



Mark Scheme (Results)

January 2022

Pearson BTEC Nationals
In Applied Science (31629H)
Unit 7: Contemporary Issues in Science

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Unit 7: Contemporary Issues in Science - Sample marking grid

General Marking Guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the marking grid not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks if the learner's response is not rewardable according to the marking grid.
- Where judgment is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

Specific Marking guidance

The marking grids have been designed to assess learner work holistically.

Rows within the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

- Examiners should first make a holistic judgement on which band most closely matches the learner response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band depending on how they have evidenced each of the descriptor bullet points.

BTEC Next Generation Mark Scheme

Question 1: *Discuss the implications of the scientific issue identified in the articles. (12 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
	0	1-3	4-6	7-9	10-12
Understanding the impact in terms of ethical/social/economical/environmental	Level of response not worthy of credit	<ul style="list-style-type: none"> Demonstrates limited knowledge and understanding of the scientific issues with generalised comments made. No or limited attempt to draw links to ethical/social/economic/environmental implications. The discussion will be unstructured and limited to basic points made. 	<ul style="list-style-type: none"> Demonstrates adequate knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. Attempts to draw links to ethical/social/economic/environmental implications. The discussion shows some structure and coherence. 	<ul style="list-style-type: none"> Demonstrates good knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. Draws some links to and between ethical/social/economic/environmental implications. The discussion shows a structure which is mostly clear, coherent and logical. 	<ul style="list-style-type: none"> Demonstrates comprehensive knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. Draws a wide range of links to and between ethical/social/economic/environmental implications The discussion shows a well-developed structure which is clear, coherent and logical.

Possible indicative content for Question 1:

Learners:

- **may include other valid suggestions, not listed below, which should be credited**
- **may cover a number of examples from the list below**
- **would not be expected to cover all points to get full marks.**

Scientific Issue

- Wave power is less advanced than other forms of low carbon power sources such as wind, solar and tidal power
- Wave power can generate power continuously
- Wind and tidal barrage/lagoon systems only generate power intermittently
- Tidal current power systems, not relying on a lagoon in an early stage of development
- Tidal energy generators can generate electricity nearly continuously
- Tidal generators make use of water's higher density, giving a greater output power compared to wind turbines
- Difficulties in siting of tidal turbines, these need to be in specific locations where the geographical features are able to give a steady flow of water
- Tidal generators can be operated remotely
- UK has very large tidal ranges, which makes operating tidal power systems more effective
- Technical expertise is available in the UK to build and operate tidal generators, utilising experience in other offshore technology such as gas and oil. However, there are cost implications for development of large-scale systems, there is a danger of the expertise going abroad
- Research is needed into mapping the oceans to find areas with high wave energy, large tidal surges and places with the right geographical features
- Environmental Impact Assessments (EIA) of various technologies need to be considered

- Investing in such schemes would greatly reduce CO₂ emissions globally
- Difficulties in providing electrical connection between the sea-based power stations and land-based power grids and keeping a steady power output for the grid
- Battery storage is being considered as a means of smoothing out supply of electricity, but technology still needs developing

Comment	Implication	Factor
Wave power is a costly means of generating electricity at present	<p>People would have to pay more</p> <p>Or other technologies would have to remain in place that emit more carbon dioxide</p>	<p>Economic</p> <p>Environmental/Ethical</p>
Tidal systems are of two types, lagoon based and open sea/ocean	<p>Lagoon-based systems generate electricity intermittently, leading to not always being able to meet maximum demand</p> <p>Tidal open sea systems are able to generate electricity more consistently so would be able to meet demand</p> <p>Both generate more electricity compared to wind turbines due to the greater density of water generating more force</p>	<p>Economic/ Social</p> <p>Economic/Social</p>
Location of the power plants needs to be considered carefully	<p>Only specific areas of ocean/sea are able to be used</p> <p>Submerged tidal systems need a funnel-shaped valley to keep the flow fast</p> <p>Wave systems need large waves and so have to be in remote places</p> <p>Opportunities for employment in remote areas increases</p> <p>Traditional occupations may suffer as a result of the sea/ocean in the locality being used to generate power so may affect traditional industries such as fishing</p> <p>Difficulty of maintenance compared to land-based systems</p>	<p>Environmental</p> <p>Environmental/Social</p> <p>Environmental/Social</p> <p>Economic/Social</p> <p>Ethical/Social</p> <p>Economic</p>
Reduction in CO ₂ emissions	If the technology works on the large scale the generators	Environmental/Social

	could replace many gas/coal power stations, reducing the amount of CO ₂ in the atmosphere so reducing the effects of climate change	
Remoteness of wave-based power stations as large waves are found in open sea/ocean locations	Problems of getting the power generated onto land for use in populated areas	Economic/Social
Ability of National Grids to deal with fluctuations in power received from offshore power stations	Grid supply networks need to be upgraded to deal with power surges due to larger than expected waves/faster flowing water This could mean developing storage systems using land-based facilities, e.g. Dinorwig Pumped Storage facility to meet excess demand/take up unused power Use of battery storage as a means of smoothing out supply and demand.	Economic Environmental/Economic Environmental/Economic
UK knowledge base and expertise in designing and building offshore facilities	Danger of the development of sea/ocean-based power systems going overseas, as the wind generating systems did some decades ago R&D not UK based so costs rise, some UK companies have lost out to overseas companies and in some cases industrial espionage is suspected	Social Economic/Ethical
The offshore power industry is in its early stages	Some companies that started in developing power systems ceased trading due to the difficulties in developing commercially viable systems	Economic/Social
There may be an environmental impact, so EIA needs to be carried out	Development may result in marine habitats being lost or possible issues with noise pollution for marine mammals.	Environmental/Ethical

Question 2: *Identify the different organisations/individuals mentioned in the articles and suggest how they may have an influence on the scientific issue. (6 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3
	0	1-2	3-4	5-6
Understanding the influence of different organisations / individuals	Level of response not worthy of credit	<ul style="list-style-type: none"> Demonstrates adequate knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying different types of organisations/individuals. A basic explanation of how the organisation/individual may have an influence is given but with general statements made and limited linkages to the articles. 	<ul style="list-style-type: none"> Demonstrates good knowledge and understanding of how key organisations/individuals can influence the scientific issue by identifying different types of organisations/individuals (including any references/ acknowledgments in footnotes) from all three articles. An explanation of how these organisations/individuals may influence the issue is given which is occasionally supported through linkage and application to the articles. 	<ul style="list-style-type: none"> Demonstrates comprehensive knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying and selecting different types of organisations/individuals (including any references/ acknowledgments in footnotes) from all three articles. An explanation of how these organisations/individuals may influence the issue is given which is supported throughout with linkage and application to the articles.

Indicative content for Question 2:

Learners:

- **may include other valid suggestions, not listed below, which should be credited**
- **may cover a number of examples from the list below**
- **would not be expected to cover all points to get full marks.**

Government and global organisations	
Organisation	Influence on scientific issue
Energy Technology Institute (ETI) (1)	Tasked by the UK Government to reduce UK carbon emissions. Works with government, universities and industry to develop technologies to reduce CO ₂ . Invests in R&D and works with universities and major international companies. Highly reputable source.
Scottish Government (1)	Instigated development of offshore power plants.
International Renewable Energy Agency (IRENA) (1)	Abu Dhabi based agency focused on renewable energy. Has international standing and has United Nations observer status, highly reputable.
European Marine Energy Centre (EMEC) (2)	Set up by public sector organisations to provide access to high wave areas and places with tidal energy potential. Provides facilities to test various kinds of device for commercial use.
Department for Business, Energy and Industrial Strategy (2)	UK Government department with responsibility for policy on renewable energy development. Determines UK policy on which projects should be funded and developed.
German Federal Maritime and Hydrographic Agency (3)	Provides research data on weather and sea conditions, used by companies developing generators.
Equitable Testing and Evaluation of Marine Energy Extraction	EU organisation that determined the protocols for testing and evaluation of various projects in the EU member states, had a

Devices in terms of Performance, Cost and Environmental Impact (EquiMar) (3)	coordinating role (now wound up). Set acceptable EU standards in the field.
International Energy Agency (IEA) and Ocean Energy Systems (OES) (3)	International cooperation along the same lines as IRENA but looking at monitoring and regulation of various international projects.
Non-governmental organisations	
Organisation	
Atlantis Resources (now SIMEC Atlantis Energy) (1)	Multinational company, providing turbines for marine power projects. Leading company directly involved in supplying infrastructure.
Pelamis Wave Power (1)	UK company that developed means of generating offshore power (ceased trading due to lack of investment) highlights risks involved in developing new technologies.
Aquamarine Power (1)	UK company that developed means of generating offshore power (ceased trading due to lack of investment) highlights risks involved in developing new technologies.
Orbital Marine Power (2)	UK company manufacturing floating tidal stream turbines. Currently involved in the Meygem programme to harness tidal energy from northern Scottish sites. Has experience in making tidal energy systems work.
Carnegie Clean Energy (1)	Australian company developing wave energy technology, builds renewable power systems for use around the world.
Fortum (1)	Finnish state-owned energy company owning power plants in Europe across a wide range of technologies, has wide experience in the power generation industry.
Seatricity (1)	UK company that developed means of generating offshore power (ceased trading due to lack of investment) highlights risks involved in developing new technologies.
Rolls-Royce (1)	UK company manufacturing motors for a wide variety of transport modes, very successful and highly regarded internationally for the quality of its manufacture.
British Petroleum (BP) (1)	UK company with multinational links in the world of energy products.
Electricite de France (EDF) (1)	French energy company that is a major supplier of electricity to the UK and runs some UK power production. Highly regarded.
Minesto (2)	Swedish company developing sea/ocean power generation systems. Currently working in developing some UK-based projects that may prove economically worthwhile.

Universities and research groups	
Organisation	
UK Energy Research Centre (UKERC) (1)	Based at Imperial College, it provides support for a range of UK universities researching into sustainable energy. Highly regarded and influences government policy as well as advancing sustainable technology.
Streamlining of Ocean Wave Farms Impact Assessment (SOWFIA) (3)	University of Plymouth based team monitoring pan EU wind and wave projects. Assisting with collaboration between different teams of researchers.
Marine Renewables Infrastructure Network for Emerging Energy Technologies (MARINET) (3)	Research group coordinating pre-commercial infrastructure across the EU for research work to consider viability of various systems.
Voluntary and pressure groups	
Organisation	
RenewableUK (1)	Trade association for wind, wave and tidal power. Represents the associated companies to the UK Government and international bodies. Lobbies for renewable energy.
Marine Alliance for Science and Technology for Scotland (MASTS) (2)	Consortium of organisations facilitating cooperation and coordination within the marine research community. Assists with coordination between many interested developers of renewable energy generation at sea.
Journals and magazines	
Organisation	
The Guardian (1)	Reported on the lack of advance in wave power as a means of generating UK power. Regarded as a credible source of information to the UK public.

Individuals	
Adam Vaughan (1)	Former energy correspondent at The Guardian, responsible for writing Article 1, regularly reported on such issues.
Alex Salmond (1)	Former Scottish First Minister, in charge of Scottish government policy during the time that some projects were being instigated.
Maf Smith (1)	RenewableUK Deputy Chief Executive has a major input into company policy and adviser to the Scottish Government.
Tim Sawyer (1)	CEO of Carnegie Clean Energy, in charge of a large company building generators at sea. Major decision maker in the company.
Andy Bristow (1)	Director of now defunct company Seatricity , no longer involved in the company.
Andrew Scott (2)	CEO and Director of Orbital Marine Power, makes policy for the company, in contact with UK agencies and organisations to further R&D in various tidal turbine projects.
Barnaby Wharton (2)	Head of Policy at RenewableUK, advises trade-affiliated companies and has links to UK Government.
Martin Edlund (2)	CEO Minesto, in charge of strategy to commercialise green energy systems produced by the company.

Question 3: *Discuss whether Article 3 has made valid judgements. (12 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Interpretation, analysis and evaluation of scientific information	0 Level of response not worthy of credit	1-3 <ul style="list-style-type: none"> Vague statements about the validity of article 3 are made with limited attempt to consider: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made the validity and reliability of data references to other sources of information. The discussion will be unstructured and limited to basic points made. 	4-6 <ul style="list-style-type: none"> The validity of article 3 is discussed which is partially supported by a consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made the validity and reliability of data references to other sources of information. The discussion shows some structure and coherence. 	7-9 <ul style="list-style-type: none"> The validity of article 3 is discussed which is mostly supported by a consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made the validity and reliability of data references to other sources of information. The discussion shows a structure which is mostly clear, coherent and logical. 	10-12 <ul style="list-style-type: none"> The validity of article 3 is discussed and is consistently supported throughout the consideration of: <ul style="list-style-type: none"> how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made the validity and reliability of data references to other sources of information. The discussion shows a well-developed structure which is clear, coherent and logical.

Indicative content for Question 3:

Learners should consider how the article has analysed the scientific information to support the conclusions/judgements being made; the validity and reliability of the data; references to other sources of information.

Learners:

- **may include other valid suggestions, not listed below, which should be credited**
- **may cover a number of examples from the list below**
- **would not be expected to cover all points to get full marks.**

General

Learners may comment on the fact that this is published in a peer reviewed journal and has many references.

They may also state that the article has drawn on many other articles (a meta-analysis) and that the various pieces of research all support the conclusions.

Conclusions/judgements

- There are conflicting demands on the sea and modelling of the implications of using various kinds of generators, research needs to be widened to accommodate conflicting interests such as fishing, shipping and wind farms
- Areas have been identified for further research into improving the technology
- Technical difficulties relating to getting the power produced onshore need to be overcome
- Currently the lifetime of the turbines is not fully known in the harsh environment of the ocean, research needs to be done on the lifetime of tidal array structures
- It is not clear as to the legal framework under which some of the projects operate, particularly in the open sea
- Strengthening of national grids needs to be implemented to deal with the varying power levels that will use it. These will be subject to highs and lows that could cause problems for some systems
- Considering in more detail the economic and social impacts of ocean energy in terms of operation, maintenance and security
- The impact on job creation needs to be considered, particularly in very remote areas of a country
- Environmental impact needs to be considered in terms of habitat protection
- Cooperation between various nations would improve the viability of many projects.

Validity and reliability

- Article 3 is a review of research into the current state of wave and tidal power technology
- There is a large amount of research reviewed by organisations and individuals, both in universities and government
- The same conclusions are arrived at by many of the people and institutions referenced
- The research considers environmental and economic factors in particular as well as considering some issues with the technology and making sure it works reliably
- The focus is international and draws on research from a number of different places around the world increasing the reliability of the evidence produced
- Many of the projects have been overseen by international agencies that have ensured that due process has taken place.

References

- A considerable number of references has been given, which are based mainly on research papers from university departments but also from commercial companies working in the field
- Much of the work has been fully peer reviewed
- Many of the references are of a very technical nature and consider quite narrow aspects of the field
- Sources are mainly from the past 15 years, but many within the last 10 years so the articles and papers are quite relevant
- Article 3 considers papers from many sides in the field so it not giving an unbalanced view.

Question 4: *Suggest potential areas for further development and/or research of the scientific issue from the three articles. (5 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3
Interprets, analyses and evaluates articles to identify potential areas for further development and/or research	0	1	2-3	4-5
	Level of response not worthy of credit	<ul style="list-style-type: none"> Areas for further development and/or research of the scientific issue are identified but these are usually vague descriptions with limited analysis/evaluation of the articles to support the statements being made. 	<ul style="list-style-type: none"> A description for further areas of development and/or research of the scientific issue is given. Provides occasional evidence from the analysis/evaluation of the articles and attempts to synthesise and integrate relevant knowledge. 	<ul style="list-style-type: none"> A description for further areas of development and/or research of the scientific issue is given. Consistently provides evidence from the analysis/evaluation of the articles and demonstrates throughout the skills of synthesising and integrating relevant knowledge.

Indicative content for Question 4:

Learners:

- **may include other valid suggestions, not listed below, which should be credited**
- **may cover a number of examples from the list below**
- **would not be expected to cover all points to get full marks.**

Further research needed on

- Cost effectiveness of projects in terms of delivering a viable power output for the initial costs of construction. How to reduce costs of building
- Developing infrastructure that will last for an economic timescale
- Care and maintenance of the infrastructure in what are very inhospitable sea conditions
- Mechanisms for getting the power produced onshore
- Environmental impact of construction on marine life
- Detailed studies of undersea currents to identify any cyclic patterns
- Development of materials resistant to corrosion from sea water.
- Developing energy storage/ battery systems to even out electrical supply in local areas

Wider research

- Cooperation between governments needs to be coordinated and ways need to be found for that
- Consequences for the National Grid of erratic power delivery from generators
- Effects on local populations in remote areas in terms of social and economic impact of locating offshore stations
- The effect of the power stations on other industries such as fishing and tourism.

Credit other valid suggestions.

Question 5: *You are a researcher working for a general news website. The website wants to produce an article about the UK Government’s tidal renewable energy policy. Your task is to write an article that evaluates the advantages and disadvantages of possible tidal power projects to generate electricity. (15 marks)*

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
	0	1-4	5-8	9-12	13-15
Synthesises content ideas and demonstrates an understanding of scientific reporting and its relationship with reporting medium and target audience	Level of response not worthy of credit	<ul style="list-style-type: none"> Identifies some of the main points and evidence from the three articles with limited attempt to summarise these. Shows little awareness of audience or purpose. The article will be unstructured and limited to basic points made. 	<ul style="list-style-type: none"> Summarises the main points and evidence including any supporting and conflicting statements from the three articles. Shows an awareness of audience and purpose. The article shows some structure and coherence. 	<ul style="list-style-type: none"> Summarises and attempts to synthesise the main points and evidence including any supporting and conflicting statements from the three articles. Selects material to suit audience and purpose, with appropriate use of tone, style and scientific terminology. The article shows a structure which is mostly clear, coherent and logical. 	<ul style="list-style-type: none"> Summarises and synthesises the main points and evidence including any supporting and conflicting statements consistently from the three articles. Consistently selects and organises material for particular effect, with effective use of tone, style and scientific terminology. The article shows a well-developed structure which is clear, coherent and logical.

Indicative content for Question 5:

Learners:

- **may include other valid suggestions, not listed below, which should be credited**
- **may cover a number of examples from the list below**
- **would not be expected to cover all points to get full marks.**

Tone and style show awareness of audience

- A mixed audience with a range of backgrounds, some well-informed, others with no knowledge of the details
- Some will have a limited scientific background
- Report should be structured so it can be easily understood
- Explains the types of ways wave power and tidal power stations work
- Considers the advantages and disadvantages of each
- Avoids unexplained acronyms but does use scientific terminology to propose the advantages and disadvantages
- Discussion based on facts not uninformed opinion
- Should be balanced across advantages and disadvantages
- Gives some evidence of using own sources of information to support the arguments

Advantages of tidal power

- A sustainable means of generating electricity
- Does not take up areas of land that could be used for other purposes
- Does not generate greenhouse gases in use
- Predictable power output most of the time
- Efficient at slow speeds as the higher density of water provides a greater force on the turbine blades
- Cheap to run
- Tidal barrages can last a long time before they need replacing
- Tidal barrages have a long record of use already around the world

Disadvantages of tidal power

- Spinning blades can kill marine life
- Acoustic disturbance can affect some marine life
- They can change coastal geographical features over time
- Tidal barrages can cut navigation to rivers/silt rivers
- Expensive to construct
- Connecting tidal generators to the National Grid can be difficult
- Can severely impact on ocean/sea ecosystems
- Some schemes using tidal generators other than barrages are not yet proven commercially

Conclusion

- Tidal schemes can generate significant amounts of power, but not always continually
- Some tidal generators need further research before a commercial decision can be made
- Use of supporting/conflicting statements from the three articles



Llywodraeth Cynulliad Cymru
Welsh Assembly Government

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