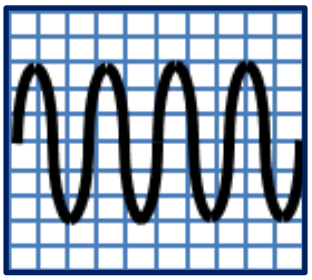
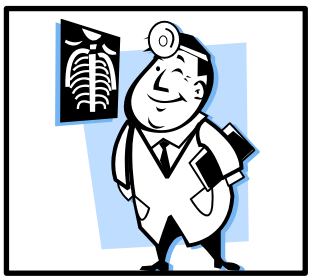
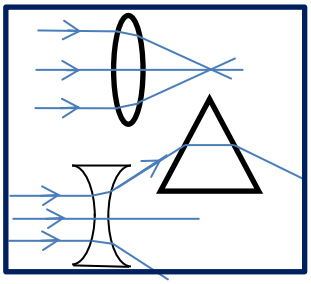
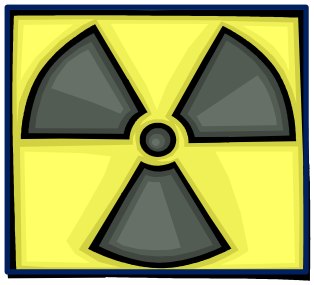
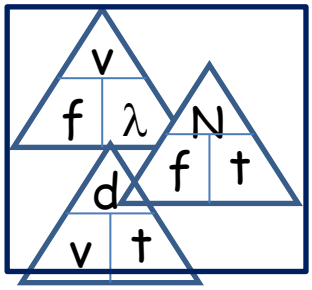
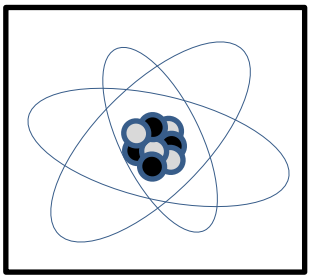
Cumbernauld Academy

National 4&5 Physics



Electricity and Energy Homework

Homework 1. - Current, Potential Difference and Electrical Charge

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.

QUANTITY	SYMBOL	UNIT	UNIT SYMBOL
time	t	second	s
current			
voltage			

(2)

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. (3)

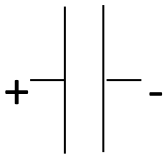
   (b) Calculate the charge that passes through a bulb if it draws a current of 500 mA for 8 seconds. (3)

   (c) 12 Coulombs pass through a lamp in 6 seconds. What is the current flowing through the lamp? (3)

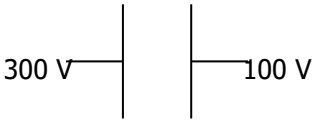
4. What is the definition of the voltage of a supply? (1)

5. Draw the electric field around the following charges. You must show the direction of the field clearly. (4)

(a) 

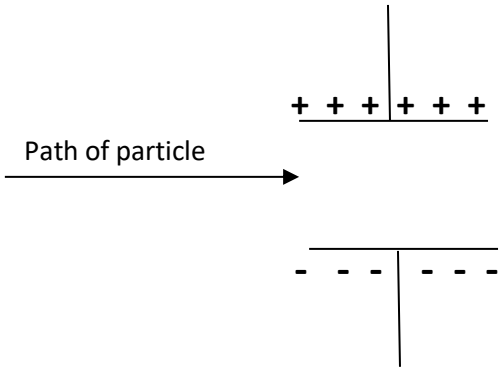
(b) 

6. Look at the following diagram.



What is the potential difference between the two plates? (1)

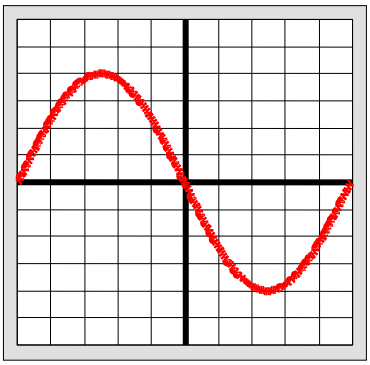
7. Sketch the paths which (a) an α-particle,
(b) a β-particle,
and (c) a neutron,
would follow if each particle entered the given electric field with the same velocity. (2)



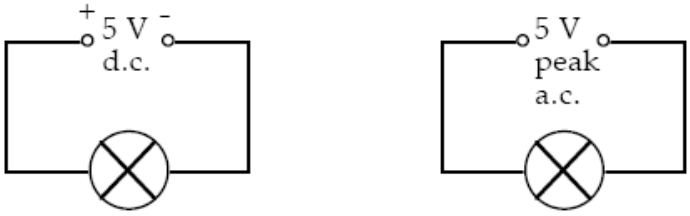
Total 20 marks

Homework 2. - AC & DC

1. Explain what alternating current and direct current mean, and state the type of supply (mains or battery) that produces each. (3)
2. (a) State the value of the mains voltage in Scotland?
   (b) State the frequency of the mains supply? (2)
3. Look at this oscilloscope pattern:



   (a) Is this trace representing ac or dc input? (1)
   (b) If the gain is set at 1.5V per division, what is the peak voltage of the trace? (1)
   (c) Describe what would happen to the trace on the screen if a 3V source was used instead. Use the words frequency and amplitude in your answer. (2)
4. How does the ***peak*** value of an alternating voltage compare to its quoted value? (1)
5. Two identical bulbs are lit by the supplies shown below.

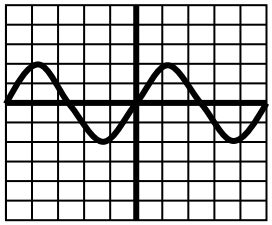


   (a) Which bulb will be the brighter? Explain your answer. (2)
   (b) The d.c supply is altered so that both bulbs have the same brightness. The a.c. supply remains at the 5 V peak value. Was the d.c. supply increased or decreased? (1)
6. The Y- gain of a CRO is set at 2V/division. Taking each line in your jotter as one division, draw the trace seen for
   (a) 5V d.c.
   (b) 4V a.c.

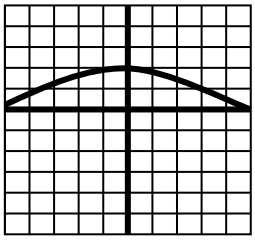
PTO

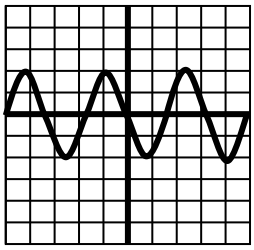
Q7 on the next page

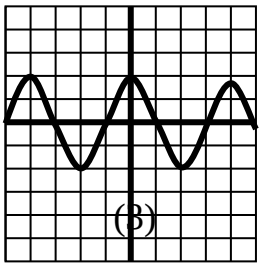
7. When this trace was seen on the CRO screen, the input frequency was 50 Hz.



Several other signals were connected to the CRO, without changing the controls. What is the frequency of each of them?

(a) 

(b) 

(c) 

(8)

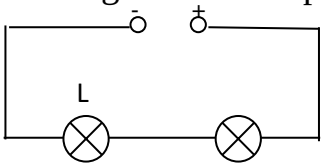
Total 20 marks

Homework 3. - Series and Parallel Circuits

1. Construct a table showing the following components with their correct symbol:

   Cell, bulb, resistor, diode, variable resistor, voltmeter, ammeter, fuse (4)

2. 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)



3. What happens to the current in a circuit when the resistance is increased? (1)

4. Give one example from your home where two switches are used in series to switch on an appliance. (1)

5. (a) Draw a circuit diagram for a circuit that has three lamps in series attached to a battery, 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)

6. (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. (2)

   (b) If the three lamps are rated "6 V, 0.06 A", calculate the current drawn from the battery pack. (2)

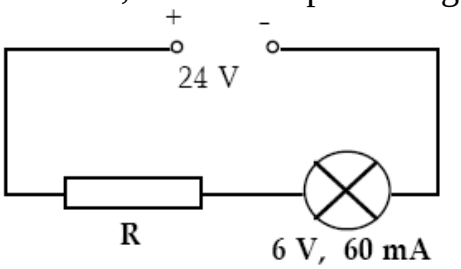
   (c) What size voltage must the battery be to allow them to operate properly? Explain why it is this value. (2)

7. Why is household wiring connected in parallel? (1)

Total 20 marks

Homework 4. - Ohm's Law and Resistance

1. The diagram below shows a 6 V, 60 mA lamp working off a 24 V supply.



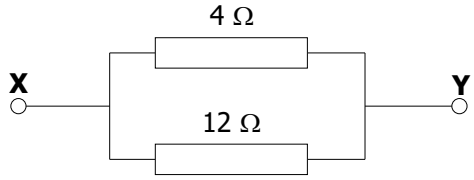
(a) What must be the potential difference across the resistor if the lamp is operating correctly? (2)

(b) Calculate the value of the resistance of resistor R. (3)

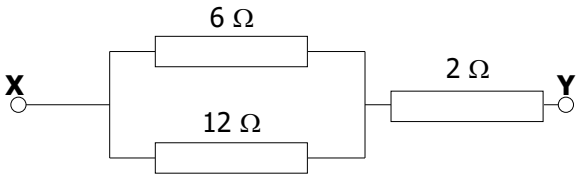
2. A lamp has a resistance of 960 Ω. It needs to draw a current of 0.25 A to operate at its correct brightness. What size of voltage does it need? (3)

3. Calculate the equivalent resistance between **X and Y** in each of the following networks, showing all the working for each one:

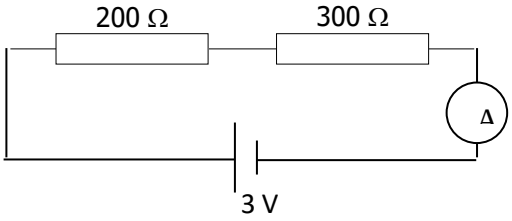
(a) (3)



(b) (4)



4. Find the reading on the ammeter in the following circuit. (3)



5. An electrician has five 100 Ω resistors. State the highest and lowest resistances she can make using these resistors. (2)

Total 20 marks

Homework 5. - Electrical Power

1. (a) A hair dryer connected to the mains (230 V) draws a current of 5.2 A. Calculate the power of the hairdryer. (3)

   (b) The dryer is used for 5 minutes. How much electrical energy is used in this time? (3)

2. An electric fire is rated at 2 kW, 230 V.
   (a) What is the current in the heating element when it is switched on? (3)

   (b) Calculate the resistance of the heating element. (3)

3. Calculate the power rating of a heater, working off the mains voltage of 230 V, which has a resistance of 53 Ω. (3)

4. Calculate the power rating of a car radio of resistance 6 Ω drawing a current of 2 A. (3)

5. Using the formulae V = IR and P = IV, show that

   (a) $P = I^2 R$ ***(2)***

   (b) $P=V^2/R$

Total 20 marks

Homework 6. - Generation of Electricity &Energy Transformations

1. 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. (2)
   (b) Which fuels are commonly used in thermal power stations? (1)

2. 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)

3. (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)

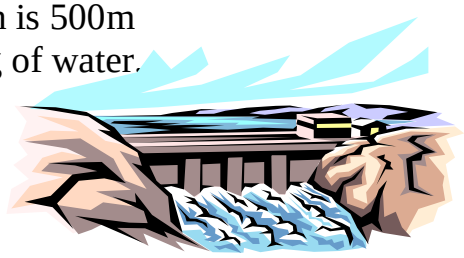
4. One kilogram of uranium can release 8.19×10^{13} J of energy, while 1 tonne of coal releases only 2.8×10^{10} J. How many tonnes of coal release the same amount of energy as 1 kg of Uranium?

   (2)

5. 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. (3)
   (b) What is the power station's maximum power output? (2)

6. 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? (3)
   (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? (4)

Total 20 marks

Homework 7. - Electromagnetism

1. Copy the diagrams below and add lines with arrows to show the magnetic fields.

(a) 

(2)

(b) 

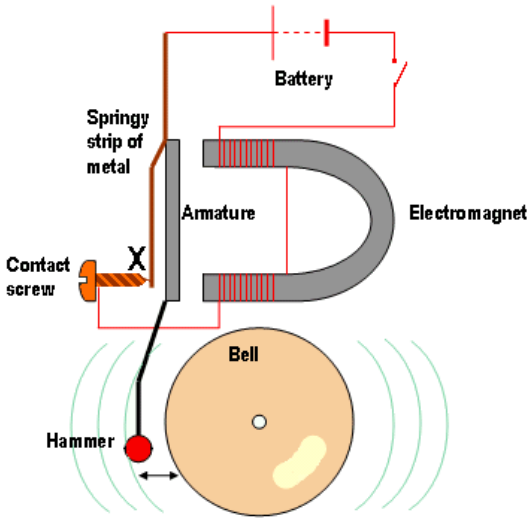
(2)

(c) 

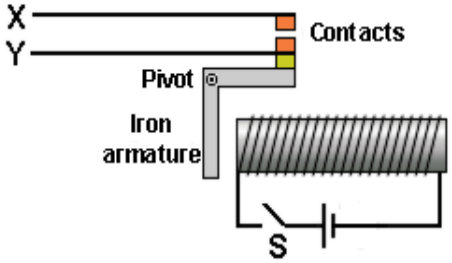
(2)

2. (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) State 3 ways in which this device can be made stronger. (3)

3. (a) Use the following diagram to explain how an electric bell works. (4)



(b) Use the following diagram to explain how a relay switch works. (3)



   (c) Explain why relay switches are used. (1)
   (d) State one other use of electromagnets. (1)

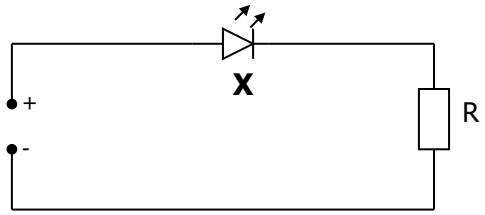
Total 20 marks

Homework 8. - Output Devices

1. Copy and complete the following table: (5)

OUTPUT DEVICE	SYMBOL
	
Motor	
	
Solenoid	
	

2. State an output device which could be used in each of the following:
   (a) a walkie-talkie (1)
   (b) a power-on indicator (1)
   (c) a calculator display (1)
   (d) a time-lock bolt on a safe (1)

3. 

   (a) Name the component marked **X** in the circuit. (1)
   (b) What would happen in the circuit if component **X** was connected the opposite way around? (1)
   (c) Why must there always be a resistor in series with this component? (1)

4. An LED is attached to a 6 V supply. An excerpt from its data sheet is given below:

   Maximum forward voltage: *2.7 V*
   Maximum forward current: *110 mA*

   (a) Draw a circuit diagram that will allow this LED to light safely. (4)
   (b) Calculate the value of the resistor needed. (4)

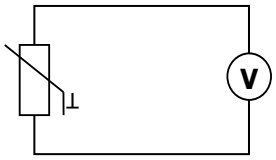
Total 20 marks

Homework 9. - Input Devices

1. Copy and complete the following table: (3)

INPUT DEVICE	ENERGY CHANGE
solar cell	→
	heat → electrical
microphone	→

2. A girl decides to find out how a thermistor could be used to investigate temperature changes. She sets up the following circuit:



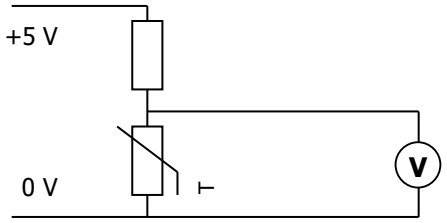
(a) Suggest why this circuit is not suitable for her purpose. (1)
(b) Explain how she could change the circuit. (1)

3. Use the following list of input devices to choose the most appropriate input for the following systems: (4)

microphone; solar cell; LDR; switch; voltage divider; capacitor; thermistor.

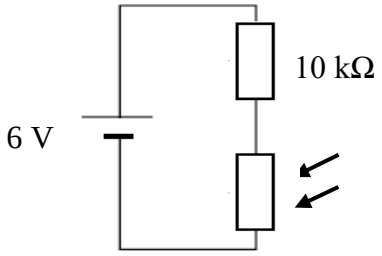
(a) Karaoke machine
(b) Automatic camera flash
(c) Temperature control in a fish tank
(d) Time delay switch on a burglar alarm

4. The circuit shown below was set up. The thermistor used has its resistance vary with temperature as show in the table. The fixed resistor has a value of 1000Ω.



TEMPERATURE (°C)	RESISTANCE (Ω)
20	1000
50	700
100	100

(a) What is the reading on the voltmeter at room temperature (20 °C)? (2)
(b) The thermistor is now heated to 100 °C. Calculate the new reading on the voltmeter. (4)



5. The LDR in the following circuit has a resistance of 500 Ω in daylight and 8.5 kΩ in darkness.

(a) Calculate the voltage across the LDR at noon, (4)

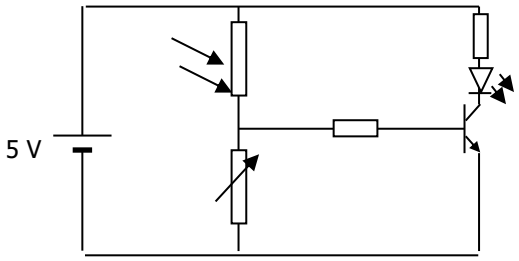
(b) What is the voltage across the 10 kΩ resistor at this time (1)

Total 20 marks

Homework 10. - Transistors & Switching Circuits

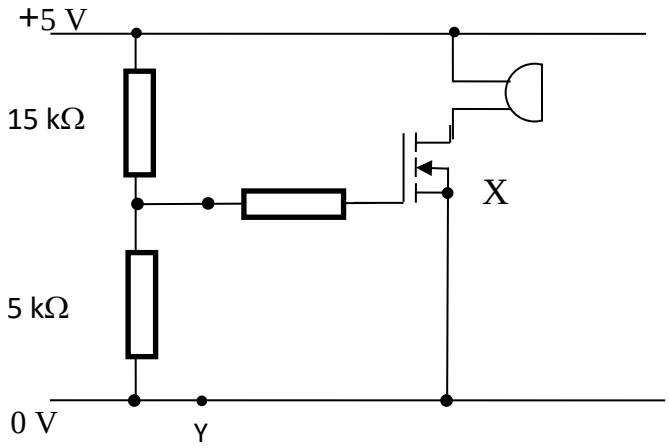
1. (a) Draw the circuit symbol for an npn transistor, and label each terminal. (3)
   (b) Give one use for a transistor in an electronic circuit. (1)

2. A circuit is designed to give a warning when the light level falls too low. Explain how the circuit works.



(3)

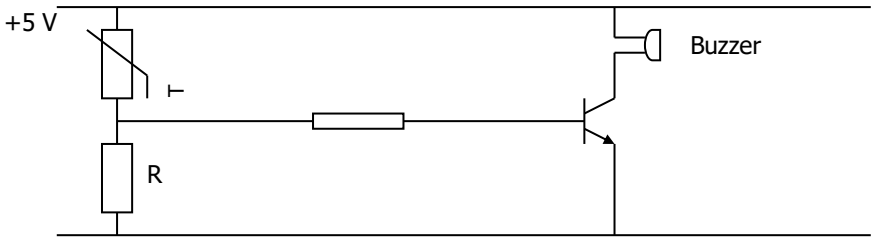
3.



(a) (i) In the above circuit name component X. (1)
(ii) Copy the circuit symbol for this component, and label each terminal. (2)

(b) (i) Calculate the potential difference across the 5 kΩ resistor. (3)
(ii) State whether the buzzer is ON or OFF.
Explain your answer. (2)

4. The circuit shown below is used as an alarm.



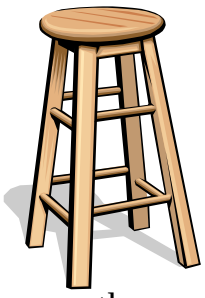
(a) The thermistor is positioned in a car engine. At normal engine temperatures, the transistor is OFF. What will happen if the engine overheats? (1)

(b) Explain how this circuit works. (4)

Total Marks 20

Homework 11 - Gas Laws and Kinetic Theory

1. The stools in the physics rooms have four round feet, each with a surface area of approximately 1 cm^2. The physics teachers complain that when people swing onto just one leg of the stool, the flooring under it is damaged. For the purposes of this problem, take the average mass of a pupil to be 60 kg.



(a) Calculate the area of one of the stool's feet in **m^2**. (1)

(b) Calculate the pressure exerted on the floor when all four feet are on the ground (as they should be!) (3)

(c) Calculate the pressure exerted on the floor when just one foot is on the ground. (1)

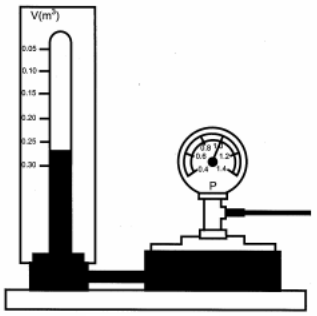
2. A car has its tyres inflated to a pressure of 240 kPa on a day when the temperature is 5 °C. The car is then driven for several hours, and the temperature of the tyres is found to have risen to 35 °C.

(a) Assuming the mass and volume of the air in the tyres has remained constant, calculate the new pressure in the tyres. (3)

(b) Explain why this happens to the pressure as the temperature rises, making reference to the kinetic theory of gases. (2)

3. In preparation for a party, a balloon is inflated to a volume of 0.5 m^3 in a cold room (0 °C). During the party, the room temperature rises to 22 °C.
Calculate the new volume of the balloon, assuming the pressure inside it remains constant. (3)

4. A student carries out an experiment to investigate the relationship between pressure and volume of a fixed mass of gas at a constant temperature using the apparatus shown.



The student obtained the following readings.

Pressure/Pa	1·15 x 10^5	1·21 x 10^5	1·27 x 10^5	1·33 x 10^5
Volume/m^3	0·250	0·238	0·226	0·216

(a) Using **all** of the data, establish the relationship between the pressure and volume of the gas. (4)

(b) Explain the change in pressure with volume in terms of the movement of the gas particles. (2)

Total 20 marks