

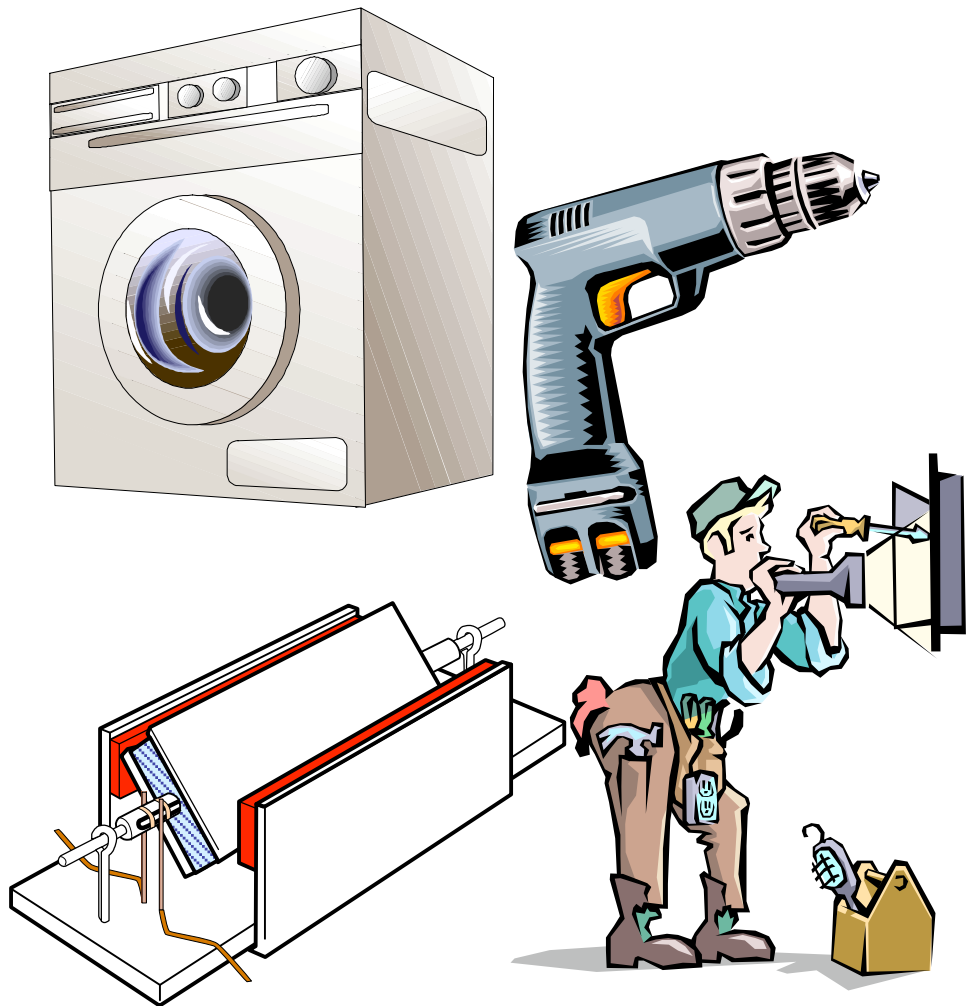
# Standard Grade Physics

Number :

Name:

## Thurso High School Physics Department

### UNIT 2 USING ELECTRICITY PUPIL PACK



Study Guides  
Summary Notes  
Homework Sheets

# USING ELECTRICITY

## *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
2.1	From the Wall Socket 1			
2.2	From the Wall Socket 2			
2.3	Alternating and Direct Current 1			
2.4	Alternating and Direct Current 2			
2.5	Resistance 1			
2.6	Resistance 2			
2.7	Useful Circuits 1			
2.8	Useful Circuits 2			
2.9	Behind the Wall			
2.10	Movement from Electricity 1			
2.11	Movement from Electricity 2			

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



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



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

# USING ELECTRICITY

## *Study Guide*

### Section 1 - From the Wall Socket

*Electricity is very important in the modern world. It is used in offices, factories, hospitals and for transport. In this section, you will be thinking about the safe use of electricity in the home.*

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

- 1. Describe the mains supply or a battery as a supply of electrical energy.
- 2. Describe the main energy changes in some household appliances.
- 3. State approximate power ratings of different household appliances.
- 4. Choose the correct flex for an appliance if you are given its power rating.
- 5. State that the fuse in a plug is intended to protect the flex.
- 6. Choose the correct fuse for an appliance if you are given its power rating.
- 7. Give the correct colour of insulation for the *live*, *neutral* and *earth* wires.
- 8. State to which pin each wire must be connected in a plug, extension socket or lamp holder.
- 9. State that the human body is a conductor of electricity.
- 10. State what water does to this ability to conduct.
- 11. State that the earth wire is a safety device.
- 12. State that appliances do not require an earth wire if they have the double insulation symbol.
- 13. Draw the double insulation symbol.
- 14. Explain why situations involving electricity could result in accidents.

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

- 15. In addition to **11** above, explain how the earth wire acts as a safety device.
- 16. Explain why fuses and switches must be in the live lead.

# USING ELECTRICITY

## *Study Guide*

### Section 2 - Alternating and Direct Current

*In this section you will find out about the differences between electricity from the mains and electricity from a battery.*

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

- 1. State that the mains supply is *a.c.*
- 2. State that a battery supply is *d.c.*
- 3. Explain what *a.c.* and *d.c.* mean in terms of current.
- 4. State that the frequency of the mains supply is 50 Hz.
- 5. State that the mains voltage is 230 V.
- 6. Draw and identify the circuit symbol for the following components:  
*cell; battery; fuse; lamp; switch; resistor; variable resistor; capacitor; diode.*
- 7. State that electrons are free to move in a conductor.
- 8. Describe electric current in terms of moving charges.
- 9. State that the unit of current is the ampere (*A*) and that the unit of voltage is the Volt (*V*).

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

- 10. State that the quoted value of an alternating voltage is less than its peak value.
- 11. Carry out calculations involving the relationship between charge (*Q*), current (*I*) and time (*t*).
- 12. State that the unit of charge is the Coulomb (*C*).
- 13. State that the voltage of a supply is a measure of the energy given to the charges in a circuit.

# USING ELECTRICITY

## *Study Guide*

### Section 3 - Resistance

*All electrical conductors have some 'resistance'. This means that some electrical energy is changed to heat as the current flows around the circuit.*

*In this section you will use electrical meters to investigate how the resistance of a circuit affects the size of the current and the amount of energy used.*

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

- 1. Draw and identify the circuit symbols for an ammeter and a voltmeter.
- 2. Draw circuit diagrams to show the correct positions of an ammeter and a voltmeter in a circuit.
- 3. State that in a circuit, an increase in resistance leads to a decrease in current.
- 4. Carry out calculations involving the relationship between resistance ( $R$ ), current ( $I$ ) and voltage ( $V$ ).
- 5. State that the unit of resistance is the ohm ( $\Omega$ ).
- 6. Give two practical uses of variable resistors.
- 7. State that when there is an electric current in a wire, there is an energy transformation.
- 8. Give three examples of household circuits that use resistors to transform electrical energy to heat energy.
- 9. State that the electrical energy transformed each second =  $VI$ .
- 10. Carry out calculations involving the relationship between power ( $P$ ), current ( $I$ ) and voltage ( $V$ ).
- 11. State the relationship between energy and power.
- 12. Use the terms *energy*, *power*, *joule* and *watt* correctly and in context.
- 13. State that electrical energy is transformed to heat and light in a lamp.
- 14. State that the energy transformation in an electric lamp takes place in:  
the *wire* for a filament lamp;  
the *gas* for a discharge tube.
- 15. State that a discharge tube is more efficient than a filament lamp.
- 16. State that the energy transformation in an electric heater takes place in the element.

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

- 17. State that for a resistor, the ratio  $V/I$  remains approximately constant for different currents.
- 18. Explain why power can be calculated using  $P = I^2R$
- 19. Carry out calculations using this relationship between power ( $P$ ), current ( $I$ ) and resistance ( $R$ ).

# USING ELECTRICITY

## *Study Guide*

### Section 4 - Useful Circuits

*In this section you will find out about some rules which control the design of electric circuits and investigate some circuits used in cars and at home. You will also learn how to test for electrical faults.*

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

- 1. State a practical example in the home that needs two (or more) switches used in series.
- 2. State that in a series circuit, the current is the same at all points.
- 3. State that in a parallel circuit, the sum of the currents in the parallel branches is equal to the current drawn from the supply.
- 4. State that in a series circuit, the sum of the voltages across the components is equal to the voltage of the supply.
- 5. State that in a parallel circuit, the voltage across each branch is the same.
- 6. Explain that connecting too many appliances to one socket can be dangerous because a large current may be drawn.
- 7. Describe how to make a simple continuity tester.
- 8. Describe how this continuity tester may be used for fault finding.

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

- 9. Draw circuit diagrams to show how various car lighting circuits work.
- 10. Carry out calculations involving resistances in series:

$$R_t = R_1 + R_2 + \dots$$

- 11. Carry out calculations involving resistances in parallel:

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

# USING ELECTRICITY

## *Study Guide*

### Section 5 - Behind the Wall

*In this section you will find out about the wiring in houses (but not enough for you to try anything dangerous at home!)*

**NOTE: THE WIRING SYSTEM IN A HOUSE IS COMPLEX AND DANGEROUS.  
YOU MUST NOT INTERFERE WITH IT.**

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

- 1. State that household wiring connects appliances in parallel.
- 2. State that the mains fuse protects the mains wiring.
- 3. State that a circuit breaker is an automatic switch that can be used in place of a fuse.
- 4. State that a kilowatt-hour (*kWh*) is a unit of energy.

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

- 5. Describe a ring main circuit using a diagram.
- 6. State the advantages of the ring main over a simple parallel circuit.
- 7. Give two differences between the lighting circuit and the ring main circuit.
- 8. State a reason why a circuit breaker may be used instead of a fuse.
- 9. Explain the relationship between kilowatt-hours (*kWh*) and joules (*J*).

# USING ELECTRICITY

## *Study Guide*

### Section 6 - Movement from Electricity

*Electric motors are used in the home in washing machines, tape recorders, toys, central heating pumps and many other devices. They are also used in industry and transport.*

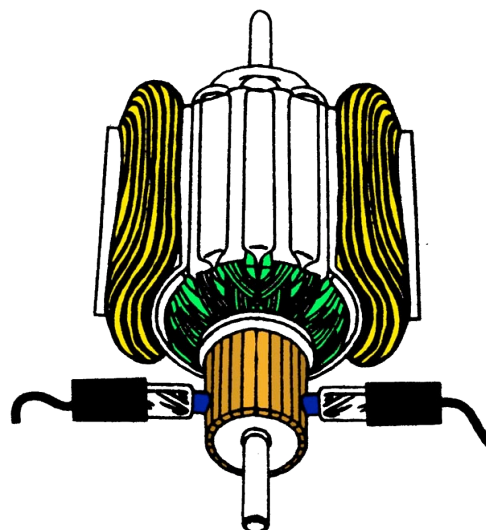
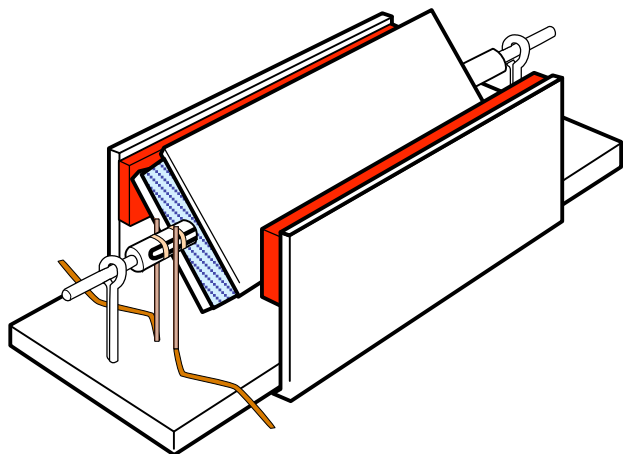
*In this section, you will find out about electric motors and other devices that use electricity to make movement.*

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

- 1. On a diagram of a simple electric motor, identify the following parts:  
*rotating coil;*  
*field coil;*  
*brushes;*  
*commutator.*
- 2. State that a magnetic field exists around a current carrying wire.
- 3. Give two examples of applications that make use of this fact.
- 4. State that a current carrying wire experiences a force when it is in a magnetic field.

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

- 5. In addition to 4 above, state that the direction of the force on a current carrying wire depends on two things:  
*the direction of the magnetic field;*  
*the direction of the current.*
- 6. Explain the operation of a simple *d.c.* electric motor in terms of forces acting on the coil.
- 7. Explain the purpose of the brushes and the commutator in a motor.
- 8. In commercial motors, explain why the following are used:  
*carbon brushes;*  
*multi-section commutators;*  
*field coils.*



# USING ELECTRICITY

## *Homework Exercises*

### Homework 2.1 - From the Wall Socket I

1. For each appliance, fill in the correct energy change. (3)

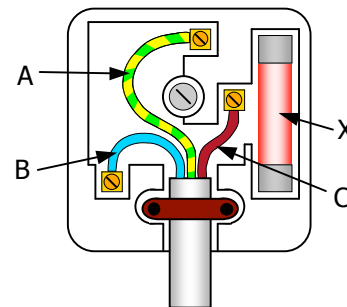
APPLIANCE	MAIN ENERGY TRANSFORMATIONS
Lamp	Electrical →
Vacuum Cleaner	Electrical →
Iron	Electrical →
Fan Heater	Electrical →
Television	Electrical →
Hi-fi	Electrical →

2. Copy and complete the table below: (2)

APPLIANCE	POWER RATING	FUSE
Clock	10 W	
Table lamp	60 W	
Iron	1200 W	
Kettle	2000 W	

3. The questions below refer to this diagram:

- Make a table to show which wires (A, B or C) are the live, neutral and earth wires.
- Add another column to your table to show which colours of insulation each wire should have.
- Name the part of the plug labelled 'X', and say what its function is.



(1½)

(1½)

(2)

**Total 10 marks**

# USING ELECTRICITY

## Homework Exercises

### Homework 2.2 - From the Wall Socket II

1. What does water do to the human body's ability to conduct electricity? (1)

PS

2. Information about flex sizes is given in the table below:

CONDUCTOR SIZE	MAXIMUM POWER (W)	FLEX USED FOR	MAXIMUM CURRENT (A)
0.50 mm <sup>2</sup>	750	Lamps, hairdryers, hi-fi	3
0.75 mm <sup>2</sup>	1500	Fridges, TVs, cleaners	6
1.00 mm <sup>2</sup>	2400	Electric drills, kettles	10
1.25 mm <sup>2</sup>	3200	Electric fires, extensions	13
1.50 mm <sup>2</sup>	4000	Lighting circuits	16
2.50 mm <sup>2</sup>	7200	Sockets, immersion heaters	30
10.00 mm <sup>2</sup>	6000 - 12 000	Cookers, instant showers	60

- (a) What is the maximum current that a 1.00 mm<sup>2</sup> flex is expected to carry? (1)
- (b) What size of flex would be needed for an appliance rated at 13.5 A? (1)
- (c) A pupil states that if the size of a flex is doubled, it will be able to carry double the current. Do you agree with this? Use values from the table to justify your answer. (1)
- (d) If a flex of cross-sectional area 0.75 mm<sup>2</sup> were to be used with an appliance rated at 13 A, what energy transformation could take place in the flex? Explain your answer. (1)
3. (a) Draw the double insulation symbol. (1)
- (b) Which wire is not required in the flex of these appliances? (1)

CR

4. Fuses, switches and earth wires are all safety devices.
- (a) Explain **how** the earth wire acts as a safety device. (2)
- (b) Why must the fuse and any switches be placed in the live lead? (1)

**Total 10 marks**

# USING ELECTRICITY

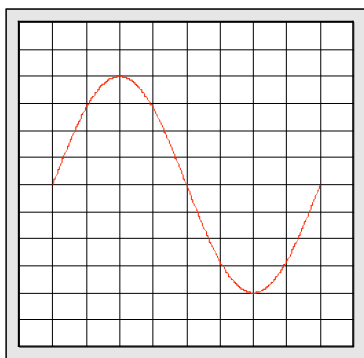
## Homework Exercises

### Homework 2.3 - Alternating and Direct Current I

1. Explain what alternating current and direct current mean, and state the type of supply (mains or battery) that produces each. (3)
2. (a) What is the value of the mains voltage in Scotland? (½)  
(b) What is the frequency of the mains supply? (½)
3. Construct a table showing the following components with their correct symbol:  
*cell; bulb; resistor; diode* (2)



4. Look at this oscilloscope pattern:



- (a) Is this trace representing ac or dc input? (1)
- (b) If the gain is set at 2 V per division, what is the peak voltage of the trace? (1)
- (c) Describe what would happen to the trace on the screen if a 3 V source was used instead. Use the words frequency and amplitude in your answer. (1)



5. How does the *peak* value of an alternating voltage compare to its quoted value? (1)

**Total 10 marks**

# USING ELECTRICITY


## *Homework Exercises*

### Homework 2.4 - Alternating and Direct Current II

1. State the symbol, the correct unit and the shortened form of the unit in the appropriate columns for each of the quantities listed. The first one has been done for you. (2)

QUANTITY	SYMBOL	UNIT	UNIT SYMBOL
time	t	second	s
current			
voltage			

2. What is an electric current? (1)

-  3. (a) Calculate the charge that passes along a wire if a current of 10 A flows for 30 seconds. (2)  
(b) Calculate the charge that passes through a bulb if it draws a current of 500 mA for 8 seconds. (2)  
(c) 12 Coulombs pass through a lamp in 6 seconds. What is the current flowing through the lamp? (2)

-  4. What is the definition of the voltage of a supply? (1)

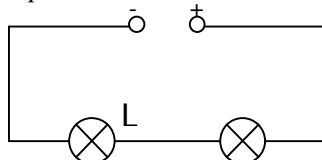
**Total 10 marks**

# USING ELECTRICITY

## Homework Exercises

### Homework 2.5 – Resistance I

1. Draw this circuit diagram carefully in your homework jotter, adding the circuit symbol for an **ammeter** in position to measure the current through lamp L. Then add the circuit symbol for a **voltmeter** in position to measure the voltage across lamp L. (2)

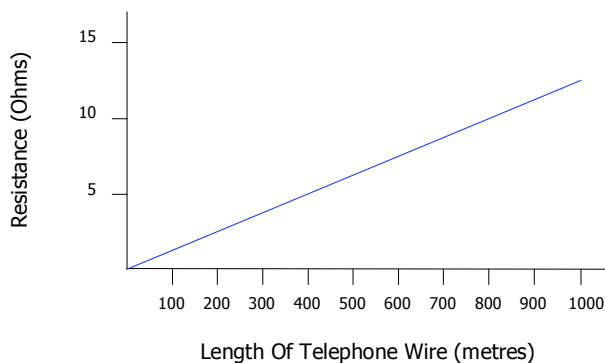


2. What happens to the current in a circuit when the resistance is increased? (1)
3. Variable resistors can be used in two main ways – to alter voltage, or to alter current.
- (a) What do we call the variable resistor when it is set up to alter the size of the current in the circuit? (1)
- (b) What do we call the variable resistor when it is set up to alter the size of the voltage over the resistor? (1)
4. A lamp has a resistance of  $960\ \Omega$ . It needs to draw a current of  $0.25\ \text{A}$  to operate at its correct brightness. What size of voltage does it need? Use Ohm's law to calculate the answer. (2)



PS

5. The graph below shows how the resistance of telephone wire varies with length.



- (a) From the graph, what will be the resistance of a length of wire 400 metres long? (1)
- (b) Use this answer to calculate the resistance of a piece of wire 20 000 m long. (1)
- (c) The electrical signals must be boosted at regular intervals in order for the signal to remain strong enough. One amplifier is required for every  $50\ \Omega$  of resistance.

Calculate the number of amplifiers needed for the 20 000 m long piece of wire in part (b). (1)

**Total 10 marks**

# USING ELECTRICITY

## *Homework Exercises*

### Homework 2.6 – Resistance II

1. Name 3 electrical devices from the home that use resistors to convert electrical energy into heat. You should only list devices that do this on purpose – for instance, televisions heat up, but you don't switch on the TV to heat the room! (1)

2. (a) A 1200 W hair dryer is connected to the mains (230 V). Calculate the current drawn. (2)  
(b) The dryer is used for 5 minutes. How much electrical energy is used in this time? (2)



3. Match the heads and tails of the sentences, and then copy them into your jotter: (2)

The energy transformation in a filament wire occurs in	the gas.
The energy transformation in a discharge lamp occurs in	light.
In a lamp, electrical energy is transformed into	heat.
In a resistive circuit electrical energy is transformed into	the resistance wire.

4. Which is more efficient at transferring electrical energy to light - a filament lamp or a gas discharge lamp? (1)



5. A 100 W light bulb is found to draw a current of 0.43 A when it is operating correctly. Use this information to calculate the resistance of its filament. (2)

**Total 10 marks**

# USING ELECTRICITY

## *Homework Exercises*

### Homework 2.7 – Useful Circuits I


1. Give one example from your home where two switches are used in series to switch on an appliance. (1)
  
2. (a) Draw a circuit diagram for a circuit that has three lamps in series attached to a battery pack, and add a switch that controls all three lamps. (1)  
(b) If the three lamps are rated as "6 V, 0.06 A", calculate the **supply voltage** needed to allow them to operate properly. (2)  
(c) What size of current will be drawn from the battery? Explain why it is this value. (2)
  
3. (a) Draw a circuit diagram for a circuit that has three lamps in parallel attached to a battery pack, and add a switch that controls all three lamps. (1)  
(b) If the three lamps are rated "6 V, 0.06 A", calculate the current drawn from the battery pack. (1)  
(c) What size voltage must the battery be to allow them to operate properly? Explain why it is this value. (2)

*Total 10 marks*

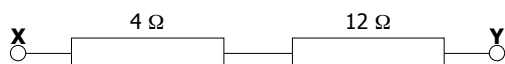
# USING ELECTRICITY

## Homework Exercises

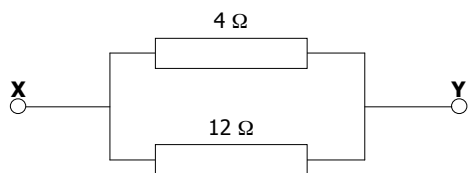
### Homework 2.8 – Useful Circuits II

- Draw a circuit diagram for a simple continuity tester using an L.E.D. and a battery. (2)
  - Describe how this equipment would be used to check for faults in a circuit. (1)
- A pupil uses an ohmmeter to check a circuit for open and short circuits.
  - How would a short circuit be identified using the ohmmeter? (1)
  - How would an open circuit be identified using the ohmmeter? (1)
- Why can connecting too many appliances to one socket be dangerous? (1)
-  Calculate the equivalent resistance between **X and Y** in each of the following networks, showing all the working for each one: (4)

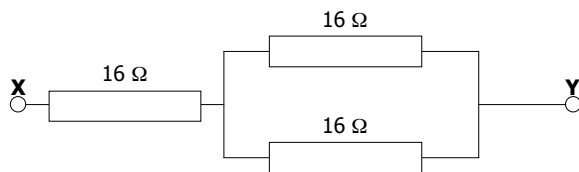
(a)



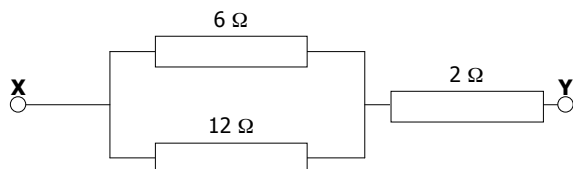
(b)



(c)



(d)



**Total 10 marks**

# USING ELECTRICITY

## *Homework Exercises*

### Homework 2.9 – Behind the Wall

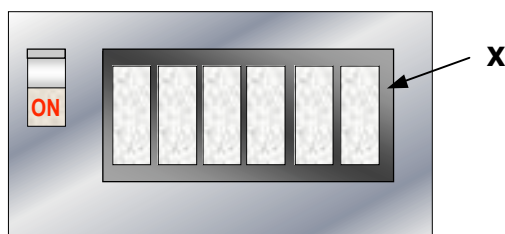
1. Answer the following questions about household wiring:

- (a) How are appliances connected in household wiring – in series or in parallel? (1)
- (b) What is the purpose of the mains fuses? (1)
- (c) What is a circuit breaker? (1)
- (d) Electricity bills are made up based on a unit called the *kilowatt-hour*. What physical quantity is measured in kilowatt-hours? (1)



- 2. (a) Give two reasons why the ring circuit is the preferred method for wiring sockets in parallel. (2)
- (b) Sketch a circuit diagram of a ring circuit with three sockets connected to it. Label each wire drawn. (2)

3. Look at this diagram. It is a piece of equipment placed in every home by the Electricity Board.



- (a) Name this piece of equipment. (1)
- (b) The part labelled X in the diagram holds several fuses or circuit breakers. Give one reason why a circuit breaker would be preferable to a fuse. (1)

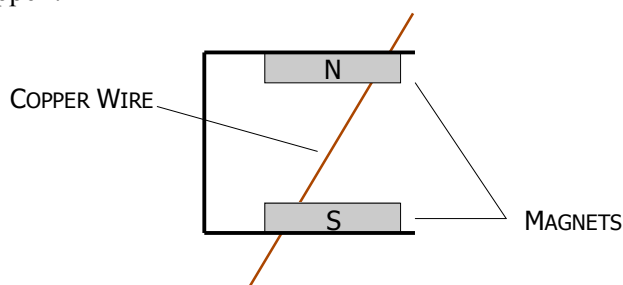
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# USING ELECTRICITY

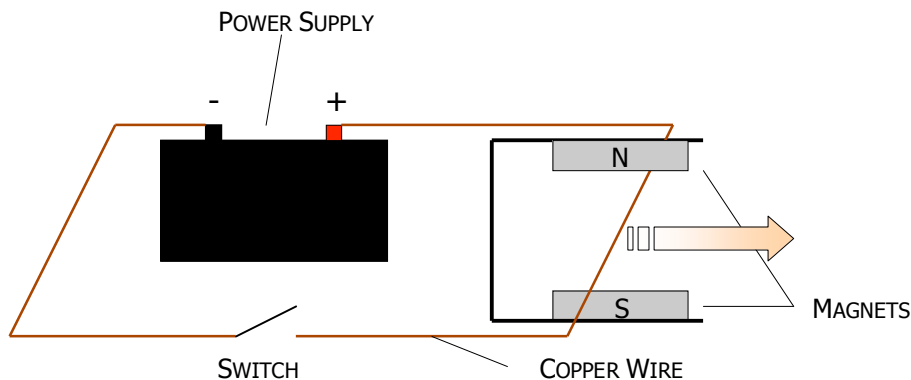
## *Homework Exercises*

### Homework 2.10 – Movement from Electricity I

1. (a) What exists around a wire when an electric current flows through it? (1)
- (b) If the wire is wrapped into a coil, what does the coil become when a current flows through it? (1)
- (c) List two practical applications that make use of this effect. (2)
  
2. A wire is placed in a magnetic field as shown. When a current flows through the wire, what happens to it? Why does this happen? (2)



- CR** 3. In the diagram below, the copper wire moves to the right when the switch is closed. Describe **two** ways of getting the wire to move to the left when the switch is closed. (2)



4. Draw the circuit symbol for a reed relay. (1)
  
  - PS** 5. A magnet can destroy data stored on a computer floppy disc. This is because the floppy disc stores data magnetically. (1)
- Why could placing the disc on a piece of electrical equipment destroy the data? (1)

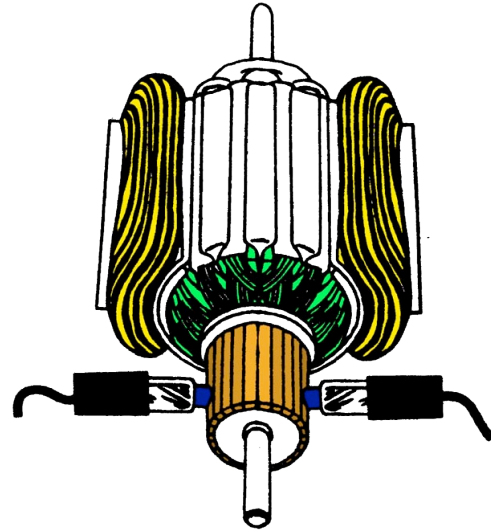
**Total 10 marks**

# USING ELECTRICITY

## *Homework Exercises*

### Homework 2.11 – Movement from Electricity II

1. Label this diagram to show the four main parts of an electric motor. The parts are listed in the table for *question 2*.



(2)

- CR** 2. Copy the following table, and complete it to show the function of each part of an electric motor:

(4)

PART	FUNCTION
Rotating coil	
Field coil	
Brushes	
Commutator	

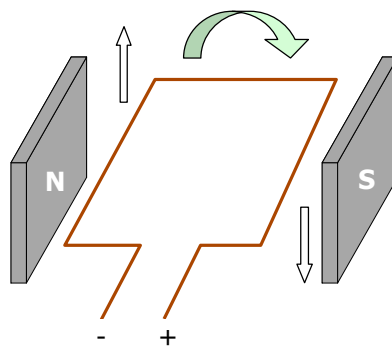
- CR** 3. Commercial motors use improved components to offer a better performance. Instead of wire brushes, carbon is used. The split-ring commutator is replaced with a multi-segment commutator.

Explain the benefit gained from each of these changes.

(2)

- CR** 4. A simple DC motor comprises a loop of current-carrying wire in a magnetic field. Explain why the loop of wire rotates as shown. You must mention the current direction and the force on each part of the loop in your answer.

(2)



**Total 10 marks**