



ASSESSMENT and  
QUALIFICATIONS  
ALLIANCE

# Mark scheme January 2003

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## GCE

### General Studies A

### Unit GSA5

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**Unit 5: Science, Mathematics and Technology****Question 1**

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

This is a new element in General Studies specifications. In the past, there has been a focus on the knowledge of facts and the marshalling of evidence – on what might be called ‘first order’ knowledge. This is still fundamental; but AO4 is about understanding what counts as knowledge; about how far knowledge is based upon facts and values; and about standards of proof.

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 experience 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 knowledge, evidence or arguments, for example, used in a text, set of data or other form of stimulus material;
- understanding of the crucial difference 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.

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)	<b>Good response to the demands of the question:</b> 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)	<b>Competent attempt at answering the question:</b> 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)	<b>Limited response to the demands of the question:</b> 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)	<b>Inadequate attempt to deal with the question:</b> 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	<b>No response or relevance to the question</b>

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 It is just over one hundred years since the first transatlantic radio transmission by Guglielmo Marconi.  
Explain the scientific principles behind the transmission and reception of radio signals  
Discuss the extent to which you consider the radio to be the most important invention of the last century**

This question requires a clear understanding of the scientific principles behind radio transmission and reception followed by a discussion of the importance of the invention of radio. The discussion ought to demonstrate a good knowledge of the applications of radio and its spin-offs and show some comparison to other important inventions. Some value judgement about its importance ought to be made (possible AO4) and there may be a reference to the difference between discovery and invention.

Scientific principles ought to cover the following processes:

The continuously varying electrical signal produced by voice/music in a microphone undergoes A/D conversion; is improved; is modulated (AM for higher frequencies and FM for lower frequencies); upconverted to RF; amplified for emission at an antenna; sent through the atmosphere as a ground wave – hugging the earth's surface with a range upto several hundred miles (suitable for VLF, LF and MF frequencies) or a sky wave deflected back to Earth by the ionosphere; has a wider range than a ground wave (and is suitable for HF frequencies). A space wave is usually not reflected by the ionosphere and is used over line of sight distances (suitable for VHF, UHF and SHF frequencies). The aerial receives the transmitted RF signal which is filtered; down converted from RF to a low frequency signal; demodulated and finally D/A converted back to the original analogue signal and played back through a loudspeaker.

Radio Frequencies (RF) occupy a section of the electromagnetic spectrum ranging from about 50 KHz (VLF) upto around 100 GHz (EHF).

The discussion may be an argument based on the notion of an invention being for the benefit of mankind or its impact in changing civilisation. Its importance may be measured in terms of its scale of operation, its effect and availability or future potential (the radio was a precursor of the global village, a focus of family life pre TV and reaches the poorest people on Earth through the Trevor Baylis mechanical model) or its contribution to aspects of later telecommunication systems (TV, internet, telephones, radar). Claims may be made for manned flight, the automobile, the computer, the light bulb, refrigeration, psychoanalysis, birth control, the Hoover, the washing machine and others. There is plenty of scope for powerful responses.

## 2.2 What is sleep and why is it needed?

**Describe the conditions for a good night's sleep.**

**To what extent do you consider sleeping well contributes to quality of life?**

The response to this question requires a definition of sleep and an attempt at establishing why we need it. The latter may need to be expressed in terms of the body's response to lack of sleep as the function of sleep is not clear. The remainder of the question asks for conditions for a good night's sleep and a judgement about the contribution a good night's sleep makes to our quality of life (possible AO4).

### Sleep

- is a state of reduced awareness, activity, metabolism
- occurs at regular intervals in most mammals and birds – a circadian rhythm
- is daily for humans but variability in time spent at it – similar to hibernation which is seasonal and deeper
- in humans is linked with hormone levels and specific brain activity.

The function of sleep is unclear but its rhythm is probably set by the availability of daylight by which to work. Deprivation can cause irritability, lack of co-ordination, forgetfulness, hallucinations and even psychosis. A feature of brain activity in sleep is delta waves. These are not present in the brain during wakeful activity. REM (rapid eye movement) phases associated with dreams occur at regular intervals during sleep – the eyes move rapidly beneath closed lids.

### Tips for healthy sleep:

- keep regular hours and avoid stimulants (e.g. caffeine)
- use the bed only for sleeping and avoid bright home lights
- do not worry if getting enough and avoid exercise near bedtime
- avoid heavy meals near bedtime but do not go to bed hungry
- try to avoid looking at the clock if awoken in the middle of the night
- if still awake after 30 minutes get up and do something boring in a dim light
- keep the bedroom at a comfortable temperature, if noisy use a white noise generator (e.g. a fan)
- a night cap has its price-it may aid sleep but can cause waking in the middle of the night – alcohol can make sleep apnoea worse.

### What is quality of life?

A sense of well being supported by good health and being a self-actualising individual. The contribution of a good night's sleep is substantial and takes its place with good diet, physical fitness and a sense of purpose and value – having a good lifestyle? The proverb “Early to bed, early to rise...” along with revision tips such as go to bed early the night before the exam and revise in the early morning may be recalled.

- 2.3 It has been suggested that because of the journey times and the distances involved, the only way we will successfully colonise other planets is to send large groups of people into space  
What are the challenges involved in setting up such a venture? How far do you agree that we will need to do it?**

Candidates are invited to consider a range of social, political, economical and technological challenges to interstellar travel and then come to a conclusion after some discussion about whether we will need to do it (possible AO4).

One interpretation is to consider solar system planets only and this is acceptable. However planets that are similar to Earth, if they exist, will be outside our solar system. The scale of interstellar travel and the technological challenges must be appreciated. Our fastest rockets e.g. Voyager 1 would take 85 000 years – 3000 human generations – to reach alpha centauri, the nearest star. Even moving at 1/10 the speed of light, it would take in the order of 40/100 years. What seems more realistic is that civilisation, perhaps driven by the need to escape a planet which has become inhospitable for life (more about this later), might send out a craft at 1% the speed of light (still 200x faster than what we have now) which could reach nearby planetary systems in around 1000 years. Barnard's star at 10 light years away is considered to be a better bet than alpha centauri for possible colony sites. There is some doubt about whether there are planets out there capable of sustaining human life – we have no evidence of alien intelligent life!

This question may well attract “trekkies” with what are currently science fiction physics solutions to interstellar travel (warp speeds, star gates, wormholes). However, we do not presently have the breakthroughs that will make journeys fast or cheap. viz.

- new propulsion methods that will eliminate or dramatically reduce the need for propellant
- attainment of relatively high transit speeds to dramatically reduce deep space travel times
- new on-board energy production methods to power propulsion devices.

These may come with time – all are currently NASA goals in the Breakthrough Propulsion Physics Program.

The size and blend of the colony crew would require social/psychological and probably genetic judgements given that the eventual colonisers would be perhaps thirty or more generations on – a reliable ark capable of meeting all the basic needs of the crew(s) would be needed. There is the economics to consider-who pays? The politics of who controls the venture and who goes and who stays may be crucial if there is a dangerous and imminent problem on Earth at the time of launching. The sun will eventually burn out but there is a risk in the mean time of meteor/comet strike or another astronomical disturbance to the solar system. We are quite capable of a self-inflicted nuclear/pollution/biological catastrophe.

The final judgement about whether we should do it or not should be based on the balance of threats v opportunities.

**2.4 The number of British house sparrows is reported to have fallen from seventeen million in 1972 to around ten million in 1996  
How would these estimates have been established? What could be the reasons for the reduction and why should it concern us?**

This question requires some knowledge of ecology statistical method followed by the ecology of population dynamics, perhaps aided by man made pollution and finally a possibility of AO4 in making a judgement about why the reduction may be of concern to us.

This question was asked in the House of Lords on behalf of London sparrows in 1997 by Lord Kennet. In 2000, the Prime Minister acknowledged "the house sparrow, once more cockney than the cockneys, is now a rarity in London". Although the body of anecdotal evidence left little doubt that something was amiss, systematic studies were necessary to piece together the nature and scale of the problem. One of the longest studies comes from the work of the Royal Parks Wildlife Group in Kensington Gardens. In 1925, 2603 birds were counted in the park one autumn day. This compares with 8 in October 2000. Similar results have been obtained by surveys in Glasgow, Edinburgh and Bristol. It is the results of on-site surveys like these that combine to give the overall estimates of the question. There is a current investigation (see the RSPB website) into sparrow watching which invites members and the public to take part. Some candidates may be taking part in this. The problem seems to extend to Germany, Austria, Scandinavia, Belgium and Netherlands. By contrast, visitors to Paris (where there is a proportionately higher use of diesel fuel?) still see small parties of birds gathering around café tables as they used to do here.

The problem may be caused by a systematic disease (e.g. rabbits and myxamatosis or the virus that attacked grey seals). However, there is no evidence of this (e.g. sick birds or corpses). Another possibility is increased predation – Magpies have increased greatly in number over the past 50 years (a decline in game keeping). However, a Manchester study of the food given to magpie nestlings showed that small birds made up only a small proportion of their diet. Kestrels declined in the nineties, however the sparrow hawk population increased in the given time span. In some urban areas there may be a shortage of suitable nesting sites – sheer fronted office blocks and modern houses with sealed roof cavities. There may be a shortage of insects in early spring to feed young birds. A study in Hamburg suggested that changes in air quality, including chemicals (particularly methyl tertiary butyl) in unleaded petrol, could be affecting the aphid population on which young sparrows depend. Farm use of pesticides could also have affected insect populations. On the other hand blue tits (insect eaters) seem to be thriving. Sparrows may be losing out in the competition for such food. On leaving the nest sparrows feed largely on seeds and a shortage of these could be a problem-in the wake of agricultural intensification and the switch to autumn sowing of cereals which removes a favoured foraging ground amongst autumn stubble.

In short, the answer is yet to be found. Have we changed something in the environment and should the house sparrow be seen like the miner's canary, warning us of troubles which may affect our own species in time? Have we protected our own economic assets to a point where other species are at risk?



**2.5 The Commission for Integrated Transport (CFIT) is proposing a scheme to charge motorists for motorway travel. Similarly, Ken Livingstone, the mayor of London, is proposing a scheme for congestion charging in central London.**

**Outline the technological systems involved in the identification and charging of motorists in such schemes.**

**Indicate the need for an integrated transport policy and identify the main problems in its introduction.**

For the CFIT scheme every car is fitted with a black box which provides info to a Global Positioning Satellite-GPS. The GPS tracks distance travelled, time of day and roads used. It could also detect poor air quality and impose a surcharge. The data is relayed to charging authorities by computer. Data is checked against DVLA database and fees charged to the vehicle owner. Owner pays by monthly bill or pre-paid smart car in the vehicle. This scheme has major implications for civil liberties and may shift traffic onto smaller but cheaper routes. The black box could be “jammed”.

In central London, motorists pay £5 for entry with 700 CCTV cameras at 174 entry points. The cameras scan number plates for every vehicle crossing the zone boundary. Images are sent to a central database which provides the exact time and date images were taken. The computer matches images against a database of those who have paid and discards those who have paid. Not paid number plates checked against the DVLA database and an £80 penalty issued (£40 for swift payment).

CFIT propose scheme introduced in 2010 when £180 billion investment in public transport will have taken effect. Ken Livingstone wishes London scheme to be in place within 2 years. The timing of introduction is quite crucial to acceptance and road users may only be tempted off the roads when the railways and buses provide an acceptable alternative. Ken Livingstone is working quickly knowing that the average travel speed in central London has dropped to 8mph – exactly the same as in 1900 and he wishes to avoid gridlock.

Why we need an ITP policy and the problems in its introduction provide an opportunity for AO4. Problems on the roads include a dependence on oil supplies (a disappearing natural resource) and high levels of exhaust pollution e.g. carbon monoxide and dioxide, benzene, hydrocarbons, lead, nitrogen oxides, PAHs, particulates, sulphur dioxide with consequent problems such as cancer, asthma, brain damage, bronchitis, global warming. Car owners see cars as liberating and as status symbols-manufacturers market these themes- owners will be reluctant to let go!

The government has some leverage here with tax disincentives but remember the fuel blockades of 2000?; people who live in the country with no public transport?; smaller electrical cars for urban travel?; larger juggernauts for freight transport; road maintenance; witness the asylum seekers at San Gatte and their effect on cross channel freight transport; the under capitalised state of the railways generally– It won't be easy!

**2.6 Explain why there is a conflict between Creationism and Darwin's Theory of Evolution.**

**A similar conflict between science and the establishment view was Galileo's defence of a heliocentric universe.**

**Explain how the scientific method has encouraged acceptance of Darwin's and Galileo's accounts.**

The first part of the question invites a comparison between Creationism-claiming a fairly literal interpretation of Genesis in the Bible where the world and humanity were created by a supernatural creator not more than 6000 years ago (After a study of biblical chronologies, in 1654, Archbishop Ussher declared 23 Oct 4004BC as the first day of creation.) A judge in Arkansas in 1982 ruled that for schools to enforce equal treatment of creationism and evolutionary theory was unconstitutional. The discovery of fossils had already thrown doubt on the Bible's account of how the Earth was created. A pioneering Eighteenth Century geologist, James Hutton showed the Earth is renewed as well as worn away by geological processes, influenced the later work of another geologist Charles Lyell, a friend of Darwin who is credited with making Darwin aware of the large timescales associated with the Earth's age and which underpinned the Theory of Evolution. Evolution is about the slow process of change from one form to another. Darwin assigned the major role in evolutionary change to natural selection acting on naturally occurring variations. Natural selection occurs because those individuals better adapted to their environment reproduce more effectively thus contributing their genes to future generations.

The second part of the question asks for a judgement (possible AO4) about why Darwin's Theory and Galileo's defence of Copernicus's Heliocentric Theory are to be favoured because they use Scientific Method. Both of these scientists used the scientific cycle. They attempted to provide systematic, justifiable explanations of natural phenomena. An experiment was performed, observations were made (Galileo looked upon the moons of Jupiter with his telescope or Darwin made his observations and had his thoughts on them whilst on "The Beagle"). A hypothesis is produced and predictions are based on it. Further experiment and observation then test the truth of these predictions. As evidence builds up to confirm the hypothesis it may become a theory. Science is highly regarded. It is widely believed that there is something special about science and its methods. The adjective "scientific" means that there is a reliability about a line of reasoning or a piece of research. Science has been a highly fruitful human activity.