GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

General Studies A
Unit GSA5

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

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 What is genetically modified food?

Considering the health and environmental effects, discuss the safety of genetically modified food.

Genetic engineers may try to change the way genes work in a given plant or animal or try to transfer genes from one species to another. This may result in improved nutritional value, visual appeal, processing potential, resistance to disease/pesticides/herbicides or longer shelf life e.g. BST hormone improving milk yields, Flavr Savr tomato, insect proof crops.

From a political point of view; The UK government's strategy unit reported in July 2003 that GM crops offer little economic value, there is little point in farmers growing them if the public carries on refusing to buy them. The government, on the one hand, risks a potential transatlantic trade war if they do not lift their de facto ban on GM and are likely to find inward investment drying up if they appear to be hostile to science based companies. On the other hand, sits an alliance of anti-GM groups whose views hold sway over a sceptical electorate.

From a scientific point of view;

- Is it safe?
  Arpad Pusztai lost his job in 2000 at the Rowett Research Institute in Aberdeen when claiming that rats fed with GM potatoes had damaged stomach linings – a report rebuffed by other scientists. A huge unofficial experiment is going on in USA where millions of meals containing GM foods have been eaten since 1995 – with no apparent problems!
  Only hint of danger in 2001 when a type of GM maize approved only for animal food because it contained a potentially allergy inducing protein got mixed up with normal maize and turned up in tacos across the US. Some people complained of a range of ailments but the FDA failed to establish whether the GM maize was to blame.
- Higher yields from GM crops?
  Several studies have shown yield improvement especially if resistant to pests – one study shows that pest resistant GM corn upped yields in America by the equivalent of 500 000 hectares a year.
- Does it affect organic farming?
  Because GM crops are capable of crossing with non GM varieties, there is a worry that the purity of organic produce is threatened. Pollen from oilseed rape can travel upto 3km on the wind.
- Does it affect farmland wildlife?
  GM crops are often used with broad-spectrum herbicides i.e. wipe out everything
  If used carelessly broad-spectrum herbicides could turn farmlands into almost lifeless wastelands. Evidence of damage to Monarch butterfly larvae who ate large amounts of Bt maize in the lab!
- GM crops lead to superweeds?
  The vast majority of available GM crops are either resistant to certain herbicides or produce toxins that kill pests. Some GM crops have the potential to give rise to superweeds if they cross with other plants. In the UK the only crop that is likely to cross with wild relatives is oilseed rape.
- Are herbicides used with GM crops better than traditional herbicides?
  Modern broad spectrum herbicides do appear to be more environmentally friendly, their effects depend largely on how responsible farmers are in their usage. Some GM crops could be farmed with less tilling saving energy and soil (from wind loss).
- Will we get pesticide resistant insects?

  This is likely but a minimal risk in Britain – more likely in places with lots of crops and pests.
- Can GM food be identified?
  Main tool is simple labelling but tensions in US where labelling is not compulsory. In Europe there is a requirement for mandatory labelling of any food containing more than 0.9% GM ingredients

2.2 Where do "near earth objects" come from and what can be done to protect our world from them?

This question will allow an able candidate to demonstrate his/her knowledge of the astronomy of these objects – what they are, from where do they come and then demonstrate AO4 in the discussion of the evidence of their threat to us.

A near earth object **(NEO) is an asteroid or comet** whose orbit comes close to Earth. Asteroids range in size from tiny dust particles to mini planets, hundreds of kilometres across. They are the left over debris of the solar system – fragments too scattered to gather together to form a proper planet. Most lie in a wide band between Mars and Jupiter called the asteroid belt but some spin near the Earth and occasionally crash into it. Fortunately most are so small that they burn up as they hit the atmosphere, glowing in the night sky as meteorites (that get through to hit the Earth) or shooting stars (that do not!). A meteorite found on Earth in 1997 caused some excitement because it was from Mars, knocked from the planet by a previous meteorite – tiny fossils of possible life-forms were found in this Martian rock.

The central part or nucleus of a **comet** is a large "dirty snowball" – a lumpy block of ice covered in dust usually a few hundred metres across. Comets follow long elliptical orbits around the sun – they come in from deep space, and are thought to originate in the Oort cloud, swing around the Sun and head off again to return years or centuries later. A characteristic tail is formed by the solar wind always pointing away from the Sun's direction. If Earth passes through the remains of a comet's tail, the particles of dust burn up in the atmosphere producing a spectacular meteor shower.

There is $4 million spent annually in investigating NEOs almost all going towards **detection and orbit prediction.** We are not sure how we would divert one – a blast from a nuclear explosion is the Hollywood solution. Many asteroids are not solid rock but loosely connected multi-component objects − rubble piles − which makes it very difficult to predict how they will move in response to impulsive forces.

Up until now because of uncertainties in measuring NEO orbits asteroids that initially have a finite chance of hitting Earth are being discovered and collision is then subsequently ruled out by follow up measurements. One exception is asteroid 1950DA which if it is spinning in one particular direction may have a 1 in 300 chance of hitting Earth on 16 March 2880. If it spins in the opposite direction it is sure to miss us.

With sufficient effort in the form of larger telescopes we could soon have nearly all the **hazardous** rocks (defined as over 1km across) in the heavens tracked in a celestial version of air traffic control. This survey would signal the all clear (odds of say 1000:1) for any object larger than 300 metres across on collision within the next century. This would need to be accompanied by a growing understanding of how to apply a small diversion to an asteroid. Ways of doing this that are currently being explored include slowing the spin of asteroids, giving it a whitewash or parcelling it up in tinfoil. A rotating asteroid absorbs solar energy and recoils a little when it releases the energy in the infra red region later. This is known as the Yarkovsky Effect. Painting the surface white or wrapping it in tinfoil would alter the nature of the energy transfer (reflecting light) sufficiently to change the orbit slightly. A "booster" rocket fixed on the surface firing occasionally would be able to alter the spin characteristics of the asteroid sufficiently to change the orbit. Another possibility is a large reflecting mirror focussed onto the surface vaporising the surface to the point where momentum of the vapour dictates a change of orbit. All of these methods are not as dramatic as a nuclear explosion but applied over time, will deflect the object sufficiently.

However, the question offers the possibility of doing nothing and some candidates will balance NEO cataclysms against more pressing needs for our resources such as warfare, plague and ecological collapse triggered by human disregard.

2.3 The 2003 SARS epidemic illustrated our vulnerability to a new viral disease.

Discuss the measures that can be taken to protect populations from infectious diseases.

This question provides the opportunity for an able biologist to demonstrate the application of his/her knowledge to the problems of infectious diseases, including the distinction between bacteria and viruses as **pathogens,** with ample opportunity for AO4 in the discussion.

Disease is any condition that impairs the normal state of an organism and usually alters the function of one or more of its organs or systems. A disease is usually characterised by a set of specific symptoms and signs although these may not always be apparent to the sufferer. Diseases may be inborn (congenital) or acquired through infection, injury or other causes.

Infection is usually the result of bacteria or viruses (pathogens) entering the body – disease is when this results in a change of the state of health. Infectious disease is by far the greatest cause of morbidity and mortality world-wide. **Respiratory and gastrointestinal infections** cause more deaths world-wide than all other diseases added together.

Immunity is the protection that organisms have against pathogens. The cells that provide this protection are called white blood cells, or leucocytes. Immune cells co-ordinate their activities by means of chemical messengers including the antiviral messenger interferon. The lymph nodes play a major role in organising the immune response. Immunity is also provided by a range of physical barriers such as the skin, tear fluid, acid in the stomach and mucus in the airways. AIDS is one of many viral diseases that affects the immune system. **Antibodies** are proteins produced in the blood by lymphocytes in response to the presence of foreign or invading substances-antigens. Each antibody acts against only one type of antigen and combines with it to form a "complex". Complexes then form clumps which can then be detected and engulfed by white blood cells. Each bacterial or viral infection will bring about the manufacture of a specific antibody which will then fight the disease. Many diseases can only be contracted once because antibodies remain in the blood after the infection has passed, preventing any further invasion. Vaccination boosts a person's resistance by causing the production of antibodies specific to particular infections. In 1796 Edward Jenner inoculated a child successfully with cowpox virus to produce immunity to smallpox. In the UK children are routinely vaccinated against diphtheria, tetanus, whooping cough, polio, measles, mumps, German measles-rubella and tuberculosis. There is much debate about the triple MMR or single measles jab. Measles is making a come back in parts of the UK because certain populations of children are not sufficiently immunised to a percentage where herd immunisation keeps the disease at bay.

An **antibiotic** is a drug derived from living organisms such as bacteria or fungi that kills or inhibits the growth of bacteria. The earliest antibiotics, the **penicillins** were developed in 1941 and quickly joined by many others. Each antibiotic acts in a different way and may be effective against either a broad spectrum or a specific type of disease causing agent. Use has become more selective as side effects have been better understood. Bacteria have the ability to develop immunity following repeated or subclinical (insufficient) doses so more advanced and synthetic antibiotics are continually required to overcome them. The hospital disease –MRSA – may be mentioned in this context.

SARS is caused by a new coronavirus – about one third of common colds are caused by viruses from the same family. Because this is a new virus – thought to originate in civet cats sold as food in China – there are no antibodies in the blood and a vaccine could take ten or more years to be produced. It may be seasonal and could recur in an unhealthy population with poor hygiene practices, inadequate infection control measures and a poor living environment. Several scientists have made links with ebola virus which stems from African monkeys and has similarly jumped species causing a human epidemic. Tests for SARS are not highly developed and it is characteristically at its most infectious during the hospital treatment period.

2.4 " Scientific evidence suggests that climates are changing."

Discuss the validity and implications of this statement.

This is an opportunity for an able candidate to demonstrate his/her knowledge of global warming and its effect, if any, on climate change. The discussion about the degree to which this is happening and the possible outcomes ought to provide the opportunity to demonstrate AO4.

Natural greenhouse gases have created an atmosphere warm enough to support life but which is apparently being destabilised by human activity. A decade ago global warming was a matter of conjecture but now there does appear to be convincing **evidence** that it exists.

- The Inuit sees disappearing ice, starving polar bears and wayward whale migrations.
- Latin America and south east Asia see it in lethal hurricanes, landslides and floodwaters.
- Europeans see it in vanishing alpine glaciers, Mediterranean droughts and freak storms.
- Researchers see it in everything from tree rings and lake sediments to ancient coral and bubbles trapped in ice cores.

All reveal that the earth has not been warmer for a millennium or more and that it has never warmed as fast as it has done in the last 25 years. A period when natural influences on global temperatures such as sunspots should, if anything, have been cooling us down. It is hard to disagree with the overwhelming majority of climatologists who say that what we are seeing is man-made climate change.

The evidence includes the lower slopes of the great Greenland icecap which are melting fast – by over 18ins a year in places. 1998 was the warmest year in the warmest decade in the warmest century of the last millennium. The second and third warmest years were 1997 and 1995 respectively. The US National Climate Data Center claims this was at a rate of 0.25 degrees centigrade a decade. It was greatest in the Arctic. Much of Siberia has warmed by 5 degrees centigrade – eight times faster than the global average – causing melting of permafrost, buckling of roads and toppling of buildings. In Alaska, ice cellars used by hunters for centuries to store caribou meat and whale blubber in summer are melting. Ships can now sail through the legendary north west passage most summers. This has an effect on the number of krill in arctic and Antarctic seas and may have resulted in population crashes of sea lions off the Falklands and elephant seals off the South Shetland Islands. Snow cover on the earth's surface has diminished by 10% since the 1960s. The Gruben glacier in Switzerland has retreated 200m in the 1990s. Sea levels rose by 4-8ins in the twentieth century.

There have been **natural fluctuations** in global warming e.g. there have been two ice ages in the last 160 000 years. We know the northern hemisphere enjoyed a relatively warm period in the Middle Ages from 12^{th} – 14^{th} centuries (grape growing!) followed by a little ice age that lasted fitfully until 19^{th} Century. However, experts tend to agree that the 20^{th} century is more than just a recovery. Causes of past temperature fluctuations are well known e.g.volcanic eruptions cool the planet, sunspot cycles indicate changes in the amount of radiation leaving the sun, changes in the earth's orbit known as Milankovitch wobbles which change the distribution of heat reaching the planet's surface operate over thousands of years. Natural causes cannot explain the recent temperature surges.

The key greenhouse gases are **water vapour and carbon dioxide**. Warmth from the sun heats the earth's surface which in turn radiates energy outwards but at infra red frequencies which are more likely to be trapped by greenhouse gases which effectively make a warming blanket around the earth. The speed of increase of carbon dioxide is a concern and it comes primarily from burning forests, vehicle emissions especially aeroplanes, industrial plants and power stations. The second most significant greenhouse gas is **methane** which, molecule for molecule, is 20 times more potent than carbon dioxide. It is produced largely through the actions of certain bacteria found in the guts of ruminant animals, in landfills and in rice paddies. One way of buying time for reducing emissions of carbon dioxide would be to try to capture some of the emitted gases through biological carbon sinks such as forests. There is some debate about the USA's commitment to reducing carbon dioxide emissions according to Kyoto protocol targets. Ecologists fear that the impact on biodiversity could be most destructive. The speed of climate change is likely to outpace nature's ability to adapt.

2.5 Explain how similes might have achieved their everyday meaning and give a precise scientific meaning for each of the italicised words in four of the following:

as hard as nails; as flat as a pancake; as drunk as a lord; as dense as a brick; as certain as tomorrow; as vibrant as a spring; as brittle as glass; as black as night.

This question is quite explicitly AO4 in nature. The first part of the question allows more able candidates to argue, using the given similes or others for illustration, that a simile is the result of a generalisation made on the basis of many individual observations. There may be references to hypotheses and the scientific cycle but an intuitive awareness in the explanation may be enough.

The second part of the question allows candidates to demonstrate a more precise scientific definition of the adjectival elements of four of the given similes within a scientific context.

Hard – may be defined geologically using Mohs' hardness scale or in a metallurgy context
Flat – an index of flatness may be defined and is crucial in applications requiring smooth mirror surfaces
Drunk – no absolute measure of this but there is a limit to the amount of alcohol in the blood for driving and certain occupations
Dense – density as mass/volume
Certain – a probability definition required
Vibrant – characterised by exhibiting vibration/resonance-wave or sound context
Brittle – easily cracked, snapped or broken-metallurgy context
Black – absence of colour in a light context or absorption surface in a heat context.

2.6 Explain the scientific principles underlying mobile phones.

How far do the advantages of mobile phones outweigh their disadvantages?

This will be a most popular question and the most able candidates will be able to both explain the underlying scientific principles of mobile phones and discuss their advantages and disadvantages.

Known as cell phones in USA because the country is divided up into cells – smaller areas for large populations of phone owners and larger areas for sparse mobile density. Each cell has a transmitter and receiver station and each mobile phone communicates with this cell station sending out a microwave signal in the radio frequency end of the spectrum that identifies each phone in that cell. An up-loader at the station sends information to a satellite which downloads to another station once a connection has been made

Advantages include:

- Instant communication – teenagers love the freedom this gives them and parents are happy that their children have this facility in an emergency or to keep tabs on them
- Convenience in any situation needing assistance-emergency services, the AA, taxis or when travelling abroad
- A new network of 20 000 stations has just been set up in Britain to accommodate the wider bandwidth of the new 3G phones (third generation). These provide video-on-the-move, downloadable games, built in cameras and internet access
- Parents may find instant access to email accounts attractive
- Ugly masts are being replaced by more aesthetically pleasing forms – garage hoardings, fake trees etc
- Fashion statements – smaller mobiles are better and more expensive!
- Texting is the lingua franca of many teenagers. Inexpensive because the digital message is so short and it keeps friends in touch.

Disadvantages include:

- Relatively expensive to buy and run – pay as you go offers better control than contract arrangements and fashion statement cost mentioned above
- There still may be a health risk associated with brain tumours – government advice is to use the phones sparingly and young children should try and avoid them – the jury is still out – hands free option is preferred because phone rings and is used away from the head. There may be mention of how two older phones were used to fry an egg placed between them
- Provider organisations are aware of the opposition a station mast will generate if it is positioned near a primary school
- It is now an offence to use a phone when driving
- Crime risk – they are highly desirable and the main object of street crime amongst teenagers
- Convenience advantage is subject to abuse e.g. ringing mountain rescue team to descend from mountain when there is no real risk and there has been no accident
- There are still areas of the country where there is no cell – mainly in poorly populated and upland regions
- Cells can become overloaded and the network goes down – new year's eve is notorious for this
- It is still socially unacceptable for phones to ring in trains where the peace of others may be breached
- It may be dangerous for other equipment when phones are used in hospitals, landing aircraft etc.
- Station masts look ugly
- There is some evidence that students in examinations have used their phones to cheat
- There is some concern that texting is an abuse of language but other educational experts welcome it
- Expensive to run compared with land line phones.