
		4.3	**State** that an 'Electric Field' is a region in which an electric charge experiences a force, and that the direction of the field is the direction of the force on a positive charge.
		4.4	**Sketch** the electric field around a point charge, between two-point charges, around a conducting sphere, and between parallel plates. {Edge effects can be ignored}

		4.5	**State** that a body becomes charged if electrons are added or removed.
		4.6	**Describe** 'Static Electricity' as the effects of the electric fields due to separated charges.
		4.7	**Describe** methods of producing charge separation.
		4.8	**Describe** the difference between insulators and conductors in terms of the actions of electrons.
		4.9	**Explain** the effects of static electricity in terms of the actions of electrons in simple situations where a charged insulator is brought close to either a charged insulator, a conductor, or an uncharged insulator.
		4.10	**Explain** why a build-up of charge on an insulator is dangerous.

7	Magnetism		
Aim Magnetism is a fundamental physical force and controlling it allows much of our modern world to function. The aim of this subject content is to describe how magnetic fields can be produced, explain how they can be used to create rotation, and explain how they are used to produce and transfer electricity.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand magnetic fields.	1.1	**State** that all magnets have a North pole and a South pole.
		1.2	**Describe** the direction of the force between: Two North poles; Two South poles; A North and a South pole; A North or South pole and a magnetic material.
		1.3	**State** the difference between a permanent magnet and an induced magnet.
		1.4	**Use** 'Iron' and 'Steel' as examples of materials for constructing permanent and non-permanent magnets.
		1.5	**Describe** methods for magnetising and demagnetising a permanent magnet.
		1.6	**State** that a 'Magnetic Field' is a region in which a magnetic pole experiences a force, and that the direction of the field is the direction of the force on a North Pole.
		1.7	**Sketch** the magnetic field lines around a bar magnet or two separate magnetic poles near each other, and label the direction of the field.
		1.8	**Outline** an experiment to determine the pattern of the magnetic field around a magnet, and which direction the field points in.
		1.9	**Explain** why the North Pole of the Earth must be a South Magnetic Pole.
2	Understand electromagnets and the motor effect.	2.1	**State** that a moving charge (current) produces a magnetic field.
		2.2	**State** that a solenoid is a coil of conducting wire.
		2.3	**Sketch** the magnetic field around a straight conducting wire and a solenoid.
		2.4	**Use** the right-hand grip to determine the direction of the magnetic field around a straight conducting wire or solenoid.
		2.5	**Outline** an experiment to show that a current carrying wire produces a magnetic field.

		2.6	**Describe** how the strength of the magnetic field produced depends on the current flowing through the wire and the distance from the wire.
		2.7	**Explain** how the strength of the magnetic field can be increased.
		2.8	**Use** Fleming's Left Hand Rule to relate the direction of the force on a current carrying wire inside a magnetic field to the directions of the magnetic field and the current.
		2.9	**Solve** problems using $F = BIL$ (equation given).
		2.10	**Describe** the construction of an electro-magnet and some simple uses for it.
		2.11	**Explain** why an electromagnet uses an iron core and not a steel core.
		2.12	**Explain** how an electric motor works. {The turning effect only}
		2.13	**State** that a split-ring commutator reverses the current through a DC motor, allowing it to keep turning in the same direction.
		2.14	**Describe** how the turning force of a motor can be increased.
3	Understand electromagnetic induction.	3.1	**Describe** how changing the magnetic field that a conductor sits inside creates a potential difference across the conductor.
		3.2	**State** that 'Electromagnetic Induction' is the production of a potential difference in a conductor due to a changing magnetic field. {Use of the term 'e.m.f.' will not be expected}
		3.3	**Outline** an experiment to demonstrate electromagnetic induction.
		3.4	**Explain** how a rotating coil generator produces A.C. current.
		3.5	**State** that a slip-ring maintains contact with the same side of the generator coil during rotation, and therefore gives A.C. output.
		3.6	**State** that a split-ring switches contact with the sides of the generator coil during rotation, and therefore gives D.C. output.

		3.7	**Explain** how a microphone converts pressure variations (sound wave) into an electrical signal.
		3.8	**Explain** how a loudspeaker converts an electrical signal into a pressure variation (sound wave).
		3.9	**Explain** how the current produced by electromagnetic induction must produce a magnetic field that opposes the inducing magnetic field (Lenz's Law).
4.	Understand transformers.	4.1	**State** that a 'Transformer' is a device for changing the voltage in an A.C. circuit.
		4.2	**State** the changes that 'Step-up' and 'Step-down' transformers cause to the output voltage and current.
		4.3	**Describe** the construction of a transformer.
		4.4	**Explain** how a transformer works.
		4.5	**Solve** problems using $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ (equation given).
		4.6	**Solve** problems using $I_pV_p = I_sV_s$ (equation given) for 100% efficiency.
		4.7	**Describe** how transformers are used in the transmission of electricity across large distances.
		4.8	**Explain** why the power loss along transmission wires is less when the voltage is higher.

8	Thermal Physics		
Aim The aim of this subject content is to describe the different states of matter, explain how thermal energy is transferred and how we can reduce that transfer, and how the amount of internal energy affects a substance.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the states of matter and the transitions between them.	1.1	**Draw** diagrams of the particle arrangements in solids, liquids, and gases.
		1.2	**Describe** the particle arrangement and motion in solids, liquids, and gases
		1.3	**Define** the term 'Density'.
		1.4	**Solve** problems using $\rho = \frac{m}{v}$.
		1.5	**Outline** an experiment to find the density of an object with a complicated shape.
		1.6	**Explain** the relative densities of solids, liquids, and gases in terms of particle arrangements. {The special case of ice is not needed}
		1.7	**Define** the state change terms 'Melt' [solid->liquid], 'Freeze' [liquid->solid], 'Evaporate' [liquid->gas], 'Condense' [gas->liquid], 'Sublimate' [solid->gas], and 'Deposit' [gas->solid].
		1.8	**Explain** why state changes are physical changes and not chemical changes.
2	Understand the changes in internal energy as a substance is heated or cooled.	2.1	**State** that the energy stored in a chemical bond is negative (you are required to put energy into the bond in order to break it).
		2.2	**State** that 'Internal Energy' is the energy stored in the chemical bonds (P.E.) and motion of the particles (K.E.) in a substance.
		2.3	**Describe** how heating a system increases its internal energy.
		2.4	**State** that the temperature of a gas is proportional to the average kinetic energy of the gas molecules.
		2.5	**Explain** why heating a system either increases its temperature or changes its state.
		2.6	**Define** the term 'Specific Heat Capacity (of a substance in a specific state)' as the energy required to increase the temperature of 1kg of a substance by 1^{o}C.

		2.7	**Define** the term 'Specific Latent Heat (of a substance in a specific state)' as the energy required to change the state of 1kg of a substance.
		2.8	**Solve** problems using $\Delta E = mc\Delta T$, where *c* is the Specific Heat Capacity (equation given).
		2.9	**Solve** problems using $\Delta E = mL$, where *L* is the Specific Latent Heat, (equation given).
		2.10	**Outline** an experiment to calculate the Specific Heat Capacity of a liquid.
3	Understand the relationship between pressure, volume and temperature of an ideal gas.	3.1	**Recall** that an 'Ideal Gas' as a simple model of a gas that allows us to create equations that describe its behaviour, and that most gases behave like an ideal gas.
		3.2	**Explain** how the pressure on the walls of a container is the result of collisions between the gas molecules and the wall.
		3.3	**State** that the force on a surface due to the pressure of the gas is directed at right angles (normal) to the surface.
		3.4	**Explain** the relationship between pressure and temperature at constant volume (qualitative*).
		3.5	**Explain** the relationship between pressure and volume at constant temperature (qualitative*).
		3.6	**Explain** the relationship between volume and temperature at constant pressure (qualitative*). {The derivation of PV=nRT is not necessary. PV=nRT will not be used for calculation, and it is not expected to be known}.
		3.7	**Solve** problems using $PV = \text{constant}$ (equation given)
		3.8	**Explain** how doing work on a gas can increase its temperature.

4	Understand how thermal energy flows from one place to another.	4.1	**Describe** the difference between 'Heat' and 'Temperature'
		4.2	**Explain** the process of heat transfer by Conduction.
		4.3	**Explain** the process of heat transfer by Convention.
		4.4	**Explain** the process of heat transfer by Radiation.
		4.5	**Explain** the process of heat transfer by Evaporation.
		4.6	**Explain** how each type of heat transfer can be prevented or reduced.
5	Understand black body radiation.	5.1	**State** the effect of surface colour and texture on the absorption, emission, and reflection of radiation.
		5.2	**Define** a 'Black Body' as an ideal object that absorbs all radiation that falls on it and emits all frequencies of radiation.
		5.3	**State** that the radiation emitted by a black body is a characteristic of its temperature.
		5.4	**Sketch** the emission graph of a black body.
		5.5	**Explain** that the energy emitted and absorbed by a body in thermal equilibrium with its surroundings is balanced.

9	Nuclear		
Aim Nuclear processes power the Sun, create electricity, and have many other uses in our modern world. The aim of this subject content is to describe the internal structure of the atom, explain how energy can be released by nuclear processes, and explain the uses and hazards of radiation.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the composition of the atom.	1.1	**Describe** the structure of an atom.
		1.2	**State** the typical size of atoms, molecules and nuclei (order of magnitude).
		1.3	**Describe** how the accepted model of the atom has changed over time.
		1.4	**Explain** how Rutherford's Gold Foil experiment provides evidence for the nucleus.
		1.5	**State** that electrons inside an atom have specific energy levels they can be in.
		1.6	**Describe** how the electrons move between energy levels as the absorb and emit energy.
		1.7	**State** that electrons that gain enough energy will leave their atoms, and that that loss of electrons changes those atoms into ions.
2	Understand nuclear terms.	2.1	**Define** the term 'Isotopes' as nuclei with the same number of protons but a different number of neutrons.
		2.2	**Define** the term 'Radiation' as energy or particles emitted by a source in all directions.
		2.3	**Define** the term 'Radioactive decay' as a change in the nucleus (of an atom) the causes radiation to be emitted
		2.4	**Define** the term 'Radioactive' (Substance) as (a substance that is) undergoing radioactive decay.
		2.5	**Define** the term 'Half-life' as the time it takes (on average) for half of the nuclei in a radioactive substance to decay.
		2.6	**Define** the term 'Background radiation' as the radiation that is not produced by the source under consideration.

3	Understand radioactive decay.	3.1	**Explain** that radioactive nuclei are unstable and undergo radioactive decay by emitting radiation.
		3.2	**State** that unstable nuclei can emit alpha particles, beta particles, neutrons, or electromagnetic radiation (gamma-rays).
		3.3	**List** the properties of each type of nuclear radiation (what they are, relative charge, relative mass).
		3.4	**List** sources of background radiation.
		3.5	**Outline** an experiment to demonstrate the how the amount of gamma radiation varies with distance from the source, taking background radiation into account.
		3.6	**Explain** the changes in the nucleus when radiation is emitted.
		3.7	**Use** nuclear notation to write balanced equations for radioactive decay.
		3.8	**Explain** how radiation can cause the ionisation of atoms they interact with.
		3.9	**State** the relative penetration and ionisation power of alpha, beta and gamma radiation.
		3.10	**Outline** an experiment to determine the type of radiation emitted from a source, taking background radiation into account.
		3.11	**Calculate** the half-life of a radioactive material using data tables or graphs. {Simple multiples only}
		3.12	**Describe** how to correct for background radiation when measuring the activity of a radioactive source.
		3.13	**Calculate** the activity of a radioactive source by correcting for background radiation.
		3.14	**Calculate** the amount of radioactive material left after a whole number of half-lives.
4	Understand nuclear fission and nuclear fusion.	4.1	**Describe** the process of induced nuclear fission.
		4.2	**Explain** how the release of multiple neutrons during a fission event leads to a chain reaction.
		4.3	**Describe** the function of the moderator and control rods in a nuclear fission reactor.

		4.4	**Describe** the process of nuclear fusion.
		4.5	**Use** nuclear notation to write balanced equations for nuclear fission and nuclear fusion.
		4.6	**Compare and contrast** nuclear fission and nuclear fusion.
5.	Understand the hazards and applications associated with nuclear processes.	5.1	**Explain** the difference between contamination and irradiation.
		5.2	**Compare and contrast** the relative danger of ionising radiation and radioactive material.
		5.3	**Describe** the danger associated with ionising radiation.
		5.4	**Explain** the dangers of associated with radioactive material, and how they depend on the half-life of the material.
		5.5	**Describe** uses for each type of ionising radiation.
		5.6	**Explain** what sort of source is best for a given application in terms of the penetrating power of the radiation and the half-life of the source.
		5.7	**Outline** how Carbon-14 can be used to find out how old an object is.
		5.8	**Explain** why Carbon dating is limited to the last 50,000 years.

10	Space		
Aim Space is the final frontier. The aim of this subject content is to describe our solar system, the life-cycle of stars and how the universe has changed over time.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the structure and motion of the solar system.	1.1	**Define** the term 'Solar system' as a collection of moons, planets, asteroids and comets orbiting a star.
		1.2	**Define** the term 'Galaxy' as a collection of stars and solar systems held together by gravity.
		1.3	**Compare and Contrast** the main features of the Solar System – The Sun, Planets, Moons, Comets, Asteroids, and Artificial Satellites.
		1.4	**Explain** that an orbit is an example of circular motion where the force towards the centre is provided by gravity.
		1.5	**Explain** why, for a stable orbit, the velocity of a satellite must constantly change while its speed stays the same.
		1.6	**Explain** why changing the speed of the satellite will change the radius of its orbit.
2	Understand the life cycle of a star.	2.1	**State** that nuclear fusion requires high densities and temperatures.
		2.2	**Describe** the formation of a main sequence star (nebula -> main sequence).
		2.3	**Explain** how the balance of gravitational forces and the energy produced via fusion produces a stable star.
		2.4	**State** that fusing Helium or larger nuclei requires much higher temperatures than fusing Hydrogen.
		2.5	**Describe** the progression of a low mass main sequence star (main sequence -> white dwarf).
		2.6	**Describe** the progression of a high mass main sequence star (main sequence -> neutron star or black hole.
		2.7	**Label** the points in a star's life cycle on a Hertzsprung-Russell diagram.

3	Understand the evidence for the expansion of the Universe.	3.1	**Explain** the doppler effect's effect on observed electromagnetic radiation.
		3.2	**Explain** what 'Red-shift' and 'Blue-shift' mean.
		3.3	**State** that light from all distant galaxies is red-shifted, and that the amount of red-shift is proportional to their distance from Earth.
		3.4	**Explain** how the red-shift of galaxies is evidence that the Universe is expanding, and that they are unlikely to be just moving away from us.
		3.5	**Explain** that an expanding universe suggests that in the far past all matter was in one small place (The 'Big Bang' theory).

APPENDIX

MATHEMATICAL REQUIREMENTS

Calculators may be used in all parts of the examination.

Candidates should be able to:

1. Complete equations involving addition, subtraction, multiplication, and division
2. Calculate percentages
3. Calculate percentage change
4. Manipulate a range of formula to identify the unknown variable.
5. Carry out unit conversions
6. Judge appropriate orders of magnitude and scale
7. Calculate surface area and volume of a range of shapes circle, square, rectangle and triangle
8. Estimate values based on trends / sequences
9. Apply standard form to data
10. Able to sufficiently round data correctly
11. Provide answers to significant figures
12. Present values in line with equipment measurements e.g., 1.1cm^3 for a burette
13. Calculate energy efficiency
14. Calculate mean, mode and median
15. Calculate probability
16. Understand ratios.

SAFETY IN THE LABORATORY

Candidates should be able to:

1. Identify relevant hazards and associated risks of equipment used
2. Identify relevant hazards and associated risks chemicals used
3. Carry out practical procedures carefully and thoroughly applying good practice
4. Individual core practical hazards and risks can be found at https://www.cleapss.org.uk/ (Members only)

The safety of candidates and staff are the responsibility of the centre involved, full guidance can be found on https://www.cleapss.org.uk/ (Members only).

FORMULA

Motion

For constant acceleration: $v^2 = u^2 + 2as$

Forces

Pressure due to a column of liquid: $P = \rho g h$

Energy

Energy stored in a spring: $\Delta E = \frac{1}{2}kx^2$

Magnetism

Force on a current carrying conductor: $F = BIL$

Conservation of energy across a transformer: $I_p V_p = I_s V_s$

Transformer equation: $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Thermal Physics

Specific Heat Capacity: $\Delta E = mc\Delta T$

Specific Latent Heat: $\Delta E = mL$

Gas at constant temperature: $PV = \text{constant}$