GCE 2005
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ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

General Studies Specification A

Unit GSA5 – Science, Mathematics and Technology

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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	**D**	**1.11**	**A**
1.2	**C**	**1.12**	**C**
1.3	**D**	**1.13**	**B**
1.4	**D**	**1.14**	**B**
1.5	**C**	**1.15**	**C**
1.6	**D**	**1.16**	**A**
1.7	**A**	**1.17**	**D**
1.8	**B**	**1.18**	**A**
1.9	**B**	**1.19**	**B**
1.10	**D**	**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 Proposals for the new British national ID card include biometric data on fingerprints or iris patterns.

Describe the technological aspects of the way this data will be collected and stored. Discuss any ethical and practical concerns which might be raised.

- The proposal is that the ID card information will be name, date of birth, gender, immigration status, unique personal number and a confirmed biometric identifier such as eye scan or electronic fingerprint. This will be enshrined in law. The police and other organisations will not have "routine" access to the national identity register except for terrorist and serious crime investigations. The police will not have the power to stop someone in the street and demand to see their card. However if they believe that somebody is committing an arrestable offence they will be able to demand they come to the station and prove their identity. In time new "livescan" technology will mean that a police officer will be able to scan a card on the street and check the entry on the central database.

- Everybody will have an eye or fingerprint scan at the post office or local council office so that their biometric information can be stored on a microchip embedded in the card and on the national identity register. There is a debate going on in Europe about what biometric data should be stored – the European commission says that maximum security would be achieved with all ten fingerprints but space on the card only allows for two fingerprints, which have a much "higher error rate" or for the British preference – an iris scan, for which it is claimed there is a near-zero error rate. Proposed costs are £35 for a plain 10 year ID card, a passport version will be £77 and a driving licence version will be £73.

- Legislation that is intended to be introduced before the next election will establish in its first phase a national identity register; develop more secure passports and driving licences using biometric technology; introduce a voluntary plain identity card for those who do not need a passport or driving licence and introduce mandatory biometric ID cards for the 4.5 million resident foreign nationals in Britain. It will also include safeguards over who can access the database, to protect privacy.

- The second phase will take place when the technology is seen to be working, take up reaches more than 80% of the population and the public accepts the idea. It will require full debate and a vote in both houses of parliament. It will be compulsory to have the card but not carry it and to produce the card to get access to public services, such as health, education and housing.

- The national identity register will be built from scratch over three years as people are issued with identity cards, passports and driving licences at a cost of £186m. Before an entry is accepted it will be tested against other databases such as passport, driving licences and immigration records.

- There are no proposals here to include DNA data but there is a body of support for a national DNA database – the police routinely take DNA information from those that are arrested in criminal cases – and the two databases may be collated. The overall timetable and some of the details may be influenced by changing demands to enter the USA.

2.2 Compare and contrast the scientific features of a digital camera with a traditional camera using film, indicating those applications or uses where one may be preferred to the other.

- A still film camera is made of three basic elements; an optical element (a lens), a chemical element (the film) and a mechanical element (the camera body itself). The trick in photography is to calibrate and combine these elements in such a way that they record a crisp, recognizable image. In an SLR camera the photographer sees exactly the same image that is exposed to the film and can adjust everything by turning dials and clicking buttons – it doesn't need electricity to take a picture.

- At its simplest, the lens is a curved piece of glass or plastic. Its job is to take beams of light bouncing off an object and redirect them so they come together to form a real image that looks just like the scene in front of the lens. The sharpness of the image is changed by moving the lens relative to the film surface i.e. focussing the camera. A single converging lens would produce aberrations in the image a significant aberration occurs because different colours of light bend to different degrees and this chromatic aberration can be compensated for by using several lenses made of different materials. In a **zoom** lens different lens elements can be moved backwards and forwards to change the magnification power – the focal length – of the lens as a whole. Different lenses are suited to different situations e.g. a **telephoto** lens (especially long focal length) allows one to zero in on distant objects and a wide-angle lens (especially short focal length) allows one to "shrink" the scene in front. A standard 50mm camera lens doesn't significantly magnify or shrink the image, making it ideal for shooting objects that are not especially close or far away.

- The film is made up of a collection of tiny light sensitive grains. In colour film there are three different layers of light sensitive materials which respond in turn to red, green and blue. When the film is developed, these layers are exposed to chemicals that dye the layers of the film. The lens is covered until the picture is taken when the shutter is opened. The amount of light passing through the lens is controlled by changing the size of the aperture – the lens opening. The ideal exposure depends on the size of the light grains in the film – measured as speed.

- Automatic point and shoot cameras use circuit boards and electric motors, instead of gears and springs.

- With a digital camera the aperture and shutter speed are set for optimal exposure.

- The CCD which is the electronic version of a film is reset and then exposed to the light building up an electrical charge, until the shutter closes.

- The ADC measures the charge and creates a digital signal that represents the values of the charge at each pixel.

- A processor interpolates the data from the different pixels to create natural colour. On many cameras it is possible to see the output on the LCD at this stage.

- A processor may perform a preset level of compression on the data.

- The information is stored in some form of memory device – probably a flash memory card.

- The picture is transferred to a computer or a printer.

- The picture can be attached to an e-mail message or posted to a web page.

2.3 There are over 100 000 tonnes of nuclear waste stored in the United Kingdom.

Explain how this waste was produced and evaluate the options for its disposal.

The radioactive and toxic by-products of the nuclear energy and nuclear weapons industries. It may have an active life of several thousand years. Reactor waste is of three types **High Level** – spent fuel or the residue when nuclear fuel has been removed from a reactor and reprocessed – **Intermediate** – which may be long or short lived and **low level** but bulky waste from reactors which has only short lived radioactivity.

- **Keeping it on the surface** – effectively what we are doing at the moment although this is a temporary solution – longer term surface storage over thousands of years would require much better facilities.

  Would need constant management with the waste having to be restacked from time to time. Easily monitored and would allow a better solution to be adopted in the future.

  Concerns about terrorist attacks and ability of future societies to keep managing the waste. The next Ice Age (due within 100 000 years) could threaten the integrity of the stores.

- **Burying it underground** – favoured solution of most scientists. The USA, Sweden and Finland are actively developing underground repositories. The UK has considered this in the locality of Sellafield which is also adjacent to the Lake District national park and in existing deep gypsum mines under Billingham in the north east. The waste is vitrified into glass cylinders for burial. Radiation would be unable to penetrate the hundreds of metres of rock to the surface thought there are some concerns about corrosion and leakage. However such facilities are expensive to build and future generations might dig into such a store accidentally.

- **Dumping it at sea** – barrels of waste were dropped off ships in the past but this is now banned by several international treaties. Burying it under the seabed in sediment or drilled boreholes is also currently outlawed. So is the idea of placing the waste in subduction zones where one piece of the earth's crust passes under another.

- **Disposal in ice** – makes use of the heat generated by some wastes which if placed on a huge stable ice sheet in Greenland would melt its way downwards with the ice resealing itself above. Clearly not popular with environmentalists and would require considerable transportation to the disposal point on the surface.

- **Firing it into space** – On paper the perfect solution. Once clear of the earth's gravitation canisters of waste would be gone forever but the catastrophic consequences of a launchpad explosion or other accident make this a bit of a non-starter – the many flights that would be needed make an accident more likely.

- **Transmutation** – a futuristic solution based around changing the harmful waste into more benign forms by bombarding it with protons or neutrons to reduce the radioactivity. Technically difficult and expensive and would need the waste to be separated into clearly defined types.

2.4 A low carbohydrate, high protein diet is regarded by many health professionals as unbalanced.

What is a balanced diet and why is it regarded as important for our health and lifestyles.

- A well balanced diet can help prevent a number of health problems, including heart disease, some forms of cancer, high blood pressure, osteoporosis, obesity and diabetes.
- Food is needed for both energy measured in calories or kilojoules and nutrients which are converted to body tissues.
- The building blocks of food are nutrients and humans can utilize the following:

  Carbohydrates: as starches found in bread, potatoes and pasta – as simple sugars in sucrose and honey – as fibres in cereals, fruit and vegetables.
- Protein: as from nuts fish, eggs meat and milk and some vegetables.
- Fats: as found in most animal products – meat, lard, dairy products, fish also in margarine, nuts and seeds, olives and edible oils.
- Vitamins are found in a wide range of foods except for B12 which is found mainly in animal foods.
- Minerals are also found in a range of foods e.g. calcium in milk or broccoli, iodine from seafood, iron from liver and green vegetables.
- Water-ubiquitous in nature.
- A balanced diet is defined as a selection from the six basic food groups or pyramid as follows:

  2 to 4 servings of fruit
  3 to 5 servings of vegetables
  6 to 11 servings of breads and cereals
  2 to 3 servings of meat
  2 to 3 servings of milk products a day
  fats, oils and sweets should be used sparingly.
- If a variety of foods is eaten, it is probably not necessary to take a vitamin supplement unless pregnant, elderly or a special medical condition exists.
- To maintain a desirable weight a healthy low calorie but balanced diet should be combined with exercise.
- Foods high in saturated fat and cholesterol should be avoided. Alcohol should be imbibed in moderation.
- The Atkins diet is a low carbohydrate, high protein diet. It is one of several high profile diets in the last several years with much popular appeal and commercial success – over 25m copies of the book have been sold and the book was in the New York Times bestseller list for five years. Celebrities such as Jennifer Aniston and Geri Halliwell have been linked to the Atkins diet.
- The Atkins diet is stringent and there tends to be initial rapid weight loss mainly because of the low carbohydrate element. However, in the short term, followers could suffer poor concentration, low energy, dehydration, constipation and bad breath. In the long term the health problems referred to in bullet point one become more probable but there is uncertainty about long term effects.
- Feeling fit and healthy is an ideal many strive for by dieting to lose weight and exercising in the gym or through different sports.

2.5 Discuss the arguments for and against using animals in scientific research to improve the quality of human life.

- Decisions about the right and wrong uses of science lie in the field of **ethics** – weighing benefits against risks can often provoke strong feelings as with the arguments over animal experimentation.

- Animals are used in three main ways; in medicine, cosmetics and transgenics each raising different questions about risk versus benefit.

- Thousands of lives are saved every year through medicines and surgical techniques that were first tested out on animals. Research into cancer, mental illness and neurological diseases such as multiple sclerosis – all conditions for which there is clear need for new treatments – rely heavily on animal experiments. In this case most of us would agree that the benefits in terms of reduced human suffering outweigh the inevitable suffering inflicted on the animals – in 1990 3.2 million animal experiments took place.

- A minority of animal experiments are carried out to test cosmetics and toiletries. Here the balance seems to shift in the opposite direction. Some of these items are undoubtedly necessary, but should animals suffer just to bring a new kind of makeup or deodorant to supermarket shelves.

- Transgenic animals which carry genes from humans and other species, can be used to test new treatments for diseases such as sickle-cell anaemia. New drugs can be developed by creating transgenic sheep and cattle that carry genes for human proteins that are produced in their milk. Dolly, the cloned sheep, was created as part of this research programme (although she was not herself transgenic). In this case, the science is so new that judging long-term benefits and risks is difficult.

- Some say that animals have rights and should never be subjected to experiments, regardless of the benefits to humans. Animal rights activists believe humans are guilty of "speciesism", a notion suggested by the Australian philosopher Peter Singer in 1975. Even if we argue that humans have greater rights, because they are rational and self conscious, we have to realise that chimpanzees show intelligence, some self-awareness and possess a sophisticated social awareness.

The government was alert to these ethical problems and brought in the Animals Act in 1986 to control animal experimentation. This incorporates the "Three Rs" principle – **Reduction**, **refinement** and **replacement.** Reduction refers to cutting the number of animal experiments e.g. by harmonising regulations between different countries so that experiments do not need to be repeated. Refinement means extracting the maximum information from the minimum number of experiments and there are many possible replacements for animal experiments e.g. using so-called lower organisms such as the horse shoe crab, tissue slices, cell cultures and computer models.

2.6 Outline the different ways in which alcoholic drinks are produced and discuss the claim that drinking alcohol is a harmless pleasure.

- Yeasts feed and grow on naturally occurring sugars such as glucose-the process is called **fermentation** and alcohol or more accurately ethanol is produced as a waste product. The main crops fermented for alcoholic drinks are grapes to make wines and barley to make beer.

- There are hundreds of kinds of beers with alcohol contents between 3% and 6%. In wines the content varies between 5% and 13%-the point at which yeast dies and the fermentation stops.

- Spirits are closely related to wine and beer – brandy is **distilled** from wine and whisky from ale. Gin is made from fermented grain, vodka from fermented potatoes, rum is based on molasses and bourbon on maize.

- When wine or beer is distilled the alcohol is driven off, resulting in vapours or "spirits". When these spirits are cooled they produce a liquor which is more than 80% alcohol. This level can be raised by further distillation – the final distillate is made drinkable by adding water until alcohol levels are between 40% and 50%.

- Alcohol is our favourite drug – at its best a stimulating and uplifting tonic, oiling the wheels of social life. It reduces stress, helps us feel good and makes the world around us appear more rosy. No important life event marriage, success at work and play, even death – is complete without it. At its worst alcohol is damaging, degrading, deadly – and addictive. The key is moderation!

- Most alcohol is absorbed from the stomach and gut but because it does not require any digestive enzyme to be absorbed into the blood stream, it starts its work the moment it enters the mouth. Blood carries alcohol directly to the liver where about 90% of it is broken down. Alcohol is oxidised in the liver into acetaldehyde, a toxic chemical and then into acetic acid, the substance that gives vinegar its characteristic smell. It is only in this form that alcohol may be used by the body as an energy source but this is a slow process. It takes an averagely sized man an hour to metabolise one unit of alcohol. The remaining 10% is sweated out through the skin, passed in urine and exhaled in breath. The proportion of alcohol in the breath has a direct relationship to the level of alcohol in the blood – hence the breathalyzer.

- Women are more affected than men because they tend to weigh less and are fattier than men – alcohol is not very fat-soluble – both of these lead to a greater concentration of alcohol in the blood – 50% more for an equally weighted woman.

- People react differently to alcohol due to variations in brain chemistry. Some become sleepy, others aggressive. Research shows that an inherited gene gives some people a propensity for alcoholism. Alcohol causes the body to lose heat, affects balance through fluid in the inner ears, dilation of blood vessels in the scalp can cause headaches, dyspepsia in the stomach, erectile dysfunction otherwise known as brewer's droop. The receptor in the brain that responds to dopamine, the chemical that triggers pleasure feelings, is commoner amongst alcoholics than the rest of the population.