Required Practicals planning summary

GCSE science

Assessment of practical skills encompasses a number of different elements.

- Apparatus and techniques (AT) criteria
- Working Scientifically (WS) criteria
- Scientific language associated with practical investigations – subject specific language
- The science behind the practical (linking content in the spec to the practical)
- Application of the maths skills appropriate to that practical
- AO2 requirement of scientific techniques and procedures being broader than the Required Practicals
- Questioning about the Required Practicals so they address the different assessment criteria for each of the AOs
- Building on progress from KS3 scientific enquiry.

It would be very difficult to cover every element in every set of RP lessons. One approach is to focus on just a number of these elements in one RP but cover all elements eventually over the whole course. This requires some joint planning across the three sciences and deciding where the most appropriate place is to teach and embed the skills.

Below is a modelled approach mapping possible opportunities to cover the first five bullet points above. These are just suggestions as many aspects of WS could be covered in any practical. Teachers can use this as a starting point and review and amend to suit their own students and teachers.

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Biology Required Practicals

Microscopy	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Use a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included.	Trilogy 4.1.1.5 Synergy 4.1.3.2 Biology 4.1.1.5	AT7 – use of appropriate apparatus, techniques and magnification, including microscopes to make observations of biological specimens and produce labelled scientific drawings. **MS** Recognise and use standard form, make and use estimations, appropriate use of significant figures, make order of magnitude calculations (1b, 1d, 2a, 2h). 3d – solve equations.	Cell structures Animal and plant cells Microscopy/calculating magnification Specialisation of cells How microscopes have changed over time and increased our understanding **WS** 1.1, 1.2, 4.4, 4.5	Resolution Magnification Mitochondria Ribosomes Eukaryotic Prokaryotic Accuracy Measurement error – would this be random or systematic if humans read it incorrectly?

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Osmosis	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.	Trilogy 4.1.3.2 Synergy 4.1.3.3 Biology 4.1. 3.2	AT1 – use of appropriate apparatus to measure and record a range of measurements accurately including length, mass and volume of liquid. AT3 – use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes. AT5 – measurement of rate of reaction by a variety of methods including an uptake of water. **MS** Work out percentages and percentage change (1c) gain and loss. Graphs (4a-4d) – plotting graphs with negative values. Calculate surface areas.	Big picture – difference between diffusion, osmosis and active transport Situations where the above occur Understanding high concentration and low concentration Explain what osmosis is Application of osmosis in different situations Link osmosis and surface area to cell membranes and transport systems Measure rate of water uptake **WS** 1.2, 3.4, 3.5	Diffusion Osmosis Surface area Partially permeable Solute concentration Active transport Accuracy Reproducible

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Food tests	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars; iodine test for starch; and Biuret reagent for protein.	Trilogy 4.2.2.1 Synergy 4.2.1.5 Biology 4.2.2.1	AT2 – safe use of appropriate heating devices and techniques including the use of a Bunsen burner and a water bath.	Food tests, indicator and colour change Carbohydrates – sugars and starch Why you need a water bath **WS** 2.3, 2.4	Indicator Reagent Iodine Benedict's solution Starch Biuret Spotting tile Water bath Pipette Lipids

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Enzymes	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the effect of pH on the rate of reaction of amylase enzyme. Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater.	Trilogy 4.2.2.1 Synergy 4.7.4.7 Biology 4.2.2.1	AT1 – use of appropriate apparatus to make and record a range of measurements accurately including time, temperature, volume of liquids and pH. AT2 – safe use of appropriate heating devices and techniques including use of a Bunsen burner and water bath or electric heater. AT5 – measurement of rates of reaction by a variety of methods including using colour change of an indicator. **MS** Decimal form (1a). Percentages (1c). Carry out rate calculations.	Enzymes as biological catalysts: • their function in process of digestion • simple structure and how they work (lock and key) • sites of production • word equation • how temperature and pH affect them Names of enzymes and type of molecule they act on: • Carbohydrases: starch, carbohydrate, glucose • Lipases: fats and oils, lipids, glycerol and fatty acids • Proteases: proteins, amino acids pH scale Why use a water bath Why use continuous sampling	Carbohydrase Lipids Glycerol Fatty acids Protease Amino acids Types of errors

			Relate to digestive system and the uses of the products of digestion link to metabolism (4.4.2.3)	

Photosynthesis	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.	Trilogy 4.4.1.2 Synergy 4.2.2.6 Biology 4.4.1.2	AT1 – use of appropriate apparatus to make and record a range of measurements accurately, including time and volume of a gas. AT3 – use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes. AT4 – safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment. AT5 – measurement of rates of reaction by a variety of methods including the production of gas. **MS** Measure and calculate rates using data from graphs	Photosynthesis: What it is, where it occurs, word equation, products and what they are used for Rate of photosynthesis: effects of variables on rate of photosynthesis How rate is limited (HT) Interpreting graphs of limiting factors (1 factor only FT more than 1 HT) Application to greenhouses Inversesquare law and light intensity (HT) Balanced symbol equations (HT) Use of glucose from photosynthesis Safety of using ethanol	Photosynthesis Respiration Cellulose Protein synthesis Nitrate ions Phloem Prediction Range Continuous variable Control, dependent, independent

			Linking ideas – translocation and structure of phloem is adapted to its functions in the plant **WS** 3.1, 3.3, 3.7	

Reaction time	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Plan and carry out an investigation into the effect of a factor on human reaction time.	Trilogy 4.5.2 Synergy 4.2.1.6 Biology 4.5.2.1	AT1 – use of appropriate apparatus to make and record a range of measurements accurately including length. AT3 – use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes. AT4 – safe and ethical use of a living organism (plants or animals) to measure physiological functions and responses to the environment. **MS** Construct bar charts and histograms (2c, 4a)	Automatic rapid control system Function and structure of the nervous system (CNS, sensory and motor neurons and sensory receptors) Reflex arc – structure related to its function (students always find this really hard) Manipulating and analysing data collected **WS** 2.5, 2.6, 2.7	Stimulus Receptor Coordinator Effector Response Reflex action Sensory neurones Impulses Relay neurones Motor neurones Synapse Errors Anomalies Control variables

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Field investigations	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.	Trilogy 4.7.2.1 Synergy 4.4.2.4 Biology 4.7.2.1	AT1 – use of appropriate apparatus to make and record a range of measurements accurately including length and area. AT 4 – safe and ethical use of a living organism (plants or animals) to measure physiological functions and responses to the environment. AT 6 – application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field. **MS** Understand the principles of sampling as applied to scientific data (2d) Mean, mode and median (2f) Scatter diagrams (2g) Calculate areas (5c)	Levels of organisation in an ecosystem Feeding relationships – food chains and webs Predator and prey relationships How to measure the size of a population (always poorly answered) How to ensure sampling is random Interdependence and competition How to carry out a line transect Factors affecting communities – abiotic and biotic **WS** 2.5, 3.6	Transects Quadrats Species Ecosystems Habitats Population Community Producers and consumers Predator and prey Stable community Abiotic factor Biotic factor Biodiversity

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Chemistry Required Practicals

Making salts	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate, using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.	Trilogy 5.4.2.3 Synergy 4.7.3.2 Chemistry 4.4.2.3	AT2 – safe use of appropriate heating devices and techniques including the use of a Bunsen burner and water bath or electric heater. AT4 – safe use of a range of equipment to purify and/or separate a chemical mixture including evaporation, filtration and crystallisation. AT6 – safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products.	Acids and alkalis Reactions of acids with metals and metal carbonates – word equations pH scale and neutralisation Making soluble salts from metals , metal oxides, hydroxides and carbonates Processes – filtration and crystallisation Weak and strong acids (HT) **WS** 2.3, 2.4	Acid Base Alkali Salt Soluble Insoluble Neutralisation Reactants Filtration Crystallisation

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Electrolysis	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.	Trilogy 5.4.3.4 Synergy 4.7.5.3 Chemistry 4.4.3.4	AT3 – use of appropriate apparatus and techniques for conducting and monitoring chemical reactions including appropriate reagents and/or techniques for the measurement of pH in different situations. AT7 – use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds.	Process of electrolysis What is formed at each electrode and why Electrolysis of aqueous solutions Half equations (HT) Test for gases Oxidation and reduction in electrolysis Why we use electrolysis **WS** 1.4, 2.1, 2.2	Reagent Electolysis Ions Electrolytes Electrodes Anode Cathode Ionic componds Molten state Oxidation Reduction Types of variables

Temperature changes	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the variables that affect temperature changes in reacting solutions, (eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals).	Trilogy 5.5.1.1 Synergy 4.7.3.3 Chemistry 4.5.1.1	AT1 – use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature and volume of liquids. AT5 – making and recording appropriate observations during chemical reactions including changes in temperature. AT6 – safe and careful handling of gases, liquids and solids including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products. **MS** Significant figures (2a) Means (2b) Plotting graphs (4c)	Exo and endothermic reactions Everyday examples Energy transfer during a chemical reaction Energy is conserved in chemical reactions Identify examples Reaction profiles Bonds breaking and forming (HT) Calculate energy transferred (HT) **WS** 2.6, 2.7, 3.1	Exothermic Endothermic Carbonates Neutralisation Displacement Activation energy Reaction profiles Resolution Accuracy Precision Repeatability Reproducible

Rates of reaction	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced and a method involving a change in colour or turbidity. This should be an investigation involving developing a hypothesis.	Trilogy 5.6.1.2 Synergy 4.7.4.3 Chemistry 4.6.1.2	AT1 – use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature and volumes of liquids and gases. AT3 – use of appropriate apparatus and techniques for conducting and monitoring chemical reactions. AT5 - making and recording appropriate observations during chemical reactions including the measurement of rates of reaction by a variety of methods such as production of gas and colour change. AT6 – safe and careful handling of liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes. **MS** Percentages and percentage change (1c). Means (2b). Draw and use the slope of a tangent to a curve as a measure of rate of reaction (4e).	Factors that affect rates of reactions: • Concentration • Pressure • surface area • temperature • catalyst Calculating rates of reactions and units (g/s or cm3/s) Analysis of results from the reactants Quantity of reactants in terms of moles Collision theory – understanding, predicting and explaining the effects of changes in variables on rate **WS** 2.2, 2.3, 3.6, 3.7	Concentration Surface area Catalyst Collision theory Activation energy Types of errors Random error Systematic error Zero error

Chromatography	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.	Trilogy 5.8.1.3 Synergy 4.2.2.4 Chemistry 4.8.1.3	AT4 – safe use of a range of equipment to purify and/or separate chemical mixtures including chromatography. **MS** Significant figures (2a). Substitute numerical values into algebraic equations using appropriate units for physical quantities (3c).	What a pure substance is and how melting and boiling point are used to distinguish it from a mixture. Look at relevant data Formulations – what one is, how they are made, types of this that are formulations – interpret info to identify them Chromatography – what its used for, explain how it works, what the different phases mean Calculate Rf value and what it means Effect of using different solvents on Rf values What is a pure substance Interpreting chromatograms **WS** 2.2, 3.5, 4.6	Pure Formulations Stationary phase Mobile phase Solvent Chromatogram

Water purification	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.	Trilogy 5.10.1.2 Synergy 4.4.1.8 Chemistry 4.10.1.2	AT1 – use of appropriate apparatus to make and record a range of measurements accurately including mass. AT2 – safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater. AT3 – use of appropriate apparatus and techniques for the measurement of pH in different situations. AT4 – safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, distillation.	This needs to be put into the wider context of using the Earth's resources, sustainable development and life cycle assessment and recycling What we use the Earth's resources for, what these natural resources and agriculture provide for use and what are finite resources What life cycle assessments are and what they are used for Ways of reducing the use of resources Using the issue of water shortages in the world define potable water and the methods used to produce it by Difference between potable water and pure water – test for pure water	Life cycle assessment Potable water Finite Renewable Sterilising Desalination Sedimentation Effluent

			Differences in treatment of ground water and salty water Reasons for the steps used to produce potable water. What is removed from waste water – sewage, agricultural and industrial waste What sewage treatment includes **WS** 1.4, 2.3	

Physics Required Practicals

Working Scientifically
Use SI units (4.3)
Use prefixes and powers of ten for orders of magnitude (4.4)
Interconvert units (4.5) and use an appropriate number of significant figures in calculations (4.6) should be reinforced in **all** the physics practicals

Maths skills
3b,3c and 3d apply **whenever equations** are applied.

Specific heat capacity	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
An investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored.	Trilogy 6.1.1.3 6.3.2.2 Synergy 4.1.1.4 Physics 4.1.1.3 4.3.2.2	AT1 – use of appropriate apparatus to make and record measurements of mass, time and temperature accurately. AT5 – use in a safe manner appropriate apparatus to measure energy changes/transfers and associated values such as work done. **MS** Recognise and use decimals (1a). Use an appropriate number of significant figures (2a). Find arithmetic means (2b). y=mx+c represents a linear relationship (4b).	Calculate the amount of energy stored or released in a system Change in thermal energy = mass × specific heat capacity × temperature change Thermal energy measured in joules Definition of specific heat capacity	A system Joules Work done/energy transfer Specific heat capacity Power

		Plot variables (4c). Determine the slope and intercept of a linear graph (4d).	Different ways to calculate power: $\text{Power} = \frac{\text{energy transferred}}{\text{time}}$ $\text{Power} = \frac{\text{work done}}{\text{time}}$ Definition of work done (energy transfer) Conservation and dissipation of energy Calculate gradients from a graph **WS** 2.3, 2.4, 2.7	

Resistance	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include: • the length of a wire at constant temperature • combinations of resistors in series and parallel.	Trilogy 6.2.1.3 Synergy 4.7.2.2 Physics 4.2.1.3	AT1 – use appropriate apparatus to measure and record a range of measurements accurately including length. AT6 – use of appropriate apparatus to measure current, potential difference and resistance and to explore the characteristics of a variety of circuit elements. AT7 – use circuit diagrams to construct and check series and parallel circuits including a variety of common circuit elements. **MS** y=mx+c represents a linear relationship (4b). Plot variables (4c). Determine the slope and intercept of a linear graph (4d).	Standard circuit symbols Difference between series and parallel circuits Electrical charge and current Charge flow = current × time The relationship between current, resistance and potential difference Potential difference = current × resistance Explain behaviour of current/ potential difference and resistance in series and parallel circuits R = R1 + R2 **WS** 1.2, 2.4	Electrical charge Current Potential difference Resistance Amps Ohms Volts

I–V characteristics	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Use circuit diagrams to construct appropriate circuits to investigate the I-V characteristics of a variety of circuit elements including a filament lamp, a diode and a resistor at constant temperature.	Trilogy 6.2.1.4 Synergy 4.7.2.2 Physics 4.2.1.4	AT6 – use appropriate apparatus to measure current and potential difference and to explore the characteristics of a variety of circuit elements. AT7 – use circuit diagrams to construct and check series and parallel circuits including a variety of common circuit elements. **MS** Use a scatter diagram to identify a correlation (2g). y=mx+c represents a linear relationship (4b). Plot variables (4c).	Names of components where resistance is not constant as current changes Relationship between the resistance of common components as current changes Use of LDRs Drawing circuit diagrams using correct symbols Interpreting the graphs representing these relationships (linear or non-linear), relating the curves to their function and properties **WS** 3.5	Ohmic conductor Diodes Thermistors LDRs Filament lamp

Density	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus.	Trilogy 6.3.1.1 Synergy 4.1.1.2 Physics 4.3.1.1	AT1 – use appropriate apparatus to make and record a range of measurements accurately including length, mass and volume. Use such measurements to determine the density of solid objects and liquids. **MS** Calculate volumes (5c).	Particle model of solid, liquids and gas – diagrams Definition of density: $\text{Density} = \frac{\text{mass}}{\text{volume}}$ Use the particle model to explain why there are differences in density between the different states of matter – arrangement of atoms. **WS** 1.2, 2.7, 3.1, 3.5,	Density

Extension of a spring	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the relationship between force and extension for a spring.	Trilogy 6.5.3 Synergy 4.6.1.6 Physics 4.5.3	AT1 – use appropriate apparatus to make and record a range of measurements accurately including length. AT2 – use appropriate apparatus to measure and observe the effect of forces including the extension of springs. **MS** y=mx+c represents a linear relationship (4b). Plot variables (4c). Determine the slope and intercept of a linear graph (4d).	How you change the shape of an object Weight, gravity and gravitational field strength Calculate weight Weight = mass × gravitational field strength The relationship between force, spring constant and either extension or compression F = k × e Explain what happens when a spring is stretched or compressed in terms of work done and elastic potential energy if it is not inelastically deformed From the resulting data/graph describe the relationship (linear/non-linear) Calculate a spring constant in linear case	Gravitational field strength Spring constant Extension Compression Elastic potential energy Deformation

			Calculate work done using elastic potential energy = 0.5 × spring constant × (extension)^2 **WS** 3.5	

Acceleration	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate the effect of varying the force on the acceleration of an object of constant mass and the effect of varying the mass of an object on the acceleration produced by a constant force.	Trilogy 6.5.4.2.2 Synergy 4.7.1.6 Physics 4.5.6.2.2	AT1 – use appropriate apparatus to make and record a range of measurements accurately including length, mass and time. AT2 – use appropriate apparatus to measure and observe the effect of force. AT3 – use appropriate apparatus and techniques to measure motion, including determination of speed and rate of change of speed (acceleration/deceleration). **MS** 2g, 1d, 3a (~), 1c. y=mx+c represents a linear relationship (4b). Plot variables (4c).	Recap difference between scalar and vector quantities, and examples of each Definition of velocity Acceleration= $\frac{\text{change in velocity}}{\text{time taken}}$ Investigate effect of varying the force and mass on an object on acceleration Newton's second law Velocity time graphs: • draw and interpret • interpret and measure areas in the graph (HT) Apply v2 – u2 = 2as	Scalar Vector Velocity Acceleration Resultant Inertia

Waves	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.	Trilogy 6.6.1.2 Synergy 4.1.4.1 Physics 4.6.1.2	AT4 – make observations of waves in fluids and solids to identify the **suitability** of apparatus to measure speed, frequency and wavelength.	Describe wave motion in terms of amplitude, wavelength, frequency and period (period = 1/frequency) Wave speed = frequency × wavelength Identify amplitude and wavelength Describe how to measure speed of sound through air and speed of ripples on a water surface Identify the suitability of apparatus to measure speed, frequency and wavelength **WS** 2.3	Amplitude Wavelength Frequency Period

Radiation and absorption	Spec ref	Skills, ATs and maths skills (MS)	Content including WS	Key words and subject specific vocabulary
Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.	Trilogy 6.6.2.2 Synergy 4.1.4.3 Physics 4.6.2.2	AT1 – use appropriate apparatus to make and record a range of measurements accurately including temperature. AT4 – make observations of the effects of the interaction of electromagnetic waves with matter.	What are electromagnetic waves? Types and examples of electromagnetic waves and how they are grouped by frequency and wavelength Properties, uses and application of electromagnetic waves Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength (HT)	Absorption Reflection Radiation