



General Certificate of Education
Advanced Subsidiary Examination
January 2013

Critical Thinking

CRIT2

Unit 2 Information, Inference and Explanation

Source Material

This source material is to be read in conjunction with the questions in Unit CRIT2.

A

Document A

Box 1 – Information

- *Fossil Fuels* are coal, oil and gas. *Renewables* are wind, hydroelectric and solar power.
- 1 kilowatt-hour (kWh) = 1000 watt-hours of electrical energy used;
- 1 gigawatt-hour (GWh) = 1 billion (1,000,000,000) watt-hours;
- 1 terawatt-hour (TWh) = 1 trillion (1,000,000,000,000) watt-hours.

Box 2 – Global Warming

According to the United Nations' panel of climate scientists, as temperatures rise, ice sheets and glaciers will melt, so the seas will rise, flooding major cities, polluting sources of drinking water with salt and submerging farmland. Other fertile land, far from the sea, will turn to desert. But, not only will the direct effects be terrible, climate change will worsen the problems we already face. How will poor countries develop if the cost of food increases? Unchecked climate change means disease, starvation, poverty and conflict. We must check it at all costs.

Source: United Nations Framework Convention on Climate Change

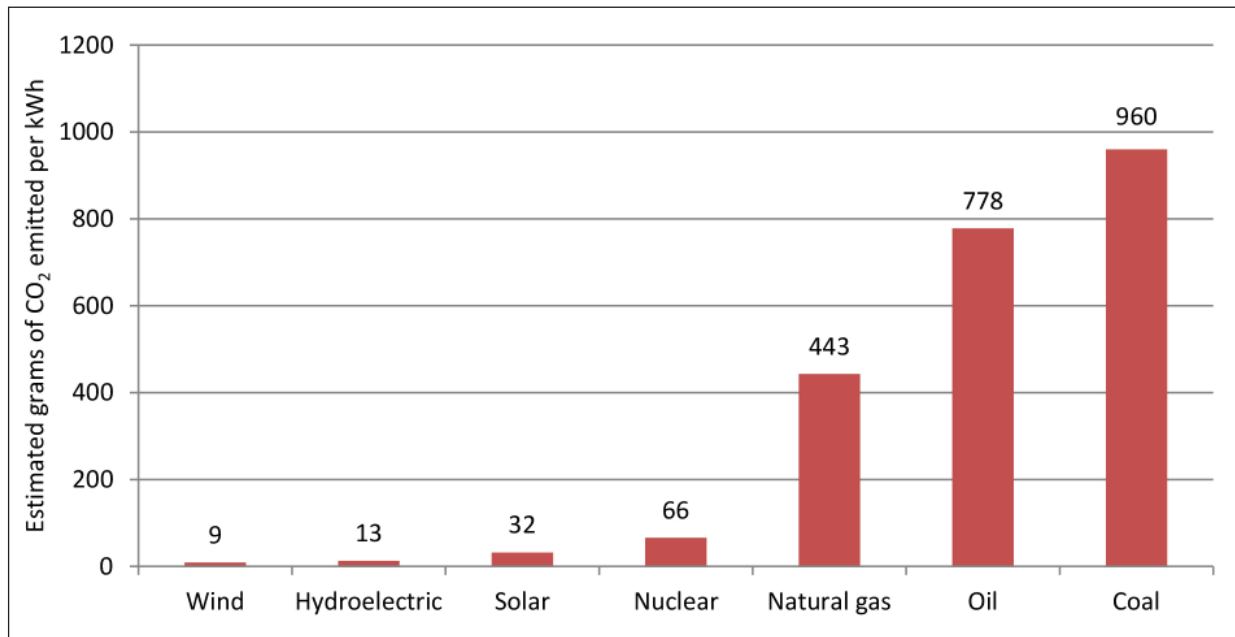
Hazards posed by nuclear technologies

The text has been removed due to copyright restrictions. The text was three paragraphs from an interview with Helen Caldicott on *Democracy Now*, March 2011,

The text is available in the hardcopy of the question paper from AQA Publications.

* The Windscale plant (now decommissioned) is part of the Sellafield site in Cumbria.

The author, **Helen Caldicott**, is an anti-nuclear campaigner, and former medical doctor who taught paediatrics at the Harvard Medical School.

Figure 1: Estimated Carbon Dioxide emission by energy source

Source: text adapted from an interview with HELEN CALDICOTT for *Democracy Now*, 30 March 2011

Source: Figure 1 data from 'Valuing the greenhouse gas emissions from nuclear power: A critical survey'
BENJAMIN K. SOVACOO, *Energy Policy* (2008)

Turn over for Document B

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Document B

How the Fukushima disaster taught me to stop worrying and embrace nuclear power

1. You will not be surprised to hear that the tsunami and nuclear power station meltdown in Japan have changed my view of nuclear power. You will be surprised to hear how they have changed it. As a result of the disaster at Fukushima, I am no longer nuclear-neutral. I now support the technology.
2. The accident occurred because an old nuclear power plant with inadequate safety features was hit by a monster earthquake and a vast tsunami. The electricity supply failed, knocking out the cooling system. The reactors began to explode and melt down. The disaster exposed a familiar story of poor design and corner-cutting. Yet, as far as we know, no one has yet received a lethal dose of radiation.
3. Some greens have wildly exaggerated the dangers of radioactive pollution. Even the infamous nuclear disaster at Three-Mile Island did not cause anyone living within 10 miles of the plant to die because they received a total radiation dose of only one 625th of the maximum yearly amount permitted for US radiation workers. This, in turn, is half of the lowest dose clearly linked to an increased cancer risk, which, in its turn, is one 80th of an invariably fatal exposure. I'm not ignoring safety here, I am putting things in perspective. Nuclear power is potentially dangerous, but it is much safer than its opponents think.
4. If other forms of energy production caused no damage, the impact of radiation would weigh more heavily. But energy is like medicine: if there are no side-effects, the chances are that it doesn't work.
5. Replacing current nuclear power stations with new ones when they reach the end of their lives is a tough decision. So is not replacing them. But not replacing them is a decision to do one of two things:
 - A. To switch to coal or gas, which means greatly increasing the rate of industrial deaths and injuries, levels of pollution and the impacts of climate change.
 - B. To rely on renewables to produce an even greater proportion of our energy.
6. Option A is far more likely, and appears to be taking place already. For example, in Germany, where the government claims that it's going to remove nuclear power entirely. Option B is unlikely because in places such as the UK renewables do not give year-round, 24 hour reliable supply.
7. It is vital to compare nuclear to other options on a level playing field. Here is a list of double standards that some who oppose nuclear power use when arguing against it.

Double Standard 1: Deaths and Injuries

8. No one has yet died from radiation exposure due to the Fukushima disaster. What about coal?
9. In China alone, the government estimates that 2433 people died in coal mining accidents last year. That's not injuries or exposures. It's deaths. What this means is that, in normal operations, at least 6 people are killed in Chinese coal mines every day. Chinese coal mining alone kills as many people every week as the worst nuclear power accident in history – the Chernobyl explosion – has done in 25 years. We could add deaths from air pollution and the lingering lung diseases suffered by miners.

Double Standard 2: Radioactive Pollution

10. If low-level radiation really was the problem that some environmentalists say it is, the focus of their campaign should be coal plants, not nuclear power. As *Scientific American* notes:

“the ash emitted by burning coal for electricity carries into the surrounding environment 100 times more radiation than a nuclear power plant producing the same amount of energy.”

This is because coal ash contains uranium and thorium. People living around coal plants receive higher doses of radiation than people living around nuclear plants.

Double Standard 3: Mining

11. Anti-nuclear campaigners emphasise the harm caused by uranium mines. They are right to do so. Some of these mines are hideous, and they are one reason why we should develop new technology which reduces the need for fresh uranium. But the impact of coal mining is massively greater. There are hundreds of times more coal mines than uranium mines, often many times bigger and more destructive than the largest uranium mines. This doesn't make uranium mining right, but it makes switching to coal even more wrong.
12. Yes, I still loathe the liars who run the nuclear industry. Yes, I would prefer to see the entire sector shut down, if there were harmless alternatives. But there are no ideal solutions. Every energy technology carries a cost; so does the absence of energy technologies. Atomic energy has just been subjected to one of the harshest of possible tests, and the impact on people and the planet has been small. The crisis at Fukushima has converted me to the cause of nuclear power.

The author, **George Monbiot**, is an investigative journalist specialising in environmental issues and a regular columnist for *The Guardian* newspaper.

Supporting data for Document B are on the next page

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Figure 2: Energy production safety

Energy source	% of world energy production	Deaths per Terawatt-hour (TWh)
Coal	26.00%	161
Oil	36.00%	36
Other (including biofuels)	7.80%	12
Natural Gas	21.00%	4
Hydroelectric (i.e. water power)	2.20%	1.4
Solar (rooftop)	0.10%	0.44
Wind	1.00%	0.15
Nuclear	5.90%	0.04

Deaths per TWh shows the average number of deaths caused in the production of 1 terrawatt-hour of energy. It includes deaths from obtaining raw materials for energy production, such as mining, and from long-term effects, such as pollution.

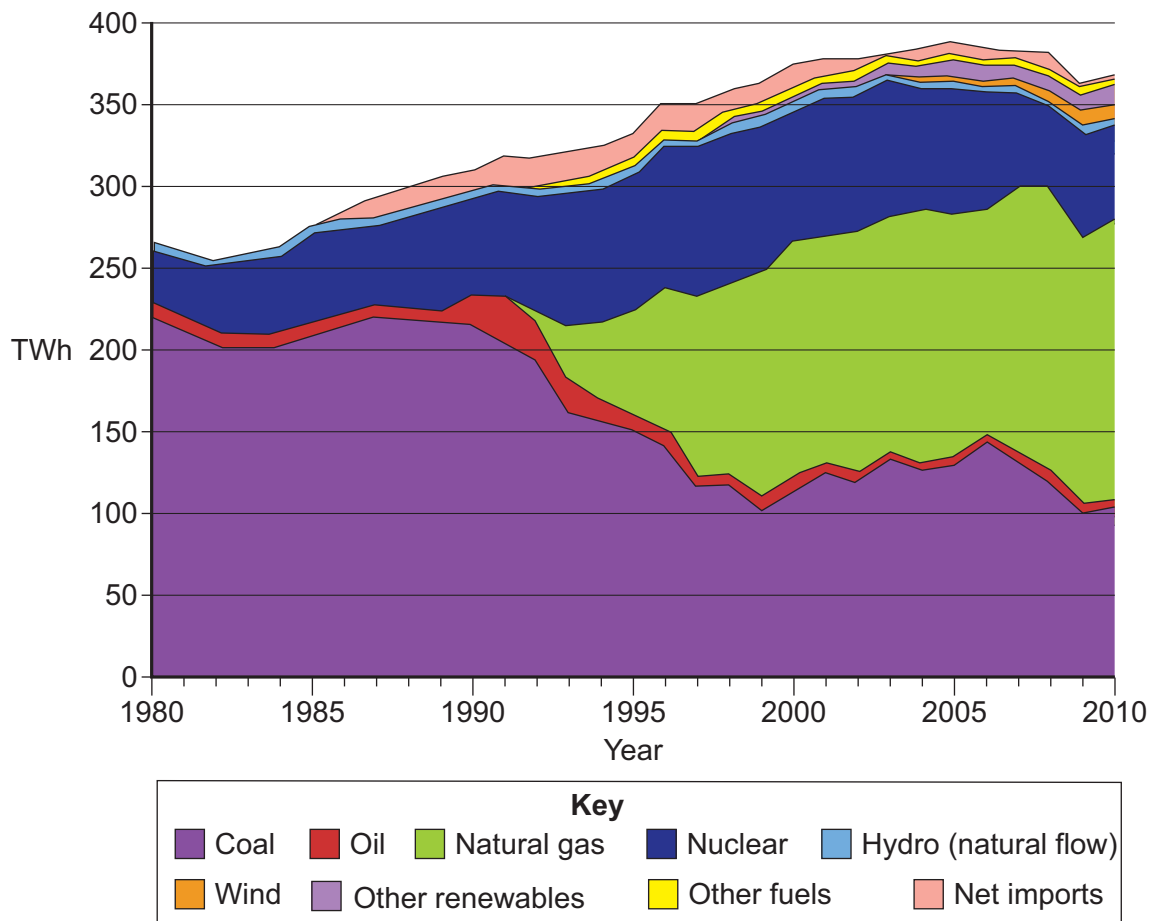
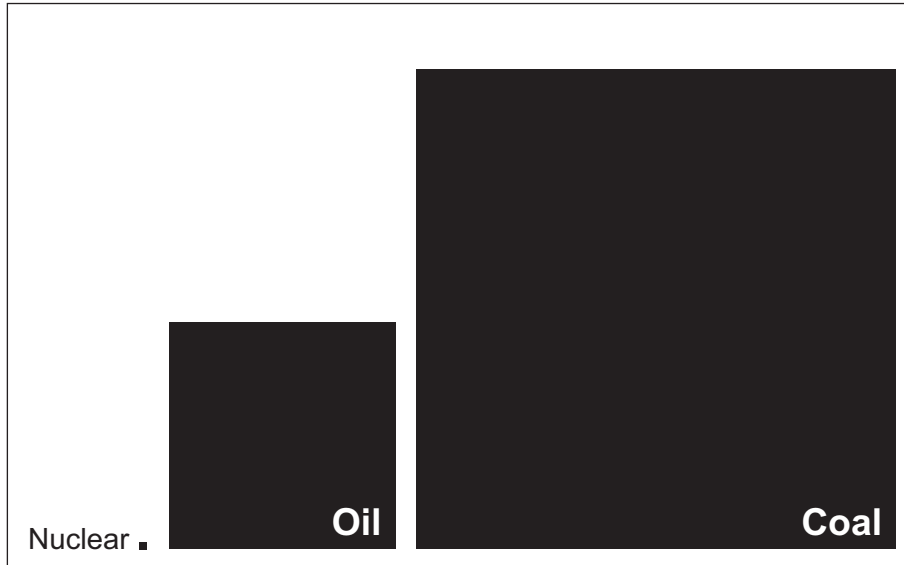
Figure 3: Electricity production by fuel type, 1980 to 2010 (UK)

Figure 4: Death rate per watts produced



Source: text adapted from GEORGE MONBIOT, published in *The Guardian*, 21 March 2011
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Sources:
Figure 2 data from Technology blog, nextbigfuture.com
Figure 3 from *UK Energy in Brief 2011*, Office for National Statistics
Figure 4 from sethgodin.typepad.com

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Document C

The potential and potential dangers of nuclear power

1. China is the world's most populous country. It has the world's most ambitious nuclear programme with more than 70 gigawatts of new capacity planned by 2020. This would meet 5% of Chinese electricity demand. Renewables will meet 25% of demand and the remaining 70% will be met by coal and gas – mainly coal. In climate change terms, even the world's largest nuclear programme only affects the margins. We need new technology to capture and store the CO₂ generated by fossil fuels, to make coal environmentally friendly.
2. Nuclear power cannot be made to work for peace without making it available for war. This is a lesson we learned the hard way. Originally, five states had nuclear weapons; now there are nine and these will soon be joined by a tenth (Iran). All the newcomers have acquired their weapons after first developing civil nuclear-power programmes, through which they learned the skills used to build nuclear weapons. Do we really want to risk nuclear war?

The author, **Tom Burke**, is an environmental policy adviser to Rio Tinto plc (the world's fourth largest mining company, in 2009) and a visiting professor at Imperial and University Colleges, London.

Source: adapted from TOM BURKE 'The proposer's opening remarks', *The Economist*, 6 April 2011



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