**Section A**

**Question 1. Energy Beyond Kyoto**

The end period of the Kyoto Protocol first phase is almost upon us. The EU will probably miss its 8% greenhouse gas reduction target; the UK will certainly miss its non-Kyoto 20% CO$_2$ reduction target. However, awareness of climate change and of the energy issues generally is now much higher up the public agenda, partly prompted by significant price increases in recent times. A great deal is now happening in the United States at state level and it is almost certain that George Bush will do a u-turn on the climate issues before he leaves office.

There is a wide range of views emerging on the priorities out to 2020 and beyond. India’s and China’s emissions per capita are way below those of the West – as their economies expand, they are perfectly entitled to increase their emissions to those of the West. Another view is that the West should work closely with them at whatever cost, to ensure that they only use the most energy efficient and low carbon technologies as they grow. They should not replicate the bad practice of the West.

Sometimes targets for the future can become pointless – they are usually missed. The only solution is to invest in new clean technologies, for permeation throughout economies. Nevertheless it is essential to have some targets in that objectives must be set and progress must be measured. Many cost effective energy efficient technologies are never used, why invent more?

In the UK there is shortly to be a new White Paper focusing on additional nuclear capacity to replace aging plants. Greenpeace has recently won a delaying case against the government, arguing that renewables and energy efficiency can provide the solution without more nuclear power.

The situation both internationally and within the UK is therefore complex and there is no single answer. If you were advising the UK government on the domestic nuclear issues and the line it should take in the wider international debate, what would your views and advice be?

[50 marks]
Section B

Question 2. Corporate Energy Management

Many organisations, both public and private sector, which have not paid much attention to energy efficiency in the past, now realise that they must engage with it, not only to offset ever increasing costs but also to address staff and stakeholder concerns about carbon footprints and their reduction.

A local authority has six main sites, including the town hall and thirty smaller sites including four schools. Energy management has never featured as a priority as costs, at £2.5m, are only one or two percent of operating costs. There is no history of consumption and bills are just paid without validation. Capital investment programmes, whether for new photocopiers or a building refurbishment never address the energy issues.

You have just been appointed energy manager and are tasked with developing a three year plan to put energy management firmly in place. What would your key priorities be?

[25 marks]

Question 3. Industrial Refrigeration

You are employed in a food processing plant which spends £1.5m per annum on refrigeration. This comprises partly a central plant supplying secondary refrigerant to cool fermenting vessels and partly for a series of cold stores for food storage at -26°C.

Sketch the layout of the type of plant which might provide the secondary refrigerant. If you were concerned with the initial specification of the plant, which features would offer some choices for a capital cost versus energy efficiency trade-off?

[15 marks]

For the cold store, give some examples of good operating practice to reduce energy consumption.

[10 marks]
Question 4. Lighting

Lighting systems have emerged from the tungsten filament bulb through to the compact fluorescent lamp widely promoted for domestic use. For commercial compact fluorescent applications there are also systems where the control gear is built into the lampholder, rather than the replaceable lamp as for domestic applications.

Why do we want to move away from tungsten lamps, do they still have any benefit?  
[5 marks]

What is the advantage of the commercial compact option over the domestic one? Why is it not used domestically?  
[5 marks]

Your office comprises five open plan floors, each with some side rooms, all lit from one central control point. One side of the building faces south and is well lit by natural light during the day. However you note that usually the blinds are drawn during the day, because of the glare and the lights are on anyway because the north side is quite dull and so they are needed. Stairwells and corridors are quiet brightly lit. Normal office hours apply, but there are sometimes small meetings late into the evening.

A lighting refurbishment is due. With energy efficiency in mind, what would be the main points of your advice for improved lighting control?  
[15 marks]

Question 5. Fuel Cells

Describe the basic principles of fuel cell operation, with sketches and how it compares with an engine based combined heat and power unit.  
[10 marks]

Fuel cells sometimes get included under the heading renewable technology. Why must we be very careful about this and when would that inclusion be wrong?  
[5 marks]

You are considering a 200kW fuel cell installation in your office complex. You have a capital cost quote of £300k. An engine based equivalent would cost £80k. What would you be looking for when evaluating the options?  
[10 marks]