Version 1.0

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

General Studies 6761
Specification A

GSA5 Science, Mathematics and Technology

Mark Scheme

2006 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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

Unit 5 Question 1
(GSA5 Science, Mathematics and Technology)

This component is an objective test for which the following list indicates the correct answers used in marking the candidates' responses.

1.1	**D**	**1.11**	**D**
1.2	**C**	**1.12**	**A**
1.3	**A**	**1.13**	**B**
1.4	**D**	**1.14**	**D**
1.5	**A**	**1.15**	**A**
1.6	**C**	**1.16**	**B**
1.7	**B**	**1.17**	**D**
1.8	**C**	**1.18**	**A**
1.9	**C**	**1.19**	**C**
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.

1 How can music be explained scientifically?

Discuss how and why music affects us in different ways, for example emotionally, psychologically and physiologically.

In the first part a good candidate may be expected to attempt an explanation of music using the scientific language of sound with perhaps some sensory and neurological awareness demonstrating that music may be analysed in scientific and physiological terms but rules governing its creation and its effects lead nicely into a philosophical second part.

The candidate may go on to discuss the second part of the question with a knowledgeable and convincing account using a range of illustrations and perhaps some personal experience. There ought to be ample opportunity for the use of AO4 in the quality of the arguments in the discussion.

- Music may be analysed in terms of sound waves from voice or instruments and structural components such as scales but there is no formula for creating or predicting great music. A broad definition is an artful arrangement of sounds across time. A narrower definition may not allow for its wide variety amongst cultures in style and structure.
- Defining characteristics of music include **melody** (the prominent musical sequences within a piece), **rhythm** (the relative lengths and spacing of notes), **harmony** (the combination of notes played at the same time), **timbre** (tone colours, the characteristic difference in sound between two instruments playing the same note), **key** (in western music the tonality produced by seven tones in a recognisable relationship to a central tone). The overall shape or architecture of music is known as **form.** Most western music is based on the chromatic scale – 12 equally spaced tones half steps or semitones per octave (the gap between two pitches where one frequency is twice the other.)
- The ear has the fewest sensory cells of any sensory organ – 3 500 inner hair cells cf 100million photoreceptors in the eye. The brain processes sounds starting at the cochlea of the inner ear where complex sounds produced by say a violin into constituent elementary frequencies. The cochlea transmits this information along separately tuned fibres of the auditory nerve as trains of neural discharges. These eventually reach the auditory cortex in the temporal lobe. However, processing is not the simple relaying of sound that one sees in a telephone or stereo system – the pattern of a melody matters! (see "Music and the Brain" Sciam. Oct 2004).
- The "music of the spheres" was thought by Pythagoras in 6th C BC and by later philosophers to be a perfectly harmonious music, inaudible on earth, produced by the stars and planets. The ancient Chinese had similar thoughts and their musical scale was derived through arithmetic from a basic note.
- Like language, music has well-developed rules of construction, much like grammar. Corresponding to speech variables are musical variables such as **dynamics** (force and volume), **register** (range of music or voice), **mode** (arrangement of a set of tones) and **articulation** (e.g. staccato, legato). However, it appears that the brain might not have a specific music centre! The pleasure of music is illustrated neurologically by the way the same centres of the brain light up as when eating chocolate for example.
- An interesting question is whether music can exist without sound? Can you play music in your head? Are 4 minutes and 33 seconds of silence music? Can typewriters or metronomes produce music?
- Music surrounds us – it accompanies many of our ceremonial and everyday activities – we would not have it any other way! It is unusual in the way it can bring tears to our eyes, send shivers down our spines, add emotive punch to background film or TV sound, galvanise church congregations or football crowds into singing, soothe fractious infants or teenagers or even adults.

- Could the emergence of music have enhanced human survival (e.g. by aiding courtship, promoting social cohesion in groups too large for grooming or is it just "auditory cheesecake")?
- There are numerous examples from many genres (e.g. jazz, rock, folk) and other cultures that could be used to enrich this answer e.g. Confucian ideal where music was not meant to entertain but to purify one's thoughts. Indian melody patterns – "Ragas" are traditionally played at specific hours or during specific seasons-it is believed to depart from this timetable would be harmful to the performer and audience.

2 Examine the technological achievements of the NASA space shuttle.

Evaluate its contribution to space exploration and other aspects of modern living.

In the first part a good candidate may be expected to know something of the historical and technological development of the shuttle including its role in satellite delivery, space station servicing, Hubble telescope servicing and various experiments in space.

The candidate may go on to the evaluation in the second part of the question either with a view that the shuttle's many significant missions have been a vital element of our understanding and exploitation of space or may take the view that it has been a luxury that we have not been able to afford and has cost the lives of the crew on two infamous occasions (Challenger in 1986 and Columbia in 2003).

Either view is acceptable depending upon the range and quality of the arguments in the discussion. There ought to be ample opportunity for the use of AO4 in this evaluation.

- Apollo space program showed that one-shot disposable rockets were an expensive way of placing astronauts and equipment in space – the shuttle was a reliable, reusable solution that launched like a rocket but landed like a plane. Previous spacecraft used ablative heat shields that burned away on re-entry to the atmosphere – designers came up with the idea of insulating ceramic tiles that could absorb the heat of re-entry without harming astronauts. A shuttle had four major parts – An **orbiter**, an **external fuel tank** and 2 **solid rocket boosters.**
- Four shuttles were made (Columbia, Discovery, Atlantis, Challenger) – first flight was in 1981.
- In 1986 Challenger broke up shortly after launching when a flame from a leaky joint on one of the solid rocket boosters ignited the fuel in the external fuel tank. The cause was established by the physicist Richard Feynman as the poor reaction of rubber O-rings to frost and then intense heat on the morning of the launch. The whole crew was lost. Challenger was replaced by Endeavour and shuttle flights started up again some years later.
- Discovery was used in placing The Hubble Telescope into orbit in 1990. Poor initial optical images were corrected by a shuttle servicing mission in 1993 and high quality imaging began in1994. Working outside the atmosphere has advantages for the HST because images obscured by the atmosphere and certain infra-red frequencies were filtered out. By carrying diverse instruments and dividing time between many astronomical projects from all over the world, Hubble has contributed to an extraordinary variety of astronomical discoveries, e.g. confirmation of dark matter, observations supporting the current accelerating universe theory and studies of extrasolar planets. The last servicing mission, as the HST is nearing its life expectancy, due in Feb 2005 has been cancelled because of the Columbia disaster (when a lump of foam insulation was lost from a wing on take off and this weakness caused the disaster on re-entry to the atmosphere. The lives of the crew of seven were lost). All future shuttles must be inspected externally before re-entry and as the shuttle cannot reach the HST and the international space station, ISS, on the same mission, this procedure may make manned shuttle missions prohibitively expensive.
- The ISS established a long duration habitable laboratory in space for science and research activities investigating the limits of human performance, experience of living and working in space and enabling the commercial development of space.
- Computing benefits from the program include a scheduling system using artificial intelligence that provides real time planning and optimisation of manufacturing operations, integrated supply chains and customer orders; semiconductor cubing – dramatic reduction in size and weight e.g. medical imaging devices; the spacecraft design software has been adapted for use in automobile industry and machine tool manufacture; Windows visual news reader – allows exchange of technical information

amongst a large group of users; air quality monitor – capable of measuring the various gases in bulk smokestack emissions; virtual reality.

- Other spin-offs include enriched baby food; water purification system; scratch resistant lenses; pool purification; ribbed swimsuit; golf ball aerodynamics; portable coolers/warmers; sports training; athletic shoes; microspheres; solar energy; weather forecasting- the barorator; forest management; digital imaging breast biopsy system; laser angioplasty; ultrasound skin damage assessment; cool suit; programmable pacemaker; ocular screening; voice controlled wheelchair; magnetic liquids; welding sensor system; microlasers; high pressure water stripping – in use in commercial airline industry. (See www.thespaceplace.com/nasa/spinoffs for longer list).

3 Examine the scientific and technological developments that have contributed to mass transport systems.

To what extent are fast, affordable and convenient mass transport systems desirable and sustainable?

The question is calling for information on 'mass transport systems', by which it is intended to mean systems for transporting people in large numbers – i.e. trains, planes, light transit systems, buses. Answers which simply discuss the motor car (which is generally thought of as a means of individual, not mass, transport) should not receive credit, unless it is explicitly argued that the widespread availability and use of motor cars in effect constitutes a system of mass transport.

The discussion is essentially about whether transport systems have delivered on the three criteria and what the future may bring. The discussion ought to provide opportunities to use AO4.

- Travel between cities has got faster in the air (Concorde has been a prime example), slower at airports (because of security concerns and travel time of airports from city centres), cheaper in Europe (Easyjet etc.) and across the Atlantic (bucket seats and competition). Orders for new planes show growth is expected and despite recent hikes in crude oil prices and pollution concerns cheap air travel for the masses looks in good health. Baggage check-in and its collection cause delay and its misdirection can be inconvenient. Ryanair have suggested carry on luggage only as a norm on its flights.
- Train travel between cities tends to be city centre to city centre without the security and baggage problems of airlines. However, the Madrid bombings of 2004 may bring increased concern in these areas. There is some price competition between trains and planes for longer flights in the UK and TGV are selling advance cheaper tickets to south of France to compete with air companies. An issue with inter-city train travel in the UK may be that purchase of a ticket does not guarantee a seat. Tickets bought in advance and on the internet tend to be cheaper. There is a problem with reliability and safety of services – there have been some high fines for persistent lateness and some high profile crashes since deregulation. Virgin trains are now tilting on the north western route to speed up journey times. Many trains are perceived as uncomfortable and dirty and suffering, along with the infrastructure, from lack of investment.
- Buses run between cities courtesy of national express and are cheaper than trains or planes but the journey times tend to be longer, have more stops and buses are subject to roadworks and traffic problems. Hostesses, videos and toilets are usual on longer journeys.
- Within cities mass transport may be effected by a light transit tram or railway – as in Manchester or Newcastle or Docklands or an underground system – as in London in competition with buses although a more enlightened approach has seen tickets for use on either system. Tickets can be bought in advance or as a season ticket which speeds up inspection and hence journey time. Public transport is not perceived as being as convenient or as cheap as the private car and the roads are fairly congested and polluted as a result. Various attempts are being made to ease congestion (e.g. bus/HGV/HOV lanes, toll roads, congestion charging, contra flow at peak times).
- Candidates may draw upon systems in other countries (e.g. bullet trains of Japan) to illustrate their answers and may speculate upon possible future changes (e.g. the scram-jet promises journey times of a couple of hours between London and Sydney – see notes for Q4), the tussle between private/public transport may become better resolved and pollution is being fought with new vehicle propulsion designs and alternative fuels. (e.g. electric and hydrogen based cars).

4 Explain how oil is refined and processed for different applications.

Discuss the problems raised by our dependence on oil and consider the extent to which there are viable alternatives.

A good candidate may be expected to be aware of where we get our oil from and what needs to be done to it to provide materials for a diverse range of applications. The explanation of fractional distillation is one of those areas where a suitably labelled diagram **may** aid the intelligent general reader's understanding. The discussion ought to provide the opportunity to assess our dependence on oil in different applications indicating whether or not alternatives are available or likely to become available. It is in the quality of this discussion that use of AO4 may be displayed.

- Crude oil or petroleum is a fossil fuel meaning it was made naturally from decaying plants and animals in ancient seas millions of years ago – it varies in colour from clear to tar-black and varies in viscosity from water to almost solid. Crude oils are such a useful starting place for so many different substances because they contain hydrocarbons. "Average" crude oil is made of **carbon** 84%, **hydrogen** 14%, **sulphur** 1% to 3%, **nitrogen** <1%, **oxygen** <1%, **metals** <1%, **salts**<1%.
- Two things about hydrocarbons excite chemists – they contain a lot of energy and they can take on many different forms. The smallest hydrocarbon is methane (CH_4) which is a lighter than air gas. Longer chains are liquids and very long chains are solids like wax or tar.
- The major classes of hydrocarbons in crude oil are **paraffins**, **aromatics**, **napthenes**, **alkenes**, **dienes** and **alkynes**. The mixture of crude oil can be separated using **fractional distillation –**different hydrocarbon chain lengths all have progressively higher boiling points so they can be separated by distillation – in order – **Petroleum gas** used for heating, cooking and making plastics; **Naphta** intermediate that is further processed to make **gasoline** used for motor fuel; **kerosene** provides fuel for jet engines and tractors; **gas oil or diesel distillate** is used for diesel fuel and heating oil; **lubricating oil** is used for motor oil and grease; **heavy gas or fuel oil** is used for industrial fuel and **residuals** make coke, asphalt, tar and waxes. Very few of the components come out of the fractional distillation column ready for market. Many must be further chemically processed to make other fractions, e.g. only 40% of distilled crude is gasoline so some other fractions are processed to become gasoline and thus maximise output.
- Fractional distillation steps are as follows – heat the mixture with high-pressure steam to 600^{o}C where the mixture boils forming vapours. The vapours enter the bottom of a tall column that is filled with trays – these have many bubble caps in them that allow the vapour to pass through and their large surface area enables one of the vapours to condense at the appropriate temperature and collect in a tray and is then taken to be stored or for further chemical processing – breaking large hydrocarbons into smaller pieces (**cracking**), combining smaller pieces to make larger ones (**unification**) or rearrangement of various pieces (**alteration**).
- Problems with oil – it is running out, is non-renewable, causes pollution and we are so dependent on it for our energy needs. Some would say it is a cause of much conflict in the world. First commercial hydrogen fuel garage for adapted cars opened in Washington (Nov 2004). US seems to be heading for a hydrogen based economy but China is now an awakening giant.
- USA, Australia, Japan, Korea, India and China who use 45% of the worlds energy and cause 50% of its carbon dioxide emissions, have formed an alternative pact to Kyoto – jury out!
- Difficult to see aircraft using less fuel – planes tend to have a longer working life than road vehicles and there is growing demand. NASA have tested (Nov 2004) an aircraft that flies at ten times the speed of sound using a scram-jet engine which may help aircraft manufacturers to build lighter and faster aircraft. The scram-jet engine works by mixing fuel with oxygen obtained from the air unlike rocket engines that carry their own bulky supply of oxygen.

Additional mark scheme notes for Question 2.4, GSA5/2, June 2006

- In considering **alternative sources of energy**, at least some of the following should be considered: wind power; wave power; solar power; hydroelectricity; tidal power; ocean thermal energy conversion; geothermal power; biofuels.

- Consideration of **viability** should include at least some of the following issues: economics – the economic viability of producing electricity on a large scale; yield – whether the source can produce more than a tiny fraction of the needs of consumers; ecological footprint – the impact on the environment, including infrastructure costs, damage to wildlife, etc; aesthetics – potential pollution, including visual and noise pollution; intermittent production – energy may not be produced at times of greatest need; problems of storage.

- In addition, **nuclear power** should be regarded as an alternative. The use of nuclear power is controversial: because of the problem of storing radioactive waste for indefinite periods; the potential for possibly severe radioactive contamination by accident or sabotage; the possibility that its use could in some countries lead to the proliferation of nuclear weapons.

- **Proponents**, including some national governments, claim that these risks are small and can be lessened with new technology. They note that France and all of the industrialised economies of Asia see nuclear power as a key economic strategy, that the safety record is already good when compared to other energy forms, that it releases much less radioactive waste than coal power and that nuclear power is a sustainable energy source.

- Many **environmental groups** claim nuclear power is an uneconomic, unsound and potentially dangerous energy source, especially compared to renewable energy, and dispute whether the costs and risks can be reduced through new technology.

- There could be some consideration of **energy conservation** measures to reduce dependence on oil.

- Oil is not only a source of fuel, but is the raw material for a wide variety of other products which modern society depends upon: agricultural chemicals such as pesticides, herbicides and fertilisers, and other items such as solvents, plastics, asphalt and synthetic fibres. A wide variety of industrial chemicals are petrochemicals.

- Even if dependence on oil as a source of fuel was successfully reduced, it is difficult to see any viable alternatives to oil as feedstock for these products.

5 Using one or more sports for illustration, discuss the part played by science and technology in improving sporting skills and achievement.

A good candidate will demonstrate good knowledge, possibly from personal experience, of the part played by science and technology in developments in his/her chosen sport. The discussion ought to provide opportunities to demonstrate AO4.

- Athletics is chosen as an illustrative sport here. Ideal sports choices are those where success can be measured in an individual's performance although a reasonable answer could be based on a team performance in certain sports. Candidates who choose an unsuitable sport will be struggling to get depth and range into their answers.
- Training methods include a better knowledge of the body's physiology in relation to sports activities (e.g. proportions of slow twitch and fast twitch muscles needed for different events; lung size and heart rate studies; video studies and analysis of sporting movements) and how the body processes food and delivers muscular energy with different specific diets (e.g. a marathon runner's diet of pasta for energy is different from a sprinter's protein rich diet to build upper body strength)
- Equipment changes would include the development of training shoes/running shoes from an awareness of gait studies and the sponsorship of commercial giants like Nike or Adidas have facilitated this. Also, track surfaces are much improved – certain tracks are favoured for world beating performances because they are known to be "fast".
- Pain killing and anti-inflammatory drugs are a feature of preparation – read Paula Radcliffe's autobiography – provided these drugs are not on the banned list or are taken outside of competition times so that there is no trace. As well as a personal trainer and physiotherapist a knowledge of pharmacy is also required. This area has been a minefield in recent years and with customised drugs and blood doping it is likely to provide much controversy in years to come!
- The lottery has been responsible in this country for funding many of our Olympic medal hopefuls and essentially making competitors full time professionals. Prize money has become the norm to lure top performers to particular meets. The women's pole vault has been a good of example of incremental changes in the world record to maximise cash returns.
- Recent changes recommended for the school curriculum, (four hours PE per week) are more to do with our perception of obesity, than sporting prowess, but may result in improved performances.
- One (unacceptable) method of improving sporting success using science has been by the use of performance-enhancing drugs and doping techniques – for example, anabolic steroids, such as nandrolone, and blood doping. In recent years, gene doping has been reported as being an emerging form of doping. Gene doping would be very difficult to detect and when used it will last for many years.
- Science is also at the forefront in combating this practice, which amounts to cheating. The principal method is to test the blood or urine of an athlete for evidence of a banned substance or practice. This approach requires a well-documented chain of custody of the sample and a test method that can be relied upon to be accurate and reproducible.
- Science and technology have improved methods of measuring sporting achievement – for example, in sprint events highly sensitive pressure pads at the start and photocells and digital cameras at the finish are used to establish precise times and placings.
- Technological devices also aid training – for example, stopwatches, showing split times and lap times, and heart rate monitors, showing average heart rate over exercise period, time in a specific heart rate zone, food energy burned etc.

6 Explain the part that technology plays in allowing employment to be home-based.

Discuss the implications of home-based working for people in different occupations.

Good candidates ought to be able to assemble a range of advantages and disadvantages of home-based employment that will include the part played by science and technology. In the discussion, there will be some assessment of how well different occupations are adapting to this new phenomenon. The discussion ought to provide the opportunity to display AO4.

The evidence seems to be that more and more people are working from home and advantages would include:

- Relevant computing equipment in PC World or Staples
- Office equipment on sale in IKEA or Habitat
- Work becoming service and skills based in tertiary sector
- It is cheaper for companies than providing central accommodation
- Improved employee retention – e.g. parents with childcare responsibilities
- A wider pool of applicants from which to recruit e.g. disabled people
- Possible productivity gains – fewer interruptions and less commuting time
- Increased staff motivation with reduced stress and sickness level
- Sales staff may be located nearer clients.

Drawbacks would include:

- Difficulty of managing performance
- Possible deterioration in employees' skills and work quality
- Initial costs of training and providing suitable equipment, including adaptations to meet health and safety standards and the needs of disabled employees
- Difficulty of maintaining staff development and upgrading skills
- Risk of information-security problems
- Increased telecommunication costs
- Risk of communications problems and a sense of isolation among workers
- Can be harder to maintain team spirit
- Home working is unsuitable for certain types of jobs.

Home-based employment has taken off in a big way with self-employment – the internet providing a shop window. Further advantages here might include tax concessions, overheads savings, travel savings, dressing down with savings on a wardrobe budget.

A shift towards home-working does not mean employees have to work exclusively from home, often, splitting time between home and the workplace is the most productive solution.

There are many areas where most or all work needs to take place in a specialist workplace outside the home and it is difficult to imagine home based alternatives but the pressure is on employers to accommodate home-working where it is possible and ingenious solutions may be found.