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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

General Studies 6761

Specification A

GSA5 Science, Mathematics and Technology

Mark Scheme

2007 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.

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Unit 5 Question 1

(GSA5/1 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**	**1.11**	**C**
1.2	**D**	**1.12**	**D**
1.3	**B**	**1.13**	**C**
1.4	**C**	**1.14**	**C**
1.5	**B**	**1.15**	**C**
1.6	**B**	**1.16**	**A**
1.7	**A**	**1.17**	**D**
1.8	**C**	**1.18**	**D**
1.9	**A**	**1.19**	**D**
1.10	**C**	**1.20**	**A**

Unit 5 Question 2
(GSA5/2 Science, Mathematics and Technology)

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 "Britain is sleepwalking into a surveillance society."

Outline a range of technologies used by governmental and commercial organisations which gather and retain information about individuals, and explain in detail one such technology.

Consider the extent to which such technologies are a benefit to society or a threat to personal privacy and individual liberty.

This question will give candidates an opportunity to demonstrate their knowledge of the wide range of surveillance technology and systems used in Britain today, and to explain the operation of one of them. The discussion in relation to the impact on individual liberty of these systems will give ample opportunity for AO4. **Strong answers** will identify a number of different technological systems and demonstrate sound scientific knowledge. They will also discuss the benefits and dangers of this technology in a balanced manner, and may come to a firm conclusion on one side or the other.

Technologies which can be used for surveillance purposes include:

- CCTV cameras which record digitally or to tape; used in town centres, shops, car parks, residential and play areas, on roads and motorways, stations, airports, in buses and taxis, etc.
- number plate recognition cameras, used to enforce speed limits and the London congestion charge, by linking to the DVLA database
- mobile phone records can show not only who was called and when, but the location based on proximity to particular cell base stations
- cash machines (ATMs) record the account being accessed via a magnetic stripe on the card, the user via a PIN number, the time and location and, in some areas, security cameras record images of the user
- store loyalty cards contain personal details on magnetic stripes which enable stores to gather information on purchases by card holders to be used for marketing purposes
- the Oyster travel card in London is a contactless smartcard which can be read by machines at Underground stations and on buses; it records details of when and where it was used which are centrally stored; recent usage can be checked by card-holders
- bio-metric recognition systems store details such as iris patterns and fingerprints on computer chips; they are used in some pubs and clubs for security purposes and will soon be employed in passports and (probably) national ID cards
- there are a number of government databases, holding criminal records, details of car ownership and taxation, qualified and licensed drivers, electoral registers, TV licences, etc.
- the national DNA database holds profiles of 3.5 million people in the UK, including more than ½ million under-16s; subjects include those convicted of criminal offences, but also those arrested but not charged or convicted.

Positive benefits of some or all of these technologies:

- many of them are important in the prevention, deterrence and detection of crime (CCTV, DNA database, criminal records, etc.)
- speed cameras make for safer roads and motorways; the congestion charge improves the environment in London

- commercial records can lead to better marketing, improved services
- many databases are necessary for law enforcement and efficient government (DVLA, DLA, etc.)
- bio-metric passports and ID cards are said to be necessary for enhanced security and access to public services.

Concerns over the impact on individual liberty include:

- many of these technologies are an imposition on personal privacy – an individual's movements around the streets, on transport, in public places can now all be followed and recorded
- they could be used for political repression – identifying those leading or participating in demonstrations, or following the movements of political dissidents
- they can be used as a form of social control – for example, CCTV monitoring young people for "anti-social behaviour"
- there is a danger that minorities may be targeted for surveillance – more than a third of all black men are on the DNA database, but fewer than 10% of white men
- details on databases, both public and commercial, can be (and are) sold to commercial organisations, leading to unwanted marketing pressure.

2.2 The 'precautionary principle' argues that the development of scientific or technological advances should be restricted if there is a possibility of damage to individuals or the environment.

Discuss how far this principle should be applied in relation to *two* of the following: reproductive human cloning; nanotechnology; nuclear energy; genetically modified food; mobile telephone systems.

This question gives candidates the opportunity to demonstrate their knowledge and understanding of an important area of science policy. The discussion will enable candidates to show breadth and/or depth of knowledge of particular topics, and to demonstrate AO4. **Strong answers** may elaborate on the nature of the principle and will identify the alleged potential problems of two of the identified topics. They will discuss the extent to which the precautionary principle should apply.

The **precautionary principle** is the idea that, if the consequences of an action are unknown, but are judged to have some potential for major or irreversible negative consequences, then it is better to avoid that action. In practice, the principle is most often discussed in the context of the impact of new technology on the environment, as the environment is a complex system where the consequences of some kinds of actions are often unpredictable.

Reproductive human cloning: this is the creation of a genetically identical copy of an existing, or previously existing human or growing cloned tissue from that individual. Reproductive cloning involves the implantation of a cloned embryo in the uterus with the intention of it developing into a normal baby. Therapeutic cloning (<u>not</u> the subject of this question) involves the removal of stem cells from a cloned embryo with the intention of developing tissue or organs for the purposes of transplant or therapy.

There are no confirmed examples of human clones grown to term (though there have been unsubstantiated claims from, for example, Clonaid). It is claimed that reproductive cloning could be used to create children for infertile couples, to replace terminally ill or deceased children with genetically identical copies, or to enable an adult to 'live on' in a new body.

However, due to the high failure rates in animal cloning (only about 1 or 2 viable offspring for every 100 experiments), many scientists argue that it would be unethical to attempt to clone humans. Not only do most attempts to clone mammals fail, about 30% of clones born alive are affected with debilitating conditions. Several cloned animals have died prematurely from infections and other complications. The same problems would be expected in human cloning. In addition, scientists do not know how cloning could affect mental development. With so many unknowns concerning reproductive cloning, any attempt to clone humans is considered potentially dangerous and ethically irresponsible. In this case, therefore, it is argued that the precautionary principle implies complete prohibition of reproductive human cloning.

Nanotechnology: this comprises technological developments on the nanometer scale, usually 0.1 to 100 nm. (one nanometer equals one millionth of a millimetre). The term has sometimes been applied to microscopic technology.

Areas which could benefit from nanotechnology include telecommunications and information technology, with faster computers and increased data storage; and healthcare, with advanced pharmaceuticals, drug delivery systems and nerve and tissue repair.

Critics, who advocate the precautionary principle, point to problems such as "grey goo", a hypothetical substance into which the surface objects of the earth might be transformed by self-

replicating nanobots running amok; the potential toxicity of new classes of nanosubstances that could adversely affect the stability of cell membranes or disturb the immune system when inhaled or digested; and the potential use of nanotechnology for military purposes.

Nuclear energy: this is the controlled use of nuclear reactions to do useful work including propulsion, heat, and the generation of electricity. Nuclear power is used to power most military submarines and aircraft carriers and provides 7% of the world's energy and 17% of the world's electricity.

There is renewed interest in nuclear energy because of concerns about limited reserves of oil, and the need to reduce greenhouse gas emissions.

Concerns about nuclear energy relate to possible radioactive contamination (Chernobyl disaster), the indefinite storage of radioactive waste, vulnerability to terrorist attack, and the possibility it could lead to the proliferation of nuclear weapons (e.g. Iran). The precautionary principle, advocated by some environmental groups, would suggest that the use of nuclear energy is phased out, not extended.

Genetically modified food: genetic engineering or genetic modification (GM) refers to technologies that allow single genes to be inserted or altered in living organisms such as animals, plants, or bacteria. A genetically modified food is a food product derived in whole or part from a genetically modified organism.

Genetically modified foods may potentially offer consumers and farmers a crop with more desirable properties. The majority of commercially available crops have an agronomic advantage like herbicide resistance. There is evidence of environmental and economic benefits for the crops already available.

However, critics point to both known and unknown risks. Controversies surrounding GM foods and crops commonly focus on human and environmental safety. Some proponents of the precautionary principle advocate the ending of the growth of GM foods; others propose stringent regulation and labelling of GM foodstuffs.

Mobile telephone systems: most current mobile phones connect to the network using a wireless radio wave transmission technology. These mobile phones communicate via a cellular network of base stations (mobile phone masts), which is in turn linked to the conventional telephone network.

They are now pervasive in many countries and are used for the transmission and reception of speech, text, still and video images, to download music, and to access the internet.

There are concerns about their alleged impact on health, principally tumours as a result of heavy use or living or working close to a base station.

Although scientific evidence for health hazards of low level mobile phone radiation is weak, the precautionary principle recommends limitations on mobile phone use, the limitation of use by at-risk populations (such as children), the wider use of hands-free systems (e.g. Bluetooth), and minimum distances of base station masts from housing, schools, etc.

2.3 An 'Earth-like' planet has recently been identified in a star system 21 500 light years away.

Identify and explain the conditions that are assumed to be necessary for a planet to support life.

Candidates can utilise a number of different areas of knowledge in this question – biological, astronomical, chemical, geological, etc – or a combination of all of them, which will demonstrate AO4. **Strong answers** will be those which consider a wide range of conditions necessary for life.

The assumption of this question is that an Earth-like planet is a pre-requisite for the development of advanced life. This is not a question for science fiction-based speculation.

Candidates might consider what is meant by **life**:

- it is comprised of one or more cells
- it has a metabolism which produces energy by converting nonliving material into cellular components
- it grows
- it adapts to its environment, which is fundamental to the process of evolution
- it responds to stimuli
- it reproduces, either asexually or sexually
- on Earth, all life is based on the chemistry of carbon compounds

Stars:

For life on a planet to begin and develop, it must have an **energy source** – usually, but not necessarily, a star:

- this should have a temperature which can sustain life on its planets
- it should exist for at least a few billion years to give life a chance to evolve
- it should emit enough high-frequency ultraviolet radiation to trigger important atmospheric dynamics such as ozone formation
- a suitable star's position in its galaxy should be away from sources of radiation, black holes, etc.
- a high proportion of metals in a star make it more likely that planets of sufficient mass will be formed in its solar system.

Planet:

- a habitable planet will be terrestrial – i.e. primarily composed of silicate rocks – and will not have accreted the gaseous outer layers of hydrogen and helium found on gas giants, such as Jupiter or Saturn
- a habitable planet should have sufficient mass to give it enough gravity to retain an atmosphere
- planets without a thick atmosphere lack the matter necessary for primal biochemistry, have little insulation and poor heat transfer across their surfaces, and lesser protection against high-frequency radiation and meteoroids

- a habitable planet will have sufficient energy left over from its formation to sustain volcanoes, earthquakes and tectonic activity, which supply the surface with life-sustaining material and the atmosphere with temperature moderators like carbon dioxide
- a life-bearing planet would have to have liquid water on its surface; it would therefore have to be sufficiently far away from its star for water not to evaporate, and sufficiently close for it not to freeze – i.e. in a 'habitable zone'
- no large-mass body, such as a gas giant, should be present in or relatively close to the habitable zone of a star, as this would disrupt the formation of Earth-like bodies
- a planet with a large iron core is likely to have a magnetic field to protect the planet from excess solar radiation
- a habitable planet will be in a relatively stable orbit around its star, to prevent excessive variations in temperature
- its day-night cycle will be not be excessively long, again to avoid extremes of temperature
- it will have some variation in its axis, giving moderate seasons which act as a stimulus to biospheric dynamism
- any extra-terrestrial life is likely to be made up of the four elements most vital for life, carbon, hydrogen, oxygen and nitrogen, which are also the most common chemically reactive elements in the universe; these four elements together make up amino acids, which in turn are the building blocks of proteins, the substance of living tissue.

2.4 What is meant by the term 'superbug'? Explain how superbugs such as MRSA develop.

Explain the scientific measures needed to reduce the impact of superbugs on the health of the population, and consider their political and economic implications.

This question should be accessible to candidates with a background in biological science or health-related subjects. **Strong answers** will deal with all parts of the question, explaining resistance, development through evolution, the importance of good hygiene, restrictions on use, and the search for alternatives. They will be aware of some of the wider issues involved in dealing with this problem (AO4).

Antibiotic resistance is the ability of a micro-organism to withstand the effects of an antibiotic. A **superbug** is a bacterium which carries several resistance genes to antibiotics.

Antibiotic resistance is a consequence of evolution via natural selection. The antibiotic action is an environmental pressure; those bacteria which have a mutation allowing them to survive will live on to reproduce. They will then pass this trait on to their offspring, which will be a fully resistant generation.

Several studies have demonstrated that patterns of antibiotic usage greatly affect the number of resistant organisms which develop. Overuse of broad-spectrum antibiotics hastens the development of resistance, as a result of:

- incorrect diagnosis
- unnecessary prescriptions
- improper use of antibiotics by patients
- the use of antibiotics as livestock food additives for growth promotion

The best known 'superbug' is MRSA (methicillin-resistant Staphylococcus aureus). This is a specific strain of the Staphylococcus aureus bacterium that has developed antibiotic resistance to all penicillins, including methicillin and other narrow-spectrum antibiotics. It was first discovered in the UK in 1961 and is now widespread, particularly in hospitals. It is commonly found on the skin and/or in the noses of healthy people. Although it is usually harmless, it may occasionally get into the body (e.g. through breaks in the skin such as abrasions, cuts, wounds or surgical incisions) and cause infections. These infections may be mild (e.g. pimples or boils) or serious (e.g. infection of the bloodstream, bones or joints). In vulnerable patients, infection can lead to death.

To reduce the impact of superbugs, there are a variety of short-term and longer-term actions. In the short term, hospital staff, patients and visitors should be rigorous in observing hygiene procedures:

- washing hands scrupulously, using antibacterial soap and disposable towels
- isolation of infected patients
- MRSA can survive on inanimate objects or surfaces such as linen, sinks, floors and even mops used for cleaning; for this reason, areas where MRSA patients are nursed should be thoroughly cleaned using disinfectants

Also in the shorter term, both doctors and patients should ensure that existing antibiotics are only used sparingly (the Department of Health has recently run an awareness campaign on this issue).

In the longer term:

- appropriate vaccines may be developed; vaccines do not suffer the problem of resistance because a vaccine enhances the body's natural defences, while an antibiotic operates separately from the body's normal defences; while theoretically promising, anti-staphylococcus vaccines have shown limited efficacy, because of immunological variation between staphylococcus species, and the limited duration of the effectiveness of the antibodies produced
- renewed efforts are being made to seek antibacterial agents effective against pathogenic bacteria resistant to current antibiotics.

There are issues of cost here – arguably, one reason why superbugs have gained such a hold in hospitals is because of cost-cutting on cleaning contracts, as well as poor procedures. Effective measures of prevention require significant expenditure.

The political implications include:

- the prevalence of MRSA has become the subject of party political dispute
- the government has made dealing with MRSA a priority
- the debate on how the NHS is run has been fuelled: it is alleged that private hospitals are less prone to MRSA than NHS hospitals; but it also claimed that cost-cutting on private contracts has been one of the factors leading to the spread of superbugs.

The economic implications include:

- the high level of costs for a 'clean-up' of hospitals, staff education, and a much stricter long-term hygiene regime
- the costs of extended treatment and longer hospital stays for infected patients
- possible costs of court cases arising from infections and deaths.

2.5 Discuss the scientific and ethical arguments for *and* against the use of non-human animals in scientific experiments.

This question is an opportunity for candidates to consider an important current scientific, ethical and political controversy. The discussion gives ample scope for AO4. **Strong answers** will look at both sides of the debate, though they are not precluded from reaching a firm conclusion on one side or the other.

Animal experiments fall into three broad and overlapping categories:

- basic or pure research
- applied research, studying diseases and developing medicines
- toxicological testing of chemicals (safety testing)

In Britain, in 2004, almost 3 million animal experiments took place. Of these, the vast majority were on rodents, fish and amphibia. Experiments also took place on dogs, cats and non-human primates.

The moral basis of the pro-testing position is the belief that human beings are unique amongst animals, and are therefore morally entitled to use them for their own purposes. There is a moral imperative to develop medical and veterinary science for the relief of suffering.

There are a number of different positions opposing testing, including:

- the animal rights view, that animals have rights that are worthy of equal consideration to those of humans
- the animal welfare view that, while they may well be superior to animals, humans have a moral duty not to inflict harm on inferior beings

Advocates of animal testing argue that:

it would be unethical to test substances or drugs with potentially adverse side-effects on human beings

- controlled experiments usually require confinement to a laboratory – human beings could not be confined in this way
- animals are good surrogates for humans in the study of living systems including cells, tissue and organs
- animals have shorter life and reproductive spans, meaning that several generations can be studied in a relatively short time
- animals are bred especially for animal testing purposes, meaning they arrive at the laboratory free from disease
- many of the greatest medical advances have been the result of animal experiments
- animals themselves have benefited from advances in veterinary science as a result of animal tests

Opponents of animal testing argue:

- the animal testing industry is a multi-million pound concern with a commercial rather than a scientific interest in continuing testing

- the suffering of the animals is excessive in relation to whatever benefits may be gained
- animal testing facilities are not properly regulated or inspected, which has led to animal abuse
- animal testing is regarded by opponents as bad science because they believe:
    - some animal models of disease are induced, and should not be compared to the same disease in humans
    - some drugs have dangerous side-effects that are not predicted by animal models
    - some drugs appear to have different effects on human and non-human animals
    - the conditions in which the tests are carried out may undermine the results, because of the stress the environment produces in the animals

Alternative approaches to testing include:

- **reduction** – methods which enable researchers to obtain comparable levels of information from fewer animals, or to obtain more information from the same number of animals
- **replacement** – the use of non-animal methods to achieve a scientific aim
- **refinement** – methods which alleviate or minimise potential pain, suffering or distress, and which enhance animal welfare for those animals which still have to be used.

2.6 In Britain, we throw away 4.6 million tonnes of waste packaging from food products each year.

Explain why so much food packaging is used, and why it is so difficult to dispose of in an environmentally acceptable manner.

Discuss the effectiveness of policies designed to reduce, reuse and recycle domestic waste.

This question should be accessible to many candidates, who will be able to demonstrate their understanding of an area of environmental policy that is topical and politically prominent. **Strong answers** will be able to explain the reasons for much of the packaging of food products, identify the principal methods of waste disposal and explain some of the problems associated with them. They will discuss fully the alternative methods of dealing with waste.

The figures quoted in the question relate only to food packaging waste. Total domestic waste is 30 million tonnes per year (500 kg per person per year); and the total for all wastes is 343 million tonnes per year.

Food packaging:

Food packaging comes in a variety of forms – bags, boxes, cartons, bottles, cans, etc. – and in a variety of materials – cardboard, paper, plastics, glass, metals.

Packaging is needed for:

- physical protection of food products during transportation, storage and handling by people or machines;
- protection from contamination by pathogenic bacteria, viruses and parasites;
- essential information, including weight, price, ingredients, cooking instructions, use-by date, etc;
- marketing information, design, etc.

Much of the packaging for fresh food (meat, fish, some dairy products, etc.) is necessarily non-biodegradable to prevent seepage and cross-contamination with other foods.

Waste disposal:

The traditional method of managing domestic waste is by collection and disposal. Currently 72% of municipal waste is landfilled and 9% is incinerated.

Landfill involves rubbish being buried in disused quarries, mines or other sites. One of the problems of waste food packaging is its sheer volume, which requires large areas of land for disposal. Another is the length of time it takes to degrade – ranging from months for paper to centuries for some plastics. Other problems can include wind-blown litter, vermin, soluble pollutants leaching from the site into groundwater, and landfill gas – principally methane and carbon dioxide.

Modern landfills are separated into cells which are lined and capped to contain any leachate, are compacted and covered to minimise vermin and litter, and have landfill gas extraction systems which may be used to generate power.

Despite such improvements, landfills are unpopular with nearby residents, and there is a limit to the availability of suitable sites. It is government policy to discourage the use of landfill, for example through the landfill tax.

Incineration is the process of destroying waste by burning it. Critics argue that it is a poor use of waste materials, as all the resources bound up in the waste are destroyed; and that toxic gases and dioxins are produced, and the residual ash can also be hazardous.

Proponents point out that many incinerators are used to power an electricity generation plant; that exhaust gases can be cleaned before release; and that solid residues can be recycled.

Alternative policies:

The concept of the waste hierarchy is the basis of revisions to traditional methods of waste management. The waste hierarchy specifies the preferred order for dealing with waste: reduce – reuse – recycle – disposal.

Policy in most developed countries is to seek to move away from disposal to methods higher up the hierarchy. In the UK, the landfill tax aims to encourage waste producers to produce less waste, recover more value from waste, for example through recycling or composting, and to use more environmentally friendly methods of waste disposal. Local authorities have all been given targets to increase recycling.

Reduce: The best way to deal with domestic waste is not to produce it in the first place. This is largely the responsibility of producers – either by eliminating some or all of the packaging (which raises the issue of the importance of packaging of food for reasons of hygiene and information) or by using biodegradable packaging (e.g. paper rather than plastic). Individuals can make a contribution through exercising consumer choice.

Reuse: Many items that are disposed of can be reused by others, either in the UK or in developing countries: for example, computers, clothing, shoes, furniture, spectacles, etc. This has limited relevance in terms of food and food packaging.

Recycle: This is based on the notion that waste is a resource to be exploited rather than simply disposed of. The most common items of domestic waste that can readily be recycled include aluminium and steel cans, some plastics, glass bottles and jars, newspapers and magazines, and cardboard.

Organic wastes, such as food scraps and garden waste can be recycled by composting, which decomposes the organic matter and kills pathogens; it can then be used for gardening or landscaping purposes.