AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme
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GCE

General Studies A

Unit GSA5

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Unit 5 Question 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	**A**	**1.14**	**B**
1.2	**B**	**1.15**	**D**
1.3	**D**	**1.16**	**B**
1.4	**B**	**1.17**	**B**
1.5	**A**	**1.18**	**A**
1.6	**D**	**1.19**	**C**
1.7	**A**	**1.20**	**A**
1.8	**C**	**1.21**	**C**
1.9	**B**	**1.22**	**B**
1.10	**C**	**1.23**	**A**
1.11	**A**	**1.24**	**B**
1.12	**C**	**1.25**	**B**
1.13	**C**		

Question 2

INTRODUCTION

The overall assessment objectives for General Studies are set out below:

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.

1 Explain why flooding in some parts of the United Kingdom is a regular occurrence and discuss the steps that might be taken to minimise its effects.

A question on a fairly topical regular occurrence which ought to elicit good knowledgeable responses especially from candidates who have first hand experience or those who live in a flood plain and may be anticipating trouble. The quality of the discussion in the second part of the question ought to have potential for possible AO4.

Flooding is the inundation of land that is not normally covered with water. Flooding from rivers in the UK normally takes place after heavy rainfall or elsewhere in the spring after snow has melted. The river's discharge becomes too great and water flows over the banks onto the surrounding flood plain. Drainage of moors is a contributing factor – water is not retained and rivers quickly rise. Another contributory feature is the speed of run off from agricultural land which has increased with better drainage and removal of hedgerows and ponds which would retain water. Another urban feature is the increase in concrete or tarmac surfaces and roof areas which increase run off. Germany is proposing a tax incentive to householders who make "living rooves" using water retaining vegetation to help offset the problem. Flooding may also occur at the coast in stormy and or high tide conditions – a so-called storm surge. The Thames Flood Barrier was constructed in 1982 to prevent the flooding of London from the sea. The North Sea is a funnel from north to south and in certain weather conditions, Holland and The South East of England are where storm surges are most likely to be expected. The worst home case was on Canvey Island in 1953 when 58 people died during the night of 1st February after millions of tonnes of sea water broke through the dykes protecting low lying Canvey Island and foamed through the streets of sleeping residents. Today, Canvey is a fortress armoured against the sea by a ring of steel and concrete so formidable and reassuring that its population has more than trebled since 1953. The proposal for Thames Gateway – a ribbon housing development along the Thames east of London may put another one million people at risk. Pressure for housing is resulting in many river flood plains being used for new housing (more than one in three applications). There are plans to tax houses built in flood plains with a connection charge to pay specifically for building or maintaining flood defences.

In England and Wales the Environment Agency (part of DEFRA) operates a flood warning service in areas of risk of flooding from rivers or the sea. There are three stages or levels of concern; "flood watch"; "flood warning" and "severe flood warning" hopefully followed by "All Clear". However in the case of a flash flood, a severe flood warning may be issued immediately. These are updated every 15 minutes and may be viewed on the environmental agency website or through the media as TV weather bulletins (a minimum two hours warning is offered.) or radio weather and travel reports. Also Teletext and Ceefax pages show flood warnings in force. Flooding is a natural process that can happen suddenly. Whilst the Environment Agency aims to provide advance warning and local authorities and emergency services may provide assistance, the person who can do most to help is the householder – see the website at "www.environment-agency.gov.uk/subjects/flood" for a comprehensive account of what householders may do to minimise effects from having adequate insurance (which is under threat from insurance companies not offering cover in flood prone areas), through having sandbags handy to having a family flood plan.

2 Discuss the technological options for electricity production in the United Kingdom and explain why some are preferred to others.

This question examines the candidate's knowledge of different technologies for electricity production and the discussion (possible AO4) ought to examine the relative merits of different types of conventional and renewable methods. This ought to be set in the context of the government's energy white paper which was published on 24 February 2003 entitled "Our energy future – creating a low carbon economy". It defines a long term strategic vision for energy policy combining our environment, security of supply, competitiveness and social goals. It sets out the challenges we face on the environment, the decline of our indigenous energy supplies and the need to update our energy infrastructure and the policies we need to pursue over the next twenty years and beyond to meet these challenges. Central to these policies are four goals for our energy policy to:

- cut the UK's carbon dioxide emissions by 60% by 2050 with real progress by 2020
- maintain reliability of energy supplies
- promote competitive markets in the UK, help raise the rate of sustainable economic growth and improve productivity
- ensure every home is adequately and affordably heated (e.g. good insulation).

The DTI figures for electricity production in 2001 were:

- natural gas – 37%
- coal – 33% (cf 76% for coal/oil in 1991)
- nuclear – 22% (cf. 22% in 1991)
- imports – 3%
- Hydro – 1%
- Renewables – 2%

Whilst nuclear power is a relatively "clean" method and favoured by the Royal Society, Britain's premier scientific body, ministers have shelved the idea of building new nuclear power stations as it is the most expensive form of energy production and taxpayers have been bailing out both British Energy and British Nuclear Fuels, the two nuclear generators. There is also serious concern about the terrorist risk – a plane crashing into the intermediate level waste stores at Sellafield could lead to 30000 deaths within two days (from a report by the IPPR an influential think tank close to New Labour).

The government has turned to wind and wave power to provide Britain's future energy needs and meet the UK's targets for reducing carbon dioxide emissions.

A European wide cap on carbon emissions from coal-fired power stations will be brought in during 2005. The future of the nuclear industry will be reviewed in 2005 alongside plans for a major increase in funding to the renewable sector. The next two years will be spent examining improvements in "green" technology in order to create a watertight case against expanding nuclear power plants.

Undersea turbines producing electricity from the tides are set to become an important source of renewable energy. Operating on the same principle as wind turbines (which Britain originally developed and then abandoned for twenty years allowing the Dutch to make it a major industry) but with the difference that tidal currents are predictable (the best sites are between islands or around heavily indented coasts) and the power output is constant. A marine turbine needs to be about one-third the size of a wind generator to produce three times more power. Each turbine will connect to a grid via underwater cable. (Ref. A Level Revise Guide General Studies Walton, Ruddy & Dutton. Pub.Longman 1994 or www.guardian.co.uk – special reports and links).

3 To what extent is it possible to justify the research and expense involved in the voyages of spacecraft, such as Beagle 2, to Mars?

A question aimed at candidates with an interest in current astronomy – will be topical at the time of the exam-and who realise the importance and significance of a mission which may well establish that there has been life on Mars – possible AO4.

NASA has sent two Mars rovers and the European Space Agency has sent Beagle 2. Beagle 2 is due to land in December 2003 and the American rovers are due to land in January 2004.

The idea for Beagle 2 was very much that of Professor Colin Pillinger of the OU. He is essentially a chemist who took the opportunity to study moon rocks at Bristol and his working life has been studying extraterrestrial material including meteorites. He was able to determine which meteorites may have had their origins on Mars (splinters of Martian rock knocked into space by asteroids hitting Mars) and in the mid 1990s had strong circumstantial evidence that mars had once contained water. There was also a suggestion that some meteorites from Mars showed evidence of fossilised bacteria When he heard in 1997 that the European Space.

Agency was planning a Mars shot he began pestering them to include a "lander" on it. They replied they did not have the technology or the money. Thus was born Beagle 2, christened in honour of Darwin, and Pillinger winkled £7m out of the government to build it. Beagle 2 looks like an extremely high tech dustbin lid. It will be placed on the Mars Express and the launch should take place at the end of May 2003 and after a 93 million-mile piggyback it should land on Mars about Christmas2003. On the ground it will open out its 10ft long "mole" which will begin to burrow and take samples. These will be analysed and the results transmitted back to Earth. The Britishness of Beagle 2 is epitomised by it having a call sign written by Alex James of Blur and the graphic against which the instrument calibration will be checked is a Damien Hirst spot painting. Sponsorship is now being touted by Saatchi and Saatchi. Pillinger has not lost much sleep over funding. He thinks it is not a good thing to have unlimited resource because people respond better to a challenge.

The importance of discovering that there has been life on Mars is that it shows that if life existed on one of our nearest planetary neighbours, then the probability of life elsewhere in the universe suddenly increases by a large amount. We are aware that life can evolve – a link with Darwin – and the probability of human life elsewhere in the universe also experiences a quantum leap upwards. There is also the significant potential to colonise Mars or exploit it for its minerals. Teraforming, the science of making Mars Earth like in its atmosphere is not science fiction and may be a strong possibility once we know more about Mars and its capacity for sustaining life.

Mars has always held fascination for us since the use of telescopes in the early 1600s – what appeared to be canals and season changes were observed – and the terrain suggests that there was once flowing water and wind. NASA's intention is focused on ways of getting humans to Mars and keeping them alive once they arrive.

Mars has been visited by Mariner missions in the sixties. Viking 1 and Viking 2 were missions to Mars that consisted of both an orbiter and a lander. Mars Observer was sent in 1992 to photograph a mountain on Mars called Cydonia – which looks like a human face and to search for landing spots for future astronauts. However, the mission was a failure. The most recent NASA mission to Mars was the Pathfinder Sojourner.

Going to Mars is expensive and the costs have to be set against alternative enterprises here on Earth. However, the Beagle 2 lander does look relatively cheap and will be a romantic triumph for Colin Pillinger and Britain.

4 There are several accepted dating techniques e.g. dendrochronology, carbon dating, thermoluminescence.

Explain the scientific principles underlying at least one dating technique and discuss why we need to use a range of different methods.

A question that require some good biological/physical or chemical knowledge to successfully explain the scientific principles to an intelligent general reader followed by the opportunity for AO4 in the discussion, within the context of usage, of why we need a range of different techniques. This question may also appeal to a budding archaeology student. A candidate who limits himself or herself to explaining only one technique in some depth with a good discussion may be considered equivalent to a candidate who explains the scientific principles of more than one technique each in less depth but thereby gives himself or herself an advantage in covering the range required in the discussion.

An excellent website for detailed information on **relative dating techniques** e.g. cation ratio, cultural affiliation, fluorine dating, obsidian hydration, patination, pollen analysis, rate of accumulation, seriation and varve analysis is http://emuseum.mnsu.edu/archaeology/dating/ and there is also there a range of **absolute dating techniques** e.g. archaeomagmetism, astronomical dating, dendrochronology, electron spin resonance, fission track, optically stimulated luminescence, oxidizable carbon ratio (OCR), potassium-argon dating, racemization, radio-carbon dating (carbon-14), thermoluminescence dating and uranium-thorium dating.

I suspect that most candidates will limit themselves to the examples given in the question but credit ought to be given to those who demonstrate that there are many different techniques,
Dendrochronology: is the study and comparison of tree ring growths. This can provide very accurate dates about the wood itself or artefacts found in close proximity to it. Dates may be established for when timber has been transported, processed, felled or used in construction. Rings are made of xylem. Pith is found in the centre of the stem followed by the xylem, which makes up the majority of the tree's circumference. The cambium layer keeps the xylem separated from the rough bark. Each spring or summer a new layer of xylem is formed, producing the rings we can count. A moist climate will produce wide rings and dry weather produces thin rings.

Non growing wood is biodegradable and this process can be slowed by a very dry climate, water logging or fossilising which may preserve wood for hundreds or thousands of year. European Oak may be used in dating objects upto 11000 years old.

Carbon Dating: a method of obtaining age estimates on organic materials and has been used to date samples as old as 50000 years. Radioactive carbon is produced when Nitrogen 14 is bombarded by cosmic rays in the atmosphere, drifts down to earth and is absorbed from the air by plants. Animals eat the plants and take C14 into their bodies. When an organism dies, it stops absorbing C14 and the existing absorbed C14 begins to disintegrate. Scientists can use this fact to establish the date of death. The half-life of C14 is 5730 years – half of the original amount of C14 present will have disintegrated after 5730 years.

See the web site for further details of techniques and the discussion of why we need a range should be based on recognising that different techniques apply to different age ranges and on the type of material being dated.

5 "Human cloning is ethically unacceptable".

Discuss the extent to which you agree or disagree with this statement.

A topical opportunity for Biologists to display their social responsibility in discussing what could turn out to be the biggest ethical dilemma of the twenty first century and the quality of this discussion which ought to consider the balance of positive features against negative ones ought to be a rich source of AO4.

In January 2001 a consortium of scientists led by Panaylotis Zavos and the Italian Severino Antinori said they planned to clone a human in the next two years. At the same time an American couple were willing to pay half a million dollars to Las Vegas based Clonaid for a clone of their deceased daughter from preserved skin cells. In January 2003 the Realian sect in the USA claimed to have produced a clone – still not proved!

Two types of cloning produce complete genetically identical animals.

Blastomere separation (sometimes called **twinning** after the naturally occurring process that creates identical twins) involves splitting a developing embryo to give rise to two or more embryos.

Dolly the sheep however, carries the DNA of only one parent – **somatic cell nuclear transfer** was used – the nucleus from an adult sheep's udder cell was transferred to an egg whose nucleus had been removed. The embryo formed was placed in a surrogate mother through **ivf** who **gave** birth at the end of a normal gestation period. The success rate is about one or two in a hundred. It took 277 attempts to create Dolly. This is the process that scientists are intending to use for human cloning.

Therapeutic cloning is the process by which a person's DNA is used to grow an embryonic clone. However, instead of inserting this embryo into a surrogate mother, its cells are used to grow **Stem cells.** These may be used as human repair kit. They can grow replacement organs such as hearts, livers and skin. They can also be used to grow neurons to cure those who suffer from Alzheimer's, Parkinson's or Rett Syndrome. Cloning can also be used to help couples with **infertility problems** but who want a child with at least one parent's biological attributes.

Another use for cloning could be to bring **deceased relatives back to life**. Imagine using a piece of your great grandmother's DNA to create a clone of her. In a sense you would be the parent of your great grandmother. This opens a door to many ethical problems and it could soon be opened!

The FDA has said that anyone in the USA attempting cloning must first get its permission. In Japan, human cloning is a crime punishable with upto ten year in prison. In Britain, cloning of human embryos is allowed but a ban on total human cloning is expected. 98% of clones end in failure. The embryos are either not suitable for implanting into the uterus or they die during gestation or shortly after birth. Clones that do survive wind up suffering from genetic abnormalities. Some clones have been born with defective hearts, lung problems, diabetes, blood vessel problems and malfunctioning immune systems. Even Dolly, the first successful cloned mammal, died quite young and had arthritic problems whilst alive. With animals, the defectives are not as significant as they would be with humans. Advocates reason that defective embryos will be spotted before implantation. There are three major grounds for objections; making a xerox of someone is criminal. However, this is unlikely to ever happen because of the infinite number of permutations that come into play in the development of each individual, so cloning is no threat to unique personhood. Cloning is "playing God" and evil in nature. In a Time/CNN 1997 poll in the USA 75% thought that it was against God's will to clone human beings. Maybe it was still unfamiliar compared to IVF and embryo transfer. It is against human rights and dignity embodied in the Roman Catholic Church's official statement against cloning in that it denies "the dignity of human procreation and of the conjugal union" Opponents argue that clones are no more alike than twins raised in separate environments and no-one is suggesting that twins do not have rights or dignity or that they should be banned. (See "www.newscientist.com" for more info).

6 Discuss the ways of dealing with household rubbish and explain the need to improve recycling methods.

Landfill: Most waste in most countries still goes into holes in the ground but the number of appropriate and available sites is shrinking all the time, with growing numbers of people prepared to fight to prevent new sites in their area – NIMBYs. (Not In My Backyard).

Although it is becoming more expensive landfill is unlikely to disappear but the conditions imposed on this industry will get tougher and tougher. Apart from the problems of dealing with leaching into waterways, smell, vermin and litter, landfill sites will need to capture the methane gas produced as waste rots, particularly as this is a powerful greenhouse gas. In some sites this gas may burn underground as a hazard. Some waste will not rot away e.g. ceramics and some plastics. A 2001 study in the British medical Journal concluded that neural tube defects, such as spina bifida, increase for those living within 2km of landfills and Wansbeck – 0.9% which is around 80% of the British population and 90% of British waste goes into them. The chancellor has announced a rise in landfill tax from £13 to £35 per tonne.

Incineration: Most people hate the idea of any sort of incinerator being sited nearby and this still remains at core a "dirty" technology, in spite of repeated plant upgrades and the introduction of flue gas treatment technologies. Although most incinerators meet tough environmental standards, many of us worry about toxic emissions such as dioxins being released into the air and affecting our health. Most particularly, that of children. (Dioxins are an accidental by-product of the chlorine industry (e.g. PVC), the use of chlorine in the pulp and paper industry and incineration – whenever chlorine is present in the fuels or wastes burned. Metal smelters and municipal waste incinerators are major sources). Some plants reclaim the heat and convert it into useful energy but many do not. Incinerators produce a fair amount of greenhouse emissions but, surprisingly, less than landfill sites.

As these two methods become less acceptable recycling, including composting of perishable material become more acceptable, although still relatively expensive. Making the case for improving recycling ought to provide an opportunity for AO4.

Every person throws away about five times their body weight each year as household rubbish. The urban average is slightly higher than that of people who live in the country. A typical week's rubbish shows that plastic items, the most difficult to dispose of in an environmentally sound way far outnumber anything else. However, much of this typical week's rubbish could be recycled, in particular, paper and glass and much of the general waste, fruit and vegetable peelings could be composted. There is much being considered in tax incentives (e.g. VAT cuts on recycled paper and glass items) and disincentives (e.g. Irish supermarkets charging 35p per plastic bag) to bolster recycling.

European 1998 figures for percentage of household waste recycled show how far down the league table we are:

Switzerland – 52% ;	Germany – 46% ;	Netherlands – 45% ;
Austria – 45%;	Sweden – 35% ;	Norway – 34% ;
Finland –30%;	Denmark –28%;	UK – 12%.

There is variation in councils' approaches with the best three being:

Bournemouth – 37 % ;	Castle Morpeth – 37%	and Dorset – 33%	compared to
Corby – 1.3% ;	Durham – 1.0%	and Wansbeck – 0.9%	

(see www.guardian.co.uk/waste for further information and links).