Number :

Standard Grade Physics

Name:

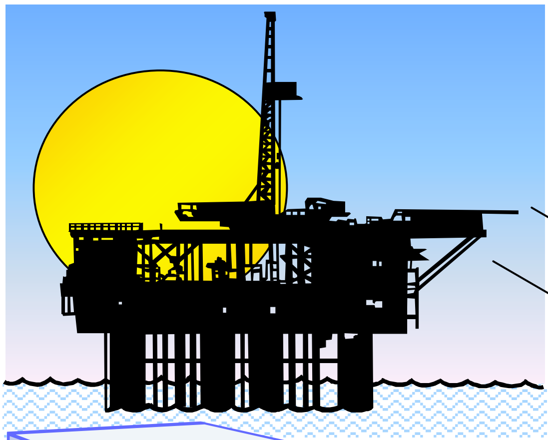
Strathaven Academy

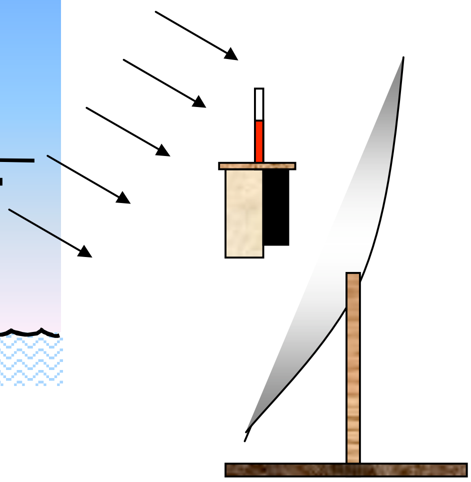
Physics Department

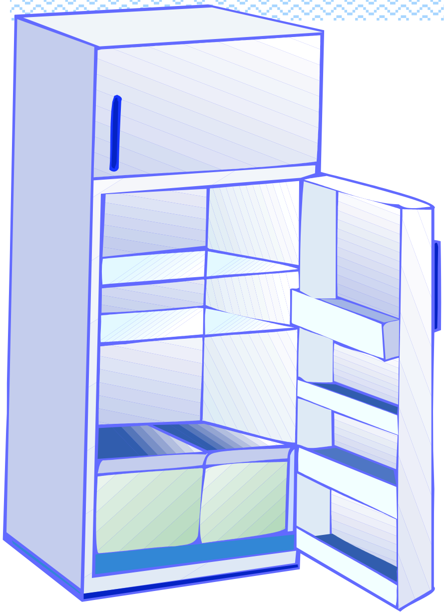
UNIT 6

ENERGY MATTERS

PUPIL PACK







Study Guides
Summary Notes
Homework Sheets

ENERGY MATTERS
Working at Home

TO THE PUPIL

Each day you have physics at school, you should set aside time for work at home. By this stage you should be accepting more responsibility for your own learning and should undertake the following tasks on a regular basis:

- Tackle the supplied homework sheets as each section of work is completed in class.
- Check your own progress in the homework sheets by referring to the homework answer files available in class. Discuss any difficulties that arise with your class teacher.
- Complete any formal homework tasks that your teacher may issue from time to time and hand them in on the due date for marking.
- Revise the work you have covered in class activities by referring to your classwork jotters.
- Complete the supplied summary notes as the coursework allows you to, then use the summary notes to help you in your revision of the course content.
- Make your own short notes to cover each learning outcome in the supplied study guides.

TO THE PARENT

Your co-operation would be appreciated in ensuring that pupils are encouraged to complete homework. It would be helpful if you could talk over the work given for homework and sign the homework record sheet on this page after they have completed each exercise.

The physics department hopes that this record of your child's achievement will be of interest to you, and we would welcome any comments on this or other areas related to the work of the department.

Please sign here to confirm that you have seen the homework record sheet: ______________________

HOMEWORK RECORD SHEET

HOMEWORK	SECTION OF WORK	MARK	CHECK	PARENTAL SIGNATURE
6.1	Supply and Demand 1			
6.2	Supply and Demand 2			
6.3	Generation of Electricity 1			
6.4	Generation of Electricity 2			
6.5	Source to Consumer 1			
6.6	Source to Consumer 2			
6.7	Heat in the Home 1			
6.8	Heat in the Home 2			

Some questions in the pack are marked with symbols to give you specific information. Here is the key:

CR Credit Level question. This relates directly to the Credit Level learning outcomes.

PS Problem Solving question. This puts the knowledge you have gained into new contexts.

ENERGY MATTERS
Study Guide

Section 1 - Supply and Demand

Energy is vitally important to our survival. In the world today, we consume huge quantities of energy in heating, manufacturing and transport. All of this energy must come from somewhere. At the moment, most of our energy still comes from fossil fuels.

Fossil fuels are running out, though, and alternative supplies of energy must be found. These should be safe, plentiful, and environmentally friendly. At the same time, we have to look at ways of conserving our supplies of fossil fuels.

At General level, by the end of this section you should be able to:

- ❑ 1. State that fossil fuels are our main source of energy at the moment.
- ❑ 2. State that reserves of fossil fuels are *finite* - *i.e.* they will run out one day.
- ❑ 3. State and explain one method of conserving energy in:
  - a) *Industry*;
  - b) *The home*;
  - c) *In transport*.
- ❑ 4. Carry out calculations relating to energy supply and demand involving the units *gigawatts* and *gigajoules*.
- ❑ 5. Classify sources of energy as renewable or non-renewable.

Additionally, at Credit level you should also be able to:

- ❍ 6. Explain the advantages and disadvantages of at least *three* renewable energy sources.

ENERGY MATTERS
Study Guide

Section 2 - Generation of Electricity

The main type of energy used in our homes and industry is electricity. It is chosen because of its convenience and cleanliness. It is produced in a variety of power stations: coal, oil or gas burning; nuclear, and hydro, for example. Each of these has its particular advantages and disadvantages, but the disadvantages of nuclear power stations, whilst major, are probably the most publicised yet least understood.

In each energy conversion, some energy is "lost". Energy cannot be destroyed, however, and this energy is really wasted as low temperature heat energy. This cannot be used, and is scattered into the atmosphere. Because of this, the efficiency of any power station is much less than 100%.

At General level, by the end of this section you should be able to:

❑ 1. Identify, **from a diagram**, the energy transformation at each stage of:
  a) a thermal power station (coal, oil or gas fired);
  b) a hydroelectric power station;
  c) a nuclear power station.

❑ 2. State that nuclear reactors produce radioactive waste.

❑ 3. Carry out calculations on energy transformations using the principle of *conservation of energy*.

❑ 4. Describe the principle of a pumped hydroelectric scheme.

❑ 5. Give the advantages of a pumped hydroelectric scheme.

Additionally, at Credit level you should also be able to:

❍ 6. Compare energy output from equal masses of coal and nuclear fuel.

❍ 7. Carry out calculations involving efficiency of energy transformations.

❍ 8. State that in every energy transformation, some energy is wasted as heat and/or sound.

❍ 9. Explain in simple terms a nuclear chain reaction.

ENERGY MATTERS
Study Guide

Section 3 - Source to Consumer

Reliable and efficient electric generators are the basis of the electricity production industry. The alternating voltage they produce can be stepped up or down to different values as required by transformers. This allows very high voltages to be used for energy transmission over long distances in the National Grid and Super Grid systems, so reducing the power loss in cables. At the place of use, the voltage is transformed down to a safer and usable value.

At General level, by the end of this section you should be able to:

❑ 1. Identify the circumstances in which a voltage will be induced in a conductor.

❑ 2. Identify, **on a diagram**, the main parts of an *a.c.* generator.

❑ 3. State that transformers are used to change the size of an *a.c*. voltage.

❑ 4. Describe the physical structure of a transformer.

❑ 5. Carry out calculations involving primary voltage (V_p), secondary voltage (V_s), number of turns in the primary coil (N_p), and in the secondary coil (N_s).

❑ 6. State why high voltages are used in electricity transmission.

❑ 7. Describe the stages in the transmission of electrical energy by the National Grid system.

Additionally, at Credit level you should also be able to:

❍ 8. In addition to ***2*** above, explain how an *a.c*. generator works.

❍ 9. State the main differences between an *a.c*. generator, a car's alternator and a simple dynamo.

❍ 10. State the three factors that affect the size of the induced voltage and explain the effect of each.

❍ 11. Explain why a transformer is not 100% efficient.

❍ 12. In addition to ***5*** above, carry out calculations involving primary and secondary voltages (V_p & V_s), turns ratio (N_p & N_s), primary and secondary currents (I_p & I_s), power (P) and efficiency.

❍ 13. Carry out calculations involving power loss in transmission lines.

Section 4 - Heat in the Home

A large proportion of the electricity used in our homes is used to produce heat: for space heating; for cooking; etc. Because of the high cost of electricity, it is important to keep the loss of this heat to a minimum. This can be done by various methods of insulation - plastic foam in cavity walls, double glazing, draught proofing, etc.

It is common knowledge that the water in a kettle, once boiling, does not get any hotter. The heat energy coming from the element is used to change the water from its liquid state to its gaseous state and is called latent heat. Latent heat is useful in some applications such as cooling ice cream by solid carbon dioxide, refrigeration and picnic box coolant keeping the food cold.

At General level, by the end of this section you should be able to:

- ❑ 1. Use the following terms correctly: *temperature*, *heat* and *Celsius*.
- ❑ 2. Describe methods for reducing heat loss due to conduction, convection and radiation.
- ❑ 3. State that heat loss depends on temperature *difference* between the inside and the outside of a house.
- ❑ 4. Carry out calculations involving heat energy (E_h), mass (m), specific heat capacity (c) and temperature change (ΔT).
- ❑ 5. Give examples of applications which involve a change of state (*e.g.* a refrigerator or picnic box).
- ❑ 6. Use these terms correctly: *specific heat capacity*, *change of state*, *latent heat of fusion*, *latent heat of vaporisation*.
- ❑ 7. State that a change of state does not involve a change in temperature.
- ❑ 8. State that energy is absorbed or given out by a substance as it changes state.

Additionally, at Credit level you should also be able to:

- ❍ 9. Use the principle of *conservation of energy* to carry out calculations on energy transformations which also involve temperature changes; *i.e.* $E_e = ItV = E_h = cm\Delta T$.
- ❍ 10. Carry out calculations involving specific latent heat (L), heat energy (E_h) and mass (m).

ENERGY MATTERS
Homework Exercises

Homework 6.1 – Supply and Demand I

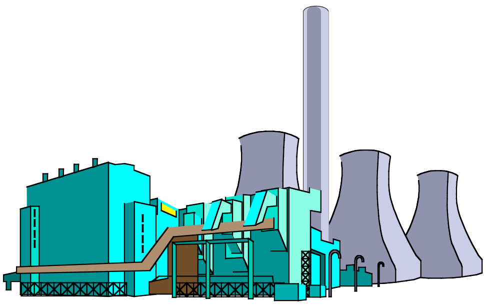
1. (a) Name the three main fossil fuels. (1)
   (b) These fuels are known as non-renewable sources. What does this mean? (1)

2. Explain how the following reduce energy consumption in home, industry and transport:
   (a) Giant fans are fitted to the ceiling of some factories. (1)
   (b) Some power stations are designed to pump hot water from their heat transfer system to local factories and homes. (1)
   (c) Commuters are encouraged to use trains and buses rather than their own cars. (1)
   (d) Dripping hot water taps should be turned off properly. (1)

PS

3. A power station uses 1.5 million tonnes of coal in a year (1 tonne = 1000 kg). On average, each kilogram of coal supplies 2.8×10^7 J of heat energy.
   (a) What is the power station's total energy consumption in 1 year? (2)
   (b) The power station is only 40% efficient. This means that its energy output in one year is only 1.68×10^{16} J.

   Calculate the power output of the station. Take one year to be roughly 31.5×10^6 s. (2)

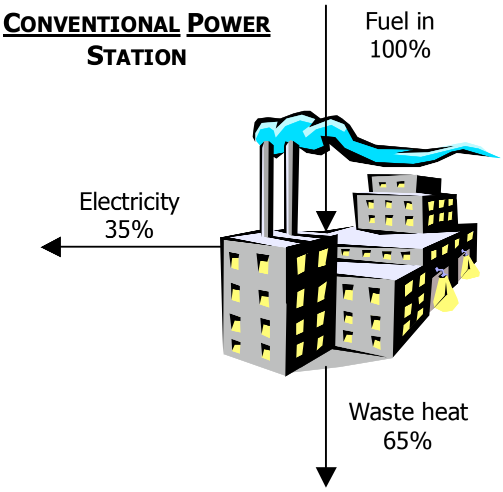


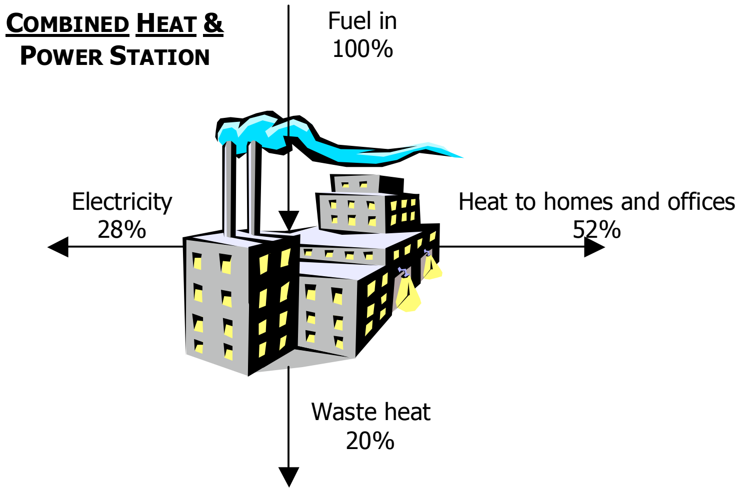
Total 10 marks

Homework 6.2 - Supply and Demand II

PS

1. The diagrams below show how a combined heat and power (CHP) station uses its energy compared with a conventional power station. The fuel input in each case is 200,000 GJ.





(a) What is the percentage drop in production in electrical energy when switching to a CHP station? (1)
(b) How much of the waste heat is saved by a CHP station (in Joules)? (2)

2. Make a table with two columns called *renewable energy sources* and *non-renewable energy sources*. Put each of these sources into the correct column.

solar; wind; coal; waves; uranium; natural gas; geothermal; oil. (2)

CR

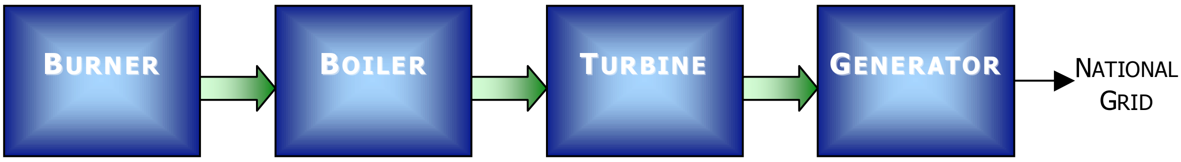
3. Copy and complete this table. Remember to leave enough room in each row to explain the advantages and disadvantages fully! (5)

ENERGY SOURCE	ADVANTAGE	DISADVANTAGE
Solar		
Wave		
Hydroelectricity		
Geothermal		
Wind		

Total 10 marks

Homework 6.3 – Generation of Electricity I

1.



The sketch shows a block diagram of a coal-fired (thermal) power station.
State the main energy change that occurs at each of the four stages. (2)

2. Thermal power stations and nuclear power stations both use heat energy to boil water, but their methods are different.

   (a) Which fuel is used in a nuclear power station? State the energy change that takes place as this fuel is used. (1)

   (b) Which fuels are commonly used in thermal power stations? (1)

3. Nuclear power stations can produce electricity as cheaply as coal fired power stations and they do not give out carbon dioxide or acid gases. Why are so many people opposed to them? (1)

4. (a) In a hydroelectric power station, there is no boiler. Where does the energy come from to drive the turbine? (1)

   (b) In a pumped storage system, water is pumped back up into the reservoir during the night. Why is this done? (1)

5. (a) A kilogram of uranium-235 can release 8.19×10^{13} J of energy. How many tonnes of coal equivalent is this if one t.c.e. = 2.8×10^{10} J? (2)

   (b) A large coal-fired power station will burn about 4 million tonnes of coal per year.
   How much uranium-235 would a nuclear power station use to produce the same amount of energy? (1)

Total 10 marks

Homework 6.4 - Generation of Electricity II

1. A loch on the mountains can hold 20 million tonnes of water and is 300m above a suitable site for a power station.

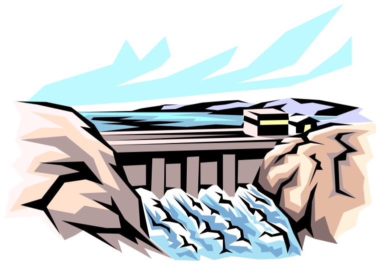
   (a) If water flows out of the loch at the rate of 1500 kg per second, calculate the potential energy transferred each second. (1)

   (b) What is the power station's maximum power output? (2)

2. In a pumped storage hydroelectric scheme, the upper loch is 500m above the lower loch. When it is full, it stores 500,000 kg of water.

   (a) If the pumps are taken to be 100% efficient, how much energy must be supplied to completely fill the upper loch with water? (2)

   (b) If all the water is allowed to run down the pipeline in 4 hours and the generators are 80% efficient, how much power would be available from this plant? (2)



3. A crane, driven by a petrol engine, lifts several 750 kg cars to the top of a 13m high stack of scrap vehicles. One litre of petrol can supply 33.3 MJ of energy.

   (a) Assuming that no energy is lost, how many cars could be lifted to the top of the stack on 1 litre of petrol? (2)

   (b) The actual number would be far less than this due to the engine being inefficient. State one way in which energy is wasted in the engine. (1)

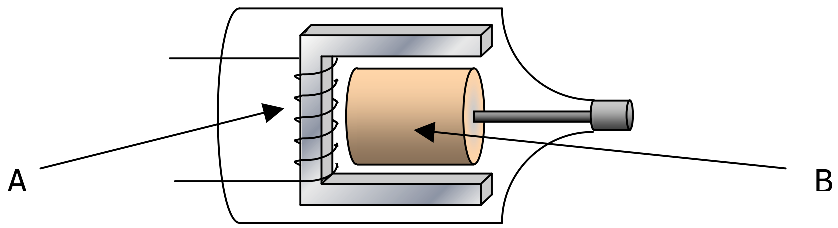
Total 10 marks

Homework 6.5 – Source to Consumer I

1. While doing an experiment, Jane connects a coil of wire to a voltmeter. With the aid of a permanent magnet, she produces a reading on the meter.

   There are two ways Jane could have used the equipment to produce a voltage. What are they? (2)

2. (a) The diagram shows the inside of a bicycle dynamo. Name the parts labelled '**A**' & '**B**'. (2)



   (b) What type of voltage does this dynamo produce, *ac* or *dc*? (1)

PS (c) As '**B**' turns, the magnetic field around it changes.
   How would a cyclist produce a bigger output voltage from the dynamo? (1)

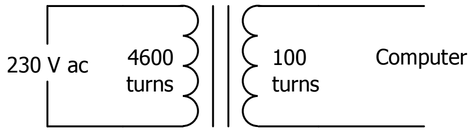
   (d) What is '**B**' replaced by in a generator? (1)

CR 3. Name the three factors that affect the size of the induced voltage and explain the effect of each. (3)

Total 10 marks

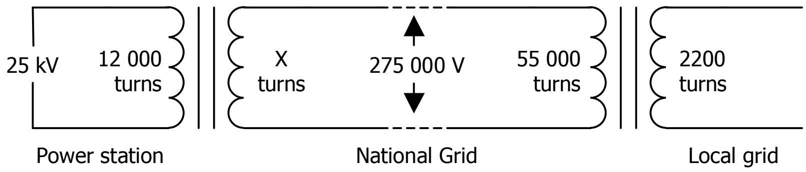
Homework 6.6 - Source to Consumer II

1. The transformer shown below allows a computer to operate properly from the 230 V mains.



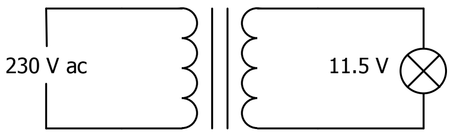
(a) State a transformer's function. (1)
(b) Copy the above diagram and label the core, primary coil & secondary coil. (1)
(c) Calculate the computer's operating voltage. (2)

2. A power station generates electricity at 25 kV. This voltage is stepped up to 275 000 V for the National Grid by a transformer as shown below. A few hundred miles away, another transformer in a substation steps the voltage back down for the local grid.



(a) Calculate the number of turns in the secondary coil of the step-up transformer (marked **x** in the diagram). (1)
PS (b) Calculate the size of the voltage used in the local grid. (1)
(c) Why are such large voltages used for the National Grid? (1)

CR 3. A transformer used to allow a projector to run from a 230 V mains is shown below:



(a) The current drawn from the mains is 0.1 A. Calculate the output current, assuming the transformer is 100% efficient. (2)
(b) In practice, transformers are not 100% efficient. Give one reason why not. (1)

Total 10 marks

Homework 6.7 – Heat in the Home I

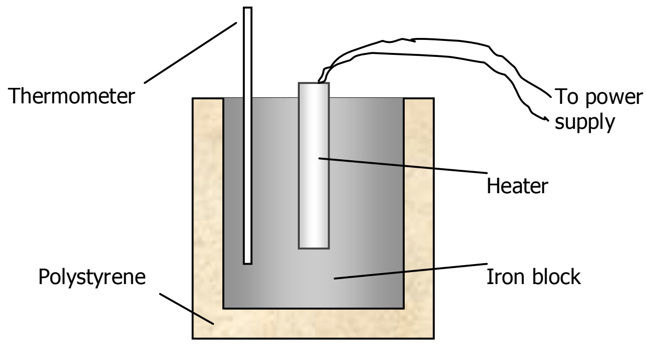
1. (a) Give a definition of temperature. (1)
   (b) What unit is temperature measured in? (½)

2. (a) Describe one way of reducing convection heat losses in a house. (½)
   (b) Describe one way of reducing radiation heat losses in a house. (½)
   (c) Describe one way of reducing conduction heat losses in a house. (½)

3. Assuming the specific heat capacity of water to be 4200 J/kg°C, how much heat energy is required to:

   (a) Heat 1 kg of water in a kettle from 20°C to 100°C? (2)
   (b) Heat 400 litres of water in a tank from 20°C to 60°C? (1 litre of water has a mass of 1 kg) (2)

4. In an experiment to determine the specific heat capacity of iron, the following experiment is set up:



The block of iron has a mass of 2 kg. The heater is left on for 5 minutes and it supplies 6000 J of heat energy to the block in this time. The temperature rises from 20°C to 26.25°C.

   (a) What value do these figures give for the specific heat capacity of iron? (2)
   (b) Why was the block encased in polystyrene? (1)

Total 10 marks

Homework 6.8 - Heat in the Home II

1. When a liquid changes to a gas, it takes heat energy in from its surroundings.

   (a) What must happen to the temperature of the surroundings? (1)
   (b) What happens to the temperature of the liquid as it changes to a gas? (1)
   (c) Give an example of an everyday use for this principle. (1)

2. Use your knowledge of latent heat to explain the following situations:

   (a) In desert countries, water is stored in skin bags that are slightly porous to keep it cool. Some water leaks out of the pores. (1)
   (b) A climber is more likely to suffer from hypothermia in mild, wet and windy weather than on a calm, frosty day. (1)

3. A 2 kW kettle contains 1.5 kg of water. Its automatic cut-off is broken, meaning it will not switch off when it starts to boil. The specific latent heat of vaporisation for water is 2.26×10^6 J/kg.

   (a) Calculate how much heat energy would be required to turn all of the water into water vapour. (2)
   (b) How long would the kettle take to evaporate all the water? (1)

4. The specific latent heat of fusion for ice is 3.3×10^5 J/kg. What mass of water could be turned into ice if a freezer removed 165 000 J of heat energy? (2)

Total 10 marks