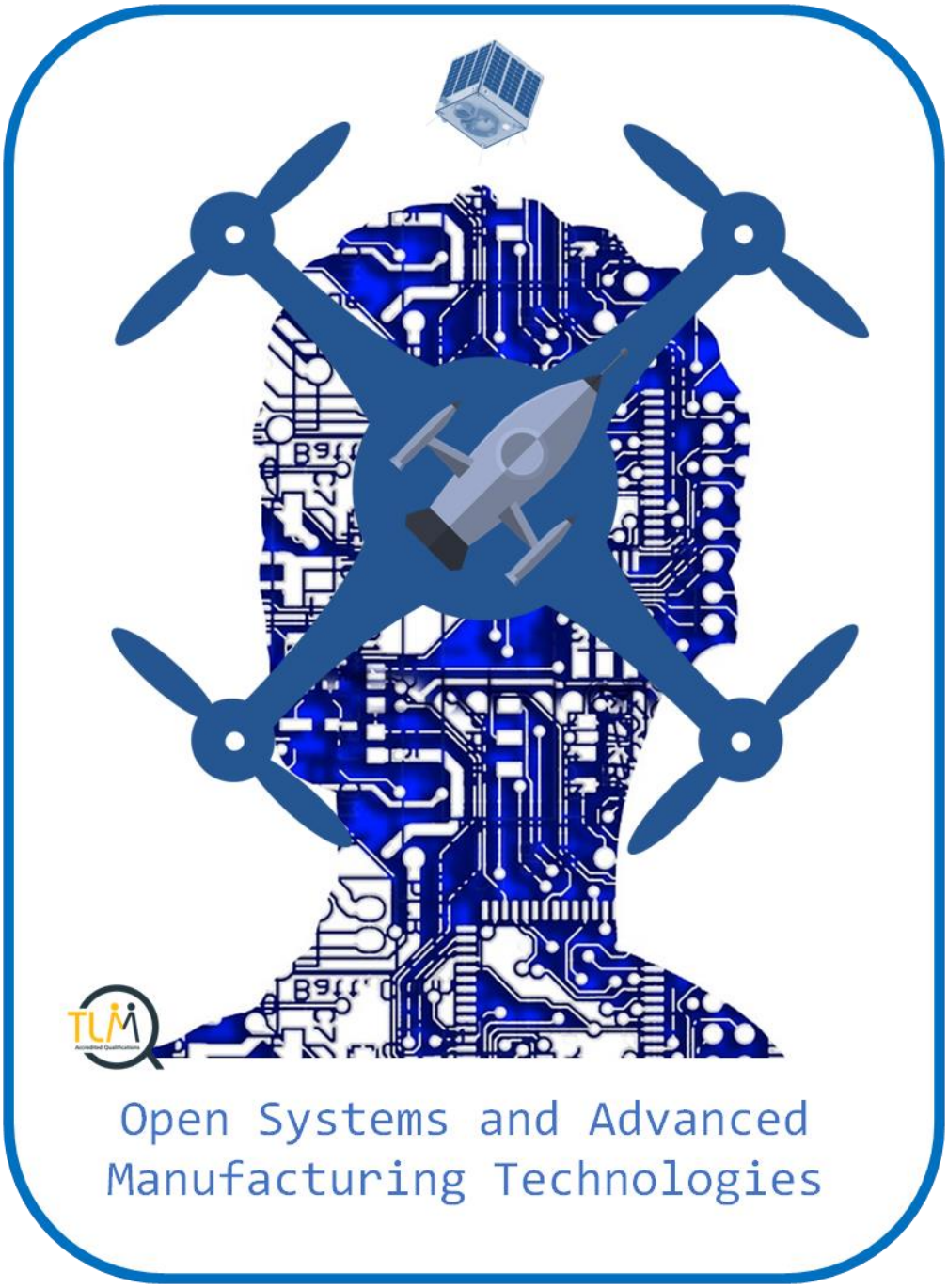
Teachers Guide



2019 League Table Points

Cross Curricular – Science, D&T, ICT, Computing, Maths

Contents

The Qualification Key Facts

This qualification looks at different elements relating to space and technology

- Rockets
- Micro Satellites
- Artificial Intelligence
- Unmanned Vehicles

Subjects covered =

Design and Technology, Maths, Science and Computing/ICT

The course is broken into:

- 4 x Units of coursework
- 1 x Exam
- You will be required to develop evidence to submit for the coursework
- It is graded as A*-C

Units of Coursework

- Unit 1 - The Understanding and Appreciation of Rocket Science
- Unit 2 - The Understanding and Application of Microsatellites
- Unit 3 - Working with Robotics and Artificial Intelligence
- Unit 4 - The Development and Deployment of Unmanned Vehicles

2017-2019 long term planning

Year 1	Sept – Oct ½ term	Oct ½ term – Xmas	Xmas – Feb ½ term	Feb ½ term – Easter	Easter – May ½ term	May ½ term - Summer
Topic Overview	Introduction and theory elements	Unit 1 - The Understanding and Appreciation of Rocket Science		Unit 2 - The Understanding and Application of Microsatellites		Recap on theory elements and exam theory

Year 2	Sept – Oct ½ term	Oct ½ term – Xmas	Xmas – Feb ½ term	Feb ½ term – Easter	Easter – May ½ term	May ½ term - Summer
Topic Overview	Unit 3 - Working with Robotics and Artificial Intelligence		Unit 4 - The Development and Deployment of Unmanned Vehicles		Exam Theory	Exam Leave

Theory Elements - Knowledge and Understanding Overview

Knowledge Specification	Theory Content	Subjects
1.1 Demonstrate knowledge and understanding associated with product and system design development and advanced manufacture terms	≈ Product life cycle, ≈ Project planning, ≈ Visual prototype, ≈ Functional, ≈ Aesthetic and preproduction prototypes, ≈ 2D, ≈ 3D, ≈ Embedded electronics, ≈ Rapid prototyping, ≈ 3D printing, ≈ Additive manufacture, ≈ Computer aided design, ≈ Fit and clearance, ≈ Tolerance, ≈ Sketch design and modelling, ≈ User interface, ≈ Environment sensing, ≈ Sustainability, ≈ Mind maps, ≈ Project plans, ≈ Design for manufacture (DFM), ≈ User testing and evaluation, ≈ Ergonomics and anthropometrics.	ICT D&T
1.2 Demonstrate mathematical knowledge	≈ Quantitative methods, ≈ Programming, ≈ Simple statistics, ≈ Algebra, ≈ Geometry, ≈ Cartesian coordinates, ≈ 2D and 3D, ≈ Rotation axis and planes, ≈ Perspectives, ≈ Computer numeric control	Maths Computing ICT
1.3 Demonstrate scientific knowledge	≈ Physical properties of atoms and electrons, ≈ Voltage and electricity, ≈ Magnets and electromagnets and applications in motors and relays, ≈ Material science and basic mechanical properties of materials such as stress, ≈ Breaking point, ≈ Fatigue, ≈ Bending, ≈ Elasticity and using them within product application.	Science
1.4 Demonstrate knowledge and understanding associated with the information and data terms	≈ Data, ≈ Information, ≈ File type, ≈ File properties, ≈ Compatibility, ≈ Export, ≈ Import, ≈ Conversion, ≈ Units, ≈ Scale, ≈ Visualisation, ≈ Render, ≈ Computer aided design, ≈ Computer aided manufacture, ≈ Digital modelling, ≈ Physical modelling, ≈ Standards, ≈ Input output, ≈ Analogue, ≈ Digital, ≈ Logic, ≈ Controller, ≈ Software, ≈ Program, ≈ Transducer, ≈ Sensor. ≈ Measurements,	ICT Maths D&T Computing

Units of coursework

Unit 1 - The Understanding and Appreciation of Rocket Science	**Unit 2** - The Understanding and Application of Microsatellites	**Unit 3** - Working with Robotics and Artificial Intelligence	**Unit 4** - The Development and Deployment of Unmanned Vehicles

Unit 1 - The Understanding and Appreciation of Rocket Science

1: Understanding the basic physical forces involved with rocket flight	2: Applying aspects of construction and development for rockets	3: Building, testing and launching a rocket with further development	4: Investigating further applications and exploratory topics
1.1 I can describe the physics involved in rocket flight	2.1 I can identify materials used in the construction of rockets and explain why they are useful.	3.1 I can make rough designs ,test and evaluate versions of my final rocket	4.1 I can investigate and explain the application of rockets for science and experimentation
1.2 I can identify and explain limitations on rocket flight created by physical elements	2.2 I can describe the properties of materials that make them suitable for rockets	3.2 I can explain test procedures and potential outcomes	4.2 I understand the basic physics in relation to space exploration
1.3 I can explain principles of physics which make flight possible	2.3 I can describe the forces which enable rocket flight and which determine material selection	3.3 I can design and build a rocket for flight	4.3 I can describe the range of uses for rockets, as well as their limitations
1.4 I can explain environmental factors which will make flight possible	2.4 I can explain historical construction techniques and developments	3.4 I can describe the procedure for launch, including safety and legal aspects required	4.4 I can select potential subjects from scientific discussions which would be suitable for rocket based projects
1.5 I can explain how to incorporate an understanding of physics into the final designs	2.5 I can identify the materials needed for my test rocket and explain their suitability for the job	3.5 I can select an appropriate launch venue, taking into consideration local guidelines and legal requirements	4.5 I can discuss and describe the importance of scientific discovery for the wider society
1.6 I can use simulation to minimise problems in my final tests		3.6 I can carry out a launch and document the findings for further development	

Notes and guidance on Coursework

Coursework task	*Guidance*
1: Understanding the basic physical forces involved with rocket flight	
1.1 I can describe the basic physical forces involved in rocket flight.	Candidates should be able to describe a number of forces that act on rocket design. ***Main aspects – gravity, friction, lift and thrust all related to rockets***
1.2 I can identify and explain limitations on rocket flight created by physical elements	Candidates should be able to add some more detail to their list of forces and give some more concrete examples. ***Main aspects – simulation software and hands on i.e. paper aeroplanes, raspberry pi robot building***
1.3 I can explain principles of forces which make flight possible.	Candidates should be able to explore more forces and environmental factors which will affect successful flights. ***Main aspects – prior flights and how forces overcome, animals and flight,***
1.4 I can explain environmental factors which will make flight possible	Candidates should be able to make judgements about suitable flight times and places based on their understanding. ***Main aspects – historical flights, launch sites, conditions of launch***
1.5 I can explain how to incorporate an understanding of physical forces into the final	Candidates should be able to use their knowledge of forces and environmental elements to come up with some designs. ***Main aspects – main forces and structures, shapes, materials, aerodynamic***

Coursework task	Guidance
designs.	*forms, stabilisers, resistance and drag*
1.6 I can use simulation to minimise problems in my final tests	Candidates should be able to use simulation software and applications effectively *Main aspects – cost, simulations, software like Kerbal, predicting outcomes*
2: Applying aspects of construction and development for rockets	
2.1 I can identify materials used in the construction of rockets and explain why they are useful.	Candidates should be able to identify a number of material that could be used for rocket construction. *Main aspects – materials, lightweight and strong, temperature,*
2.2 I can describe the properties of materials that make them suitable for rockets	Candidates should be able to create a table of properties with comments. *Main aspects – properties of plastics, composition of metal alloys, design, titanium properties, measurements, usage*
2.3 I can describe the forces which enable a rocket flight and which determine material selection.	Candidates should be able to show and understanding and appreciation of how materials are chosen for different purposes. *Main aspects – summary of materials used and why, force it is designed to overcome, heat and distortions, atmosphere – here and space*
2.4 I can explain historical construction techniques and developments.	Candidates should be able to show an understanding of the main milestones of rocket development. *Main aspects – Space race, first rocket, satellites*
2.5 I can identify the materials needed for my test rocket and explain their suitability.	Candidates should be able to use their understanding in determining the best materials for test rockets. *Main aspects – water or propellant based, use of kerbal for simulations, draw a diagram of a rocket and materials chosen and why*
3: Building, testing and launching a rocket with further development	
3.1 I can make rough designs, test and evaluate versions of my final rocket	Candidates should be able to use their understanding of forces and materials to design a basic rocket and evaluate their design. *Main aspects – draw a rocket design (inkscape / google sketchup), https://kerbalspaceprogram.com/en/ - Predesigned templates to manipulate Show any stages of development*
3.2 I can explain test procedures and potential outcomes	Candidates should be able to explain the main purpose of test procedures and show a basic understanding of possible outcomes of those tests. *Main aspects – effective test plan and changing design accordingly (easier on simulation software)*
3.3 I can design and build a rocket for flight.	Candidates should be able to carry out simple tasks and instructions to build a rocket for flight. *Main aspects – to create a basic rocket for launch*
3.4 I can describe the procedure for launch, including safety and legal aspects required.	Candidates should be able to describe the key factors to a successful launch and be aware of the dangers *Main aspects – health and safety, legal aspects, flying objects and procedures to apply for permission to launch,*
3.5 I can select an appropriate launch venue, taking into consideration local guidelines and legal requirements.	Candidates should be able to participate in the choice and checking of a launch site. *Main aspects – place and characteristics of launch site, times, refer to physical forces and materials, checklists*
3.6 I can carry out a launch and document the findings for further development	Candidates should be able to launch their own rocket. *Main aspects – can be simulation or real thing, data from launch and proposed future adjustments, improvements*
4: Investigating further applications and exploratory topics	
4.1 I can investigate and explain the application of rockets for science and experimentation.	Candidates should be able to demonstrate a wider understanding of the use of rockets and their place in science and engineering. *Main aspects – the use of satellites, good and bad use of rocketry, exploring deeper space, recent growing seeds sent to space*
4.2 I can understand the basic forces and materials in relation to space exploration.	Candidates should be able to discuss the characteristics of space in terms of the forces they have explored and materials. *Main aspects – what is required of rocket when in space, radiation exposure, temperature, lack of gravity, table of evidence*
4.3 I can describe the range of uses for rockets as well as their limitations.	Candidates should be able to show an understanding of the main uses for rockets currently *Main aspects – research and data collection – military, science and research,*

Coursework task	*Guidance*
	communication, spaceflight, rescue, hobby, sport and entertainment
4.4 I can select potential subjects from scientific discussions which would be suitable for rocket based projects.	Candidates should be able to think of areas of research that rockets could help with. ***Main aspects – imaginative ways rockets can assist, no new ideas but how are rockets used in a new field of extending one.***
4.5 I can discuss and describe the importance of scientific discovery for the wider society.	Candidates should be able to present and discuss their ideas to an audience ***Main aspects – presenting ideas for peer review, gain feedback and improvements,***

Suggested Unit to Lesson/Topic Breakdown – *total 36 hours with 4 for coursework additional*

Topic / Lesson	Lessons	Spec Covered
Intro and NASA	2	
Forces and Flight	3	1.1, 1.3
Limits (physical)	2	1.2
Limits (environmental)	2	1.4
Initial designs	2	1.5
Simulation of designs	3	1.6
Coursework	2	1.1 – 1.6
Materials and Rockets	3	2.1, 2.2
Forces and Materials	3	2.3
History	2	2.4
Materials and My Rocket	2	2.5
Design and evaluate own rocket	2	3.1
Predict and test plan	2	3.2
Create a basic rocket	3	3.3
Launching	2	3.4, 3.5, 3.6
Rockets for Science	3	4.1, 4.3, 4.4, 4.5
Forces and Materials in space	2	4.2

Unit 1 - Lesson Suggestions

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Course Introduction	<u>Lesson 1 and 2</u> ***Learners will gain an understanding of the qualification and the structure as well what NASA does*** • Introduce qualification and structure • Who is NASA and what do they do? • Group work – research a mission and create a presentation on the mission to present back to the rest of the group		
Forces and Flight (3 Lessons)	<u>Lesson 3 (1.1, 1.3)</u> ***Introduce forces in rocket launches and look at flight*** • Video of rocket launch and discuss how flight is achieved • Forces and Rockets / Flights • Objects/Animals and how they fly <u>Lesson 4 (1.1, 1.3)</u> ***Students make a water bottle rocket. They investigate the variables that affect the height and distance travelled by the rocket.*** • Water bottle rockets <u>Lesson 5 (1.1, 1.3)</u> • How flight has changed • Flights/launches that have gone wrong • Look at the Apollo Program – introducing issues in flights as well as success, looking at one program will allow pupils to see how rocket designs and launches have changed due to each launch. • Create a timeline of the launches – using online software – timetoast, or Google timeline creators and lots available	1.1 I can describe the physics involved in rocket flight ***(Main aspects – gravity, friction, lift and thrust all related to rockets)*** 1.3 I can explain principles of forces which make flight possible. ***(Main aspects – prior flights and how forces overcome, animals and flight)***	1. Candidates should be able to describe a number of forces that act on rocket design. 2. Candidates should be able to explore more forces and environmental factors which will affect successful flights. Complete section 1 of the coursework evidence booklet

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Limits (physical) (2 lessons)	<u>Lesson 6 (1.2)</u> • What physical elements affect flight, thinking about forces i.e. weight and thrust – look at weight of rocket and the thrust given to lift off • Introduction to simulation software - https://www.sciencelearn.org.nz/embeds/25-rocket-launch-simulation and worksheet to document the test flights and outcomes <u>Lesson 7 (1.2)</u> • Paper aeroplanes – making paper aeroplanes and testing a variety of designs and the distance travelled • Foam aeroplanes Extend to jumping – could add trampolines etc to look at weight elements	1.2 I can identify and explain limitations on rocket flight created by physical elements (***Main aspects – simulation software and hands on i.e. paper aeroplanes, raspberry pi robot building)***	Candidates should be able to add some more detail to their list of forces and give some more concrete examples. Complete section 2 of the coursework evidence booklet
Limits (environmental) (2 lessons)	<u>Lesson 8 (1.4)</u> • Historical flights – look at launch times and the effects, launch sites and the conditions • Where are today's launch sites? Why? <u>Lesson 9 (1.4)</u> • How can air temperature effect the launch • NASA's 10 greatest science missions – research and look at why went wrong – physical or environmental? • Paper aeroplanes and hair dryers – looking at the effect weather has on a flight and the difference of hot and cold air.	1.4 I can explain environmental factors which will make flight possible ***Main aspects – historical flights, launch sites, conditions of launch***	Candidates should be able to make judgements about suitable flight times and places based on their understanding. Complete section 3 of the coursework evidence booklet
Initial designs (2 lessons)	<u>Lesson 10 (1.5)</u> • Recap of main forces and materials to be considered in design • What shape is a rocket and does it change - Look at rocket shapes and the affect this has on the launch • What makes a good design?	1.5 I can explain how to incorporate an understanding of physical forces into the final designs. ***Main aspects – main forces and structures, shapes, materials, aerodynamic forms, stabilisers, resistance and drag***	Candidates should be able to use their knowledge of forces and environmental elements to come up with some designs. Complete section 4 of the coursework evidence

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	Lesson 11 (1.5) • Come up with a few designs and ensure annotated clearly		booklet
Simulation of designs (3 lessons)	Lesson 12 (1.6) • How to use software chosen • Practice simulations	1.6 I can use simulation to minimise problems in my final tests ***Main aspects – cost, simulations, software like Kerbal, predicting outcomes***	Candidates should be able to use simulation software and applications effectively Complete section 5 of the coursework evidence booklet
	Lesson 13 (1.6) • Costs involved in launches • Test plan of designs with predictions and actual outcomes with comparison Software – Kerbal (You receive 10 licences with this qualification and tasks can be completed in groups)		
	Lesson 14 (1.6) • Complete own simulations – edit the rocket from lesson 12 to see changes and effects		
Lesson 15 and 16 - At this point I would ensure the evidence is completed for criteria 1.1 – 1.6 – coursework writing frames have been given as an option to use but like all our qualifications it is your choice how you submit evidence and in what format.			
Materials and Rockets (3 lessons)	Lesson 17 (2.1,2.2) • Matching task on keywords • Create a mood board/poster on all materials and the advantages and disadvantages of each one (online tools available or publisher suitable for task)	2.1 I can identify materials used in the construction of rockets and explain why they are useful. 2.2 I can describe the properties of materials that make them suitable for rockets ***Main aspects – materials, lightweight and strong, temperature,*** ***Main aspects – properties of plastics, composition of metal alloys, design, titanium properties, measurements, usage***	Candidates should be able to identify a number of materials that could be used for rocket construction. Candidates should be able to create a table of properties with comments. Complete section 6 of the coursework evidence booklet
	Lesson 18 (2.1, 2.2) • Pencil Rockets – create and launch pencil rockets looking at how materials can affect the launch – experiment with changing the rocket for launch with different pencils/pens and fins		
	Lesson 19 (2.1, 2.2) • Complete the coursework task by describing the different materials and the suitability for use in a rocket		
Forces and Materials	Lesson 20 (2.3) • Rocket Mice – practical aspect looking at forces as the main aspect is the force on the milk bottle in	2.3 I can describe the forces which enable a rocket flight and which determine material selection.	Candidates should be able to show and understanding an appreciation of how materials are chosen for different purposes.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	order to launch – experimenting with different thrusts needed to get the rocket mouse to launch **Lesson 21 (2.3)** • The atmosphere • Heat and distortions • Looking at forces and materials and the effects of atmosphere on both **Lesson 22 (2.3)** • Complete the coursework task to describe how the materials you would use in a rocket are effective against the forces	***Main aspects – summary of materials used and why, force it is designed to overcome, heat and distortions, atmosphere – here and space***	Complete section 7 of the coursework evidence booklet
History	**Lesson 23 (2.4)** • What was the Space Race • First rocket launched • First Satellite • Rocket development **Lesson 24 (2.4)** • Complete coursework task on explaining the historical milestones that have impacted on rockets today	2.4 I can explain historical construction techniques and developments. ***Main aspects – Space race, first rocket, satellites***	Candidates should be able to show an understanding of the main milestones of rocket development. Complete section 8 of the coursework evidence booklet
Materials and My Rocket	**Lesson 25 (2.5)** • Water or propellant based? • Setting up Kerbal with rocket designs thinking about the materials used in the design **Lesson 26 (2.5)** • Test the designs and document the simulations and draw/print a diagram of the rocket with labels of the materials used.	2.5 I can identify the materials needed for my test rocket and explain their suitability. ***Main aspects – water or propellant based, use of kerbal for simulations, draw a diagram of a rocket and materials chosen and why***	Candidates should be able to use their understanding in determining the best materials for test rockets. Complete section 9 of the coursework evidence booklet
At this point I would ensure the evidence is completed for criteria 2.1 – 2.5 – coursework writing frames have been given as an option to use but like all our qualifications it is your choice how you submit evidence and in what format.			

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Design and Evaluate own Rocket	<u>Lesson 27 and 28 (3.1)</u> • Past lessons have looked at developing rockets now look at those and come up with some ideas that will launch successfully • Look at the templates in Kerbal and create a design for a basic rocket – document stages of development • Main aspect – look at one design and edit the parts and show the development and evaluate each one in order to come up with a final design	3.1 I can make rough designs, test and evaluate versions of my final rocket ***Main aspects – draw a rocket design (inkscape / google sketchup),*** ***https://kerbalspaceprogram.com/en/ - Predesigned templates to manipulate*** ***Show any stages of development***	Candidates should be able to use their understanding of forces and materials to design a basic rocket and evaluate their design. Complete section 10 of the coursework evidence booklet
Predict and test plan	<u>Lesson 29 and 30 (3.2)</u> • Now they have the final design – what tests should be undertaken – thinking about forces and materials • Create a test plan and thoroughly test the rocket and show improvements	3.2 I can explain test procedures and potential outcomes ***Main aspects – effective test plan and changing design accordingly (easier on simulation software)***	Candidates should be able to explain the main purpose of test procedures and show a basic understanding of possible outcomes of those tests. Complete section 11 of the coursework evidence booklet
Create a basic rocket	<u>Lesson 31, 32 and 33 (3.3)</u> • www.rocketsandthings.com • Pupils are to design and build a rocket – practically • Work in groups and document/video/photo the creation ready for launch	3.3 I can design and build a rocket for flight ***Main aspects – to create a basic rocket for launch***.	Candidates should be able to carry out simple tasks and instructions to build a rocket for flight. Complete section 12 of the coursework evidence booklet
Launching	<u>Lesson 34 (3.4, 3.5)</u> • Theory of the launch – what makes a good site? Create a written report for NASA control on the options available and making a final recommendation for launch location • Report to include – health and safety considerations, legal aspects, procedure to be undertaken, local guidelines, venue options, checklists, times etc	3.4 I can describe the procedure for launch, including safety and legal aspects required. 3.5 I can select an appropriate launch venue, taking into consideration local guidelines and legal requirements. 3.6 I can carry out a launch and document the findings for further development ***Main aspects – health and safety, legal aspects,***	Candidates should be able to describe the key factors to a successful launch and be aware of the dangers Candidates should be able to participate in the choice and checking of a launch site. Candidates should be able to launch their own rocket.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	<u>Lesson 35 (3.6)</u> • Launch day ! • Simulation or practical – practical option set plan of launches – document – video/photo • Mission report – documenting the launch and the proposal for future developments	*flying objects and procedures to apply for permission to launch,* *Main aspects – place and characteristics of launch site, times, refer to physical forces and materials, checklists* *Main aspects – can be simulation or real thing, data from launch and proposed future adjustments, improvements*	Complete section 13 of the coursework evidence booklet
Rockets for Science	<u>Lesson 36 (4.3)</u> • How are rockets used? Why are they launched? What has been achieved? What are the future missions? • Coursework task describing and also using examples to strengthen of recent seeds in space project, satellites, good and bad use of rocketry, deeper space <u>Lesson 37 (4.1, 4.4)</u> • Investigate and report on military, science and research, communication, spaceflight, rescue, hobby, sport and entertainment • What does the future hold <u>Lesson 38 and 39 (4.5)</u> • Presentation – create a presentation to show rocket design and justifying decisions made, materials chosen, parts chosen, forces considered etc • Peer review – feedback and improvements	4.1 I can investigate and explain the application of rockets for science and experimentation. 4.3 I can describe the range of uses for rockets as well as their limitations. 4.4 I can select potential subjects from scientific discussions which would be suitable for rocket based projects. 4.5 I can discuss and describe the importance of scientific discovery for the wider society. *Main aspects – the use of satellites, good and bad use of rocketry, exploring deeper space, recent growing seeds sent to space* *Main aspects – research and data collection – military, science and research, communication, spaceflight, rescue, hobby, sport and entertainment* *Main aspects – imaginative ways rockets can assist, no new ideas but how are rockets used in a new field of extending one.* *Main aspects – presenting ideas for peer review, gain feedback and improvements,*	Candidates should be able to demonstrate a wider understanding of the use of rockets and their place in science and engineering. Candidates should be able to show an understanding of the main uses for rockets currently Candidates should be able to think of areas of research that rockets could help with. Candidates should be able to present and discuss their ideas to an audience Complete section 14 of the coursework evidence booklet
Forces and Materials in space	<u>Lesson 40 (4.2)</u> • Conclusion to project on what they have learnt about	4.2 I can understand the basic forces and materials in relation to space exploration. *Main aspects – what is required of rocket when in space, radiation exposure, temperature, lack of gravity, table of evidence*	Candidates should be able to discuss the characteristics of space in terms of the forces they have explored and materials. Complete section 15 of the coursework evidence booklet
Extra Curricular Opportunities	Trips • RAF museum – free entry – V2 Rocket, Starchaser – company who does school visits, National Space Centre - Leicester		

Unit 2 The Understanding and Application of Microsatellites:

1. Understand the current place in the market of microsatellites	2. Review and define the key issues in making a microsatellite	3. Understand the key issues in space deployment	4. Investigate the control, data use and end of life issues related to microsatellites
1.1 I can review the current status of microsatellites in terms of global production and main countries involved	2.1 I understand the need for size reduction in satellite technology	3.1 I can appreciate the cost implications of getting equipment to space	4.1 I can describe how microsatellites are controlled from earth
1.2 I can list and define the key uses of microsatellites	2.2 I can describe some of the key materials used in construction and say why they are used	3.2 I can describe key terms such as "piggyback" in terms of deployment and give examples of how it is used	4.2 I can describe how microsatellites are controlled while in space
1.3 I can describe the main launch vehicles used for deployment and their characteristics	2.3 I can describe the main forces acting on satellites in their lifecycle and how this affects their manufacture	3.3 I can list and define the main propellants used by microsatellites	4.3 I can review the types of data collected by microsatellites
1.4 I can define the main versions of microsatellites including nanosatellites, picosatellites and femtosatellites	2.4 I can describe the main forms of communication used in microsatellites and give examples of their usage	3.4 I can describe the strengths and weaknesses of the main propellants used in space	4.4 I can review the dangers of microsatellites that return to earth when they finish their mission
1.5 I can assess the current market in microsatellites	2.5 I can develop a list of requirements in the manufacture of a microsatellite	3.5 I can describe the different levels of orbit used in microsatellite systems	4.5 I can assess the impact of microsatellites and recommend a possible future use for them
2.6 I can devise my own basic design for a microsatellite and define its purpose	2.6 I can describe the main legal issues relating to microsatellites		

Notes and guidance on Coursework

Coursework task	*Guidance*
1. Understanding the current place in the market of microsatellites.	
1.1 I can review the current status of microsatellites in terms of global production and main countries involved.	Candidates should be able to show they understand the most current state of the market for microsatellites. ***Main aspects – how many launches past and future, cost, countries that launch and how many etc***
1.2 I can list and define the key uses of microsatellites	Candidates should be able to demonstrate they understand the range of microsatellite use. ***Main aspects – GPS tracking – maps, weather, university use,***
1.3 I can describe the main launch vehicles used for deployment and their characteristics.	Candidates should be able to describe a number of launch vehicles. ***Main aspects – Low Earth Orbit (LEO) launches, companies that launch – UK - Virgin Galactic, US - DARPA, Garvey and Boing, Switzerland - Swiss Space Systems, Spain - PLD Space. Height operated in, payload, general cost***
1.4 I can define the main versions of microsatellites including nanosatellites, picosatellites and femtosatellites.	Candidates should be able to show they understand the basic differences between the main microsatellites. ***Main aspects –weight, cost (fuel-weight), main characteristics of device and what it can carry***
1.5 I can assess the current market in microsatellites.	Candidates should be able to show they can appreciate the reasons behind some of the market information. ***Main aspects – costs, setbacks, what is possible, type of market***
2. Review and define the key issues in making a microsatellite.	

Coursework task	Guidance
2.1 I can understand the need for size reduction in satellite technology.	Candidates should be able to show they understand the implications of size and weight on the success of satellite technology ***Main aspects – relates to rocketry section on forces and thrust based on weight – size matters – size reduction designs***
2.2 I can describe some of the key materials used in construction and say why they are used.	Candidates should be able to list and describe a number of the main construction materials used, giving reasons for their choice ***Main aspects – different layers of atmosphere – materials – pressure/forces, temperature***
2.3 I can describe the main forces acting on satellites in their life-cycle and how this affects their manufacture.	Candidates should be able to show they understand the basic forces that satellites need to endure. ***Main aspects – radiation, temperature, links to 2.2, forces from cradle to grave***
2.4 I can describe the main forms of communication used in microsatellites and give examples of their usage.	Candidates should be able to show they understand the ways that engineers control their devices ***Main aspects – transmitting data, working in the environment (close to sun etc)computerised systems, issues with distance and data volume***
2.5 I can develop a list of requirements in the manufacture of a microsatellite	Candidates should be able to use their knowledge and understanding to put together a simple shopping list of requirements. ***Main aspects – use all elements from previous criteria to build a list – materials, communication devices/types – characteristics justify choice***
2.6 I can devise my own basic design for a microsatellite and define its purpose.	Candidates should be able to construct a basic diagram of their microsatellite with labels for key components. ***Main aspects – draw or computer - basic design of their own microsatellite and label some of the main parts – clear purpose i.e. camera or gps - https://www.nesdis.noaa.gov/jason-3/spacecraft.html***
3. Understand the key issues in space deployment.	
3.1 I can appreciate the cost implications of getting equipment to space	Candidates should be able to show they understand the relationships between weight and size and cost of deployment ***Main aspects – power to weight ratios, kerbal data, nasa data***
3.2 I can describe key terms such as “piggy back” in terms of deployment and gives examples of how it is used.	Candidates should be able to show they understand some key terms used and show their understanding with clear examples ***Main aspects – costs and how to minimise, piggy back term, cost of deployment too large to launch satellites waiting***
3.3 I can list and define the main propellants used by microsatellites.	Candidates should be able to document some of the propellants used in satellites and their characteristics. ***Main aspects – propellants used to launch, propellants used in space, solar panels, small thrusters usage – propellant based on Hydrazine, table of (propellant, chemical, type, comments) inc - Anhydrous Hydrazine, Monomethyl Hydrazine and ALICE***
3.4 I can describe the main strengths and weaknesses of the main propellants used in space.	Candidates should be able to show they understand some of the characteristics of propellants. ***Main aspects – stores energy but dangerous, hygroscopic – leach water from anything in contact, combine with 3.3 – launch fuel may not be suitable in space***
3.5 I can describe the different levels of orbit used in microsatellite systems.	Candidates should be able to show they understand the different orbits in terms of their distance and characteristics. ***Main aspects – High Earth Orbit, Medium Earth Orbit, Low Earth Orbit,***
3.6 I can describe the main legal issues relating to microsatellites.	Candidates should be able to show they understand some legal issues ***Main aspects – who ‘owns’ space?, Legal issues inc - space activity, telecommunications, observation, Debris,***
4. Investigate the control, data use and end of life issues related to microsatellites.	
4.1 I can describe how microsatellites are controlled from earth.	Candidates should be able to describe some basic control mechanisms used in satellite deployment. ***Main aspects – radio transmissions, computer based control centres, data collection,***
4.2 I can describe how microsatellites are controlled while in space.	Candidates should be able to show they understand the basic aspects of AI. ***Main aspects – radio transmitter based systems, usable frequencies, effects of LEO – atmosphere, solar power, crashes***

Coursework task	*Guidance*
4.3 I can review the types of data collected by microsatellites	Candidates should be able to show they understand the different types of data available. ***Main aspects – combine with 3.5 – different data collected in different orbits – i.e. weather/GPS***
4.4 I can review the dangers of microsatellites that return to earth when they finish their mission.	Candidates should be able to document some of the dangers of space debris. ***Main aspects –space debris, burning in atmosphere or not? How to reduce space debris***
4.5 I can assess the impact of microsatellites and recommend a future use for them.	Candidates should be able to show they can think about the future of microsatellites and potential uses based on their understanding. ***Main aspects – think out of the box, own ideas how they can be used,***

Suggested Unit to Lesson/Topic Breakdown – *total 34 hours with 6 for coursework additional*

Topic / Lesson	Lessons	Spec Covered
Microsatellite types	3	1.4
Microsatellites use	2	1.1, 1.2, 1.3, 1.5
Microsatellites globally	2	1.1, 1.2, 1.3, 1.5
Microsatellite size	2	2.1
Microsatellites and materials	2	2.2, 2.3
Communication with Microsatellites	2	2.4
Plan and design a microsatellite	3	2.5, 2.6
Costs	2	3.1, 3.2
Propellants	2	3.3, 3.4
Orbits	2	3.5
Legal Issues	2	3.6
Scenario – company and gaining information Controlled from Earth, Controlled in Space, Data collection, Space Dangers, The future	10	4.1, 4.2, 4.3, 4.4, 4.5

Unit 2 - Lesson Suggestions

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Microsatellites types	**Lesson 1 (1.2, 1.4)** • Introduction – What is a microsatellite? • What are the uses of a microsatellite? Weather and GPS • Demo of GPS – look at the use – compared to map – where would we be now?	1.4 I can define the main versions of microsatellites including nanosatellites, picosatellites and femtosatellites 1.2 I can list and define the key uses of microsatellites ***Main aspects –weight, cost (fuel-weight), main characteristics of device and what it can carry Main aspects – GPS tracking – maps, weather, university use,***	Candidates should be able to show they understand the basic differences between the main microsatellites. Candidates should be able to demonstrate they understand the range of microsatellite use. Complete section 1 of coursework booklet
	Lesson 2 (1.2, 1.4) • Versions of microsatellites – research based lesson – Microsatellite versions and characteristics – build evidence written and images to complete coursework task • https://en.wikipedia.org/wiki/Small_satellite		
	Lesson 3 (1.2, 1.4) • Coursework		
Microsatellite use	**Lesson 4 (1.3)** • How are microsatellite launched into space? • https://en.wikipedia.org/wiki/Small_satellite • Where are they located – orbit level • What companies have launched and how are they used	1.3 I can describe the main launch vehicles used for deployment and their characteristics. ***Main aspects – Low Earth Orbit (LEO) launches, companies that launch – UK - Virgin Galactic, US - DARPA, Garvey and Boing, Switzerland - Swiss Space Systems, Spain - PLD Space. Height operated in, payload, general cost***	Candidates should be able to describe a number of launch vehicles. Complete section 2 of coursework booklet
	Lesson 5 (1.1, 1.5) • When were the first microsatellites launched? • What are the future launch plans for microsatellites? • How has the cost of launching changed over the years?	1.1 I can review the current status of microsatellites in terms of global production and main countries involved. 1.5 I can assess the current market in microsatellites. ***Main aspects – how many launches past and future, cost, countries that launch and how many etc*** ***Main aspects – costs, setbacks, what is possible, type of market***	Candidates should be able to show they understand the most current state of the market for microsatellites. Candidates should be able to show they can appreciate the reasons behind some of the market information. Complete section 2 of coursework booklet
Microsatellites Globally	**Lesson 6 (1.1, 1.5)** • Which countries launch microsatellites? Creating a map and link to cost (countries that can afford it) and link to companies • What setbacks has there been over the years?	1.1 I can review the current status of microsatellites in terms of global production and main countries involved. 1.5 I can assess the current market in microsatellites.	Candidates should be able to show they understand the most current state of the market for microsatellites. Candidates should be able to show they can

<table>
<tr><th>Topic Lesson</th><th>Content suggestions</th><th>Specification</th><th>Coursework Evidence</th></tr>
<tr><td></td><td>Lesson 7 - Coursework lesson</td><td>Main aspects – how many launches past and future, cost, countries that launch and how many etc
Main aspects – costs, setbacks, what is possible, type of market</td><td>appreciate the reasons behind some of the market information.

Complete section 2 of coursework booklet</td></tr>
<tr><td>Microsatellite size</td><td><u>Lesson 8 and 9 (2.1)</u>
• How big is a microsatellite?
• How does the weight effect the thrust required?
• https://en.wikipedia.org/wiki/Small_satellite
<table><tr><th>Group name[1]</th><th>Mass (kg)</th></tr><tr><td>Large satellite</td><td>>1000</td></tr><tr><td>Medium satellite</td><td>500 to 1000</td></tr><tr><td>Mini satellite</td><td>100 to 500</td></tr><tr><td>Micro satellite</td><td>10 to 100</td></tr><tr><td>Nano satellite</td><td>1 to 10</td></tr><tr><td>Pico satellite</td><td>0.1 to 1</td></tr><tr><td>Femto satellite</td><td><0.1</td></tr></table>• Paper helicopters and paperclip weights – with hairdryers to show increase needed to make heavy items fly
• Complete experiment and document the amount of thrust required to make the helicopter fly with increase of weight (number of paperclips) summarise findings</td><td>2.1 I can understand the need for size reduction in satellite technology.
Main aspects – relates to rocketry section on forces and thrust based on weight – size matters – size reduction designs</td><td>Candidates should be able to show they understand the implications of size and weight on the success of satellite technology

Complete section 3 of coursework booklet</td></tr>
<tr><td>Microsatellites and Materials</td><td><u>Lesson 10 and 11 (2.2, 2.3)</u>
• What is the atmosphere – create a diagram with annotation - https://www.youtube.com/watch?v=5sg9sCOXFIk very basic but clear
• How is temperature/radiation an issue – add annotation of temperature to diagram</td><td>2.2 I can describe some of the key materials used in construction and say why they are used.
Main aspects – different layers of atmosphere – materials – pressure/forces, temperature</td><td>Candidates should be able to list and describe a number of the main construction materials used, giving reasons for their choice</td></tr>
</table>

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	• What materials are microsatellites built from? Why are they used – thinking about the forces and linked to temp/rad above • Complete the lifecycle of a microsatellite and describe the forces that are in affect at each stage	2.3 I can describe the main forces acting on satellites in their life-cycle and how this affects their manufacture. ***Main aspects – radiation, temperature, links to 2.2, forces from cradle to grave***	Candidates should be able to show they understand the basic forces that satellites need to endure. Complete section 4 of coursework booklet
Communication with Microsatellites	<u>Lesson 12 and 13 (2.4)</u> • Look at what is communicated and how it is transmitted • What effect does flight path have on data (distance and sun) • What computerised systems are used?	2.4 I can describe the main forms of communication used in microsatellites and give examples of their usage. ***Main aspects – transmitting data, working in the environment (close to sun etc) computerised systems, issues with distance and data volume***	Candidates should be able to show they understand the ways that engineers control their devices Complete section 5 of coursework booklet
Plan and design a microsatellite	<u>Lesson 14, (2.5, 2.6)</u> • *https://www.nesdis.noaa.gov/jason-3/spacecraft.html -* investigate the microsatellites and complete a mission overview of each – a list of requirements and draw the satellite (or use image) and annotate clearly to show the microsatellite and set up ready to develop own <u>Lesson 15 and 16 (2.5, 2.6)</u> • What is needed to build a microsatellite? Materials, communication devices/types • Recap main functions – GPS/Weather • Create a list of requirements for own microsatellite and create a basic design for the microsatellite and its purpose	2.5 I can develop a list of requirements in the manufacture of a microsatellite 2.6 I can devise my own basic design for a microsatellite and define its purpose. ***Main aspects – use all elements from previous criteria to build a list – materials, communication devices/types – characteristics justify choice*** ***Main aspects – draw or computer - basic design of their own microsatellite and label some of the main parts – clear purpose i.e. camera or gps -*** *https://www.nesdis.noaa.gov/jason-3/spacecraft.html*	Candidates should be able to use their knowledge and understanding to put together a simple shopping list of requirements. Candidates should be able to construct a basic diagram of their microsatellite with labels for key components. Complete section 6 of coursework booklet
Costs	<u>Lesson 17 (3.1)</u> • What is the cost of deployment? How much does it cost to launch a satellite? • Below are some good links • Click here • Click here • Click here • Click here • Click here	3.1 I can appreciate the cost implications of getting equipment to space ***Main aspects – power to weight ratios, kerbal data, nasa data***	Candidates should be able to show they understand the relationships between weight and size and cost of deployment Complete section 7 of coursework booklet

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	• Create an informative piece on how much it would cost to allow a company the information to determine the feasibility of launching a microsatellite – new company wanting to launch a weather satellite – mini scenario		
	<u>Lesson 18 (3.2)</u> • What does the term 'piggyback' mean? • Research and add to scenario and complete coursework task	3.2 I can describe key terms such as "piggy back" in terms of deployment and gives examples of how it is used. ***Main aspects – costs and how to minimise, piggy back term, cost of deployment too large to launch satellites waiting***	Candidates should be able to show they understand some key terms used and show their understanding with clear examples Complete section 7 of coursework booklet
Propellants	<u>Lesson 19 and 20 (3.3, 3.4)</u> • What are propellants? • What are the options? propellant based on Hydrazine, table of (propellant, chemical, type, comments) inc - Anhydrous Hydrazine, Monomethyl Hydrazine and ALICE • Natural options in pace – solar panels • Complete a table of propellants • Add description to the table of the strengths and weaknesses	3.3 I can list and define the main propellants used by microsatellites. 3.4 I can describe the main strengths and weaknesses of the main propellants used in space. ***Main aspects – propellants used to launch, propellants used in space, solar panels, small thrusters usage – propellant based on Hydrazine, table of (propellant, chemical, type, comments) inc - Anhydrous Hydrazine, Monomethyl Hydrazine and ALICE*** ***Main aspects – stores energy but dangerous, hygroscopic – leach water from anything in contact, combine with 3.3 – launch fuel may not be suitable in space***	Candidates should be able to document some of the propellants used in satellites and their characteristics. Candidates should be able to show they understand some of the characteristics of propellants. Complete section 8 of coursework booklet
Orbits	<u>Lesson 21 (3.5)</u> • Space the final frontier – research and complete a diagram of space orbits – defining distance and names (links to previous unit so may be able to recap from previous to add to this aspect) • Where are satellites in the sky now - http://stuffin.space/ and https://in-the-sky.org/satmap_worldmap.php	3.5 I can describe the different levels of orbit used in microsatellite systems.	Candidates should be able to show they understand the different orbits in terms of their distance and characteristics. ***Main aspects – High Earth Orbit, Medium Earth Orbit, Low Earth Orbit,*** Complete section 9 of coursework

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	Lesson 22 (3.5) • Complete coursework describing the different levels of orbit used by microsatellites		booklet
Legal Issues	Lesson 23 (3.6) • http://stuffin.space/ look at space debris – whose responsibility is it? What happens to detached parts etc • Who owns space? • Who is responsible for space activity? • Research and complete coursework task	3.6 I can describe the main legal issues relating to microsatellites.	Candidates should be able to show they understand some legal issues *Main aspects – who 'owns' space?, Legal issues inc - space activity, telecommunications, observation, Debris,* Complete section 10 of coursework booklet
Coursework	Lesson 24 – used as a lesson to ensure all pupils at the same point ready to move on		
Section 4 theory	Lesson 25 and 26 (4.1) • Theory lessons on – controlled from earth, in space, how to collect data, space dangers, the future	4.1 I can describe how microsatellites are controlled from earth. 4.2 I can describe how microsatellites are controlled while in space. 4.3 I can review the types of data collected by microsatellites 4.4 I can review the dangers of microsatellites that return to earth when they finish their mission 4.5 I can assess the impact of microsatellites and recommend a future use for them. *Main aspects – radio transmissions, computer based control centres, data collection,* *Main aspects – radio transmitter based systems, usable frequencies, effects of LEO – atmosphere, solar power, crashes* *Main aspects – combine with 3.5 – different data collected in different orbits – i.e. weather/GPS* *Main aspects –space debris, burning in atmosphere or not? How to reduce space debris* *Main aspects – think out of the box, own ideas how they can be used,*	Candidates should be able to describe some basic control mechanisms used in satellite deployment. Candidates should be able to show they understand the basic aspects of AI. Candidates should be able to show they understand the different types of data available. Candidates should be able to document some of the dangers of space debris. Candidates should be able to show they can think about the future of microsatellites and potential uses based on their understanding. Complete section 11 of coursework booklet
Coursework scenario	Lesson 27 - 34 (4.1, 4.2, 4.3, 4.4, 4.5) • The company that are going to launch a weather microsatellite are also looking for some more information and need you to research and describe the following points: • How can the microsatellite be controlled from earth? What are out options? • How can we control the microsatellite in space? What are our options? • What dangers should we consider for our microsatellite in space and returning to earth? • What do you think is the future of microsatellites and how they could be used? • https://www.theguardian.com/business/2015/apr/05/build-and-launch-your-own-satellite-for-20000-pounds - interesting article		

Unit 3 Working with Robotics and Artificial Intelligence:

1. Understand what Artificial Intelligence is and how it works	2. Review and define examples of where robotics is used	3. Understand the processes of making a basic robot work	4. Appreciate and test the issues and challenges of robotics
1.1 I can list the main features of an artificial intelligence	2.1 I can describe instances of robotics in industrial places	3.1 I can review the equipment required to design and create robotic devices	4.1 I can test the build quality of an assembled robot against the specification
1.2 I can describe, with examples, the main uses of artificial intelligence	2.2 I can review how robotics is used in medical applications	3.2 I can assess the design tools used to create robots and use these in a basic way	4.2 I can test the main features of a built robot in terms of hardware and software
1.3 I can review some of the expectations of artificial intelligence	2.3 I can describe how robotics is used in agricultural environments	3.3 I can work with various components of robot design and appreciate their features	4.3 I can make adjustments to a robot build or control system to improve its functioning
1.4 I can review the intended uses of artificial intelligence	2.4 I can assess the wider use of robotics in society	3.4 I can build a basic robot for testing	4.4 I can recommend additional features to existing designs based on usage
1.5 I can assess the strengths and weaknesses of using artificial intelligence	2.5 I can assess and comment on the dangers associated with the reliance on robotics in society		
1.6 I can describe any legal and ethical issues associated with using robots			

Notes and guidance on Coursework

Coursework task	*Guidance*
1. Understand what Artificial Intelligence is and how it works	
1.1 I can list the main features of an artificial intelligence	Candidates should be able to show they understand the basic aspects of AI. ***Main aspects – definition of AI, what devices are classed as AI i.e. driverless cars, temperature device in the home, computer beating GO player, emergency devices to 999, subtle programming*** ***What is intelligence? – looking at research – 'deduction, reasoning and problem solving', 'knowledge representation', 'planning', 'learning', 'communication', 'perception', 'motion and manipulation', 'social', 'creativity', 'general intelligence'***
1.2 I can describe, with examples, the main uses of artificial intelligence	Candidates should be able to describe, perhaps by creating a table, the main uses of AI ***Main aspects –*** https://en.wikipedia.org/wiki/Applications_of_artificial_intelligence ***what have they come across, key areas to research – aviation, computer science, education, finance, heavy industry, hospitals and medicine, human resources and recruiting, marketing, music, news, publishing and writing, online and telephone customer service, telecommunications maintenance, toys and games, transportation.***
1.3 I can review some of the expectations of artificial intelligence	Candidates should be able to give some clear details of their chosen examples from 1.2. ***Main aspects –presentation of AI examples from 1.2 – all choose different topic areas to build group knowledge***
1.4 I can review the intended uses of artificial intelligence	Candidates should be able to demonstrate a broad understanding of using AI. ***Main aspects – applications today vs future proposals; algorithms in personalised learning in maths learning programs, AI vs Human, Google and***

Coursework task	Guidance
	Apple self-healing computer systems
1.5 I can assess the strengths and weaknesses of using artificial intelligence	Candidates should be able to demonstrate an appreciation for some of the good and bad aspects of using AI. *Main aspects – different examples – medical, monotony jobs, over reliance,* http://www.bbc.co.uk/news/technology-36517340?ocid=socialflow_twitter *finance, gaining information – democracy (free world?)*
1.6 I can describe any legal and ethical issues associated with using robots	Candidates should be able to describe the legal and ethical concerns. *Main aspects – science fiction Isaac Asimov 3 laws, human interpretation built into design, open and transparent design, rights, privacy, dignity, weapons, ethics*
2. Review examples of where robotics is used.	
2.1 I can describe instances of robotics in industrial places	Candidates should be able to list, with guidance, the main industrial applications of robotics. *Main aspects – robotic arms in manufacturing, car manufacturing, automation of book orders in large retail companies and many more examples*
2.2 I can review how robotics is used in medical applications	Candidates should be able to give some examples in their own words of robots used in medicine. *Main aspects –first appeared 1980s, heart surgery, other surgeries completed or assisted by robots, current status, nanorobotics -* https://en.wikipedia.org/wiki/Nanorobotics
2.3 I can describe how robotics is used in agricultural environments	Candidates should be able to list, with guidance, the agricultural application and use of robotics. *Main aspects – automation of harvesting crops, tackle weeds. Different fruit and vegetables, milking, automated tractors and watering systems*
2.4 I can assess the wider use of robotics in society	Candidates should be able to show other areas of robotics use. *Main aspects – space and microsatellites, around the home i.e. vacuum cleaners, education and sports*
2.5 I can assess and comment on the dangers associated with the reliance on robotics in society	Candidates should be able to show that they understand some of the dangers of using and being reliant on robots. *Main aspects – link to 2.4 uses now what are the potential dangers, reliance meaning working without supervision – investigate warfare and if robots go to war instead of soldiers what programming will they have in life and death. Book – Westworld, robots as teachers?*
3. Identify the processes of making a basic robot work.	
3.1 I can review the equipment required to design and create robotic devices	Candidates should be able to show familiarity with some of the tools available to create robots. *Main aspects – software to create and control, handheld control, range of tools*
3.2 I can assess the design tools used to create robots and use these in a basic way	Candidates should be comfortable around the various tools used to design and create robots. *Main aspects – awareness of 3D software, programming. EZ-Builder, any software used to control robots*
3.3 I can work with various components of robot design and appreciate their features	Candidates should be able to understand the main components and separate parts of a robotic device. *Main aspects – designed to mimic human functions, dependent on centre kits purchased/access to*
3.4 I can build a basic robot for testing	Candidates should be able to participate in building a basic robot system. *Main aspects – team or on their own, test functions, make changes and test outcomes*
4. Appreciate and test the issues and challenges of robotics.	
4.1 I can test the build quality of an assembled robot against the specification	Candidates should be able to appreciate quality control issues in engineering. *Main aspects – versions of devices used i.e. possibly raspberry pi, technology development fast rate, compare/contrast finished product to intended product, software/hardware availability based on design needs, turtlebot*
4.2 I can test the main features of a built robot in terms of	Candidates should be able to appreciate some of the main features of hardware and software used in robotic products.

Coursework task	*Guidance*
hardware and software	***Main aspects – open source, proprietary, SDK, Operating system, what does it need to fit the purpose***
4.3 I can make adjustments to a robot build or control system to improve its functioning	Candidates should be able to list a number of basic changes to a design. ***Main aspects – look at kits and think of own adjustments to the hardware and software that work together***
4.4 I can recommend additional features to existing designs based on usage	Candidates should be able to identify possible improvements. ***Main aspects –i.e. smartphone – thin easy to break and people put in back pocket and sit on them. What improvements could be made?***

Suggested Unit to Lesson/Topic Breakdown – *total 34 hours with 6 for coursework additional*

Topic / Lesson	Lessons	Spec Covered
What is AI?	4	1.1
Uses of AI	3	1.2, 1.3
Review and assess AI use with legal	3	1.4, 1.5, 1.6
Industrial Use	3	2.1
Medical Use	3	2.2
Agricultural Use	3	2.3
Wider use and dangers	3	2.4, 2.5
Software available	4	3.1, 3.2
Build a robot	4	3.3, 3.4
Testing and quality	2	4.1, 4.2
Improvements and recommendations	2	4.3, 4.4

Unit 3 - Lesson Suggestions

Topic Lesson	Content suggestions	Specification	Coursework Evidence
What is AI	<u>Lesson 1 (1.1)</u> • Introduction to unit • Look at IRobot trailer – introduces concept and 3 rules • What is the definition - Research AI <u>Lesson 2-4 (1.1)</u> • What is intelligence? • Split class into groups give them 1 or 2 of the headings to research on the meanings – AI development and possibilities ○ 'deduction, reasoning and problem solving', 'knowledge representation', ○ 'planning', ○ 'learning', ○ 'communication', ○ 'perception', ○ 'motion and manipulation', ○ 'social', ○ 'creativity', ○ 'general intelligence'	1.1 I can list the main features of an artificial intelligence ***Main aspects – definition of AI, what devices are classed as AI i.e. driverless cars, temperature device in the home, computer beating GO player, emergency devices to 999, subtle programming*** ***What is intelligence? – looking at research – 'deduction, reasoning and problem solving', 'knowledge representation', 'planning', 'learning', 'communication', 'perception', 'motion and manipulation', 'social', 'creativity', 'general intelligence'***	Candidates should be able to show they understand the basic aspects of AI.
Uses of AI	<u>Lesson 5-8 (1.2, 1.3)</u> • Investigation of the use of AI • Give groups of two a topic header to research and create a presentation of examples of AI there are and the expectations in that sector. • Present to rest of group and group to make notes off other presentations in order to build enough knowledge to complete coursework questions	1.2 I can describe, with examples, the main uses of artificial intelligence 1.3 I can review some of the expectations of artificial intelligence ***Main aspects –*** https://en.wikipedia.org/wiki/Applications_of_artificial_intelligence ***what have they come across, key areas to research – aviation, computer science, education, finance, heavy industry, hospitals and medicine, human resources and recruiting, marketing, music, news, publishing and writing, online and telephone customer service, telecommunications maintenance, toys and games, transportation.*** ***Main aspects –presentation of AI examples from 1.2 – all choose different topic areas to build group knowledge***	Candidates should be able to describe, perhaps by creating a table, the main uses of AI Candidates should be able to give some clear details of their chosen examples from 1.2.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Review and assess AI use with legal	<u>Lesson 9 (1.4)</u> • Recap previous lesson on uses of AI and look at what the future may be • Algorithms and personalised learning – how can computers know how you learn and change to your needs • AI vs Human discussion • Self-healing computers – Apple/Google <u>Lesson 10 (1.4, 1.5, 1.6)</u> • 'Harmful' robot aims to spark AI debate – look at the weakness of human interference • Strengths and weaknesses of AI in medical – look for case studies and create a news story on a strength and a weakness – collate stories in an online blog or wiki or shared area or printed <u>Lesson 11 (1.4, 1.5, 1.6)</u> • Look at Isaac Asimov and the 3 laws – the use of science fiction in how we develop as a society • How can the 3 laws work in developing weapons, privacy, ethical aspects • How can bias not be built into a design?	1.4 I can review the intended uses of artificial intelligence 1.5 I can assess the strengths and weaknesses of using artificial intelligence 1.6 I can describe any legal and ethical issues associated with using robots ***Main aspects – applications today vs future proposals; algorithms in personalised learning in maths learning programs, AI vs Human, Google and Apple self-healing computer systems*** ***Main aspects – different examples – medical, monotony jobs, over reliance,*** http://www.bbc.co.uk/news/technology-36517340?ocid=socialflow_twitter ***finance, gaining information – democracy (free world?)*** ***Main aspects – science fiction Isaac Asimov 3 laws, human interpretation built into design, open and transparent design, rights, privacy, dignity, weapons, ethics***	Candidates should be able to demonstrate a broad understanding of using AI. Candidates should be able to demonstrate an appreciation for some of the good and bad aspects of using AI. Candidates should be able to describe the legal and ethical concerns.
Industrial Use	<u>Lesson 12-14 (2.1)</u> • What is industrial use? • Research and create an insert for the new newspaper 'AI in Life Today' newspaper on the use of AI in industrial places covering a wide range (could be collated from group work)	2.1 I can describe instances of robotics in industrial places ***Main aspects – robotic arms in manufacturing, car manufacturing, automation of book orders in large retail companies and many more examples***	Candidates should be able to list, with guidance, the main industrial applications of robotics.
Medical Use	<u>Lesson 15-17 (2.2)</u> • What are medical applications? - Mind map • Research and create the next insert for the new newspaper 'AI in Life Today' newspaper on the use of AI for medical applications covering a wide range (could be collated from group work)	2.2 I can review how robotics is used in medical applications ***Main aspects –first appeared 1980s, heart surgery, other surgeries completed or assisted by robots, current status, nanorobotics -*** https://en.wikipedia.org/wiki/Nanorobotics	Candidates should be able to give some examples in their own words of robots used in medicine.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Agricultural use	<u>Lesson 18-20 (2.3)</u> • What are agricultural environments? - Mind map • Research and create the next insert for the new newspaper 'AI in Life Today' newspaper on the use of AI for agricultural environments covering a wide range (could be collated from group work)	2.3 I can describe how robotics is used in agricultural environments ***Main aspects – automation of harvesting crops, tackle weeds. Different fruit and vegetables, milking, automated tractors and watering systems***	Candidates should be able to list, with guidance, the agricultural application and use of robotics.
Wider use and dangers	<u>Lesson 21-23 (2.4, 2.5)</u> • How else can robotics be used? • Investigate any use of robotics • Look at examples of new developments • Look at university developments • Science museums – development of robots • Space and microsatellites – recap previous units – look at the use for gps and weather • Do we rely on robotic technology too much – look at case studies of crashed systems and effects • Look at tv series 'celebrity hunted' how they used mobile tech and cars and cameras and social media to track you • Look at the future – are we heading for terminator or irobot extreme scenarios but what if humans are replaced my robots in war – look at mercy? Look at anger? • Book Westworld • How about robots as teachers – knowledge retained but delivery? Behaviour management?	2.4 I can assess the wider use of robotics in society 2.5 I can assess and comment on the dangers associated with the reliance on robotics in society ***Main aspects – space and microsatellites, around the home i.e. vacuum cleaners, education and sports*** ***Main aspects – link to 2.4 uses now what are the potential dangers, reliance meaning working without supervision – investigate warfare and if robots go to war instead of soldiers what programming will they have in life and death. Book – Westworld, robots as teachers?***	Candidates should be able to show other areas of robotics use. Candidates should be able to show that they understand some of the dangers of using and being reliant on robots.
Software available	<u>Lesson 24 (3.1, 3.2)</u> • What are the software and hardware options available • Open source vs proprietary • Look at development from handheld radio controlled to controlled via app • Look at software available in school	3.1 I can review the equipment required to design and create robotic devices 3.2 I can assess the design tools used to create robots and use these in a basic way ***Main aspects – software to create and control, handheld control, range of tools*** ***Main aspects – awareness of 3D software, programming. EZ-***	Candidates should be able to show familiarity with some of the tools available to create robots. Candidates should be comfortable around the various tools used to design and create robots.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	Lesson 25-28 (3.1, 3.2) • Complete tasks within school software • Example programming • Usage of tools • Developing robotic actions and movement • Document tests and experiments and assess the outcome against the task	*Builder, any software used to control robots*	
Build a robot	Lesson 29-32 (3.3, 3.4) • Using schools equipment build a basic robot – individually / group work • Video / photo evidence • Test and document development of the robot to see how it is built	3.3 I can work with various components of robot design and appreciate their features 3.4 I can build a basic robot for testing *Main aspects – designed to mimic human functions, dependent on centre kits purchased/access to* *Main aspects – team or on their own, test functions, make changes and test outcomes*	Candidates should be able to understand the main components and separate parts of a robotic device. Candidates should be able to participate in building a basic robot system.
Testing and Quality	Lesson 33-34 (4.1, 4.2) • Look at the instructions and specification of the robot purchased (box or internet) • Test the built robot against these specifications to see if true • Look at versions of the software / compatability • Test the software and the hardware to see if all working ok – document software and hardware available to the device	4.1 I can test the build quality of an assembled robot against the specification 4.2 I can test the main features of a built robot in terms of hardware and software *Main aspects – versions of devices used i.e. possibly raspberry pi, technology development fast rate, compare/contrast finished product to intended product, software/hardware availability based on design needs, turtlebot* *Main aspects – open source, proprietary, SDK, Operating system, what does it need to fit the purpose*	Candidates should be able to appreciate quality control issues in engineering. Candidates should be able to appreciate some of the main features of hardware and software used in robotic products.
Improvements and recommendations	Lesson 35-36 (4.3, 4.4) • Look at built robot and make adjustments to kit or code • How could it be improved? • Look at other tech and what improvements could be made - imagination	4.3 I can make adjustments to a robot build or control system to improve its functioning 4.4 I can recommend additional features to existing designs based on usage *Main aspects – look at kits and think of own adjustments to the hardware and software that work together* *Main aspects –i.e. smartphone – thin easy to break and people put in back pocket and sit on them. What improvements could be made?*	Candidates should be able to list a number of basic changes to a design. Candidates should be able to identify possible improvements.

Unit 4 The Development and Deployment of Unmanned Vehicles (UV):

1. Understand the history and range of uses of UVs	2. Appreciate the design and development issues related to UVs	3. Explore the problems and solutions of UV usage	4. Understand the legal, moral and ethical issues related to UV use
1.1 I can research the history of UVs and list the key milestones	2.1 I can describe the range of designs currently in use	3.1 I can describe the main control methods used with UVs	4.1 I can describe the legal issues relating to UVs
1.2 I can list the primary uses of UVs currently in operation	2.2 I can assess the designs in terms of their use	3.2 I can assess the development constraints that apply in building UVs	4.2 I can assess the main laws and regulations that affect UVs use
1.3 I can explore the extended range of uses of UVs	2.3 I can assess the main materials used in the construction of UVs and list their strengths and weaknesses	3.3 I can describe the key requirements of endurance and reliability of UVs	4.3 I can review the ethical concerns relating to UVs in a commercial setting
1.4 I can describe the use of UVs in civil and military situations and give examples of each	2.4 I can describe the main forms of UVs based on their use and required characteristics such as range, height, speed, payload	3.4 I can design my own basic UV based on my understanding	4.4 I can review the ethical and legal concerns relating to UVs in a military setting
	2.5 I can describe the software and hardware used in UVs	3.5 I can describe the features and use of my UV	

Notes and guidance on Coursework

Coursework task	*Guidance*
1. Understand the history and range of uses of UVs	
1.1 I can research the history of UVs and list the key milestones	Candidates should be able to show an appreciation of the development of UV over time. ***Main aspects – drones, military use, development over time, development of UAVs (Unmanned ground vehicles), ROV (Remotely Operated Underwater Vehicles, major milestones***
1.2 I can list the primary uses of UVs currently in operation	Candidates should be able to show the most widely used areas of UV usage. ***Main aspects – military use,*** https://www.nationalpriorities.org/cost-of/drones/ ***, construction purposes,*** http://www.devoredesign.com/2015/07/31/for-the-first-time-ever-commercial-drone-usage-statistics/ ***, monitoring wildlife,***
1.3 I can explore the extended range of uses of UVs	Candidates should be able to show they understand the most current state of the market for UVs. ***Main aspects – agriculture, search and rescue, films and commercials, sports, wildlife management, science/environment, new reporting, real estate, mapping, delivery, monitoring, communications***
1.4 I can describe the use of UVs in civil and military situations and give examples of each	Candidates should be able to describe in some detail some specific uses ***Main aspects – link to 1.3 describing an area in more detail***
2. Appreciate the design and development issues related to UVs.	
2.1 I can describe the range of designs currently in use	Candidates should be able to show some of the designs currently available. ***Main aspects – sea, land and air. Different designs for one aspect i.e. submarines, look at the designs and create a table/report/ppt***
2.2 I can assess the designs in terms of their use	Candidates should be able to show they understand the relationship between design and purpose. ***Main aspects – link to 2.1, purpose vs design (materials etc), look at selection of devices and how they work in intended situations, improvements to a design***
2.3 I can assess the main materials used in the	Candidates should be able to explore devices specifications and look for ways to improve them

Coursework task	Guidance
construction of UVs and list their strengths and weaknesses	*Main aspects – materials and properties, other material options, why materials chosen, strength to weight rations or cost, Fibre Reinforced Plastic (FRP), Glass Fibre-Reinforced Polymers (GFRP), Carbon Fibre-Reinforced Polymers (CFRP).* https://www.azom.com/article.aspx?ArticleID=12234 *, table of materials and description of strengths and weaknesses*
2.4 I can describe the main forms of UVs based on their use and required characteristics such as range, height, speed, payload	Candidates should be able to demonstrate a clear understanding of the range of characteristics of UVs. *Main aspects – specific types and forms of UVs, UAV – ranges, affected by temperature and altitude, what it can carry – effect on range, speed and altitude, technology moving, Facebook = UAV – Aquila* http://www.bbc.co.uk/news/av/technology-36855166/facebook-s-aquila-drone-takes-to-the-air *. ROV – depth, mother ship, pressure, lighting, power supply, speed, search and rescue – swarming techniques – shipwrecks and plane crashes on sea floor, communication. UV – speed, terrain, environment, cold and heat, carry equipment effect on range and movement*
2.5 I can describe the software and hardware used in UVs	Candidates should be able to describe the control systems for UVs. *Main aspects – near or far, UAV – levers speeding up/slowing down, sensors, hardware on device, software to run, open source, embedded systems, Hydra Fusion, GPU, learning software, swarm based simulations, mars rover 'do what it wants' software, deep sea options.*
3. Explore the problems and solutions of UV usage	
3.1 I can describe the main control methods used with UVs	Candidates should be able to show the methods of controlling various UVs. *Main aspects – handheld – radio signals, software and control panel, small radio controlled helicopter survey of new island near Japan, characteristics of control software, features of control depending on device*
3.2 I can assess the development constraints that apply in building UVs	Candidates should be able to have an appreciation of some of the manufacturing constraints in their projects or the projects of others. *Main aspects – size, 3D printer restriction on size, scenario – kickstarter -* www.kickstarter.com/projects/torquing/zano-autonomous-intelligent-swarming-nano-drone/posts/1424636 *, privacy and safety, systems to prevent accidents, safety to other people/devices – out of control, cost and materials.*
3.3 I can describe the key requirements of endurance and reliability of UVs	Candidates should be able to describe what features aide endurance and reliability. *Main aspects – large parts – friction and resistance, motors, propellers, speed controllers, batteries,*
3.4 I can design my own basic UV based on my understanding	Candidates should be able to show they understand the key aspects of UV by designing one with labels. *Main aspects – paper or CAD software, purpose of device,*
3.5 I can describe the features and use of my UV	Candidates should be able to describe their design's features. *Main aspects – link to 3.5, power source, characteristics, control mechanisms, limitations, equipment and materials,*
4. Understand the legal, moral and ethical issues related to UV use	
4.1 I can describe the legal issues relating to UVs	Candidates should be able to list a number of key legal issues and their main features in relation to UV. *Main aspects – privacy, reserved airspace, fast development vs laws passed, data protection act, health and safety – personal injury*
4.2 I can assess the main laws and regulations that affect UVs use	Candidates should be able to show they understand the need for regulation. *Main aspects – link to 4.2, develop description of laws and health and safety and assess how good they are - examples*
4.3 I can review the ethical concerns relating to UVs in a commercial setting	Candidates should be able to show they understand some of the ethical issues of UV usage. *Main aspects – privacy of individuals, small and quiet drone = person unaware of recording, spy on people – easy to buy and use, ROV – explore shipwrecks and bodies found, use by police,*
4.4 I can review the ethical and legal concerns relating to UVs in a military setting	Candidates should be able to show they understand the main issue around the use of UV in the military. *Main aspects – UV in military setting, minimise death of own using UVs,*

Coursework task	Guidance
	desensitized from output of war and death, inaccuracy, legitimate attacks – has to be 2 countries at war, gamification of war, cost,

Suggested Unit to Lesson/Topic Breakdown – *total 34 hours with 6 for coursework additional*

Topic / Lesson	Lessons	Spec Covered
Intro and History of UVs	3	1.1
How are UVs used	4	1.2, 1.3, 1.4
Designs of UVs	4	2.1, 2.2
Materials used	2	2.3
Uses and characteristics	2	2.4
Software and Hardware	2	2.5
Control systems	2	3.1
Manufacturing constraints	2	3.2
Endurance and reliability	2	3.3
Design and features of own UV	5	3.4, 3.5
Legal Issues	3	4.1, 4.2
Ethical issues and the military	3	4.3, 4.4

Unit 4 - Lesson Suggestions

Topic Lesson	Content suggestions	Specification	Coursework Evidence
Intro and History of UVs	<u>Lesson 1 (1.1)</u> • What is a UV? • Introduction – look at the different definitions • Have they seen them/used them? • Common use as personal drones now <u>Lesson 2 (1.1)</u> • Drones and military use • How have these developed over time? • Look at the development of the drone use – surveillance to personal use • Look at drones now in cartoons – becoming standard in life – paw patrol • Drones used in film/tv – NCIS examples of military use <u>Lesson 3 (1.1)</u> • UAVs and ROV • Development and usage • Space and water • Control – introduce control systems and link to computing robots – https://code.org/hourofcode/overview	1.1 I can research the history of UVs and list the key milestones ***Main aspects – drones, military use, development over time, development of UAVs (Unmanned ground vehicles), ROV (Remotely Operated Underwater Vehicles, major milestones***	Candidates should be able to show an appreciation of the development of UV over time.

How are UVs used	<u>Lesson 4-6 (1.2, 1.3, 1.4)</u>
	• Look at different uses of UVs
	• Split into groups and develop a presentation on the use of UVs in the following areas –
	  ○ Military
	  ○ Construction
	  ○ Wildlife
	  ○ Agriculture
	  ○ Search and rescue
	  ○ Films and commercials
	  ○ Sports
	  ○ Science/environment
	  ○ News reporting
	  ○ Real estate
	  ○ Mapping
		1.2 I can list the primary uses of UVs currently in operation
		1.3 I can explore the extended range of uses of UVs
		1.4 I can describe the use of UVs in civil and military situations and give examples of each
		Main aspects – military use, https://www.nationalpriorities.org/cost-of/drones/ ***, construction purposes,*** http://www.devoredesign.com/2015/07/31/for-the-first-time-ever-commercial-drone-usage-statistics/ ***, monitoring wildlife, Main aspects – agriculture, search and rescue, films and commercials, sports, wildlife management, science/environment, news reporting, real estate, mapping, delivery, monitoring, communications Main aspects – link to 1.3 describing an area in more***
			Candidates should be able to show the most widely used areas of UV usage.
			Candidates should be able to show they understand the most current state of the market for UVs.
			Candidates should be able to describe in some detail some specific uses

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	○ Delivery ○ Monitoring ○ Communications • They then choose one of the areas and describe in more detail that area	***detail***	
Designs of UVs	<u>Lesson 7-10 (2.1, 2.2)</u> • Look at uses from previous lessons and characterise them into land, sea and air • Example – submarines and look at the way designs have changed, what could be done to improve them further? Look at depth effect on design • Choose a use and research how designs have changed – create a report	2.1 I can describe the range of designs currently in use 2.2 I can assess the designs in terms of their use ***Main aspects – sea, land and air. Different designs for one aspect i.e. submarines, look at the designs and create a table/report/ppt Main aspects – link to 2.1, purpose vs design (materials etc), look at selection of devices and how they work in intended situations, improvements to a design***	Candidates should be able to show some of the designs currently available. Candidates should be able to show they understand the relationship between design and purpose.
Materials used	<u>Lesson 11-12 (2.3)</u> • Different materials used in UVs • Key needs – strength, weight, cost • Fibre Reinforced Plastic (FRP), Glass Fibre-Reinforced Polymers (GFRP), Carbon Fibre-Reinforced Polymers (CFRP). • Link to previous investigation in design and describe the materials used and why – look at any other options and why they were discarded	2.3 I can assess the main materials used in the construction of UVs and list their strengths and weaknesses ***Main aspects – materials and properties, other material options, why materials chosen, strength to weight rations or cost, Fibre Reinforced Plastic (FRP), Glass Fibre-Reinforced Polymers (GFRP), Carbon Fibre-Reinforced Polymers (CFRP).*** https://www.azom.com/article.aspx?ArticleID=12234 ***, table of materials and description of strengths and weaknesses***	Candidates should be able to explore devices specifications and look for ways to improve them
Uses and characteristics	<u>Lesson 13-14 (2.4)</u> • Why are range, height, speed and payload important? • Look at characteristics of UAV, ROV, UV – what are they? • Facebook – Aquila – investigation and see how being used	2.4 I can describe the main forms of UVs based on their use and required characteristics such as range, height, speed, payload ***Main aspects – specific types and forms of UVs, UAV – ranges, affected by temperature and altitude, what it can carry – effect on range, speed and altitude, technology moving, Facebook = UAV – Aquila*** http://www.bbc.co.uk/news/av/technology-36855166/facebook-s-aquila-drone-takes-to-the-air ***. ROV – depth, mother ship, pressure, lighting, power supply, speed, search and rescue – swarming techniques – shipwrecks and plane crashes on sea floor, communication. UV – speed, terrain, environment, cold***	Candidates should be able to demonstrate a clear understanding of the range of characteristics of UVs.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
		and heat, carry equipment effect on range and movement	
Software and hardware	<u>Lesson 15-16 (2.5)</u> • What is a control system? Look at Yenka or Flowol as examples • What software and hardware are needed in a UV? Look at the difference in relation of environment. Space / Sea / Land • Look at the mars rover that can now 'do what it wants' lack of control more free roaming and data gathering. What does this mean?	2.5 I can describe the software and hardware used in UVs ***Main aspects – near or far, UAV – levers speeding up/slowing down, sensors, hardware on device, software to run, open source, embedded systems, Hydra Fusion, GPU, learning software, swarm based simulations, mars rover 'do what it wants' software, deep sea options.***	Candidates should be able to describe the control systems for UVs.
Control Systems	<u>Lesson 17-18 (3.1)</u> • Extension of previous lessons on control systems • Look at more options for control – handheld using radio signals, • What are the characteristics of control software? • What are the features of control? • Case studies – look at the use of control from distances i.e. surveying new land, military surveillance	3.1 I can describe the main control methods used with UVs ***Main aspects – handheld – radio signals, software and control panel, small radio controlled helicopter survey of new island near Japan, characteristics of control software, features of control depending on device***	Candidates should be able to show the methods of controlling various UVs.
Manufacturing constraints	<u>Lesson 19-20 (3.2)</u> • What is a constraint? What does this mean – check understanding • Look back at the materials aspect – what constraints are there? Size and cost • Look at safety – constraint on building – accidents, privacy, out of control • Why should these be considered? Is it too far? Is it essential? Ethical debate	3.2 I can assess the development constraints that apply in building UVs ***Main aspects – size, 3D printer restriction on size, scenario – kickstarter -*** www.kickstarter.com/projects/torquing/zano-autonomous-intelligent-swarming-nano-drone/posts/1424636 ***, privacy and safety, systems to prevent accidents, safety to other people/devices – out of control, cost and materials.***	Candidates should be able to have an appreciation of some of the manufacturing constraints in their projects or the projects of others.
Endurance and reliability	<u>Lesson 21-22 (3.3)</u> • What is endurance and reliability? Why are these important? • What is friction and resistance? • Look at different parts and link to endurance and reliability i.e. motors, propellers, speed controllers	3.3 I can describe the key requirements of endurance and reliability of UVs ***Main aspects – large parts – friction and resistance, motors, propellers, speed controllers, batteries,***	Candidates should be able to describe what features aide endurance and reliability.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	and batteries • Look at the UV they investigated and the designs they investigated and look for these parts – describe how they are used and why endurance and reliability is so essential. Look at example of a drone and the batteries/motor required to withstand long flights/temperature/weather etc		
Design and features of own UV	Lesson 23-27 (3.4) • What UV would they design? Mind map options and ideas • Peer assess ideas and choose final option • Dependent on school software – CAD software? • Design and label own UV – paper or CAD • Annotate material options • What is the purpose of the UV • Add the detail in description of plan – power source, characteristics, control, equipment/parts • Self and peer assess throughout	3.4 I can design my own basic UV based on my understanding 3.5 I can describe the features and use of my UV ***Main aspects – paper or CAD software, purpose of device,*** ***Main aspects – link to 3.5, power source, characteristics, control mechanisms, limitations, equipment and materials,***	Candidates should be able to show they understand the key aspects of UV by designing one with labels. Candidates should be able to describe their design's features.
Legal Issues	Lesson 28-30 (4.1, 4.2) • Why is privacy important with the development of UV devices? • Laws that should be passed – look at the development of the UVs vs the laws that have been passed • Data protection act and health and safety act – why important, what are they? • Describe what the laws are and how good are they – case studies where they have been needed or missed. Has health and safety gone mad?	4.1 I can describe the legal issues relating to UVs 4.2 I can assess the main laws and regulations that affect UVs use ***Main aspects – privacy, reserved airspace, fast development vs laws passed, data protection act, health and safety – personal injury*** ***Main aspects – link to 4.2, develop description of laws and health and safety and assess how good they are - examples***	Candidates should be able to list a number of key legal issues and their main features in relation to UV. Candidates should be able to show they understand the need for regulation.
Ethical issues and the military	Lesson 31-33 (4.3, 4.4) • Recap on military use – how ethical is a UV being used for surveillance? Spying • How quiet are drones? Would you know they are there? • Look at tv series – 'person of interest' tracking people • Look at tv series 'hunted' again and relate to tracking 'Bin Laden' how do they find them? How are drones	4.3 I can review the ethical concerns relating to UVs in a commercial setting 4.4 I can review the ethical and legal concerns relating to UVs in a military setting ***Main aspects – privacy of individuals, small and quiet drone = person unaware of recording, spy on people – easy to buy and use, ROV – explore shipwrecks and bodies found, use by police,***	Candidates should be able to show they understand some of the ethical issues of UV usage. Candidates should be able to show they understand the main issue around the use of UV in the military.

Topic Lesson	Content suggestions	Specification	Coursework Evidence
	used to achieve this? • Look at shipwreck recovery – still finding bodies and how to deal with this ethically when recovering ships/planes. • Gamification – has gaming affected our ability to be threatened or worried by drone surveillance or use as a weapon? We see a lot in games that we expect it? Debate – case studies	*Main aspects – UV in military setting, minimise death of own using UVs, desensitized from output of war and death, inaccuracy, legitimate attacks – has to be 2 countries at war, gamification of war, cost,*	

Example Exam Paper

Question	Multiple Choice Options	Answer
Which of the following heights above ground would be considered a Low Earth Orbit	a) 16,000 metres b) 1,600 metres c) 26,000 metres d) 160 metres	B Low Earth Orbit (LEO) is between 800 and 2,000metres above the ground.
Which of the following would NOT be a design consideration for a UAV?	a) Potential operational height b) Safe speed c) Height of operator d) Legal restrictions	C The height of the operator is not really important in the design, though the control functions of the control console or device would be.
Which of the following would be a cost saving consideration when designing a new robot?	a) Extensive use of rare earth metals b) Construction with newly developed polymers c) Employing leading programmers in the field d) Using open source software such as ROS	D Robot Operating System (ROS) is a free, community supported and developed operating system designed specifically for robots.
Which of the following is not a recognised microsatellite form?	a) Kilosatellie b) Picosatellite c) Nanosatellite d) Femtosatellite	A
What temperature does liquid oxygen burn at when used in rockets?	a) 100oC b) 300oC c) 1,000oC d) 3,000oC	D
What metal powder is now used in rocket launch fuel because it is very reactive with oxygen?	a) Lead b) Aluminium c) Magnesium d) Neptunium	B Aluminium is used in Aluminium-ice or ALICE
Which of the following statements is one of the laws of robotics devised by science fiction writer Isaac Asimov?	a) A robot may not injure a human being or, through inaction, allow a human being to come to harm b) A robot may not work as a television presenter on news programs because of the serious nature of news c) A robot may never stand as the President of the United States of America d) A robot must not be allowed to feel pain as it will then be too human like	A
Most UV devices are constructed with a material called FRP. This stands for:	a) Freon Regulated Plastic b) Fibre Reinforced Plastic c) Fibre Reinforced Polymer d) Fully Redundant Polymer	B

Question	Multiple Choice Options	Answer
The radio frequencies most suitable for communication with microsatellites are?	a) 3Hz to 30Hz b) 300MHz to 30GHz c) 30GHz to 3THz d) 30MHz to 30GHz	D
Which of the following is a reason for UAV's propellers to be based on a KV of 500-1,000?	a) Save battery power b) Kill less insects in the blades c) More flight stability d) Make less noise in sensitive area	C

Question	Answer	Marks
An engineer wants to create a large complicated 3D model of a rocket to test some ideas. Explain how he might design the model so he can try out his ideas and make changes efficiently.	Some idea of using a 3D modelling software that allows for different views and easy changes.	1
Materials used for most of the devices in this qualification are required to be both light and strong. Give two clear reasons, with examples, why you think this is the case.	Candidates should appreciate that "most" devices here, other than robots, require the ability to fly and that flight is difficult due to various forces, especially gravity. If a material is light, it will require less energy to move. (1) However, it will be subject to heat and distortion from various forces such as pressure, so it also needs to be strong to withstand these forces (1). Something similar to these examples will suffice.	2
Many companies now sell software packages to schools that use an artificial intelligence based on learning methods to schools, particularly in teaching subjects like maths. These systems fine tune themselves to give each students their own detailed learning programme. Briefly describe two advantages and one disadvantage of this type of AI system.	Candidates should be able to apply their own knowledge of AI to this particular example. They should be able to show that they understand the advantage to AI is it is constantly working to improve itself and will analyse all aspects of a student's learning to make sure it gives more examples to areas where the student's learning is weaker (1). Another advantage is that it is not personally involved so will only positively reinforce the students and not tell them off, which could be negative in its impact (1). A possible disadvantage is linked to the previous point as the AI will not know the student personally so may not help them learn effectively so that when they take an exam they might fail as they work the way the machine has trained them, rather than answering the questions. (1) Any similar example that shows the lack of human touch in this process. Someone who is excellent at a computer flying game could not step into the cockpit of a real plane and fly it easily.	3
A UAV manufacturer is building a UAV and looking for excellent flight stability. They have an input motor running at 6.75 volts and the motor is rated at 850KV. What will be the resulting rpm of the motor?	The formula is V x KV, so the answer would be 6.75V x 850rpm/V or 5,737.50rpm	1
Briefly discuss two things that affect microsatellites while in space and what adjustments need to be made to lessen their impact.	There are 3 main things listed in the specification: atmosphere, solar power and debris. Candidates need to pick two of these and give clear examples of what can be done. For example: the drag of the atmosphere means the satellite gets pulled closer to earth, so thrusters need to be fired a few times a year to keep it at the right distance (1). Lots of space	2

Question	Answer	Marks
	junk is flying about in the atmosphere in LEO, so the satellite needs to be moved, if possible, to avoid these objects. (1)	
It is estimated that there are currently 500,000 pieces of space debris in the lower levels of the Earth's atmosphere. Describe two potential problems with this material.	The main problem with this debris is damage to existing devices that are still in use. (1). The International Space Station has lots of small holes in its solar panels from debris smashing into it and the control centre needs to move it frequently from larger objects. The other problem is that some of this may well come back to earth and can be very destructive if it survives burning up in the atmosphere. (1). Something similar as long as it is clearly explained.	2
A UAV has a single propeller with a rotational speed of 1,500rpm. It has a battery with enough power to fly for 2.5 hours. How many revolutions will the propeller make with the life of the battery before it runs out? Show your working or reason	Candidates should be able to do some basic mathematics. The answer here is essential 1,500 X 60 (revs per minute, per hour) X 2.5, so 225,000 revolutions. 1 mark for an idea of working it out, 1 for the answer.	2
If your school decided that it wants to launch large rockets using combustible fuel material, what sort of license would the teacher in charge of launches require and why?	Large rockets tend to use materials similar to the high explosives used in large public fireworks, at least in terms of danger (1), so the person in charge would need to have a license to handle explosives (1). Candidates should give a clear reason of what licenses is required and why. It is not specific to the question, but they could get 1 mark for discussing health and safety.	2
Why are many robots built using open source software?	Open source allows the creators of the robots more flexibility to design their own features and actions and not be restricted by the features built in to a proprietary software that can't be altered.	1
If a school was able to launch and control it's own microsatellite with an onboard camera and was able to ensure that it was pointing at the school for most of the day, what subjects in school could use the data available and for what purpose?	The geography students could use the images to track changes in the flora and fauna at the school over the course of the school year (1). They could also use it for a detailed map to add to the school website for parents (1). Other subjects could be for art, to use for collages or for photography to practice modifying the images with digital software. The data could also be used by science to look for environmental changes over the seasons, or maths to collect data about pupil/staff movements to generate statistics.	2
In a recent experiment, seeds were sent to the International Space Station to be grown and others returned to earth for primary school students to plant and monitor. What is the purpose of this type of experiment?	Many people see the exploration and colonisation of space as important for the future of people. If the world becomes too hot or polluted, we need to be able to move on. Growing seeds in space is to see whether or not they will be affected by the forces in space and so see if we can grow what we need to eat (1). Sending seeds back to earth after being in space is to check if that impacts on them, should we need to send material back from space once grown on other planets (1). o.e	2
Give an example of a privacy concern relating to UAV and how it can be minimised.	No real right or wrong here, but candidates need to show an awareness of the issue. They need to say that people can be photographed from great heights without their knowledge (1). They can give a reason for this in that cameras now have very high resolution, even though very small (1). Some idea of a solution, perhaps a law to license people who own these devices and regular police checks of their data collected (1).	3

Question	Answer	Marks
Most microsatellites are used for GPS. What does this stand for?	Global Positioning System	1
AI is now being used in almost every area of work and is replacing people at different levels. AI has been proven to be better at driving cars with less accidents, making money for investors, teaching people and even flying planes. Discuss, with some examples, some of the ethical and social concerns you have with this progress of AI.	There is not necessarily a correct answer here as it will depend what each centre has taught for this topic. Candidates will be given marks for showing that they understand some ethical issue. For example, if they were planning to train to be an investment manager or even a lawyer, they may well not have a job once they are trained (1-2 marks). They need to show that they appreciate the ethical and social impacts, so society will be getting less "human" (1), if the AI devices can do people's work better, what will people do to live (1). 1 mark can be given for clarity and overall writing if candidates can show a good understanding and can get their argument across clearly. This is an A/A* level question.	5
A company in Japan called Softbank manufactures a robot called Pepper that has been programmed to react like a human to emotions. It has a range of human type emotions and will respond by laughing and crying to inputs. Identify and discuss three possible problems with this type of device related to the way it works with human emotions.	This is a question to allow candidates to explore their ideas and there may not be explicitly right and wrong answers and markers will need to use their professional judgement. Some examples of answers that it is hard to make judgements on what an emotion should be (1), someone might laugh at something that others find offensive (1). They could talk about the danger of over attachment (1). If the device is used by people with emotional issues they may become too attached which could cause problems if the device does not act as expected (1). Related to this, they could discuss the wider problem of de-humanisation (1). If people rely on these machines, rather than real people, we could end up with a very poor society where people avoid each other as machines are far better (1)	6
Describe, with an example, one strength and one weakness of using 3D design software for developing a device such as a robot or microsatellite.	candidates should show a strength in terms of their specified program (1 mark) being able to use POV (Point of View) features (1) to be able to see their design from every angle, so something similar (1). A weakness is likely to be that it is over complex as it is designed for professional use and has too many features, so perhaps has a feature to program in complex physical relationships to materials that require A level maths understanding or similar (1). I mark each for naming the feature they are describing.	4
Many microsatellites are built using aluminium panels that employ a honeycomb sandwich structure between the plates. Explain what this is and how it helps the design.	Candidates should be able to explain that this feature comes from the observation of bee hives which gives it the name of "honeycomb" (1). The hexagonal shaped tubes are placed between the two sheets add strength as they are harder to crush (1) but are significantly lighter than having a solid plate of the same thickness (1).	3
Some unmanned aerial vehicles (UAV) have been increasingly used by criminals for various illegal activities. The devices and their use are so new that there is no law currently to deal with them. What kinds of legal actions or practices can be taken to deal with the use of UV in illegal activities?	This question is looking for candidate's ability to synthesize what they know about the laws to come up with answers. The range of possible answers will be quite wide, but should show a clear understanding of the legal aspects. They could recommend something that was used to reduce tagging in cities by checking on who is buying the equipment, forcing shops to register the details. (1). They could suggest that a new law is passed by government just for UV. (1). Other issues might be similar to a neighbourhood watch scheme so that local people police their own skies, or similar answers. (1).	3
What is the difference between data collected by microsatellites and the information that is used as a result?	This is a generic question for all the units based on an understanding of the difference between data and information. The answer should be something along the lines of: data is the	1

Question	Answer	Marks
	raw numbers collected by the device, such as temperatures in space, information is using charts and graphs from those numbers to present a diagram of the changes in temperature so that decisions can be made. (1)	
List and describe three key safety checks that should be carried out before launching an explosives based rocket.	The first real check should be that you have notified any local airports due to the potential invasion of airspace. (1) Since there is a danger of explosion, you should also have someone on hand with fire extinguishing equipment or have notified the fire services. (1). Other checks would be to have the appropriate safety equipment or experienced people with this knowledge (1). Other examples might be to check the launcher has their explosives license or to make sure there are no people nearby who are not aware. Any other suitable examples	3
Why is it important to work to a detailed specification when assembling a robot or unmanned vehicle for usage	This is a generic question to test candidate's application of their general knowledge. The key consideration is that the specification should provide details of how and where to use the device which is useful for guidance purposes (1). It should also be a good guideline to the limitations of the device so that people using it will not endanger themselves or others by operating it outside the recommended safety limits. (1) other answers related to working within safe limits would be accepted.	2
Most devices created using advanced manufacturing technology tend to use open source software. What is open source software and how would you describe its main attributes?	Open source software is created using more liberal licenses such as ShareAlike which allow people to use someone else's code to speed up development (1). It is community based which means that it is well supported and problems get seen and fixed quickly. (1). They could also say that it is free	2
Name one open source license that could be used for advanced manufacturing and describe one of its attributes.	They could name a number of licenses such as Copyleft (1) and say that it can be used and modified, but has to then be shared back with the community if any improvements are made (1).	2
According to recent research, the power of AI is such that the devices and machines built using it will not only replace "low level" jobs, such as factory assembly, but also "high level" jobs such as legal advice or analysis. Describe the impact of this type of development on the future workforce, both positively and negatively, giving examples of the impact where appropriate. Draw a conclusion using the possible impact on you personally.	The main danger with this type of future is an over-reliance on machines (1). If machines control our electricity or food, any failure of the device will lead to huge impacts on the world (1). The other main concern is social unrest (1). If these devices take away all of our jobs, what will people do to earn money to pay for the food and other services the A devices are supplying (1). Any example they can give of the impact on themselves, such as loss of career opportunities will earn a 5th mark. Any other reasonably dangers or benefits, plus an example, for the marks.	5

20 = C	30 = B	40 = A	50+ = A*