Electricity Quiz

References

Specification
10.2 Electricity supplies

Textbook
Chapter 10

This activity is an introduction to the topic. It consists of a quiz followed by discussion of the answers.

Many students are likely to find 'electricity' a somewhat daunting topic. Here questions about electrical energy and electrical power are set in the context of daily life. The aim is to develop the abstract concepts of energy transfer, conservation and dissipation in familiar situations.

The quiz gives practice in simple calculations. A discussion about the supply of electricity must deal in quantities to have any depth.

Note on units

The unit used to compare amounts of electrical energy in Chapter 10 is the kilowatt-hour (kWh). It is a **key term** and is explained on page 130 of the textbook. In the preceding Topic 'Using fuels' the unit used for the amount of energy delivered by primary fuels was the tonne of oil equivalent or toe. The kWh and the toe are **both** units of energy. A kWh is equivalent to the energy content of a little over 1 litre of crude oil or about 1.1 litres of petrol.

The kilowatt (kW) is a unit of power. Power is the rate at which energy is converted from one form to another. Energy and power are sometimes used informally as though they mean the same thing (e.g. wind energy and wind power). Often this doesn't matter but it can lead to meaningless statements e.g. 'the wind turbine will produce 600 kW a year'.

Resources needed:

Calculators

Answers to questions:

1. One kilowatt hour. This question gives an opportunity to point out that the kWh and the toe are both units used to measure of energy.

2. During the night there is less demand for electricity but the supply still continues. The low charge encourages people to use electricity at night for such purposes as heating water or heating electrical storage heaters.

3. We must pay for transmission charges and the privilege of having a connection.

4. The Units are 'used' in the sense that we cannot give them back to the supplier. The energy is changed into other forms that spread away into the surroundings. This question revisits the idea of 'conservation of energy'. See 'The idea of energy' page 118 in the textbook.

5. 1000/4 x £6 i.e. £1500. We are paying for an energy ***service***. The supply is reliable, portable and available when we need it.

6. The single cable which links the tops of the pylons completes the circuit. It is the ‘neutral’ line and is, in theory, at the same potential as earth.

   This question about the transmission system is intended to dispel a widely held misconception that power stations supply electrons. It revisits the idea of an electric circuit.

   http://www.powerworks.com.au/VisitorsCentre/Resource/reference/factsheet.asp?P=5
   gives a very clear explanation of electricity generation. It makes an analogy between a generator and a water pump. Pressure from the pump forces water through a closed system of pipes to drive a hydraulic motor. The electricity generator creates a potential difference which makes electrons move and flow in an electrical circuit. The customer uses the energy produced by the moving electrons.

7. The generating capacity is the maximum rate at which the power station can supply energy. MW are units of power.

   Power stations do not run at their maximum capacity all of the time. The electricity from the power stations is fed into a national network known as the national grid. Customers draw electricity from the grid (not from local power stations). Because electricity cannot yet be stored economically in large quantities, demand and supply have to be balanced. In practice the demand varies widely from hour to hour and season to season. The system is run by computers. A computer model estimates what the national demand will be in the following few hours. The decision about which station runs at a given time is governed by a continuous process of competitive bidding under computer control. Stations with the lowest running costs supply the base load.

8. 7 x 500W i.e. 3.5 kW .

   This question draws attention to environmental and social aspects. While lighting may be needed for public safety much of it shines wastefully into the sky. In 1901 Emile Zola prophesied ‘....and at night (electricity) will light another sun in the dark sky, putting out the stars’. His prophecy seems to be coming true and in response the British Astronomical Association has mounted a campaign for dark skies.

9. In 24 hours a single computer consumes 12 kWh.

   The stand-by mode for electronic equipment, such as the red light that glows to show that a telephone answering machine is on, consumes a surprisingly large amount of electricity.

   This question shows that electricity demand from consumer electronics is likely to rise. It shows that the demand for electricity, based on the present use, is likely to increase. Higher product standards could lead to reductions in standby power.

An Electricity Quiz

Electricity you have used

ECONOMY 7 DOMESTIC T ARIFF

Meter No.	
Supply number	S

	Meter readings Last reading	This reading	Units used	Cost (in pence) for each unit	
Night/Low Units 5 November to 13 February......	57693E	57812	119	2.73	3.25
Day/Normal Units 5 November to 13 February...	94762E	96016	1254		
Band A Day/Normal Units to 13 February...			303	10.12	30.66
Band B Day/Normal Units to 13 February..			951	6.66	63.34
				Total charges for electricity £	97.25

E shows we have estimated the reading

Summary

Amount brought forward from the Statement section.. 0.00

Amount brought forward from the Electricity you have used section.................. 97.25

VAT	Charges	VAT Rate	VAT Amount
Energy Charges	97.25	S	4.86

5% VA T Sub Total 4.86

This is not a tax invoice. You cannot reclaim the VAT on this bill. **New Balance** **£** 102.11

Thinking about electrical energy.

1. In an average household the cost of mains electricity per day in 2002 was 72p, about the price of a large loaf of bread and less than a lottery ticket.
   Look at the electricity bill above. The meter readings give ‘Units used’. How much electrical energy is there in one unit?

2. A Night Unit is much cheaper than a Day Unit. Why are they priced differently?

3. Only about half the ‘total charge’ on the bill is the cost of generating the electricity. The price of the units covers other costs. What else do we pay for?

4. One column in the bill is headed ‘Units used’. How does this fit in with the idea that energy is conserved?

5. The small long-life battery used in a camera costs £6, yet it holds only about 4 watt-hours of electricity. Work out how much 1 kWh (one unit) costs when supplied by this battery. Why are we willing to buy electricity at such a price?

6. A power station is a power **supply** – it supplies the energy to make electrical current (electrons) flow in the circuit. Pylons carry electricity from power stations to supply points for domestic users and industry. Look at the photograph of power lines over a housing estate in Manchester on page 187 in your textbook. The six sets of cables hanging from the insulators are live. You will know that an electrical circuit has to be complete for a current to flow. If a return path is not available to make a complete circuit the flow is stopped. Where is the line that completes the circuit back to the generator? (Hint: it is a single line.)

7. Didcot power station in Oxfordshire (Fig 10.4 on page 131 of your textbook) has a *generating capacity* of 2000 MW. What does ‘generating capacity’ mean? What does the unit MW measure?

8. A church is floodlit by twelve lamps, each rated at 500W. How much power needs to be supplied when they are all alight? If the lights are lit up for 7 hours on a winter evening how much energy do they consume? The effect is attractive and uplifting but do you think it justifies using this amount of energy?

9. We are still finding new ways to use electricity, including computers and the Internet. In many offices computers (PCs) are often left on all the time. When it is in stand-by mode a typical computer consumes energy at a rate of about 100 watts. How much energy will one computer use in 24 hours? Roughly how many computers are there in your school/college? If they are left on in stand-by mode how much energy do they consume in 24 hours?