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General Certificate of Education (A-level)
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General Studies A GENA2

(Specification 2760)

Unit 2: Science and Society (AS)

Final

Mark Scheme

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Unit 2 Section A

(GENA2 AS Science and Society)

This component is an objective test for which the following list indicates the correct answers used in marking the candidates' responses.

1.1	**A**	**1.16**	**C**
1.2	**D**	**1.17**	**D**
1.3	**B**	**1.18**	**B**
1.4	**A**	**1.19**	**B**
1.5	**C**	**1.20**	**C**
1.6	**C**	**1.21**	**B**
1.7	**A**	**1.22**	**B**
1.8	**C**	**1.23**	**C**
1.9	**C**	**1.24**	**A**
1.10	**D**	**1.25**	**B**
1.11	**D**	**1.26**	**D**
1.12	**D**	**1.27**	**D**
1.13	**C**	**1.28**	**A**
1.14	**A**	**1.29**	**A**
1.15	**B**	**1.30**	**B**

Unit 2 Section B (AS Science and Society)

INTRODUCTION

The nationally agreed assessment objectives in the QCA Subject Criteria for General Studies are:

AO1 Demonstrate relevant knowledge and understanding applied to a range of issues, using skills from different disciplines.

AO2 Marshal evidence and draw conclusions: select, interpret, evaluate and integrate information, data, concepts and opinions.

AO3 Demonstrate understanding of different types of knowledge appreciating their strengths and limitations.

AO4 Communicate clearly and accurately in a concise, logical and relevant way.

- The mark scheme will allocate a number or distribution of marks for some, or all, of the above objectives for each question according to the nature of the question and what it is intended to test.
- In most cases mark schemes for individual questions are based on *levels* which indicate different qualities that might be anticipated in the candidates; responses. The levels take into account a candidate's knowledge, understanding, arguments, evaluation and communication skills as appropriate.
- Examiners are required to assign each of the candidates' responses to the most appropriate level according to **its overall quality**, then allocate a single mark within the level. When deciding upon a mark in a level examiners should bear in mind the relative weightings of AOs (see below). For example, the most weight should be given to AO1, then AO4, then AO2 and finally AO3.
- *Indicative content* is provided as a guide for examiners. It is not intended to be exhaustive and other valid points must be credited. Candidates do not have to cover all points mentioned to reach Level 3.
- A response which bears no relevance to the question should be awarded no marks.

Distribution of marks across questions and assessment objectives for Unit 2, Section B

Question Numbers		Q2 & Q3	Q4 & Q5	Q6 & Q7	Total marks for Section B
Assessment Objectives	**AO1**	**12**	**12**	**12**	**12**
	AO2	**8**	**8**	**8**	**8**
	AO3	**5**	**5**	**5**	**5**
	AO4	**10**	**10**	**10**	**10**
Total marks per question		**35**	**35**	**35**	**35**

Level of response	Mark range	Criteria and descriptors for Assessment Objectives 1-4
LEVEL 3	13–17 (18)	**Good response to question** Good to comprehensive knowledge, understanding and approach demonstrating overall grasp of the range and nature of issues (AO1). Capacity to interpret evidence and sustained ability to present relevant arguments, analysis and exemplification, focusing on the main points of the question (AO2). Shows some understanding of different types of knowledge, with some appreciation of their limitations in seeking to reach a reasoned and logical conclusion (AO3). Ability to communicate clearly and accurately in a fluent and organised manner (AO4).
LEVEL 2	7–12	**Reasonable attempt to answer question** Modest to quite good knowledge, understanding and approach demonstrating some grasp of the nature of some key issues (AO1). Moderate range of arguments, analysis and exemplification covering some of the main points of the question (AO2). Limited understanding of different types of knowledge but some ability to work towards or achieve a reasoned conclusion (AO3). Mostly clear and accurate communication and organisation (AO4).
LEVEL 1	1–6	**Limited response to the question** Restricted / narrow knowledge and understanding of key issues (AO1). Simple, perhaps mostly unexplained points – or very narrow range – with limited interpretation or analysis and exemplification (AO2). Lacking in understanding of different types of knowledge with little or no evidence of ability to work towards a conclusion (AO3). Variable levels of communication and organisation (AO4).
LEVEL 0	0	**No valid response or relevance to the question.**

02 Examine the reasons for the increased risk of extinction of plants and animals.

(17 marks)

General Guidance

There are significant clues in the stimulus passage about the reasons for the increased risk of extinctions – so, we should expect candidates to develop and explain those reasons, preferably with appropriate exemplification. More perceptive responses might note the limits of our knowledge of the number of species on Earth, and that references to extinction are largely based on estimates rather than precise figures.

A **good** answer will be in **Level 3** (13–17 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative Content

A **species becomes extinct** when the last remaining member of that species dies – hence there is no further prospect of the creation of a new generation. Extinction can be seen as part of the process of evolution – extinction is when a species can no longer survive in changing conditions or against superior competition.

Mass extinction refers to periods when there is a sharp decrease in the diversity and abundance of species. Over 97% of the species which have ever existed are now extinct, but extinction occurs at an uneven rate. Based on the fossil record, there have been five mass extinctions in the last 540 million years.

The **reasons for the current increased risk of extinctions** include:

Destruction of habitats

- the destruction of tropical rainforests and replacement by open pastureland leads to the loss of habitat of many animal and plant species
- the destruction of ocean floors and coral reefs as a result of industrial scale fishing techniques is another example of habitat loss
- habitat degradation by contamination from pollutants can affect the life span and reproductive capacity of species.

Hunting, over-harvesting, over-exploitation

- for example, American bison were hunted almost to extinction in the 19th century; some species of whales have been significantly reduced in numbers
- overfishing has resulted in many species of fish being endangered – e.g. cod, tuna; other sea animals are unintentionally killed as bycatch – e.g. dolphins, small whales, turtles
- the international trade in rare species is a serious threat – tropical fish and parrots are captured and sold as pets; sharks, whales and turtles are prized as delicacies; body parts of tigers and rhinos are used in traditional ‘medicine’; ivory, feathers and eggs are collectors’ items.

Spread of alien predators, other alien species and disease

- humans have been transporting plants and animals from one part of the world to another for thousands of years – deliberately, e.g. livestock; or accidentally, e.g. rats from ships
- invasive alien species can affect native species, by killing them directly or by out-competing them for scarce resources – a good example is the effect on Australian flora and fauna of the introduction of sheep, rabbits and cane toads (amongst others)
- alien species and industrial or agricultural development by humans may also introduce pathogens and parasites which can sicken and kill native species directly, weaken them so that they are vulnerable to other pressures, and/or destroy and degrade habitats.

Climate change

- changes in atmospheric CO_2, temperature and precipitation can all affect the distribution of plant and animal populations
- this can increase the risk of extinction directly for species which cannot adapt to the changing circumstances
- other species will become more successful and expand their ranges but, as a consequence, will increase the risk to other species because of increased competition.

Pollution

- climate change is a specific effect of particular forms of pollution
- pollution can also impact on the viability of species through, for example, acid rain, eutrophication, oil spills, etc.

Some candidates will recognise that a note of caution might be appropriate in assessing the significance of predictions on imminent extinctions. The figures given for current extinction rates are **estimates**. Only 869 extinctions have been formally recorded since 1500, though 17 300 species are considered under threat by the IUCN. Scientists have only identified approximately 2 million species and, of these, have only assessed the conservation status of about 3% of the total. Yet there are estimated to be between 5 million and 30 million species in existence. The estimates of total extinctions are based on extrapolations from the rate of loss among species for which the data exists.

Any other valid point not included here should be credited.

03 Discuss the importance of conservation and the range of measures that could be implemented.

(18 marks)

General Guidance

Answers to this question can be structured in two parts, in line with the wording of the question. We are looking for a discussion on the importance of conservation and a range of examples of conservation measures. Better responses will note that there are doubts and concerns over the value and viability of conservation measures as well as potential benefits. There is an opportunity for candidates to offer a balanced discussion and a thoughtful conclusion.

A **good** answer will be in **Level 3** (13–18 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative content

Importance of conservation

- it can be argued that the natural world has an intrinsic value and that human beings have an ethical obligation to protect other plant and animal species
- biodiversity is a vital resource for the future of the planet
- we rely on ecosystems to provide food, oxygen and natural resources, to recycle wastes and to fertilise soils for agriculture
- plants and animals are an essential source of potential new foods and medicines
- on the other hand, it can be argued that extinction is an inevitable part of the evolution of the natural world and that interfering in this process is not only unnecessary but potentially could cause unforeseen consequences
- it can also be argued that, as the claims about extinction are based on estimates, we don't really know the true picture, and therefore there is no sound basis for expensive and possibly unnecessary conservation measures
- given the huge scale of the pressures that are leading to extinctions, it might be argued that any attempt at conservation is bound to fail
- on the other hand, a positive argument is that conservation might slow down the processes of extinction until such time as climate change and habitat destruction on a large scale are brought under control
- the preservation of even small populations of threatened species can be argued to be of benefit for future generations of humans
- one can question what is the purpose of preserving threatened species if they can only be maintained in an artificial protected environment.

Conservation measures

- land management and habitat preservation – for example, through the creation of national parks and nature reserves
- wildlife management, in order to protect and maintain existing populations of threatened species
- prohibition of exploitation of sensitive areas – for example, in the Arctic and in the Amazon basin
- marine conservation measures, including fishing limits and quotas, and the prevention of development near coral reefs
- encouraging both multinational corporations and small local farmers to work in ways which respect and maintain threatened environments and species
- limiting tourist development and/or encouraging ecotourism in sensitive areas
- breeding programmes for threatened animals in captivity or reserves, with a view to releasing animals into areas from which they may have been excluded
- the collection of genetic material with a view to 'reincarnating' extinct species at some point in the future
- the cost of highly complex and expensive conservation measures needs to be balanced against likely outcomes
- the opportunity cost of not going ahead with the exploitation and development of natural resources for human consumption needs to be balanced against the needs of threatened species.

Any other valid point not included here should be credited.

04 Explain the causes and effects of earthquakes.

(17 marks)

General Guidance

There should be no lack of appropriate examples for this topic, with the Haiti earthquake, the Christchurch (NZ) earthquake and the Japanese earthquake and tsunami all in recent memory. We should expect some clear science in explaining the causes, while recent events should provide substantial opportunities to elaborate on effects. The emphasis however should be on the explanation, rather than anecdote.

A **good** answer will be in **Level 3** (13–17 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative content

An earthquake results from and is powered by the sudden release of stored energy in the Earth's crust that radiates seismic waves. This causes a shaking or displacement of the ground, and sometimes tsunamis, which may lead to loss of life and destruction of property.

Most earthquakes are related to the **tectonic nature** of the Earth:

- the Earth's crust is a patchwork of plates which move slowly across the hotter, weaker underlying parts of the mantle
- the plates move in relation to one another
- major earthquakes (and volcanic activity, mountain building and oceanic trench formation) occur along plate boundaries when the pressure of plates moving against each other is suddenly released
- earthquakes can occur other than on plate boundaries when stresses cause movement along fault planes
- some earthquake-like events may be induced by human activity – the extraction of minerals and fossil fuels, the removal or injection of fluids into the crust, large (especially nuclear) explosions and collapsing of large buildings.

The point at which the fault occurs is known as the epicentre. The magnitude of the earthquake is measured on the Richter scale.

Effects of earthquakes include:

- earthquakes can trigger landslides and, sometimes, volcanic activity
- earthquakes under the ocean can generate a tsunami – the sea-floor abruptly deforms and vertically displaces the overlying water
- loss of life
- spread of disease
- fires, caused by disruption of gas, fuel and electricity lines
- destruction of buildings

- damage to roads and bridges
- (as in Japan) damage to nuclear power stations, with potentially disastrous consequences
- economic disruption to businesses and agricultural enterprises.

Earthquakes occur on a daily basis around the world (even in Britain). Large earthquakes can cause serious destruction and massive loss of life through fault rupture, vibratory ground motion, tsunamis, landslides, fire and the release of gas or petrol from damaged pipes or containers. For most earthquakes, shaking is the dominant and most widespread cause of damage.

Any other valid point not included here should be credited.

05 Consider how 'social and economic fragility' contributes to the harm caused by earthquakes and suggest how these problems might be overcome.

(18 marks)

General Guidance

The emphasis of the question is on the way in which levels of social and economic development are related to the harm caused by earthquakes. Strong candidates may well be able to use their knowledge of earthquakes in Haiti, New Zealand and Japan to illustrate this. Responses should also offer ideas on how the impact of natural disasters such as earthquakes can be ameliorated to political, social and economic measures as well as by physical preparation.

A **good** answer will be in **Level 3** (13–18 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative content

The impact of earthquakes and other natural disasters is generally much worse in less economically developed nations, particularly in poorer urban areas. The source refers to 'poverty, weak infrastructure, political crisis, environmental degradation and international neglect'. Candidates might include the following reasons:

Weak physical infrastructure:

- poor quality housing and public buildings – unable to survive earthquakes
- overcrowding in housing areas
- lack of adequate roads and transport links
- poor telecommunications systems.

Weak political and social infrastructure:

- poor emergency services
- inadequate health services
- inefficient political decision making
- possible political and business corruption
- high levels of social and economic inequality
- high levels of international debt.

Ways in which the impact of natural disasters on less economically developed societies might be reduced include:

Political, social and economic measures:

- reduction of inequality
- reduction / cancellation of international debts
- support for democratic institutions.

Better emergency preparations:

- earthquake drills
- stockpiling of food and medical supplies
- emergency planning – for political decisions and security operations.

Physical infrastructure:

- not building at all in areas of greatest danger – e.g. on fault lines
- clearance of overcrowded poor quality housing areas
- replace with improved building standards, including space standards and stronger foundations
- earthquake-proof buildings.

Any other valid point not included here should be credited.

06 Explain the principles involved in conducting objective scientific research.

(17 marks)

General Guidance

Examiners should be looking for a well informed answer, with awareness of the importance of evidence, the nature of scientific method, and reference to the concepts of a fair test and peer review. Responses which are illustrated with appropriate examples should be suitably rewarded.

A **good** answer will be in **Level 3** (13–17 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative content

Science attempts to explain the world in which we live. Scientists try to explain phenomena and solve problems using **evidence**. The data to be used as evidence must be:

- reliable – data which can be trusted and which can be reproduced by others
- valid – data which answers the original question and from which appropriate conclusions can be drawn.

There are different ways of outlining the basic **method used for scientific inquiry**. The four essential elements are generally held to be:

- observation of phenomena leads to the start of an investigation, survey or experiment
- development of an hypothesis – a suggested explanation of the phenomena
- prediction of the reasons for the observed phenomena, that can be tested
- an investigation, survey or investigation designed to test the hypothesis and the prediction(s) based on it.

An investigation is an attempt to determine whether there is a relationship between **variables**:

- an independent variable that is selected or changed by the investigator, and
- one or more dependent variables which may or may not be changed by the application of the independent variable.

A **fair test** is one in which only the independent variable affects the dependent variable, as all other variables are kept the same.

Control groups are often used in biological and medical research to ensure that observed effects are due to changes in the independent variable alone (for example, by using a placebo as a control in medical trials):

- a ‘blind trial’ is one in which participants do not know whether they are receiving an active treatment or a placebo

- a ‘double blind trial’ is one in which neither participants nor researchers know who is receiving active treatment or a placebo, in order to avoid any unconscious bias.

Scientific research can never fully prove a hypothesis. Data from the investigation can support the hypothesis, refute the hypothesis, or point towards another hypothesis. If the data does not match with existing theories, the data itself may be incorrect or it may be that the theories need to be amended or updated.

Conclusions reached should be related to the original hypothesis and based only on the data collected, irrespective of the funding source.

Scientific journals publish detailed reports of research. The reports are **peer reviewed** – i.e. checked and commented on by other scientists with expertise in the area of research. The purpose of publication is so that

- other scientists can check and confirm (or challenge) the findings
- other scientists can incorporate the evidence into their own research, to take scientific understanding forward.

Any other valid point not included here should be credited.

07 Discuss how government policies and the interests of major industries (for example, the pharmaceutical, energy and defence industries) can influence and distort scientific research and development.

(18 marks)

General Guidance

Candidates are expected to consider how far scientists can be objective, given the political, commercial and other pressures they face. A number of likely areas are suggested in the stimulus passage and candidates should be able to identify relevant examples, as well as extending their analysis to other possible areas. We should be looking for a well-balanced discussion leading towards an informed conclusion.

A **good** answer will be in **Level 3** (13–18 marks)
A **reasonable** answer will be in **Level 2** (7–12 marks)
A **limited** answer will be in **Level 1** (1–6 marks)

Candidates should be able to achieve marks in the highest band with a selection of relevant points, not necessarily the complete range.

Indicative content

The aim of science is to find the truth and to make judgements based on evidence. However, in any society there are pressures which influence the direction and outcome of scientific research, including the status of the researcher, the political significance of the research, its funding sources, whether it can be exploited commercially, etc.

Governments play a key role in scientific research, both in commissioning research directly and as a consumer of scientific and technological products. What they choose to support or not support has a major influence on what happens in scientific research institutions. Both governments and industry can distort scientific research and public perception by actively suppressing unflattering or unwelcome data. Some religious and non-pluralist states do not encourage freedom of speech or an open exchange of views, ideas and data, all of which are necessary for science to flourish.

Examples of **government influence** include:

- many governments spend a large proportion of their budget on military / defence research – weaponry, aircraft, etc
- during the Bush era, the US government refused to put any money into research on stem cells, for religious / ideological motives
- the UK government in 2009 called for universities to concentrate on commercial and business-oriented research.

Governments generally believe that closer **links between business and science** will improve economic competitiveness and have broader benefits for society. Businesses have increasingly dominated some areas of research for their own benefit, skewing research away from, arguably, more useful areas. Examples include:

- the **pharmaceutical industry** is the largest funder of research and development in the UK and globally; while it contributes important health benefits, it concentrates on disease treatments for wealthier communities able to pay for them rather than the more common

global diseases; it also marginalises investigation of lifestyle changes as a method of disease prevention in favour of an emphasis on drug treatments

- the **tobacco industry** has a long and controversial association with health research, by trying to deny or minimise any links between smoking and ill-health
- the influence of the **military / defence sector** in science and engineering can lead to an undue emphasis on weapons and other high technology approaches to defence, rather than one that prioritises negotiation, arms control treaties and conflict resolution
- in terms of the scientific response to climate change, the influence of the **oil and gas industry** can lead to a focus on fossil fuel-based technologies or controversial biofuels, rather than controlling energy demand, increasing efficiency or rapidly expanding renewable energy technologies; some oil companies also promote 'climate scepticism' and fund political pressure groups on the issue
- the **biotechnology industry** has expanded rapidly in recent years, leading to a strong focus within agricultural and health research and development on gene-based technologies, including, most controversially, genetically modified crops.

Any other valid point not included here should be credited.

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