National Course Specification: course details (cont)

Higher Physics: Mechanics and Properties of Matter

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding associated with Mechanics and Properties of Matter.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.1 Vectors	
1 Distinguish between distance and displacement.	Exercises involving the drawing of scale diagrams: total distance compared with desired displacement, eg in orienteering, sailing, hill walking or flying along air corridors.
2 Distinguish between speed and velocity.	
3 Define and classify vector and scalar quantities.	
4 Use scale diagrams, or otherwise, to find the magnitude and direction of the resultant of a number of displacements or velocities.	Computer simulation to study vectors.
5 State what is meant by the resultant of a number of forces.	
6 Carry out calculations to find the rectangular components of a vector.	Analysis of vehicles on a slope and ski tows, structures in equilibrium, eg television masts.
7 Use scale diagrams, or otherwise, to find the magnitude and direction of the resultant of a number of forces.	
1.2 Equations of motion	
1 State that acceleration is the change in velocity per unit time.	
2 Describe the principles of a method for measuring acceleration.	Data capture using a microcomputer. The tachograph.
3 Draw an acceleration–time graph using information obtained from a velocity–time graph for motion with a constant acceleration.	Graph plotting and interpretation. Graphs to illustrate the motion of a bouncing ball and a ball thrown vertically upwards.
4 Use the terms 'constant velocity' and 'constant acceleration' to describe motion represented in graphical or tabular form.	*s-t*, *v-t* and *a-t* graphs. Orders of magnitude of accelerations and speeds, eg in funfair, thrill rides and sport.
5 Show how the following relationships can be derived from basic definitions in kinematics: $v = u + at$, $s = ut + ½at^2$, $v^2 = u^2 + 2as$.	Derivation of equations of motion.
6 Carry out calculations using the above kinematic relationships.	Distances achieved, eg in long-jumping, ski-jumping and javelin. Trajectories and sighting adjustments. Arrows fired at an angle. Inclined planes.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.3 Newton's Second Law, energy and power	
1 Define the newton	Analysis of situations, involving a number of forces acting on an object.
2 Carry out calculations using the relationship $F = ma$ in situations where resolution of forces is not required.	Order of magnitude of forces in rocket motion, jet engine, pile driving, and sport.
3 Use free body diagrams to analyse the forces on an object.	Analysis of skydiving and parachuting, falling raindrops, scuba diving, lift and haulage systems.
4 Carry out calculations involving work done, potential energy, kinetic energy and power.	Discuss energy conservation.
1.4 Momentum and impulse	
1 State that momentum is the product of mass and velocity.	Experiments involving collisions and explosions of vehicles on a linear air track.
2 State that the law of conservation of linear momentum can be applied to the interaction of two objects moving in one dimension, in the absence of net external forces.	Analysis of interactions between colliding vehicles, snooker balls, motion in space, manned manoeuvring units.
3 State that an elastic collision is one in which both momentum and kinetic energy are conserved.	Discuss rebound and the vector nature of momentum.
4 State that in an inelastic collision momentum is conserved but kinetic energy is not.	
5 Carry out calculations concerned with collisions in which the objects move in only one dimension.	
6 Carry out calculations concerned with explosions in one dimension.	
7 Apply the law of conservation of momentum to the interaction of two objects moving in one dimension to show that: a) the changes in momentum of each object are equal in size and opposite in direction. b) the forces acting on each object are equal in size and opposite in direction.	
8 State that *impulse* = *force x time*.	Sensor and force-time graphs using a computer. Computer simulations for momentum and impulse. Application of momentum and impulse to car safety design, crumple zones, golf, hockey, football and racquet sports.
9 State that *impulse* = *change of momentum*.	
10 Carry out calculations using the relationship, *impulse* = *change of momentum*.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
1.5 Density and pressure	
1 State that density is mass per unit volume.	Measure the densities of solids and liquids and compare the results.
2 Carry out calculations involving density, mass and volume.	
3 Describe the principles of a method for measuring the density of air.	Measure the density of air and consider any safety precautions.
4 State and explain the relative magnitudes of the densities of solids, liquids and gases.	Compare the values of densities of solids, liquids and gases.
5 State that pressure is the force per unit area, when the force acts normal to the surface.	
6 State that one pascal is one newton per square metre.	
7 Carry out calculations involving pressure, force and area.	
8 State that the pressure at a point in a fluid at rest is given by $h\rho g$.	Pressure gauge and liquid-filled tubing to investigate pressure variations.
9 Carry out calculations involving pressure, density and depth.	
10 Explain buoyancy force (upthrust) in terms of the pressure difference between the top and bottom of an object.	Observations of upthrust on a submerged object. Hot-air balloons, semi-submersible rigs, submarines, hydrometer.
1.6 Gas laws	
1 Describe how the kinetic model accounts for the pressure of a gas.	Use computer simulations and mechanical models to promote discussion of the behaviour of gases.
2 State that the pressure of a fixed mass of gas at constant temperature is inversely proportional to its volume.	
3 State that the pressure of a fixed mass of gas at constant volume is directly proportional to its temperature measured in kelvins (K).	Experiments to investigate the relationships between the pressure, volume and temperature of a gas.
4 State that the volume of a fixed mass of gas at constant pressure is directly proportional to its temperature measured in kelvins (K).	Application of the gas laws to diving equipment, vacuum pile drivers, pressure gauges, vacuum brakes, breathing and respirators.
5 Carry out calculations to convert temperatures in ^{o}C to K and vice versa.	
6 Carry out calculations involving pressure, volume and temperature of a fixed mass of gas using the general gas equation.	
7 Explain what is meant by absolute zero of temperature.	
8 Explain the pressure-volume, pressure-temperature and volume-temperature laws qualitatively in terms of a kinetic model.	

National Course Specification: course details (cont)

Higher Physics: Electricity and Electronics

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in order to demonstrate knowledge and understanding associated with Electricity and Electronics.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

	CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.1	**Electric fields and resistors in circuits**	
1	State that, in an electric field, an electric charge experiences a force.	Examine electric field lines in non-conducting fluids.
2	State that an electric field applied to a conductor causes the free electric charges in it to move.	Hazards, eg lightning, static electricity on microchips. Precipitators. Xerography. Paint spraying. Accelerators.
3	State that work W is done when a charge Q is moved in an electric field.	Ink jet printing. Electrostatic propulsion.
4	State that the potential difference between two points is a measure of the work done in moving one coulomb of charge between the two points.	Discuss work on energy transformation in a gravitational field and compare this with energy transformation in an electric field.
5	State that if one joule of work is done moving one coulomb of charge between two points, the potential difference between the two points is one volt.	Discuss use of terms voltage and potential difference.
6	State the relationship $V = W/Q$.	
7	Carry out calculations involving the above relationship.	Electron gun.
8	State that the e.m.f. of a source is the electrical potential energy supplied to each coulomb of charge which passes through the source.	Measure voltage across source and current drawn from source, and graph V against I. Sources of e.m.f. eg cells, thermocouple.
9	State that an electrical source is equivalent to a source of e.m.f. with a resistor in series, the internal resistance.	
10	Describe the principles of a method for measuring the e.m.f. and internal resistance of a source.	Determine the e.m.f. and internal resistance of a source.
11	Explain why the e.m.f. of a source is equal to the open circuit p.d. across the terminals of the source.	Internal resistance and load matching. Internal resistance << load for maximum voltage transfer.
12	Explain how the conservation of energy leads to the sum of the e.m.f.s round a closed circuit being equal to the sum of the p.d.s round the circuit.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.1 Electric fields and resistors in circuits (cont)	
13 Derive the expression for the total resistance of any number of resistors in series, by consideration of the conservation of energy.	Use ohmmeter to determine total resistance for: a) two resistors in series, and b) two resistors in parallel.
14 Derive the expression for the total resistance of any number of resistors in parallel by consideration of the conservation of charge.	Resistive heating. Conservation of charge and current.
15 State the relationship among the resistors in a balanced Wheatstone bridge. 16 Carry out calculations involving the resistances in a balanced Wheatstone bridge.	Investigate the relationship among the four resistors in a balanced Wheatstone bridge.
17 State that for an initially balanced Wheatstone bridge, as the value of one resistor is changed by a small amount, the out-of-balance p.d. is directly proportional to the change in resistance.	For a balanced bridge with resistance box in one arm, plot V versus ΔR for out-of-balance Wheatstone bridge. Use of Wheatstone bridge in measuring strain (eg digital balance and pressure sensors), temperature, light intensity.
18 Carry out calculations involving potential differences, currents and resistances in circuits containing resistors.	
19 Use the following terms correctly in context: charge, current, p.d., resistance, terminal p.d., load resistor, bridge circuit, e.m.f., lost volts, short circuit current.	
2.2 Alternating current and voltage	
1 Describe how to measure frequency using an oscilloscope.	Use a calibrated oscilloscope to measure the frequency of a low-voltage a.c. supply. Compare peak and r.m.s. values. National Grid and a.c.
2 State the relationship between peak and r.m.s. values for a sinusoidally varying voltage and current.	Use oscilloscope to measure voltage across lamps with a.c. and d.c. sources- adjust to equal brightness.
3 Carry out calculations involving peak and r.m.s. values of voltage and current.	Use graphical method to derive relationship between peak and r.m.s. values.
4 State the relationship between current and frequency in a resistive circuit.	Investigate the relationship between current and frequency in a resistive circuit.
2.3 Capacitance	
1 State that the charge Q on two parallel conducting plates is directly proportional to the p.d. V between the plates.	
2 Describe the principles of a method to show that the charge on a capacitor is directly proportional to the p.d. across the capacitor.	Investigate the relationship between the charge on and the p.d. across a capacitor.
3 State that capacitance is the ratio of charge to p.d.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.3 Capacitance (cont)	
4 State that the unit of capacitance is the farad and that one farad is one coulomb per volt.	
5 Carry out calculations using $C = Q/V$.	
6 Explain why work must be done to charge a capacitor.	Energy storage. Flash photography.
7 State that the work done to charge a capacitor is given by the area under the graph of charge against p.d.	Charge capacitor then discharge through a lamp or low-voltage d.c. motor.
8 State that the energy stored in a capacitor is given by ½ (charge x p.d.) and equivalent expressions.	
9 Carry out calculations using $\frac{1}{2}QV$ and equivalent expressions.	
10 Draw qualitative graphs of current against time and of p.d. against time for the charge and discharge of a capacitor in a d.c. circuit containing a resistor and capacitor in series.	Use computer and interface to plot charge–discharge graphs for a capacitor. Timing.
11 Carry out calculations involving p.d. and current in *CR* circuits (calculus methods are not required).	
12 State the relationship between current and frequency in a capacitive circuit.	Investigate the relationship between current and frequency in a capacitive circuit.
13 Describe the principles of a method to show how the current varies with frequency in a capacitive circuit.	
14 Describe and explain the possible functions of a capacitor: storing energy, storing charge, blocking d.c. while passing a.c.	Smoothing, filtering, coupling, suppressing.
2.4 Analogue electronics	
1 State that an op-amp can be used to increase the voltage of a signal.	Use an op-amp in inverting mode to amplify a.c. and d.c. voltages.
2 State that for the ideal op-amp: a) input current is zero, ie it has infinite input resistance. b) there is no potential difference between the inverting and non-inverting inputs: ie both input pins are at the same potential.	Amplifiers, attenuators.
3 Identify circuits where the op-amp is being used in the inverting mode.	
4 State that an op-amp connected in the inverting mode will invert the input signal.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
2.4 Analogue electronics (cont)	
5 State the inverting mode gain expression $V_o/V_1 = -R_f/R_1$.	Verify the inverting mode gain expression for a.c. and d.c. signals.
6 Carry out calculations using the above gain expression.	Multiplication, division, addition and D to A converter.
7 State that an op-amp cannot produce an output voltage greater than the positive supply voltage or less than the negative supply voltage.	Observe the effects of saturation in an inverting-mode amplifier by: a) increasing the gain of the amplifier and increasing the magnitude of the input signal b) square wave generation.
8 Identify circuits where the op-amp is being used in the differential mode.	Obtain information on op-amp in differential mode.
9 State that a differential amplifier amplifies the potential difference between its two inputs.	
10 State the differential mode gain expression $V_o = (V_2 - V_1)R_f/R_1$.	Verify the differential mode gain expression for d.c. signals.
11 Carry out calculations using the above gain expression.	
12 Describe how to use the differential amplifier with resistive sensors connected in a Wheatstone bridge arrangement.	Use a differential amplifier to amplify the output produced by a range of resistive sensors connected in a Wheatstone bridge arrangement. Monitoring and control applications.
13 Describe how an op-amp can be used to control external devices via a transistor.	Use a transistor connected to the output of an op-amp as a power amplifier.

National Course Specification: course details (cont)

Higher Physics: Radiation and Matter

The Content Statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in order to demonstrate knowledge and understanding associated with Radiation and Matter.

The right-hand column gives suggested contexts, applications, illustrations and activities associated with the Content Statements.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.1 Waves	
1 State that the frequency of a wave is the same as the frequency of the source producing it.	
2 State that period equals 1/frequency.	
3 State that the energy of a wave depends on its amplitude.	
4 Use correctly in context the terms: ‘in phase’, ‘out of phase’ and ‘coherent’, when applied to waves.	
5 Explain the meaning of: ‘constructive interference’ and ‘destructive interference’, in terms of superposition of waves.	Demonstrate the interference pattern produced by two coherent sources. Use computer simulations to study interference.
6 State that interference is the test for a wave.	Cancellation of sound resonances using out-of-phase speakers.
7 State that reflection, refraction, diffraction and interference are characteristic behaviours of all types of waves.	Discuss reflection, refraction and diffraction. Reception problems with TV and radio aerials.
8 State the conditions for maxima and minima in an interference pattern formed by two coherent sources in the form: *path difference* = $n\lambda$ for maxima, and *path difference* = $(n + ½)\lambda$ for minima, where n is an integer.	Investigate the effect of path difference on the intensity of radiation in the interference pattern produced by two coherent sources of microwaves. Holography. Industrial imaging of surfaces-curvature and stress analysis. Lens blooming.
9 Carry out calculations using the above relationships.	Interference colours (jewellery, petrol films, soap bubbles).
10 Describe the effect of a grating on a monochromatic light beam.	Investigate the effect of a grating on monochromatic light.
11 Carry out calculations using the grating equation $d \sin\theta = n\lambda$.	Interferometers to measure small changes in path difference.
12 Describe the principles of a method for measuring the wavelength of a monochromatic light source, using a grating.	Use a grating to measure wavelength.
13 State approximate values for the wavelengths of red, green and blue light.	
14 Describe and compare the white light spectra produced by: a grating and a prism.	Use a prism and a grating to produce white light spectra, then make a comparison.

National Course Specification: course details (cont)

CONTENT STATEMENTS		CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.2	**Refraction of light**	
1	State that the ratio $\sin\theta_1 / \sin\theta_2$ is a constant when light passes obliquely from medium 1 to medium 2.	Investigate the ratio $\sin\theta_1 / \sin\theta_2$ using rayboxes and glass or plastic blocks. Use computer simulations to study refraction.
2	State that the absolute refractive index, n, of a medium is the ratio $\sin\theta_1 / \sin\theta_2$ where θ_1 is in a vacuum (or air as an approximation) and θ_2 is in the medium.	Mirages, fish-eye view, Schlieren photography. Dispersion of high power laser beams due to hot centre with lower refractive index.
3	Describe the principles of a method for measuring the absolute refractive index of glass for monochromatic light.	
4	Carry out calculations using the relationship for refractive index.	
5	State that the refractive index depends on the frequency of the incident light.	Measure refractive index for red and blue light.
6	State that the frequency of a wave is unaltered by a change in medium.	Design of lenses, dispersion of signals in optical fibres, colours seen in cut diamonds.
7	State the relationships $\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{\lambda_1}{\lambda_2} = \dfrac{v_1}{v_2}$ for refraction of a wave from medium 1 to medium 2.	
8	Carry out calculations using the above relationships.	
9	Explain what is meant by total internal reflection.	Observe incident, reflected and transmitted rays for a light ray from a dense to a less dense medium at increasing angles of incidence.
10	Explain what is meant by critical angle θ_C.	
11	Describe the principles of a method for measuring a critical angle.	Measure critical angle.
12	Derive the relationship $\sin\theta_C = 1/n$ where θ_C is the critical angle for a medium of absolute refractive index n.	Reflective road signs, prism reflectors (binoculars, periscopes, SLR cameras).
13	Carry out calculations using the above relationship.	Optical fibres for communications, medicine and sensors.
3.3	**Optoelectronics and semiconductors**	
1	State that the intensity I at a surface on which radiation is incident is the power per unit area.	Measure I as a function of d.
2	Describe the principles of a method for showing that the intensity is inversely proportional to the square of the distance from a point source.	
3	Carry out calculations involving the relationship $I = k/d^2$.	

National Course Specification: course details (cont)

	CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3	**Optoelectronics and semiconductors (cont)**	
4	State that photoelectric emission from a surface occurs only if the frequency of the incident radiation is greater than some threshold frequency f_o which depends on the nature of the surface.	Study photoelectric emission from a zinc plate placed on the cap of a charge detector, eg gold leaf electroscope, coulombmeter. Channel plate image intensifiers, photomultipliers.
5	State that for frequencies smaller than the threshold value, an increase in the intensity of the radiation at the surface will not cause photoelectric emission.	
6	State that for frequencies greater than the threshold value, the photoelectric current produced by monochromatic radiation is directly proportional to the intensity of the radiation at the surface.	
7	State that a beam of radiation can be regarded as a stream of individual energy bundles called photons, each having an energy $E = hf$, where h is Planck's constant and f is the frequency of the radiation.	Discuss wave–particle duality.
8	Carry out calculations involving the relationship $E = hf$.	
9	Explain that if N photons per second are incident per unit area on a surface, the intensity at the surface is $I = Nhf$.	
10	State that photoelectrons are ejected with a maximum kinetic energy E_k which is given by the difference between the energy of the incident photon hf and the work function hf_o of the surface: $E_k = hf - hf_o$.	
11	State that electrons in a free atom occupy discrete energy levels.	
12	Draw a diagram which represents qualitatively the energy levels of a hydrogen atom.	
13	Use the following terms correctly in context: ground state, excited state, ionisation level.	
14	State that an emission line in a spectrum occurs when an electron makes a transition between an excited energy level W_2 and a lower level W_1, where $W_2 - W_1 = hf$.	Examine line and continuous spectra, eg from tungsten filament lamp, electric heater element, fluorescent tube, burning a salt in a Bunsen flame. Use computer simulations to study atomic spectra. Discharge lighting, laboratory and extraterrestrial spectroscopy, the standard of time.
15	State that an absorption line in a spectrum occurs when an electron in energy level W_1 absorbs radiation of energy hf and is excited to energy level W_2, where $W_2 = W_1 + hf$.	View absorption spectrum. Observe spectrum of scattered sunlight with hand spectrometer.
16	Explain the occurrence of absorption lines in the spectrum of sunlight.	(**Do not view the sun directly or by specular reflections**.)

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3 Optoelectronics and semiconductors (cont)	
17 State that spontaneous emission of radiation is a random process analogous to the radioactive decay of nucleus.	Obtain, present and discuss information on lasers.
18 State that when radiation of energy *hf* is incident on an excited atom the atom may be stimulated to emit its excess energy *hf*.	View video on lasers – any discussions limited to two energy levels.
19 State that in stimulated emission the incident radiation and the emitted radiation are in phase and travel in the same direction.	Optical alignment and component testing, distance and velocity measurements, spectroscopy, communications, pattern recognition, scribing, cutting, welding, surface hardening, semiconductor processing, opthalmology, dermatology, general and specialised surgery, laser induced nuclear fusion.
20 State that the conditions in a laser are such that a light beam gains more energy by stimulated emission that it loses by absorption – hence Light Amplification by the Stimulated Emission of Radiation.	
21 Explain the function of the mirrors in a laser.	Measure beam diameter at various distances from laser **(do not look directly into beam and avoid specular reflections)**. Compare intensity at the eye from a 100 W lamp and a 0.1 mW laser.
22 Explain why a beam of laser light having a power even as low as 0.1 mW may cause eye damage.	
23 State that materials can be divided into three broad categories according to their electrical properties – conductors, insulators and semiconductors.	Measure and compare the resistance of various conductors, insulators and semiconductors.
24 Give examples of conductors, insulators and semiconductors.	
25 State that the addition of impurity atoms to a pure semiconductor (a process called doping) decreases its resistance.	
26 Explain how doping can form an n-type semiconductor in which the majority of the charge carriers are negative, or a p-type semiconductor in which the majority of the charge carriers are positive.	Electronic devices.
27 Describe the movement of the charge carriers in a forward/reverse-biased p–n junction diode.	Measure variation of current with applied p.d. for a forward and reverse-biased p–n junction. Rectification and smoothing of a.c.
28 State that in the junction region of a forward-biased p–n junction diode, positive and negative charge carriers may recombine to give quanta of radiation.	Estimate the recombination energy in an LED from the wavelength of light emitted. Digital displays.
29 State that a photodiode is a solid-state device in which positive and negative charges are produced by the action of light on a p–n junction.	Study photodiode connected to an oscilloscope and illuminated with a light source connected to an a.c. supply.
30 State that in the photovoltaic mode, a photodiode may be used to supply power to a load.	Solar cells.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.3 Optoelectronics and semiconductors (cont)	
31 State that in the photoconductive mode, a photodiode may be used as a light sensor.	
32 State that the leakage current of a reverse-biased photodiode is directly proportional to the light intensity and fairly independent of the reverse-biasing voltage, below the breakdown voltage.	Measure variation of current with applied p.d. for a forward-biased and a reversed-bias photodiode under a constant fixed level of illumination. Measurement of light intensity.
33 State that the switching action of a reverse-biased photodiode is extremely fast.	Show that the switching action of a photodiode is extremely fast. Electronic ignition circuits. Optical isolators.
34 Describe the structure of an n-channel enhancement MOSFET using the terms: gate, source, drain, substrate, channel, implant and oxide layer.	Obtain information on an n-channel enhancement MOSFET.
35 Explain the electrical ON and OFF states of an n-channel enhancement MOSFET.	
36 State that an n-channel enhancement MOSFET can be used as an amplifier.	
3.4 Nuclear reactions	
1 Describe how Rutherford showed that: a) the nucleus has a relatively small diameter compared with that of the atom b) most of the mass of the atom is concentrated in the nucleus.	Analogue of alpha particle scattering. Use computer simulations to study Rutherford scattering.
2 State what is meant by alpha, beta and gamma decay of radionuclides.	Diagnosis in medicine, radiotherapy, tracers, smoke detectors.
3 Identify the processes occurring in nuclear reactions written in symbolic form.	Dating of rocks, carbon dating of archaeological specimens.
4 State that in fission a nucleus of large mass number splits into two nuclei of smaller mass numbers, usually with the release of neutrons.	
5 State that fission may be spontaneous or induced by neutron bombardment.	View video, slide and/or computer simulation on nuclear reactors.
6 State that in fusion two nuclei combine to form a nucleus of larger mass number.	Nuclear reactors and electricity generation, stellar evolution.
7 Explain, using $E = mc^2$, how the products of fission and fusion acquire large amounts of kinetic energy.	
8 Carry out calculations using $E = mc^2$ for fission and fusion reactions.	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.5 Dosimetry and safety	
1 State that the average activity A of a quantity of radioactive substance is N/t where N is the number of nuclei decaying in the time t.	
2 State that one becquerel is one decay per second.	
3 Carry out calculations involving the relationship $A = N/t$.	
4 State that the absorbed dose D is the energy absorbed per unit mass of the absorbing material.	View video on radiological protection.
5 State that the gray Gy is the unit of absorbed dose and that one gray is one joule per kilogram.	Biological effects of ionising radiations (Hiroshima, Chernobyl).
6 State that the risk of biological harm from an exposure to radiation depends on: a) the absorbed dose. b) the kind of radiations, eg α, β, γ, slow neutron. c) the body organs or tissues exposed.	
7 State that a quality factor Q is given to each kind of radiation as a measure of its biological effect.	
8 State that the dose equivalent H is the product of D and Q and is measured in sieverts Sv.	
9 Carry out calculations involving the relationship $H = DQ$.	
10 State that dose equivalent rate = H/t.	
11 State that the effective dose equivalent takes account of the different susceptibilities to harm of the tissues being irradiated and is used to indicate the risk to health from exposure to ionising radiation.	
12 Describe the factors affecting the background radiation level.	
13 State that the average annual effective dose equivalent which a person in the UK receives due to natural sources (cosmic, terrestrial and internal radiation) is approximately 2 mSv.	Monitor the radon background by measuring the count rate from dust collected on filter paper.
14 State that annual effective dose equivalent limits have been set for exposure to radiation for the general public, and higher limits for workers in certain occupations.	Ionising radiations safety legislation.

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
3.5 Dosimetry and safety (cont)	
15 Sketch a graph to show how the intensity of a beam of gamma radiation varies with the thickness of an absorber.	Thickness measurement, level detection, weld radiography.
16 Describe the principles of a method for measuring the half-value thickness of an absorber.	Measure the intensity of gamma radiation transmitted by different thickness of absorber and establish a relationship between intensity and thickness of absorber.
17 Carry out calculations involving half-value thickness.	
18 State that the dose equivalent rate is reduced by shielding or by increasing the distance from a source.	Measure the count rate at different distances from a gamma ray source and establish relationship between count rate and distance; compare with $I = k/d^2$ for light. Nuclear radiation safety.

National Course Specification: course details (cont)

Content Statements – Higher Physics

The following Content Statements apply to all units in the course.

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
4.1 Units, prefixes and scientific notation	
1 Use SI units of all physical quantities appearing in the Content Statements.	
2 Give answers to calculations to an appropriate number of significant figures.	
3 Check answers to calculations.	Check answers in relation to context — reject impossible solutions, use a checking procedure.
4 Use prefixes (p, n, μ, m, k, M, G).	
5 Use scientific notation.	
4.2 Uncertainties	
1 State that measurement of any physical quantity is liable to uncertainty.	
2 Distinguish between random uncertainties and recognised systematic effects.	Discuss systematic effects due to limitations of apparatus or experimental design or technique. Parallax.
3 State that the scale-reading uncertainty is a measure of how well an instrument scale can be read.	
4 Explain why repeated measurements of a physical quantity are desirable.	
5 Calculate the mean value of a number of measurements of the same physical quantity.	
6 State that this mean is the best estimate of a ‘true’ value of the quantity being measured.	
7 State that where a systematic effect is present the mean value of the measurements will be offset from a ‘true’ value of the physical quantity being measured.	
8 Calculate the approximate random uncertainty in the mean value of a set of measurements using the relationship: $\text{approximate random uncertainty in the mean} = \dfrac{\text{maximum value} - \text{minimum value}}{\text{number of measurements taken}}$	

National Course Specification: course details (cont)

CONTENT STATEMENTS	CONTEXTS, APPLICATIONS, ILLUSTRATIONS AND ACTIVITIES
4.2 Uncertainties (cont)	
9 Estimate the scale-reading uncertainty incurred when using an analogue display and a digital display.	Discuss ability to interpret between scale divisions.
10 Express uncertainties in absolute or percentage form.	Discuss the scale-reading uncertainty for digital displays as ± 1.
11 Identify, in an experiment where more than one physical quantity has been measured, the quantity with the largest percentage uncertainty.	
12 State that this percentage uncertainty is often a good estimate of the percentage uncertainty in the final numerical result of the experiment.	
13 Express the numerical result of an experiment in the form: final value ± uncertainty.	