Version 1.0

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

General Studies 6761
Specification A

GSA5 Science, Mathematics and Technology

Mark Scheme

2006 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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Unit 5 Question 1
(GSA5 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	**B**	**1.11**	**A**
1.2	**C**	**1.12**	**B**
1.3	**A**	**1.13**	**B**
1.4	**A**	**1.14**	**B**
1.5	**A**	**1.15**	**C**
1.6	**D**	**1.16**	**D**
1.7	**B**	**1.17**	**A**
1.8	**B**	**1.18**	**A**
1.9	**A**	**1.19**	**A**
1.10	**B**	**1.20**	**C**

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

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 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 Discuss the extent to which technology, vehicle design and laws affecting road users have each contributed to personal safety and health.

There is quite a wide range of examples for candidates to use in illustrating their points. Better candidates will have the opportunity to demonstrate AO4 in the quality of their discussion. A balanced response would acknowledge that all three mentioned parties have made some contribution to personal safety and health. There may be some candidates who take a valid view that there has not been enough done overall to promote personal safety and health, particularly health, with current contentious issues like global warming, fuel tax, speeding, road repairs, public/private transport balance.

Vehicle design – improved reliability and efficiency of car and truck engines, early warning of defects, catalytic converters, smart braking systems (e.g. ABS), European NCAP ratings, built in safety box for occupants, seat belts, removal of dangerous appendages from vehicles (e.g. wing mirrors and aerials), better lighting (e.g. halogen headlights, fog lamps, reversing lights/audible warnings), plastic components (e.g. bumpers), GPS navigation, anti-corrosion sprays, radial tyres, air bags.

Government legislation – clean air act, setting of speed limits, calming devices, speed cameras, drink driving, MoT testing, lead-free petrol, silencer/noise control, exhaust emission control, driving test, vehicle insurance, fuel taxation, regulation of public service and large goods vehicle driving, traffic offence fixed fines, misuse of seat belts/mobile phones, railway bridge approaches checked and improved, government advice videos (e.g. about frequent resting on motorway journeys, drink driving, headlight dimming, keeping your distance).

2.2 Explain how electrical energy can be obtained from fissile material.

Discuss the extent to which the world needs nuclear energy for power production.

The first part of this question is a straightforward examination of the scientific principles of how nuclear energy is obtained and better candidates ought to be able to demonstrate a sound scientific knowledge.

The discussion is set so that candidates may take a wider view than that of the United Kingdom and compare nuclear power with alternatives using either renewable sources or non-renewables in a context of the vulnerability of oil supplies, the uncertainties of renewables and practices in other countries (e.g. France, USA, the growing economy of China).

Candidates ought to be aware of the dangers of reliance on nuclear power, its problems regarding waste disposal and the proliferation of nuclear weapons.

Whilst the discussion is capable of a political /economical interpretation to the exclusion of technological aspects, to score highly, candidates will have to be inclusive. Again, the potential for AO4 in this question depends on the quality of the discussion.

- Fissile material is composed of heavy atomic nuclei which can be split into two or more parts accompanied by the emission of large amounts of energy. The mass of the component parts is less than that of the original nucleus, giving mass to energy conversion according to Einstein's famous equation:

$$E=mc^2$$

- Fission occurs spontaneously in Uranium 235, the main fuel used in nuclear reactors. However the process can be induced by bombarding nuclei with neutrons. Nuclei which have absorbed a neutron become unstable and soon split. Neutrons are released from the bombarded nucleus and may in turn produce further fission setting up a chain reaction that must be controlled if it is not to result in a nuclear explosion.
- A nuclear reactor supplies heat continuously from controlled fission. The heat is used to make steam which drives a turbine which in turn drives an electricity generator. The fuel used is Uranium 233 or 238 or Plutonium 239, a moderator (e.g. deuterium oxide or graphite) to slow neutrons down, control rods (e.g. boron) to absorb neutrons and a heat exchanger where the reactor coolant (water in pressurised water reactors – PWRs or carbon dioxide in advanced gas cooled reactors – AGCRs) gives up its heat to make steam.
- Government policy favours wind farms but the Royal Society and others have suggested that with oil/gas running out, renewable energy sources on their own will not be enough to satisfy future demand and have advocated nuclear power to fill the gap. We currently produce about 20% of our electricity from nuclear stations. The figure in France is about 75%.
- Disposal of waste from nuclear power plants is a problem because of the large half lifes of the radioactive fuels used possibly remaining dangerous for tens of thousands of years. Chernobyl's disaster site of 1986, is still inaccessible.
- The USA is suggesting they build and lease small reactors for export so that there is control over materials that may be used for making atomic bombs.
- China is using a lot of oil and has signalled an intention to consider the nuclear option as a means of powering its rapidly growing economy.

2.3 Explain the science that enables human organ transplants.

Should there be a law of presumed consent regarding organ donation? Give reasons to support your answer.

The intention in this two-part question is to allow candidates to demonstrate scientific knowledge of the immune system and its role in the conditions needed for transplants to work and then to go on and discuss the medical and ethical issues around the regulation of informed consent of the donor. It is in this discussion that there will be the opportunity to demonstrate AO4.

- Immunity is the protection that organisms have against foreign micro-organisms. The cells that provide this protection are called white blood cells or leucocytes. They include neutrophils and macrophages. Some of the most important immune cells are the B cells (produce antibodies) and T cells (three main types, Th (helper cells that allow other immune cells to go into action, Ts (suppressor cells which stop specific immune reactions from occurring) and Tc (cytotoxic cells which kill cells that are cancerous or infected with a virus). Both B cells and T cells have surface receptors which make them specific for particular antigens. Immune cells coordinate their activities by means of chemical messengers or lymphokines including the antiviral messenger interferon. The lymph nodes play a vital role in organising the immune response.
- In most tissue or organ transplants, the operation is for life saving purposes. The problem is that antigens of the graft are recognised as foreign and the recipient's immune system produces antibodies that target the graft that is then destroyed by white blood cells. Success has been achieved by careful matching and immunosuppressive drugs such as cortisone and cyclosporine which have been used since the 1970s.
- Corneal grafting is the oldest (1905) successful human transplanting procedure. Of the internal organs, kidneys were first transplanted successfully in the 1950s and are the most readily received by the body. More recent transplantation encompasses hearts, lungs, livers, pancreatic, bone and bone-marrow tissue. Most transplant material is taken from cadaver donors, usually those suffering death of the brain-stem or from frozen tissue banks. In rare cases, kidneys, corneas and parts of the liver may be obtained from living donors.
- The UK transplant code of 1979 covers the use of material from a donor and two doctors (independent of the transplant team and each other) must certify that the donor is brain dead before material is removed.
- Organs are also needed for research. Animals do not give the detailed knowledge needed to treat the human condition and for drug development.
- Present law allows relatives to override the known wishes of the deceased person. Presumed consent is also referred to as conscriptive donation whereby everyone is assumed to agree to organ removal unless they refuse consent.
- There may be a reference to the practice uncovered on Merseyside in 2000 where 3500 organs had been removed from dead babies without the full knowledge of relatives. The government told doctors that they must consult relatives on what they intended to remove and why – trust will only exist if there is informed consent and not just tick-in-the box consent.

2.4 Explain how a scientific experiment could be designed to field test the effectiveness of a new pesticide spray for cabbages.

What concerns would need to be addressed for the experiment to be considered valid and reliable?

The opportunity for AO4 exists in the explanation of concepts of scientific validity and acceptability and the contribution to scientific knowledge of such an experiment.

Good candidates will display a sound knowledge of the selection of and the need for a representative sample, the definition and control of variables including the concept of "effectiveness" in this context, measurement techniques, presentation and validation of the results.

- The **scope** of the experiment should be established. Comparison with other named pesticides? Define the pest or pests? Different types of cabbage? Once a set of objectives has been determined for the experiment it is usual to look to see if any similar work has been done – a **literature survey**!
- A **representative sample** of cabbages needs to be selected so that the outcome will be fair. The sample needs to be big enough to establish confidence that the results will apply more generally to the **population** of cabbages – beware of candidates who think one cabbage is sufficient for this experiment!
- Define the **variables** involved, how are they **controlled**? Dose size of pesticide is an **independent** variable. It would seem sensible to compare a group of cabbages treated with the pesticide to a group of cabbages that have not been treated at all – the **control group**! The mortality of pests would be a **dependent** variable. Other variables that need to be considered are natural predators, weather, size of cabbage – the pests' food supply may depend upon seed quality or growing conditions. Ideally, all these other variables ought to be present with the same intensity in both groups of cabbages. This can be achieved with Latin square or **random block design**.
- How is measurement of the effects carried out? How is **effectiveness** measured? If pests are being counted, is this an appropriate way to measure mortality? Is this counting done before and after the pesticide treatment and when is the optimum time for the spray to be applied? There is a need to know how **accurate** measurements are – large errors may obscure the very effects that are being measured.
- A realistic experiment would be in a field of cabbages – using a greenhouse or laboratory could lead to distortion e.g. natural predators and weather may have been removed but e.g. the effect of rainwater on the pesticide may need to be considered.
- Finally, the results should be published with sufficient detail and clarity that peers, if they wish, may repeat the experiment and get similar results – a **reliable** experiment. This is the process by which scientific research is **validated** and the results are accepted into the body of scientific knowledge.
- Another consideration is the extent to which the sponsor or funder of the research has a vested interest in the outcome. More sophisticated responses may make the link with the field testing of genetically modified food.

2.5 With reference to one or more specific areas of the countryside, examine the conflicts that might arise amongst industrial, commercial and recreational uses.

Discuss the extent to which science and technology might reconcile conservation and preservation with the economic and social needs of society.

Good candidates ought to be able to base a response to this question in the context of a named area such as: the Cairngorms, North Yorkshire moors, the fens, the Burren, the lake district.

The good candidate will recognise a range of different uses from a range e.g. arable and hill farming, rambling, climbing and other leisure pursuits, game-keeping, visiting national and country parks, SSSIs, world heritage sites, army training uses, quarrying, landfill waste sites, reservoirs and dams for water gathering /sailing /fishing, rivers for mills /kayaking /fishing, forestry. The ethical discussion of the way different interest groups are balanced ought to provide opportunities for AO4.

- An example is the Cairngorms – fragments of an 8000 years-old Caledonian pine forest that used to cover most of Scotland. A governmental working group proposed that this forest should be re-established primarily by regeneration. However, these fragments of forest are dying. There is not a tree that is under 150 years old. The need for lumber meant that great swathes of pine forest were felled reaching a climax during the Second World War when Canadian lumberjacks were drafted in.
- As lumber demand has declined a new threat to the trees has arrived- red deer. All foliage and lower branches are removed from the trees up to the browsing height of the deer and young saplings do not survive. The deer travel in herds of 20 or 30 and have been growing in numbers continuously over the last 200 years – ever since the Highlands became home to hunting estates.
- Red deer encouraged by landowners wishing to attract revenue from stalkers are the principal threat to the remains of the Caledonian forest. The deer have doubled in number over the last forty years and as their natural predators, bears and wolves, have disappeared numbers are likely to continue climbing. The governmental group suggested culling to halve numbers so that there is a balance struck between stalking continuing to be a viable economic activity and with a sustainable habitat. The reintroduction of the wolf has also been considered.
- Another solution considered is fencing to keep deer out of commercial forests with grants to help with fencing costs. Critics argue that the forest inside the fence is no more natural than that outside because the undergrowth is too dense and that what is required is deers browsing but in smaller numbers than is now the case. Fencing off parts of the forest only puts pressure on the non-fenced areas.
- Another area that could be considered is the Flow country of northern Scotland which was in the news in the 1980s when a tax loophole made investment in forest plantations here a lucrative exercise. Peat cutting is a threat here as it is in the Burren of western Ireland. Quarrying and property regulations in our national parks and the leisure and tourist demands of visitors who live in large numbers in close by conurbations would also serve as good illustrations in this question.

2.6 In the last twenty-five years food scares have been a feature of mass food production.

Discuss the scientific and hygiene conditions that have given rise to these food scares and how such scares might be avoided in the future.

Good candidates may be aware of Edwina Currie's salmonella in eggs episode, E-coli outbreaks, botulism in salmon, BSE and its human form of vCJD, foot and mouth all of which had a direct effect on the country's attitude to food production and more recently we have seen SARs (thought to have originated in a poor area of China after eating civet cats) and Asian Bird flu (thought to be caught by contact with infected birds). The last two are worrying because we are not yet properly protected with vaccines, we do not know enough about the viruses and there is evidence of cross-species infection. Genetically modified food has caused a food scare, not least because its pollen may contaminate organic crops, but this question is not meant to be just about gmf.

The discussion ought to provide the opportunity for AO4.

- Cases of food poisoning have increased by a factor of about ten in the given time scale. Reasons for this include increased use of antibiotics in farming, animals being transported longer distances to abattoirs collecting bacteria in transit, fast production lines in abattoirs, spread of abattoir waste on grazing fields, lack of training of meat handlers, insufficient inspection of premises, an increase in eating out in restaurants, more fast food outlets. Also, nearer to home, the growing obsession with fashionable anti-bacterial sprays and germ killing chopping boards has seen the emergence of the so-called "Dettox Generation", but this is not the real solution. Indeed, it kills off good germs and encourages resistance in dangerous ones. Uncooked meat should be placed at the bottom of the fridge, where it is coldest, different knives and boards should be used for uncooked meats and vegetables, hands should be washed after handling different foods, dish clothes should be changed regularly and dishwashers do have the advantage that they clean at a sufficiently high temperature to kill germs.
- Common sense suggests that cramming large numbers of animals into small spaces will result in stress which will in turn lower animals' immune defences making them more susceptible to bacterial and viral infections. To deal with over-crowding the farming industry uses growing quantities of antibiotics. These protect animals from infection but also make them grow faster. As a result, the vast majority of pigs and poultry are routinely given antibiotics in their feed or water. There is a danger that some of the antibiotics used in human medicine become less effective e.g. in the USA one of the best drugs for treating typhoid was banned from animal husbandry over a decade ago because its over-use had increased the resistance of typhoid bacteria.
- The EU has four standards for eggs – "free range", "semi intensive", "deep litter" and "barn". Despite the homely sounding name, "barn" eggs can be produced with up to 25 hens per square metre.
- Labelling, organic food, the soil association, growth promoting hormones, vegetarianism all have a place in this answer and some candidates will probably have first hand experience of the last foot and mouth outbreak