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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

General Studies 6761

Specification A

GSA5 Science, Mathematics and Technology

Mark Scheme

2008 examination – January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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Dr Michael Cresswell Director General

Unit 5 Question 1

(GSA5/1 Science, Mathematics and Technology)

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

1.1	**C**	**1.11**	**D**
1.2	**A**	**1.12**	**C**
1.3	**B**	**1.13**	**A**
1.4	**D**	**1.14**	**D**
1.5	**B**	**1.15**	**A**
1.6	**A**	**1.16**	**C**
1.7	**D**	**1.17**	**B**
1.8	**C**	**1.18**	**A**
1.9	**B**	**1.19**	**D**
1.10	**B**	**1.20**	**D**

Unit 5
(GSA5/2 Science, Mathematics and Technology)

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

AO3 Marshal evidence and draw conclusions; select, interpret, evaluate and integrate information, data, concepts and opinions.

AO4 Demonstrate understanding of different types of knowledge and of the relationship between them, appreciating their limitations.

All mark schemes will allocate a number or distribution of marks for some or all of these objectives for each question according to the nature of the question and what it is intended to test.

Note on AO2

In all instances where quality of written communication is being assessed this must take into account the following criteria:

- select and use a form and style of writing appropriate to purpose and complex subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate; and
- ensure text is legible and spelling, grammar and punctuation are accurate, so that meaning is clear.

Note on AO4

In previous General Studies syllabuses, there has been a focus on the knowledge and understanding of facts (AO1), and the marshalling and evaluation of evidence (AO3) – on what might be called 'first-order' knowledge. AO4 is about understanding what counts as knowledge; about how far knowledge is based upon facts and values; and about standards of proof – what might be called 'second-order' knowledge.

By 'different types of knowledge' we mean *different ways of getting knowledge*. We might obtain knowledge by fine measurement, and calculation. This gives us a degree of certainty. We might obtain it by observation, and by experiment. This gives us a degree of probability. Or we might acquire it by examination of documents and material remains, or by introspection – that is, by canvassing our own experiences and feelings. This gives us a degree of possibility. In this sense, knowledge is a matter of degree.

Questions, or aspects of them, which are designed to test AO4 will therefore focus on such matters as:

- analysis and evaluation of the nature of the knowledge, evidence or arguments, for example, used in a text, set of data or other form of stimulus material;
- understanding of the crucial differences between such things as knowledge, belief or opinion, and objectivity and subjectivity in arguments;
- appreciation of what constitutes proof, cause and effect, truth, validity, justification, and the limits to these;
- recognition of the existence of personal values, value judgements, partiality and bias in given circumstances;
- awareness of the effects upon ourselves and others of different phenomena, such as the nature of physical, emotional and spiritual experiences, and the ability to draw upon and analyse first-hand knowledge and understanding of these

GENERAL MARK SCHEME FOR A2 ESSAYS

The essay questions in General Studies A are designed to test the four assessment objectives (see INTRODUCTION above) as follows:

AO1 – 6 marks AO2 – 5 marks AO3 – 7 marks AO4 – 7 marks **Total – 25 marks**

Each answer should be awarded two separate marks, comprising a mark out of 20 for content (Assessment Objectives 1, 3 and 4) and a mark out of 5 for communication (Assessment Objective 2).

The mark for content should be awarded on the basis of the overall level of the candidate's response in relation to the following general criteria and descriptors for each level.

Level of response	**Mark range**	**Criteria and descriptors for Assessment Objectives 1, 3 and 4:** knowledge, understanding, argument and illustration, evaluation.
LEVEL 4	16 – 20 (5)	**Good response to the demands of the question:** sound knowledge of material (AO1); clear understanding and appreciation of topic, nature of knowledge involved and related issues (AO4); valid arguments and appropriate illustrations, coherent conclusion (AO3).
LEVEL 3	11 – 15 (5)	**Competent attempt at answering the question:** relevant knowledge (AO1); reasonable understanding and appreciation of topic, nature of knowledge involved and related issues (AO4); some fair arguments and illustrations, attempt at a conclusion (AO3).
LEVEL 2	6 – 10 (5)	**Limited response to the demands of the question:** only basic knowledge (AO1); modest understanding and appreciation of topic, nature of knowledge involved and related issues (AO4); limited argument and illustration, weak conclusion (AO3).
LEVEL 1	1 – 5 (5)	**Inadequate attempt to deal with the question:** very limited knowledge (AO1); little understanding and appreciation of topic, nature of knowledge involved and related issues (AO4); little or no justification or illustration, inadequate overall grasp (AO3).
LEVEL 0	0	**No response or relevance to the question**

The mark for communication (AO2) should be awarded using the following scale and criteria.

5 marks	Clear and effective organisation and structure, fluent and accurate expression, spelling, punctuation and grammar.
4 marks	Clear attempt at organisation and structure, generally fluent and accurate expression, spelling, punctuation and grammar.
3 marks	Some organisation and structure evident, variable fluency, occasional errors in expression, punctuation and grammar.
2 marks	Limited organisation and structure, little fluency, a number of errors in expression, spelling, punctuation and grammar.
1 mark	Lacking organisation, structure and fluency, frequent errors in expression, spelling, punctuation and grammar.
0 marks	No response

Note: A totally irrelevant response (Level 0) should also receive 0 marks for communication. A brief and inadequate response (Level 1) should be awarded not more than 2 marks and a limited response (Level 2) normally not more than 3 marks for communication. Responses at Level 3 and 4 for content may be awarded up to 5 marks for communication.

2.1 Explain the differences between organic agriculture and conventional agriculture. Identify and assess reasons for the increasing popularity of organic food.

Organic farming:

- avoids the use of synthetic chemical fertilisers and relies on methods such as crop rotation, green manure, animal manure and composting to improve soil quality
- relies on encouraging natural predators, as well as crop rotation and mechanical controls (e.g. covers) to limit pest damage; (a limited number of chemical pesticides are permitted in some organic standards)
- is usually small scale with an emphasis on crop diversity
- is often sold locally
- provides 'natural' living conditions for animals, including free-range access to outdoor spaces
- limits the use of drugs etc to those required for the animal's health (e.g. no growth hormones, no prophylactic antibiotics)
- does not grow any genetically modified crops.

Conventional farming:

- uses a range of chemical fertilisers to enhance plant growth, which can be organic (i.e. carbon-based) or inorganic, and which may be naturally occurring or manufactured
- uses chemical pesticides to eliminate weeds, insects and other pests
- usually operates on a large-scale, is highly specialised and intensive, and may lead to a monoculture covering large areas (e.g. in East Anglia)
- is an international global business
- may rear animals using 'factory farming' techniques in which animal movement is restricted, feed is controlled and drugs, including antibiotics, are regularly administered
- in some parts of the world (though not yet the EU) may produce genetically modified crops.

Organic food is increasingly popular with some consumers because of:

- perceived health risks from, for example, chemical residues on fruit and vegetables
- the environmental impact of conventional farming and concern for animal welfare
- the belief that it is more nutritious than conventionally produced food (though the Food Standards Agency has said that this is not the case)

On the other hand, conventional farming:

- produces low cost food which largely meets the global demand for food
- is efficient in its use of resources, including land and animals
- produces food which is safe to eat.

A critical view of organic farming:

- it is difficult for organic farming to operate on a sufficiently large scale to meet global demand; if it were to attempt to do so, it would require a much enlarged area of land, leading to deforestation, which would be more detrimental to the environment overall
- natural compost and manure can pollute watercourses, and can contaminate organic food products.

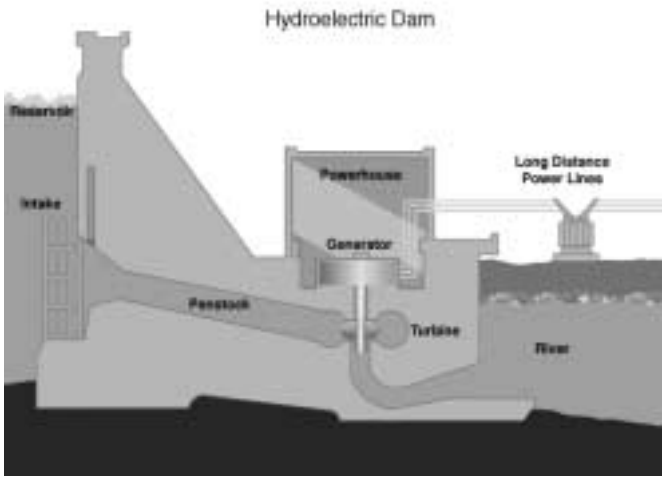
A critical view of conventional farming:

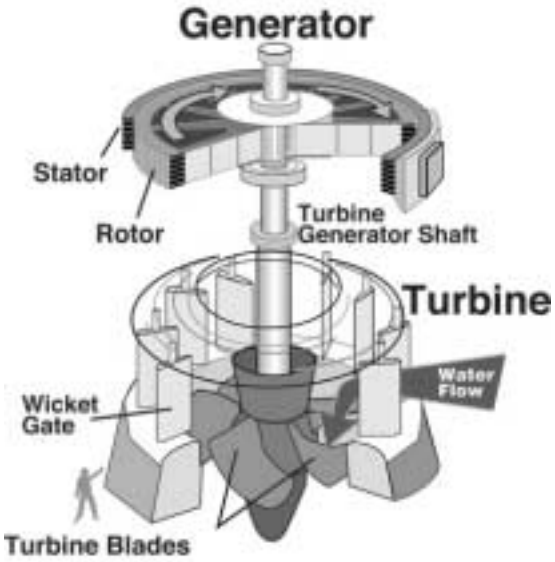
- it is leading to a loss of biodiversity, degradation of soil quality, soil erosion and pollution
- it is a major user of fossil fuels in food production and, particularly, food distribution.

2.2 Explain how electricity is generated by hydro-electric power stations.

Discuss the advantages and disadvantages of hydro-electric power generation for the environment and for society.

Hydro-electric power is obtained from the potential energy of dammed water driving a water-turbine and generator. Flowing water is directed on to the blades of a turbine, creating a force on the blades. Energy is transferred from the water to the turbine. The blades of the turbine turn the rotor of the generator. This induces a current by spinning a coil of wire inside a magnetic field. A potential difference (voltage) is produced between the ends of the coil, which causes a current to flow.





Hydro-electric schemes provide 20% of the world's electricity – in Norway 100%, Iceland 80% and Canada 70%.

The advantages of HEP include:

- it is a renewable source of energy which does not use fossil fuels (except during construction)
- it produces no carbon emissions, and therefore makes no contribution to the greenhouse effect
- pumped-storage plants can use excess generation capacity at low demand times to pump water into a higher reservoir; when capacity increases, the water can be released to drive the turbine and generate electricity
- reservoirs can be used for flood control, irrigation and for water sports and leisure activities.

The disadvantages of HEP include:

- it is only suitable in appropriate geographical locations
- it can be disruptive to aquatic eco-systems – e.g. salmon spawning (though fish ladders can be installed)

- it can have a negative effect downstream of the dam – scouring river beds, increased erosion of river banks, cold water from reservoir effecting aquatic populations
- newly-flooded reservoirs can produce large amounts of methane and carbon dioxide due to the decay of plant material
- some schemes can be very disruptive of human populations – for example, in parts of Wales; elsewhere, entire cities and towns may be destroyed and hundreds of thousands of people may have to be moved (e.g. Three Gorges dam in China)
- some schemes can be destructive of historical, cultural and other traditional sites.

2.3 Explain how the scientific method can contribute to the detection and solution of crime.

Consider in detail at least two areas of forensic science or technology that are commonly used in the collection and interpretation of evidence.

When a crime is committed, it is likely that physical evidence will be left at the scene (or scenes) where the event took place. The physical evidence may include bodies (dead or surviving), hairs, fibres (from clothes), weapons, soil and other materials, fingerprints and prints from shoes, tyres, printed material, computer discs, etc.

The scientific method deals only with evidence that is observable and measurable, as distinct from assertions, opinions, etc. Investigators should be objective – i.e. free from bias. They will develop hypotheses based on the evidence, and then test them using observation or experiment. They will use logical reasoning in offering explanations or interpretations derived from the evidence.

- **Forensic science** is the term given to a broad range of scientific specialisms which contribute to the criminal and legal systems. The answer may make reference to some or all of the following:

- **Forensic pathology** – this includes the examination of bodies to determine the cause of death; examination of wounds to determine their cause; examination of tissue specimens in cases of, for example, rape.

- **Genetic fingerprinting** – also known as DNA testing or profiling. This involves isolating DNA from cells, then comparing and contrasting the sequences of component chemicals between individuals. The DNA sample can be obtained from skin, hair, blood and other body fluids. Although differences in DNA between humans are minimal, certain regions of DNA are unique to individuals, and genetic fingerprinting can accurately distinguish individuals from one another – with the exception of identical siblings from multiple births.

- **Fingerprints** – these are friction skin ridges on the tips of fingers, thumbs and toes. No two sets of finger or palm prints have ever been found to be identical, including between identical siblings. Prints may be left on smooth objects by secretions from glands on the fingertips, or in other materials – blood, paint, oil, etc. In forensic fingerprinting, these patterns can be compared with those held on a database by an expert individual or by a computer, to determine whether they originated from known prints to the exclusion of all others.

- **Toxicology** – this is the study and identification of toxic substances which may have caused death or poisoning. Toxins may be found in urine (used for drug testing), blood (e.g. for measuring blood alcohol level) and hair (which can reveal long term ingestion of drugs). In dead bodies, toxins may be found in body fluids and organs.

- **Forensic entomology** – this is the study of insects. In cases of death, studying which insects lay eggs where, when and in what order can assist in determining the time and location of death.

- **Forensic dentistry** – the comparison of teeth and dental work is used in the identification of human remains and for the detection of violence or abuse by biting.

- **Ballistics** – this is the science of analysing firearm use in crime. Because of rifling (grooves in gun barrels), spent bullets acquire a distinct pattern of grooves and indentations which are unique to the weapon used. It is therefore possible to identify which weapon fired which bullet in the case of firearm crimes.

- **Computer technology** – the use of computer technology has significantly assisted in the solution of crimes, particularly the use of databases. A database is a structured collection of records or data – for example, DNA information or fingerprints – that is stored on a computer system. The database can be interrogated to find information that would take days or weeks to find manually. Information on different databases can be cross-referenced to establish similarities and differences between records.

- **Forensic analysis of technology** – the analysis of a range of different technologies to elicit information about crimes: for example, images from CCTV, speed and congestion charge cameras may enable the movement of people and vehicles to be plotted; records of the use of mobile phones and ATM machines can establish the whereabouts of individuals at specific times; analysis of computer hard drives can show whether the computer had accessed particular sites, such as those linked to terror organisations or child pornography.

2.4 Explain the causes and effects of earthquakes.

Discuss the extent to which it is possible to limit damage to life and property as a result of earthquakes and related natural phenomena.

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. Earthquakes (and volcanic activity, mountain building and oceanic trench formation) occur along plate boundaries.

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.

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.

A tsunami can be generated when the sea-floor abruptly deforms and vertically displaces the overlying water. Waves are formed as the displaced water mass moves to regain its equilibrium, and radiates across the ocean like ripples on a pond. Though superficially resembling a breaking wave, when a tsunami reaches land it is, in effect, a sudden rise in sea level which, combined with the weight and pressure of the ocean behind it, has far greater force than any wave.

Ideally, being able to predict an earthquake would be the best way to limit loss of life, if not damage to property. Earthquakes have been associated with changes in animal behaviour, electromagnetic fields and weather conditions among other phenomena, but scientists are not able to predict earthquakes with any accuracy.

Zones of high risk of earthquakes at plate boundaries are well known, as are certain specific locations – e.g. the San Andreas fault in California. Not placing buildings, roads and bridges in the most high risk locations might seem the most sensible way of avoiding damage to property or life.

Buildings can be protected by strengthening walls and frames; placing metal and rubber isolating pads between foundations and building to absorb energy and allow the building to remain relatively static when the ground moves; and in tall buildings, placing a large mass on an upper floor which is free to move within a limited range, which acts as a damping mechanism to counter excessive movement. While such preparations are well-advanced in developed societies such as the USA and Japan, they are much less likely to be applied in the more remote parts of less developed societies such as Pakistan and Iran, both of which have experienced major and highly destructive earthquakes in recent years.

Tsunami defences, in the form of large sea walls, have been built in some vulnerable areas, for example in Japan. However, it is not certain that they will be sufficiently high to cope with major tsunamis. In other areas, natural features such as tree cover on the shoreline enabled some areas to survive the 2004 Indian Ocean tsunami virtually unscathed. This could be extended elsewhere. In the Pacific Ocean, there is a tsunami monitoring system which can give some degree of early warning of the approach of a tsunami.

Governments and non-governmental organisations have well-established rapid response operations to assist with rescue and recovery once an earthquake or related event occurs. These include equipment to search for survivors, medical teams and emergency shelters.

2.5 Explain the process of in-vitro fertilisation (IVF) and identify the circumstances in which it might be used.

Discuss the scientific and ethical issues arising from the development and use of IVF.

IVF is a technique by which egg cells are fertilised outside a woman's body.

The process begins with hormonal stimulation of the woman's ovaries to encourage the development of eggs. Following ovulation, the fluid containing the egg cells is retrieved from the ovaries, after which the eggs are stripped of the surrounding cells and prepared for fertilisation. Sperm provided by the male partner are separated from the seminal fluid and the sperm and egg are then incubated together in the culture media for about eighteen hours. Normally fertilisation should have taken place after this time, but in cases of low sperm count, a single sperm may be injected directly into the egg. The fertilised eggs are left in a growth medium until they have reached the 6-8 cell stage. Usually embryos are transferred after three days, though if embryo quality is in doubt transfer may take place at five days. The embryo(s) judged best are transferred to the woman's uterus. Finally, the woman may receive hormone treatment to facilitate embryo implantation. Typically, there is a 20-30% chance of a successful pregnancy, depending on factors such as the age of the patient, the quality of the eggs and sperm, the length of infertility and medical skill.

IVF treatment is likely to be used mainly by infertile couples who have unsuccessfully sought to become pregnant over a long period. However, it may also be used for single women, same-sex couples and (in some places) post-menopausal women. Women who are about to undergo chemotherapy with a risk of losing their ovarian reserve may freeze fertilised or unfertilised eggs for use at a later stage. IVF makes possible pre-implantation genetic diagnosis, by which embryos can be tested for inherited conditions – e.g. cystic fibrosis – so that affected embryos may be discarded. It also enables sex selection and the selection of an embryo so that the child born as a result of this treatment could be a cord-blood stem cell donor for a sick sibling.

The scientific and ethical issues that arise can include the following:

- there are some who argue that 'creating' life in the laboratory and by-passing natural methods is in itself fundamentally wrong; a contrary view would be that assisting in the creation of life where it would otherwise be impossible is a highly moral and positive action

- embryos are regarded by some as being already human beings from the moment of conception, so the discarding of unused or unwanted embryos can be seen as killing; a different view is that 6-8 cell embryos cannot be considered to have any form of independent or sentient existence

- some people regard the use of unwanted embryos for establishing embryonic stem cell lines as being unethical; others would argue that it is highly moral to seek treatments which might ultimately provide cures for many major diseases

- it can be seen as undermining the traditional family if single people and same-sex couples can conceive in this way; it can also be argued that it is extending the possibility of family life to those to whom it is currently denied

- IVF has in the past resulted in multiple births (because of multiple implants to maximise the chances of success); multiple births are related to increased pregnancy loss, birth complications, prematurity, neonatal morbidity and the potential for long term damage to the

child; more recently, with higher success rates, there has been a policy of implanting single embryos

- use of single sperm (ICSI) raises questions about choice and potential 'danger' of development from genetic material that would not have survived naturally
- the whole principle of selection, made possible by pre-implantation genetic diagnosis, raises ethical issues about which (if any) of the bases for selection are acceptable
- the birth of children to post-menopausal women, some well into their sixties, raises issues of what is 'natural', as well as questions as to what is best for the child
- the freezing of fertilised embryos has led to disputes over control of the embryo when the couple have subsequently separated
- there is a debate about the use of medical resources, on the basis that infertility, while a problem for many individuals and couples, might not necessarily be seen as being as high a priority as many life-threatening conditions.

2.6 "There is no alternative medicine. There is only medicine that works and medicine that doesn't work." (Professor Richard Dawkins)

Discuss the differences between 'alternative medicine' and conventional medicine.

Medicine is the branch of science concerned with maintaining or restoring health through the study, diagnosis and treatment of disease and injury. It uses the disciplines of science in the study, research and knowledge of health, and in the application of that knowledge to improve health, cure diseases and understand how humans function.

Modern medicine has been able to identify the causes of many diseases and illnesses and to devise treatments to ameliorate their effects or to cure them. It has been responsible (along with improved standards of living and public health systems) for improved health and longer life spans in most advanced societies in the 20th century. On the other hand, it has been criticised for becoming too dependent on technology, leading to a more mechanistic, detached practice, with a loss of patient-focused care. There have also been examples of medical error which have sometimes undermined confidence in medicine.

These complaints have led some people to seek support from alternative medicine. The term applies to practices used in place of conventional medical practices – examples include acupuncture, homeopathy, aromatherapy, herbal therapies, Chinese medicine, reiki, etc. When used alongside conventional medicine, it is described as complementary medicine. The definition of what is and is not alternative medicine changes with time as a result of research and public and professional acceptability.

Advocates of alternative medicine argue that it offers a choice to patients not available from conventional sources; that it is often effective, even if it cannot be proven; it is more patient-centred; and it is 'holistic'. Critics argue that alternative treatments have not been proven to work in scientifically-acceptable trials; that they may directly damage people or indirectly cause hurt because patients do not seek appropriate treatment while undergoing alternative therapies; and that any successes are likely to be the result of a placebo effect.

Homeopathy is based on the idea of treating like with like, by using highly dilute remedies that seek to reproduce similar symptoms to the disease. However, medical studies have shown no evidence of effectiveness (indeed, generally the opposite) and it is regarded as being incompatible with the known laws of chemistry, as the level of dilution is often so high that not even a molecule of the original drug is present in the treatment.

Acupuncture is a technique of inserting and manipulating needles into 'acupuncture points' on the body. It is claimed that this stimulates the so-called 'meridian' system and brings relief by rebalancing 'yin', 'yang' and 'qi'. It has no basis in scientific theory, but it has been found to be effective for some specific complaints (though possibly a placebo effect). However, there is insufficient evidence of effectiveness for most conditions.