



Cambridge International AS & A Level

THINKING SKILLS

Paper 4 Applied Reasoning

9694/42

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1 hour 45 minutes



You must answer on the enclosed answer booklet.

You will need: Answer booklet (enclosed)

INSTRUCTIONS

- Answer **all** questions.
- Follow the instructions on the front cover of the answer booklet. If you need additional answer paper, ask the invigilator for a continuation booklet.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

This document has **8** pages. Any blank pages are indicated.

Questions 1, 2 and 3 refer to specific documents. You should study those documents carefully to answer those questions. You do not need to study the other documents in as much detail, but you should read them to find material to use in your answer to Question 4.

Questions 1 and 2 refer to Document 1.

- 1 (a) State the main conclusion of the argument. [1]
- (b) Identify **two** intermediate conclusions in paragraphs 3 to 4. [2]
- (c) Analyse the structure of the reasoning in paragraph 1. [5]
- (d) Identify an unstated assumption required by the reasoning in paragraph 1. [1]
- 2 (a) Identify and explain **three** flaws and/or weaknesses in the reasoning in paragraphs 4 to 5. [6]
- (b) Identify and explain the causal flaw in paragraph 6. [2]
- 3 Question 3 refers to Document 4.
 - (a) The table given in Document 4A is intended to support the claim that 'nuclear power generation is safe.'
 - Identify **three** reasons why the support given by the table is weak. [3]
 - (b) The graph given in Document 4B is intended to support the claim that 'negative publicity about safety accidents at nuclear power plants results in fewer nuclear power plants being built worldwide'.
 - Identify **three** reasons why the support given by the graph is weak. [3]
- 4 You are advised to spend some time planning your answer before you begin to write it.

'More of the world's electricity should be generated from nuclear power.'

Construct a reasoned argument to support **or** challenge this claim.
Your argument should:

 - have a clear structure and make use of various argument elements
 - use and evaluate evidence from Documents 1 to 5
 - respond to significant counter-positions. [27]

DOCUMENT 1

- 1 The world's population is increasing, and it needs to be supplied with energy. Traditional electricity generation has relied on the burning of fossil fuels, such as coal, oil and gas, but this has caused the global climate to change dangerously. We need to change our approach to energy supply, and quickly.
- 2 All sources agree that the 10 hottest years on record have all been since 2010. There is no doubt that this ominous temperature rise is a result of human carbon emissions, mostly from fossil fuels used to generate electricity, for heating and in motor vehicles. Nuclear power is a 'low carbon' energy source compared to renewable energy – it releases less carbon dioxide over its lifetime than solar power. More nuclear power would help to reverse climate change. It is well established that countries that generate a high proportion of their electricity using nuclear power have relatively low carbon emissions overall.
- 3 Nuclear power is gentle on the environment. Per unit of electricity generated, nuclear power takes up much less space than wind and solar, which means more land for wildlife or food production. Furthermore, coal burning releases not only carbon dioxide but also other gases and particulates that are bad for human health. Therefore, if we don't increase nuclear generated electricity we can expect a reduction of human life expectancy.
- 4 Many people worry about the radioactive waste from nuclear power plants, which emits large amounts of dangerous radiation. But the amount of radiation that is emitted diminishes with time, and the waste from nuclear power plants has caused very few problems since nuclear power generation began. So worries about nuclear waste are unfounded. There is always a low level of natural background radiation in the environment anyway, and most of the waste from nuclear power is classed as low-level radioactive waste. Some of the high-level radioactive waste can be reprocessed as fuel for nuclear reactors. Remaining waste can be stored deep underground. One such storage facility is due to open in Finland in the mid-2020s.
- 5 There are parts of the media who cite rare nuclear accidents, such as those at Chernobyl and Three Mile Island, to warn against nuclear power, but these scaremongering appeals are merely designed to sell newspapers. No incident has led to the global catastrophe feared at the time. Moreover, the most recent of these incidents, Fukushima, happened in 2011 at a plant built in the 1970s. Technology has come a long way since then, so we need not worry about a repeat occurrence.
- 6 Nuclear power plants are expensive to build but, once they have been built, generating electricity is very cheap. Overall, nuclear power represents low-cost electricity. France produces the highest proportion of electricity from nuclear power of any country in Europe, and the average German household pays 70% more for their electricity than the average French household.
- 7 Certain environmental groups appear to prefer other forms of electricity generation, such as solar and wind, but these groups are biased and often have a vested interest in these industries. We need to generate more electricity from nuclear power.

DOCUMENT 2

Nuclear power is not the answer to the decarbonisation question

Nuclear power is hailed by some as the ideal way in which to replace fossil fuels with a low-carbon alternative, which we all know needs to happen quickly if we are to avoid the worst ravages of climate change. Although comparable with wind and solar in terms of carbon emissions, nuclear gets a disproportionate amount of attention from some politicians. This, together with a number of industry-sponsored myths, means it is consistently favoured over meaningful investment in renewable energy, the costs and efficiency of which are improving every year, unlike those of nuclear. A spokesperson for the UK Green Party said, 'Nuclear energy is an expensive distraction at a time when we face the dual challenges of spiralling energy costs and concerns over energy security.'

Nuclear power is too slow. There is a long time-lag between planning and operation. The World Nuclear Association, which represents the nuclear industry, estimates the average construction time for reactors to be between 5 and 8 years. But the 2021 World Nuclear Industry Status Report, compiled by an independent panel of experts, states that the true figure is close to 10 years. In a climate emergency, time is precious, and wind and solar power can be up and generating electricity in months rather than years. The extra time that nuclear plants take to build means existing fossil-fuel-burning plants continue to emit CO₂ while awaiting substitution.

Nuclear energy is too expensive. Nuclear energy costs between \$112 and \$189 per megawatt-hour, according to the World Nuclear Industry Status Report. The equivalent cost for solar power is \$36–\$44 per MWh and \$29–\$56 for wind. According to a study released by environmental group Greenpeace, power from France's newest reactor will be 3 times as expensive as the country's most competitive renewable sources.

Nuclear power adds to the risk of nuclear weapons proliferation. A 2014 report by the Intergovernmental Panel on Climate Change (IPCC) recognises that there is 'robust evidence and high agreement' that nuclear weapons proliferation is a legitimate concern about the development of nuclear energy. This is because the building of a nuclear reactor for energy allows that country to import uranium for energy use, which can then be converted for use in nuclear weapons.

Nuclear power is dangerous and vulnerable. Nuclear power plants are unique in respect of the potentially catastrophic consequences of a major accident. To date, 1.5% of all nuclear power plants ever built have experienced some sort of meltdown. The nuclear industry has proposed new reactor designs that they suggest are safer. However, these designs are generally untested. They are also vulnerable to natural disasters, such as that at Fukushima, the frequency of which is likely to increase with the effects of climate change. Nuclear power plants present easy targets for terrorists or hostile nations. Nuclear power plants use a lot of water for cooling. So the warming of rivers and rising sea temperatures could weaken the cooling of power plants and equipment. Already, nuclear reactors are often shut down or slowed during heatwaves.

Nuclear power produces large amounts of radioactive waste. No country has yet resolved how to deal with it safely. Some of this nuclear waste is highly radioactive and will remain so for several thousand years. Moreover, nuclear waste management is enormously expensive – the costs for storage projects are in billions of dollars.

Nuclear energy has no place in a safe and sustainable future. It is important that we leave nuclear power in the past, where it belongs.

DOCUMENT 3

Some statistics found on a nuclear power generation company website

Worldwide energy use has increased by around 50% over the last 10 years but the proportion of this electricity that is generated using fossil fuels – around two thirds – has changed very little. Nuclear power offers an excellent way to supply cheap, safe, low carbon energy that, unlike some renewable energies, such as wind and solar, is not dependent on the weather.

The volume of carbon dioxide produced by nuclear power per unit of electricity generated is negligible, compared to burning fossil fuels, and comparable to the cleanest renewable sources of energy. And nuclear-generated electricity is cheaper than most other forms of electricity generation.

energy source	grams of CO ₂ released per kWh of electricity generated	cost in cents per kWh of electricity generated
coal	820	7.2
natural gas	490	14.0
biomass	230	7.5
solar	39	48.1
hydroelectric	24	5.7
nuclear	12	6.8
wind	11	13.3

After the negative publicity of the Chernobyl nuclear accident in 1986, a respected, peer-reviewed scientific journal published some research into the relative safety of different forms of electricity generation in the 20 years following the accident. They concluded that nuclear power was by far the safest way to make reliable electricity.

type of energy	deaths* per million kWh of electricity generated
coal	29
oil	18
biomass	4
natural gas	3
nuclear	0

*from both air pollution and industrial accidents, rounded to the nearest whole number

DOCUMENT 4A

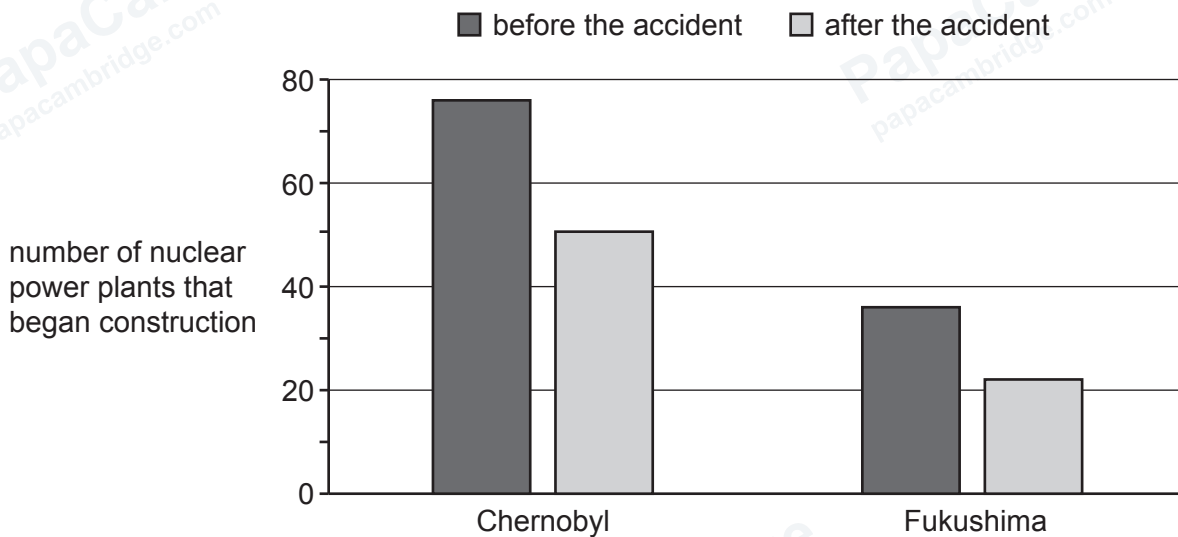
The table below was used to support the claim that nuclear power generation is safe.

industry	injuries* per million worker hours
manufacturing industry	18.0
electricity distribution	10.5
nuclear power generation	1.2

*Number of accidents resulting in lost work

DOCUMENT 4B

There is evidence that negative publicity about safety accidents at nuclear power plants results in fewer nuclear power plants being built worldwide. The graph below shows the number of nuclear power plants that began construction in the 5 years either side of the two most famous safety accidents* at nuclear power plants.



*In April 1986, a reactor at the nuclear power plant at Chernobyl, Ukraine, exploded, releasing large amounts of radiation into the atmosphere. In March 2011, an earthquake and resultant tsunami initiated a severe nuclear accident at the Fukushima Daiichi nuclear plant in Japan. Three of the six reactors at the plant sustained severe core damage and released hydrogen and radioactive materials.

DOCUMENT 5

The International Nuclear and Radiological Event Scale

In 1990, the International Atomic Energy Agency, an intergovernmental organisation that seeks to promote the peaceful use of nuclear energy, introduced the International Nuclear and Radiological Event Scale. Its purpose is to enable prompt communication of safety information in the event of nuclear accidents. The scale recognises 7 levels of event of increasing severity. The more serious events, Level 4 and above, are termed 'accidents' and the less serious events, Level 3 and below, are termed 'incidents'. Each of the levels is described in the table below.

Level: name	Description and notable examples
1: Anomaly	Human exposure above the annual permitted dose of radiation.
2: Incident	Exposure of a member of the public to more than 10 mSv of radiation or exposure of a worker above the annual permitted dose.
3: Serious incident	Exposure to more than ten times the permitted dose limit for workers or a non-lethal health effect (e.g. burns) from radiation.
4: Accident with local consequences	Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. For example, in 1999, two people died after an accident at Tokaimura, Japan.
5: Accident with wider consequences	Limited release of radioactive material likely to require implementation of some planned countermeasures. Examples include Three Mile Island, US (1979) or Goiana, Brazil (1987), in which four people died.
6: Serious accident	Significant release of radioactive material likely to require implementation of planned countermeasures. The only Level 6 accident occurred in 1957 at a plutonium-processing plant near Kyshtym, Russia. An explosion resulted in mass evacuations. An estimated 270 000 people were affected and approximately 200 died.
7: Major accident	Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures. Only two accidents have ever been categorised as Level 7. An explosion at the Chernobyl Nuclear Reactor, Ukraine, caused between 2 and 20 deaths initially, with up to 30 more dying subsequently of radiation sickness. Radioactive material from the explosion was deposited across large parts of Europe. An earthquake and tsunami led to a power loss at the Fukushima Daiichi nuclear power plant in Japan in 2011. Without cooling water, three reactors overheated. Although only one person died from the direct effects of radiation, it is estimated that around 2000 people died from indirect effects.

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