

Year 10 Chemistry									
Item	1	2	3	4	5	6	7	Rotation	
Topic Title	C3.1 Introducing Chemical Reactions	C3.2 Energetics	C3.3 Types of Chemical Reactions	C3.4 Electrolysis	C6.1 Improving Processes and Products	C6.1 Improving Processes and Products	C6.1 Improving Processes and Products	C4.1 Predicting Chemical Reaction	
Rationale	Fundamental skills (formulae, equation writing and balancing) that will be required for forthcoming topic areas in Year 10 - chemical reactions and analysis.	Having just completed how to write and use formulae and given the pupils will focus on chemical reactions in subsequent. They must have prior knowledge of writing and using equations as well as how chemical reactions have heat changes and can be wholly classified accordingly as exothermic or endothermic.	Pupils have been learning the foundations of equation writing and key terminology. They can identify heat changes and characteristics of changes such that they can now apply, analyze, explain and evaluate specific chemical reactions	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non metallic ions and that charge can be carried by conductors	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non metallic ions and that charge can be carried by conductors	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non metallic ions and that charge can be carried by conductors	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non metallic ions and that charge can be carried by conductors	Having studied the periodic table in Year 9, a more comprehensive study is to be made of Groups 1,7 and 0. This builds on previous modules on chemical reactions and working with equations	
Prior Knowledge	Types of formula. Relative formula mass and using the periodic table	KS3-Exothermic and endothermic reactions. KS4 writing chemical formulae and equations.	KS3- acids and alkalis, pH, chemicals that are acidic or alkaline, particle model. KS4 - ions, writing and balancing chemical and ionic equations	KS3 - charge movement in physics due to electrons and chemistry ions. Knowledge of diffusion of particles in systems. Introduction to the reactivity series of metals. Year 10- Writing half equations	KS3 - Extracting metals and Reactions of metals. KS4 - equilibrium reactions. Electrolysis.	KS3 - Extracting metals and Reactions of metals. KS4 - equilibrium reactions. Electrolysis.	KS3 - Extracting metals and Reactions of metals. KS4 - equilibrium reactions. Electrolysis.	KS3 study of the same groups which is expanded upon in terms of reactivity and key reactions and properties.	
Key knowledge/skills development	Writing chemical formulae of ionic compounds, using equations, writing balanced symbol equations, molar calculations	Identify and compare exothermic and endothermic reactions. Draw reactions profiles for these reactions and identify activation energy. Calculate energy changes in chemical reactions using bond energy values	What is the meaning of oxidation and reduction. Writing half equations. Define an acid, base and alkali. Recognise the particles responsible for acidity and alkalinity. Describe what happened during neutralisation and how to prepare a salt. To learn about reactions of acids, the difference between strong and weak acids and use the terms dilute and concentrated correctly.	Describe the term electrolysis. Predict products of electrolysis of molten compounds and ionic solutions. Describe how electrolysis can be used to purify copper and in the process of electroplating of metals.	Describe the importance of NPK fertilisers and how they are made. Describe and explain the conditions used in the Haber and Contact Process. Explain the processes used to extract metals with reference to copper, iron and aluminium. Evaluate bioleaching and Phytoremediation as methods of extraction. Describe the properties of alloys and how they relate to their uses. Describe the properties required for corrosion and how it is minimized. Compare the physical properties of ceramics, polymers and metals. Explain how the uses of materials are related to their properties. Describe the basic principles of a life cycle assessment and evaluate data. Describe how materials are recycled and evaluate the decisions made in recycling.	Describe the importance of NPK fertilisers and how they are made. Describe and explain the conditions used in the Haber and Contact Process. Explain the processes used to extract metals with reference to copper, iron and aluminium. Evaluate bioleaching and Phytoremediation as methods of extraction. Describe the properties of alloys and how they relate to their uses. Describe the properties required for corrosion and how it is minimized. Compare the physical properties of ceramics, polymers and metals. Explain how the uses of materials are related to their properties. Describe the basic principles of a life cycle assessment and evaluate data. Describe how materials are recycled and evaluate the decisions made in recycling.	Describe the importance of NPK fertilisers and how they are made. Describe and explain the conditions used in the Haber and Contact Process. Explain the processes used to extract metals with reference to copper, iron and aluminium. Evaluate bioleaching and Phytoremediation as methods of extraction. Describe the properties of alloys and how they relate to their uses. Describe the properties required for corrosion and how it is minimized. Compare the physical properties of ceramics, polymers and metals. Explain how the uses of materials are related to their properties. Describe the basic principles of a life cycle assessment and evaluate data. Describe how materials are recycled and evaluate the decisions made in recycling.	Recall physical and chemical properties of the Group 1, Group 7 and Group 0. Predict properties from reactivity trends. Explain the reactivity of Group 1 and Group 7. Describe and explain displacement reactions. Explain the back of reactivity down Group 0. Recall the general properties of the transition metals. Describe Laboratory skills to detect hydrogen, oxygen, carbon dioxide and chlorine.	
National Curriculum/specialisation links	C3.1a-f	C3.2a-d	C3.3a-k	C3.4a-e	C6.1a-f	C6.1a-f	C4.1a-c, C4.2 a,b		
Additional Literacy Opportunities	Regular use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks.	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks.	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Humphrey Davy discovers elements - sharpent	Read article and design an experiment to investigate the use of EDTA to hyperaccumulate lead in a variety of plants, using Indian mustard as the control plant. What are the advantages and disadvantages of phytomining compared to conventional mining methods?	Read article and design an experiment to investigate the use of EDTA to hyperaccumulate lead in a variety of plants, using Indian mustard as the control plant. What are the advantages and disadvantages of phytomining compared to conventional mining methods?	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Halides in photography - research and produce newspaper article		
Additional Numeracy Opportunities	Working out formulae and relative formula mass - molar calculation work	Bond energy calculations and use of molar quantities	Balancing of acid-base / half ionic equations and use of oxidation and reduction	Balancing half/ ionic equations and use of oxidation and reduction	Calculating yields from extractions	Calculating yields from extractions	Reacting Mass calculations		
STEM (Working Scientifically lessons 1 per week)	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 2 Sampling PAG 3 Enzymes	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 4 Photosynthesis PAG Booklet Questions	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 1 Electrolysis PAG 2 Distillation	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 5 Rates of reaction PAG Booklet Questions	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 1 Density PAG 5 Energy	Required Practicals in STEM lessons Plan Implement Analyze and Evaluate Review PAG 2 Forces PAG 4 Waves	Silver halides: https://mhhorpe.sharepoint.com/sites/STEM/learning/Shared%20Documents/STEM/20Resources/Science/KS4/Chemistry/Energetics/Burning%20and%20bonding%20Experiment.pdf Investigate for a photographic company the effect of light on halides https://edu.rsc.org/experiments/making-a-photographic-print-using-silver-chloride/454/article Problem Solving Analytical Collaboration Communication		
Cross curricular links	Mathematical skills, use of formulae and problem solving (Y7 - T1,T6, Y8 - T1,T4, T6 Y9- T1, T2, T4, Y10 - T2,T5)	Mathematical skills, use of formulae and problem solving (Y7 - T1,T6, Y8 - T1,T4, T6 Y9- T1, T2, T4, Y10 - T2, T4)	Technology / Cookery - acidity in foods. (Year 7 T2,3,4 / Year 8 T1,2,3)	Design and Technology - electroplating, Physics - electric circuits (Year 8 and Year 10)	History - Extraction of chemicals (Y8 T2, Y10 T4, Haber process - Y9 T1/2 Geography - rocks and ores. Technology Y8 T4	History - Extraction of chemicals (Y8 T2, Y10 T4, Haber process - Y9 T1/2 Geography - rocks and ores. Technology Y8 T4	Design and technology - uses of metals - Year 10		
Key vocabulary	Mole, molar mass, half equation, ionic equation, conservation of mass, molecular formula, ionic formula, compound ions	Exothermic, endothermic, reaction profile, activation energy, bond energy	Redox oxidation, reduction, acid, alkali, pH, neutralisation, titration, weak acid, strong acid, dilute, concentrated	Electrolysis, ions, electrolyte, cathode, anode, electrode, discharge, reactivity series, electroplating.	Fertilisers, Haber Process, batch and continuous process, non-renewable, hydration, ore, redox reaction, blast furnace, slag, coke, electrolysis, cathode, anode, bleaching, phytoremediation, carbon neutral, corrosion, alloy, galvanising, composite, life-cycle assessment	Fertilisers, Haber Process, batch and continuous process, non-renewable, hydration, ore, redox reaction, blast furnace, slag, coke, electrolysis, cathode, anode, bleaching, phytoremediation, carbon neutral, corrosion, alloy, galvanising, composite, life-cycle assessment	Alkali metals, noble gases, halogens, trend, reactivity, displacement, halide ion, inert, monatomic, transition metals, catalysts.		

Year 11 Chemistry COMBINED SCIENCE							
Term	1	2	3	4	5	Trible / Combined Science Rotation	Extra Science Rotation (5 lessons)
Topic Title	C5.2 Controlling Reactions & C5.3 Equilibria (Term 1 - Combined Science) 6.1.1-6.1.5 Improving Processes	C6.2 Organic Chemistry (Term 2 - Combined Science)	C6.2 Organic Chemistry (Term 2 - Combined Science)	Revision and PAGES	Revision and PAGES	C6.1 Improving Processes and Products C6.1.13-C6.1.16	C6.3 Interpreting and interacting with Earth Systems
Rationale	These two topics fit together well. The students can study how fast reactions occur and how far they go to completion. They need to have prior knowledge and been taught particle model, types of reactions (Exo/Endo) and energetics in reactions, both are taught in Year 9 and 10 respectively.	Pupils must have covered electrolysis and have a sound understanding of equations and drawing chemical structures. They are recapping key reactions such as combustion and polymerisation already	Pupils must have covered electrolysis and have a sound understanding of equations and drawing chemical structures. They are recapping key reactions such as combustion and polymerisation already	Final preparation for examinations (Completion of rotation material where necessary) - revision lessons, practice papers and review of all PAG practicals - Pupils can use this time to do practicals missed during the lockdown periods. COVID CATCHUP PLAN FOR PAGES	Final preparation for examinations (Completion of rotation material where necessary) - revision lessons, practice papers and review of all PAG practicals - Pupils can use this time to do practicals missed during the lockdown periods. COVID CATCHUP PLAN FOR PAGES	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non metallic ions and that charge can be carried by conductors	This topic is covered in conjunction with renewable/non-renewable forms of energies and fuels in physics in Year 11. Link between Science curricula. Students also cover climate change in Year 11 in Geography, hence cross curricula links at the same stage of development. The students have also covered all major pollutant gases in other topic areas and this can be studied in conjunction with the organic chemistry topic.
Prior knowledge	Year 10-Energetics in reactions and types of reactions. Year 9 and KS3 - The particle model and states of matter.	KS3- burning fuels, properties of materials - polymers KS4 - electrolysis, writing chemical equations, types of formula, structure of materials - bulk properties of polymers and ceramics	KS3- burning fuels, properties of materials - polymers KS4 - electrolysis, writing chemical equations, types of formula, structure of materials - bulk properties of polymers and ceramics	This is a review of all content covered at KS4	This is a review of all content covered at KS4	KS3 - Extracting metals and Reactions of metals/ Recycling/ Composites. KS4 - equilibrium reactions, electrolysis.	KS3 - the pupils cover climate change and water extensively in Geography in Year 9/9 and at the beginning of Year 11 which allows cross curricula links at similar stage of development
Key knowledge/skills development	Explain what is meant by rate of reaction and how to perform practical methods for its measurement. Describe and explain the effect of temperature, concentration or pressure, surface area and a catalyst on rate of reaction. Describe what a reversible reaction is and provide some examples. Describe the term dynamic equilibrium and make predictions of changing reaction conditions of the equilibrium position. Graph plotting and analysis, development of planning, analysis and evaluate techniques, numeracy skills.	Explain the term homologous series and draw structures and predict alkane, alkenes, alcohols, carboxylic acid reactions. Describe and explain the separation of crude oil by fractional distillation. Explain why crude oil is a finite resource. Describe the cracking of crude oil into fractions. Describe the principles of addition polymerisation, work out the structures of polymers and monomers. Describe DNA and other naturally occurring polymers in terms of their monomers. Explain the principles of condensation polymerisation and how they are synthesised. Evaluate the advantages and disadvantages of fuel cells and how they work. Drawing organic molecules, using a general formulae, chemical formulae. 6 marker practice.	Explain the term homologous series and draw structures and predict alkane, alkenes, alcohols, carboxylic acid reactions. Describe and explain the separation of crude oil by fractional distillation. Explain why crude oil is a finite resource. Describe the cracking of crude oil into fractions. Describe the principles of addition polymerisation, work out the structures of polymers and monomers. Describe DNA and other naturally occurring polymers in terms of their monomers. Explain the principles of condensation polymerisation and how they are synthesised. Evaluate the advantages and disadvantages of fuel cells and how they work. Drawing organic molecules, using a general formulae, chemical formulae. 6 marker practice.	Review of all key content, exam practice and technique, practise of analytical skills. Review of key terminology and their use.	Review of all key content, exam practice and technique, practise of analytical skills. Review of key terminology and their use.	Compare the physical properties of ceramics, polymers and metals. Explain how the uses of materials are related to their properties. Describe the basic principles of a life cycle assessment and evaluate data. Describe how materials are recycled and evaluate the decisions made in recycling.	Explain how the atmosphere formed and became oxygen rich. Describe the major sources of pollutants in the atmosphere and the problems these cause. Describe the atmospheric greenhouse effect and how problems can be reduced and evaluate the causes. Describe how wastewater, groundwater and salt water is made safe to drink. Describe and explain skills, opinion related and evaluative tasks.
National Curriculum/specification links	C5.2a-i, C5.3a-c.	C6.2a-q	C6.2a-q	N/A	N/A	C6.1a-r	C6.3a-g
Additional Literacy Opportunities	Research task: Haber Process Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Use of PLCs for Keywords	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Perkin Mauve - Sharepoint Silly Putty - Sharepoint	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Perkin Mauve - Sharepoint Silly Putty - Sharepoint	Exam based practice	Exam based practice		Pupils to research and develop a booklet on the effect of atmospheric pollutants
Additional Numeracy Opportunities	Measuring volumes and calculating rates of reaction - graphical analysis			Exam based practice	Exam based practice	Analysis of recycling/climate data	Analysis of climate data
STEM	Revision of Required Practicals	Revision of Required Practicals	Revision of Required Practicals	Revision for exams and review of Required Practicals / Skills	Revision for exams and review of Required Practicals / Skills	Creating a life cycle assessment	
Cross curricular links	Mathematical skills, use of formulae and problem solving, graph plotting (Yr 7 - T1, T6, Y8 - T1, T4, T6 Y9- T1, T2, T4, Y10 - T2, T4)	Engineering (Year 10 T1-4), Geography - environmental effects of crude oil extraction Geography - climate change. Y9 T4/5, Y11 T1/3: Atmosphere Y8 T3,4	Engineering (Year 10 T1-4), Geography - environmental effects of crude oil extraction Geography - climate change. Y9 T4/5, Y11 T1/3: Atmosphere Y8 T3,4	N/A	N/A	History - Extraction of chemicals (Y8 T2, Y10 T4, Haber process - Y9 T1/2 Geography - rocks and ores. Technology Y8 T4	Geography - climate change. Y9 T4/5, Y11 T1/3: Atmosphere Y8 T3,4
Key vocabulary	Rate of reaction, collision, inversely proportional, pressure, temperature, catalyst, surface area, activation energy.	Alkane, alkene, fractional distillation, cracking, combustion, addition.	Alkane, alkene, fractional distillation, cracking, combustion, addition.	N/A	N/A	Fertilisers, Haber Process, batch and continuous process, non-renewable, hydration, ore, redox reaction, blast furnace, slag, coke, electrolysis, cathode, anode, bioleaching, phytoextraction, carbon neutral, corrosion, alloy, galvanising, composite, life-cycle assessment	Climate change, pollutants, atmosphere, photosynthesis, particulates, anthropogenic, global warming, carbon capture, potable water, desalination

Year 11 Chemistry	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
Term	1/2 Teacher 1	1/2 Teacher 2	3	4	5	6	7/8	9/10
Topic Title	CS.3 Equilibria (Term 1 - Combined Science) 16.1, 16.2, Improving Processes	CS.1 Monitoring chemical reactions (Triple only)	CS.2 Organic Chemistry	Revision and PAGES	Revision and PAGES	Revision and PAGES	CS.1 Improving Processes and Products CS.1.13-CS.1.16	CS.3 Interpreting and interacting with Earth Systems
Rationale	These two topics fit together well. The students can study how fast reactions occur and how far they go in conjunction. They need to have prior knowledge and been taught particle model types of reactions (Exo/Endo) and energetics in reactions, both are taught in Year 9 and 10 respectively.	This topic uses calculation techniques previously studied in Year 9/10 collectively - Higher Tier content which has a more advanced or extended calculation content.	Pupils must have covered electrolysis and have a sound understanding of equations and drawing chemical structures. They are recycling key reactions such as combustion and polymerisation already.	Final preparation for examinations (Completion of rotation material where necessary) - revision lessons, practice papers and review of all PAG practicals - Pupils can use this time to do practicals missed during the lockdown periods.	Final preparation for examinations (Completion of rotation material where necessary) - revision lessons, practice papers and review of all PAG practicals - Pupils can use this time to do practicals missed during the lockdown periods.	Final preparation for examinations (Completion of rotation material where necessary) - revision lessons, practice papers and review of all PAG practicals - Pupils can use this time to do practicals missed during the lockdown periods.	Pupils have now learnt about half equations and how to write them. They have knowledge of both metallic and non-metallic ions and that charge can be carried by conductors.	This topic is covered in conjunction with renewable/non-renewable forms of energies and fuels in physics in Year 11. Link between Science curricula. Students also cover climate change in Year 11 in Geography. Hence cross curricula links at the same stage of development. The students have also covered all major pollutant gases in other topic areas and this can be studied in conjunction with the organic chemistry topic.
Prior knowledge	Year 10 Energetics in reactions and types of reactions. Year 9 and KS3 - The particle model and states of matter.	Molar calculations - Year 10, percentage calculations (Matter - KS3). Writing and using chemical equations - Y10, KS3/Classes - Y10.	KS3- burning fuels, properties of materials - polymers - KS4 - electrolysis, writing chemical equations, types of formula, structure of materials - bulk properties of polymers and ceramic materials.	This is a review of all content covered at KS4	This is a review of all content covered at KS4	This is a review of all content covered at KS4	KS3 - Extracting metals and Reactions of metals/ Recycling Composites, KS4 - equilibrium reactions, electrolysis.	KS3 - the pupils cover climate change and water extensively in Geography in Year 9/8 and at the beginning of Year 11 which allows cross curricula links at similar stage of development
Key knowledge/skills development	Describe the term dynamic equilibrium and make predictions of changing reaction conditions of the equilibrium position. Graph plotting and analysis, development of planning, analysis and evaluative techniques, numerical skills.	Key terminology understanding and use. Methodology in calculations. Writing chemical equations. Working Scientifically / Experimental skills - titration techniques, molar volume of gases.	Explain the term homologous series and draw structures and predict alkenes, alkanes, alcohols, carboxylic acid reactions. Describe and explain the separation of crude oil by fractional distillation. Explain why crude oil is a finite resource. Describe the cracking of crude oil into fractions. Describe the principles of addition polymerisation, work out the structures of polymers and monomers. Describe DNA and other naturally occurring polymers in terms of their monomers. Explain the principles of condensation polymerisation and how they are synthesised. Evaluate the advantages and disadvantages of fuel cells and how they work. Drawing organic molecules, using a general formulae, chemical formulae, E marker practice.	Review of all key content, exam practice and technique, practice of analytical skills. Review of key terminology and their use.	Review of all key content, exam practice and technique, practice of analytical skills. Review of key terminology and their use.	Review of all key content, exam practice and technique, practice of analytical skills. Review of key terminology and their use.	Compare the physical properties of ceramics, polymers and metals. Explain how the uses of materials are related to their properties. Describe the basic principles of a life cycle assessment and evaluate data. Describe how materials are recycled and evaluate the decisions made in recycling.	Explain how the atmosphere formed and became oxygen rich. Describe the major sources of pollutants in the atmosphere and the problems these cause. Describe the atmospheric greenhouse effect and how problems can be reduced and evaluate the causes. Describe how wastewater, groundwater and salt water is made safe to drink. Describe and explain skills, opinion related and evaluative tasks.
National Curriculum/specification links	CS.2a-i, CS.2a-c.	CS.1a-k	CS.2a-q	N/A	N/A	N/A	CS.1a-f	CS.3a-g
Additional Literacy Opportunities	Research task: Haber Process Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Use of PLCs for Keywords	Create an instruction leaflet / written practical on titration Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Use of PLCs for Keywords	Use of keyword learning and practise of six mark questions and terminology in Going for Gold or Going Forward type tasks. Perkin Mauser - Sharpshoot Silly Putty - Sharpshoot	Exam based practice	Exam based practice	Exam based practice		Pupils to research and develop a booklet on the effect of atmospheric pollutants
Additional Numeracy Opportunities	Measuring volumes and calculating rates of reaction - graphical analysis	Calculating Yields, Titrations, Gas calculations		Exam based practice	Exam based practice	Exam based practice	Analysis of recycling/climate data	Analysis of climate data
STEM	Revision of Required Practicals	Revision of Required Practicals	Revision of Required Practicals	Revision for exams and review of Required Practicals / Skills	Revision for exams and review of Required Practicals / Skills	Revision for exams and review of Required Practicals / Skills		
Cross curricular links	Mathematical skills, use of formulae and problem solving, graph plotting (Y7 - Y11, Y6, Y8 - Y11, Y4, Y5 - Y9, Y1, Y2, Y4, Y10 - Y12, Y4)	Mathematical skills, use of formulae and problem solving (Y7 - Y11, Y6, Y8 - Y11, Y4, Y5 - Y9, Y1, Y2, Y4, Y10 - Y12, Y4)	Engineering (Year 10 T1-4), Geography - environmental effects of crude oil extraction Geography - climate change, Y8 T45, Y11 T1/3; Atmosphere Y8 T4,4	N/A	N/A	N/A	History - Extraction of chemicals (Y8 T2, Y10 T4, Haber process - Y9 T1/2 Geography - rocks and ores, Technology Y8 T4	Geography - climate change, Y8 T45, Y11 T1/3; Atmosphere Y8 T3,4
Key vocabulary	Rate of reaction, collision, inversely proportional, pressure, temperature, catalyst, surface area, activation energy.	Theoretical yield, limiting reactant, actual yield, percentage yield, atom economy, reaction pathway, titration, burette, end point, molar volume, mole.	Alkane, alkenes, fractional distillation, cracking, combustion, addition.	N/A	N/A	N/A	Fertilisers, Haber Process, batch and continuous process, non-renewable, hydration, ore, redox reaction, blast furnace, slag, coke, electrolysis, cathode, anode, bleaching, phytoextraction, carbon neutral, corrosion, alloy, galvanising, composite, life-cycle assessment	Climate change, pollutants, atmosphere, photosynthesis, particulates, anthropogenic, global warming, carbon capture, potable water, desalination