Electricity Revision

Question 1 - DGC 2008 Q4

Supply of Electricity **[20 Marks]**

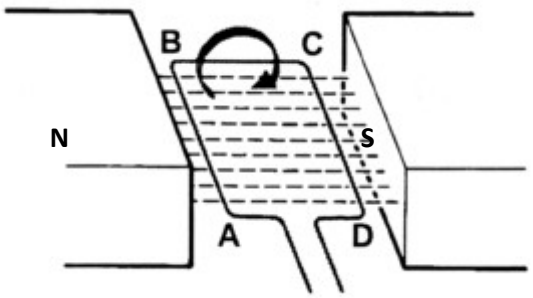
With the problems faced by Eskom in maintaining sufficient electricity supply in recent months, the development of viable alternative energy resources becomes even more important. This, in addition to considerations relating to global warming, will ensure that practical developments relating to hydroelectric and wind power remain of great significance.

In South Africa, hydroelectric power is generated at the Gariep and Vanderkloof stations (along the Orange River); Drakensberg station (KwaZulu-Natal) and the Palmiet station (Western Cape). In a hydroelectric plant, falling water is directed onto a ***water turbine*** *through special high-pressure tunnels.*

Eskom has erected three ***wind turbines*** *at Klipheuwel in the Western Cape to investigate the feasibility of wind energy as a source of power In South Africa.*

In any power plant, turbines are coupled to an ac generator which is in turn coupled to a transformer. The electric current is then distributed to transformers of sub-stations via power lines.

1.1 Consider the following simplified diagram of a portion of an ac generator:



1.1.1 **Name** and give the **function** of the apparatus that would be connected to the ends of the rotating coil of this ac generator. (2)

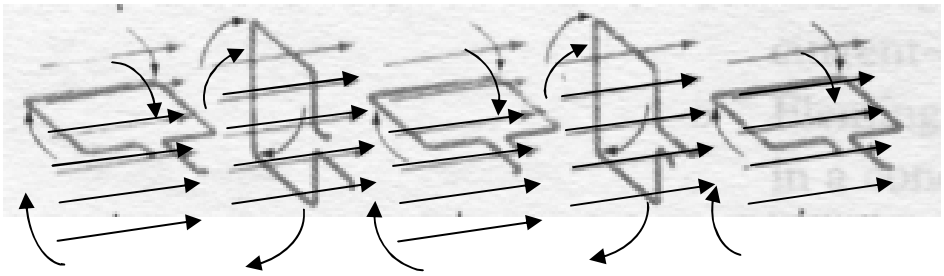
1.1.2 The coil is rotated in a magnetic field. Use Faraday's Law to explain why the induced current in the coil increases when the rate of rotation of the coil in a magnetic field increases. (3)

1.1.3 Will the current flow *clockwise* (ABCD) or *anticlockwise* (DCBA) through the coil as it is pictured? (1)

1.1.4 Electrical energy is conveyed long distances in overhead pylons, at a very high voltage but a low current. Explain why high voltage and low current are preferable for long distance transmission. (2)

1.2 Electricity supplied by Eskom has a frequency of 50 Hz. Therefore the coil of the ac generator makes one complete cycle in 0,02 s.

The following diagrams show one complete cycle of the coil:



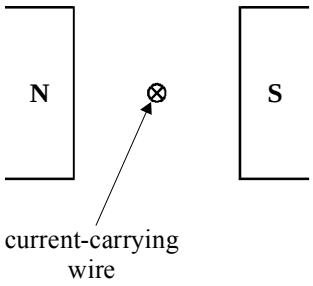
1.2.1 Draw a sketch graph of current strength vs. time for the complete cycle of the coil, giving values on the time axis. You need not give values on the axis showing current strength. (5)

1.2.2 A generator has an electrical power output of 6000W. How much electrical work can be done by the appliances connected to this generator, in 20 minutes, assuming no energy losses? (3)

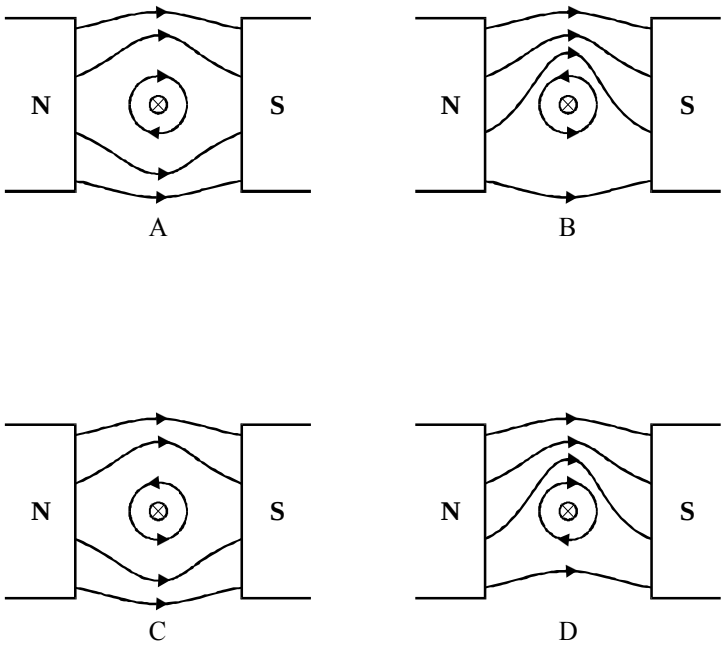
1.3 Briefly discuss the use of wind power to provide electricity, from both an environmental and an economic perspective. (4)

Question 2 - St Andrew's Girls Q11

The diagram below shows a wire carrying a large electric current between the poles of a magnet so that the current flows vertically into the paper.



2.1 Which one of the following gives the best representation of the magnetic flux pattern in the region between the poles of the magnet?

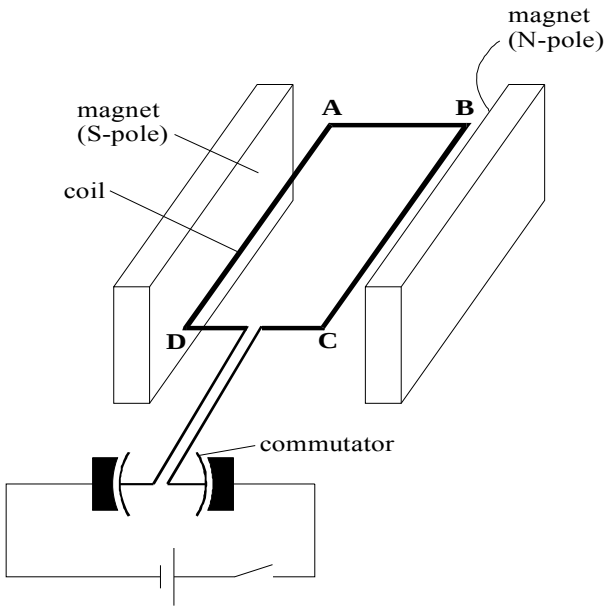


(2)

2.2 In which direction does the current carrying wire experience a force? (2)

2.3 Describe 3 ways in which the size of this force could be increased. (3)

The figure below shows a simple d.c. electric motor.



2.4 Explain the operation of the simple d.c. electric motor. (4)

2.5 When the switch is closed and the current starts to flow, in which direction will the wire BC experience a force? (Upwards/downwards) (1)

2.6 State and explain the position of the coil when it experiences the minimum value of force causing rotation. (2)

2.7 An electric motor has many uses, all of which rely on energy conversion. State what type of energy conversion happens in a motor. (2)

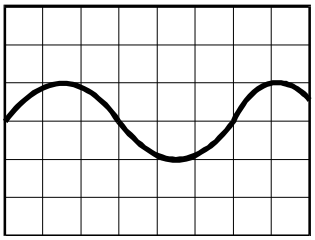
2.8 For a practical electric motor, identify two sources of energy wastage. For each, specify the location and the nature of the energy transformations that occur. (3)

[19]

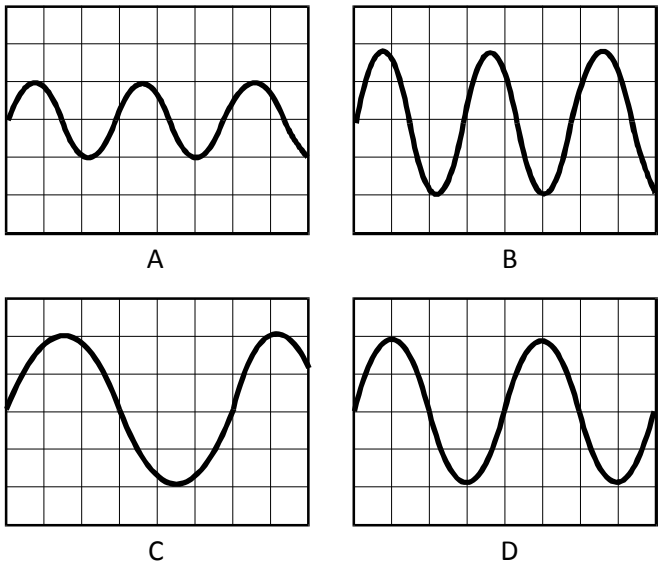
Question 3: Generating electricity. (St Andrew's Girls 2008 Q12)

With the interruption of the supply of electricity in South Africa recently many households and businesses have invested in a "generator".

3.1 The diagram below shows the waveform obtained when the output of the generator is connected to a cathode ray oscilloscope (a fancy voltmeter that allows you to see the emf produced. The amplitude is proportional to the voltage).



Which one of the following best represents the output when the speed of rotation of the generator is doubled and no adjustment is made to the oscilloscope?



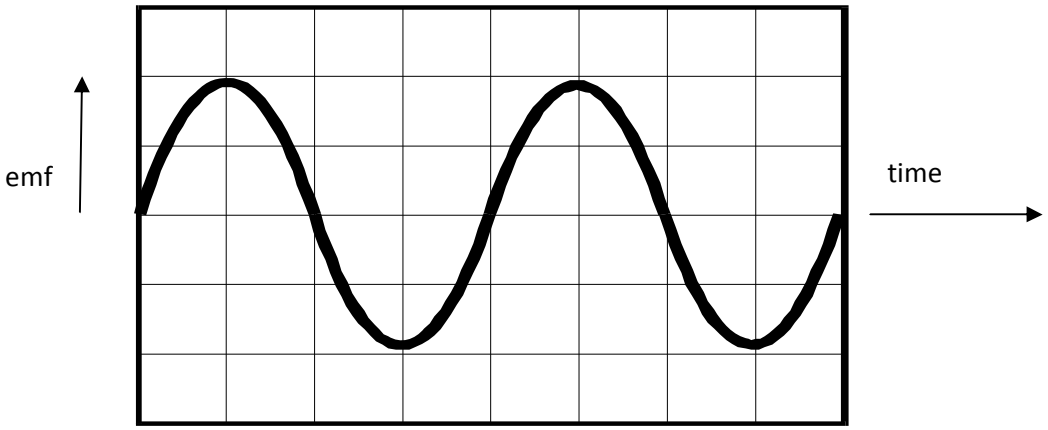
(2)

3.2 What is the difference between ac current and dc current? (2)

3.3 Often, d.c. current is needed. How would a.c. and d.c generators differ in design? (2)

3.4 On the diagram, on the answer sheet, sketch the emf that would be produced by a d.c. generator.

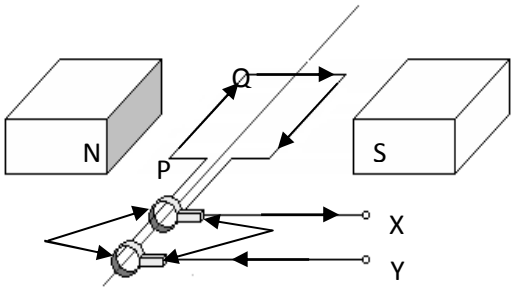
This diagram represents an emf produced by an a.c. generator. On the same diagram, sketch the emf that would be produced by a d.c. generator.



(2)

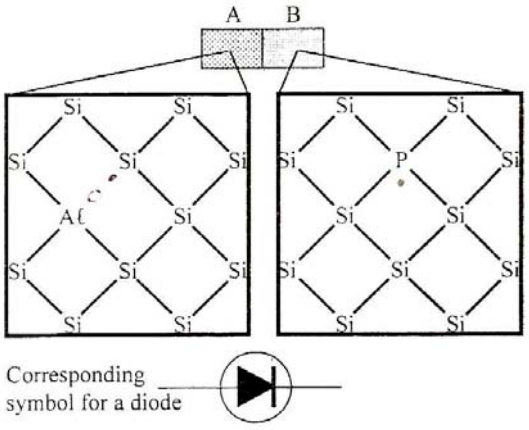
3.5 The Hoover Dam in North America generates a huge amount of electricity for that part of the country. Explain how fast flowing water can be used to do this. (3)

3.6 This is a simplified sketch that sh ıg current (AC) generator.



In which direction does segment PQ of the coil have to be rotated in order to cause the current direction as shown in the diagram? (clockwise or anticlockwise). (2)

Question 4: Electronics. (SAG 2008 Q13)

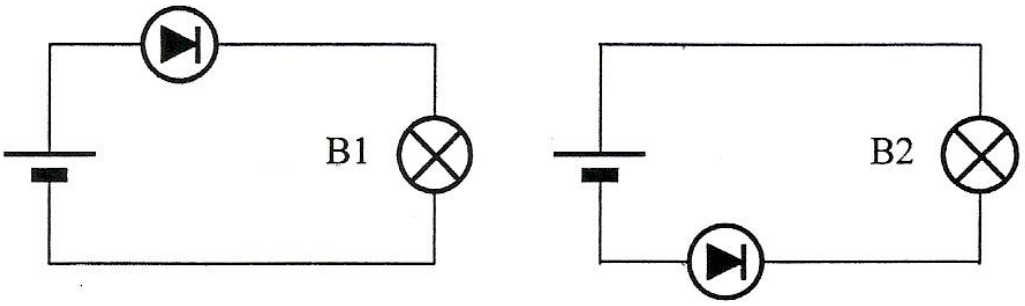


The following diagram represents a pn-junction diode labelled, A B, in the diagram. Si, P and Aℓ are the symbols for a silicon, a phosphorus and an aluminium atom respectively. A portion of the crystal lattice on each side of the diode is represented in the large squares.

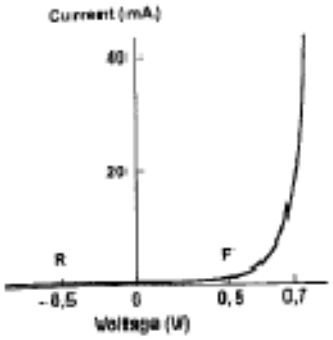
4.1 Which side , A or B, is the "p-type semiconductor material?" (1)

4.2 Explain what is meant by "n-type semiconductor material?" (1)

4.3 Which of the light bulbs in these circuits will light up? (B1 or B2) (1)



4.4 The graph below shows how current varies with potential difference across a diode.



a) Why is there no current flowing through the diode in the region marked R? (2)

b) How much current flows through the diode when the voltage across it is 0,7V? (1)

c) This diode is connected in series to a resistor R and to a 6V cell. Draw this circuit and calculate the resistance of R. (5)

4.5 Describe the structure of an LED and explain why it requires a minimum potential difference to emit light, and why the light is of a particular frequency. (3)

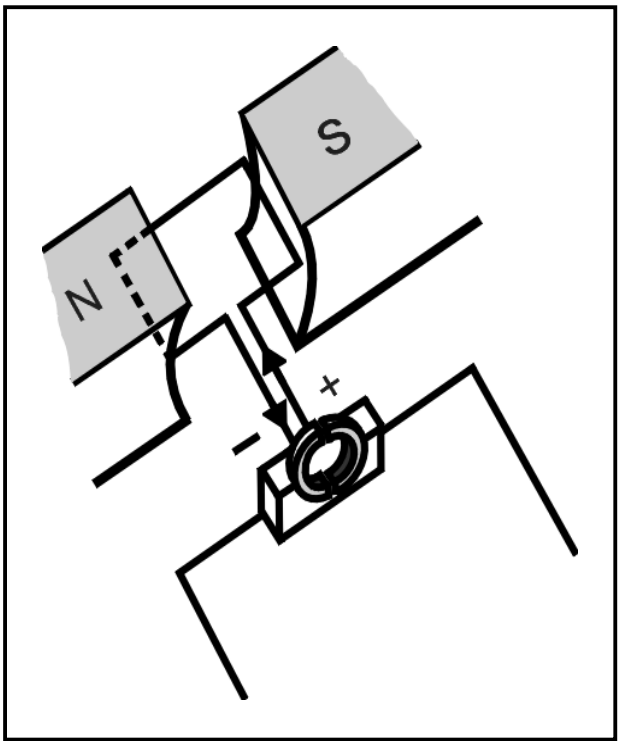
QUESTION 5 – Parklands 2008 Q10

Electric motors are an important component of many modern electrical appliances. Electric motors are described as *DC motors* or as *AC motors*.

5.1 What energy conversion takes place in all electric motors? (2)

5.2 What is the essential difference between *DC motors* and *AC motors* with regard to key components? (4)

5.3 Consider the diagram below.



(a) In which direction (clockwise or anti-clockwise) will the coiled armature rotate if the switch is closed? (1)

(b) Which law was used to determine the direction in (a) above? (1)

(c) Why does the armature continue moving once the coiled armature has reached the vertical position? (2)

[10]

Question 6 – Parklands 2008 Q11

When the Western Cape's Koeberg nuclear power station was not operating with full power output, a huge initiative was undertaken to save electricity. Read the following article carefully and then answer the questions given below.

Koeberg on track – Eskom

Refuelling and maintenance of the Western Cape's Koeberg power station would be completed and full output restored by the end of July, Eskom said on Monday.

"Koeberg Unit 2's refuelling and maintenance outage is proceeding according to schedule. The outage is planned to be completed and Unit 2 returned to full power output in the 4th week of July," company spokesperson Fani Zulu said, "whilst Koeberg Unit 2 is still being refuelled, Eskom appeals to consumers to use electricity sparingly."

Zulu said initiatives implemented recently to save electricity have been successful.

A total of 4,2 million Compact Fluorescent Lights (CFLs) have been installed throughout the Western Cape, resulting in an overall saving of 188 MW of electricity. About one million more CFLs need to be installed.

A campaign to promote the use of gas appliances has also been rolled out with much success with 15 572 appliances distributed.

"The programme to insulate geysers resulted in 54 783 geyser blankets being fitted. These two initiatives have achieved a combined saving of approximately 13.7 MW," Zulu said.

Other electricty-saving programmes have recorded savings of up to 75 MW.

The province has been plagued by power outages recently, caused by repair and maintenance work to both of Koeberg's generating units. – SAPA

Cape Argus, June 26, 2006

6.1 Why do compact fluoresent lights (CFLs) use less electricity than conventional incandescent light bulbs? (4)

6.2 What is the wisdom in using geyser blankets? (2)

6.3 Reference is made to other electricity saving programmes. Discuss at least two methods not previously mentioned. (2)

6.4 Do you think that ESKOM employed a wise strategy when distributing gas stoves? (customers using two-plate electric stoves were able to swop them for brand new free, gas stoves). Present your argument under the subheadings PROs and CONs. (4)

[12]

Question 7 – Parklands 2008 Q12

A power station generator consists of a rotating electromagnet positioned inside three sets of copper conductors. The current in each conductor is 7 500 A.

7.1 Water flows through channels inside the conductors. Why do you think that this is necessary? (2)

An initial proposal to cool underground cables suggested that liquid nitrogen be used. This is not economically viable. However, cooling the copper cables to the temperature of liquid nitrogen has one possible advantage.

7.2 What will happen to the resistance of the copper as it cools? (2)

7.3 What then happens to the electrical energy in the cable as it cools? (2)

7.4 Low currents need to be used to minimise energy losses. How is electric power generally conveyed with minimum power loss? (2)

Currently, electricity is transmitted along the National Grid using a combination of overhead and underground cables.

7.5 Why do you think overhead conductors are used in preference to underground conductors outside towns and cities? (2)

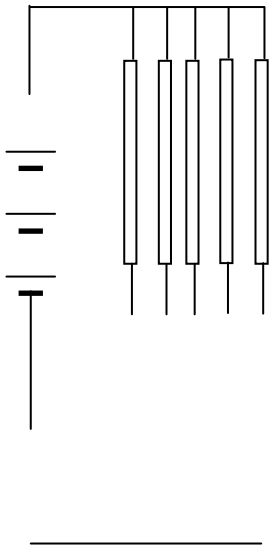
7.6 Why do you think underground conductors are used in preference to overhead conductors in towns and cities? (2)

7.7 Why are renewable sources of energy like the sun and wind only a small proportion of the electricity generated in South Africa? (4)

[16]

IEB 2002 Q8

The following diagram shows the arrangement of thin resistor wires used to heat the rear window of a motor car. Each wire has a resistance of 15 Ω. The arrangement is connected to the 12 V battery of the car. (The battery has negligible internal resistance).



8.1 What is the effective resistance of the resistance wires in the circuit? (4)

8.2 At what rate will the array of resistance wires produce heat energy? (4)

8.3 If the resistance wires were connected in series instead of parallel, explain whether you would expect a greater or lesser rate of heat production? (4)

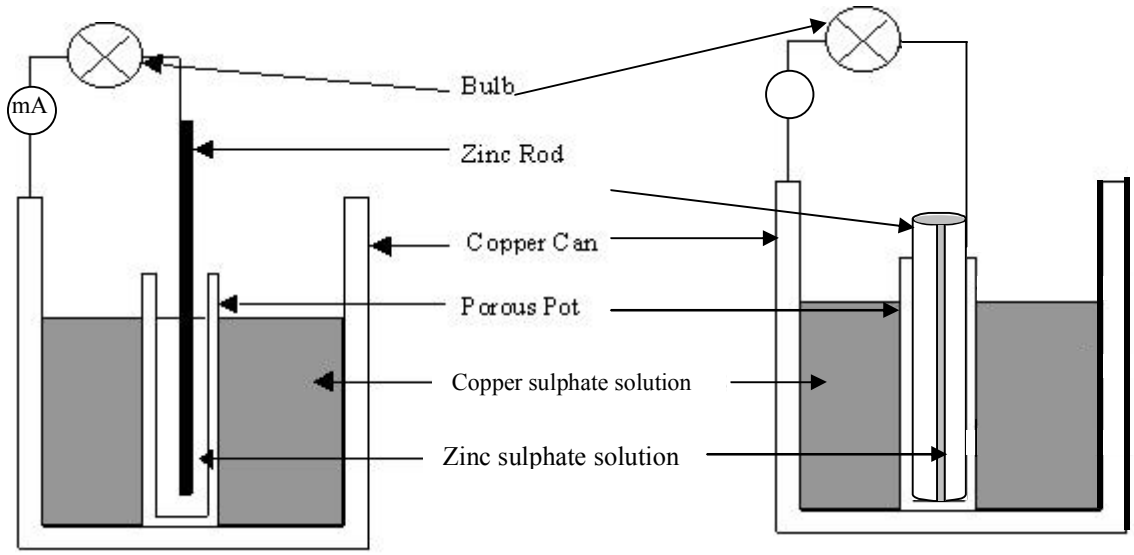
8.4 A crack forms in the rear window of the car. This crack breaks two of the resistance wires in the parallel array leaving only three working. By what factor does this change the rate at which heat energy is produced in the rear window? (4)

8.5 Before installing a new rear window made with five identical 15 Ω resistance wires a mechanic tests to see if the glass warms up. He uses a 12 V battery of internal resistance 2,5 Ω. Calculate the current that such a battery delivers to the array of five thin resistors in parallel. (4)

[20]

9.1 A Daniell cell is constructed using a zinc electrode and a copper electrode. Diagram 8.1 shows how this cell is constructed, and how a light bulb and ammeter are connected in series with the cell.

Diagram 9.1 **Diagram 9.2**



The emf of this cell is 1,10V.

The small light bulb (resistance 3,0 Ω) and a milliammeter is connected in series with the cell.

The milliammeter reads the current in this circuit as 2,5 mA.

9.1 Explain what is meant by "the emf of the cell is 1,10V". (3)

9.2 Calculate the internal resistance **r** of the cell. (4)

9.3 Two light bulbs (each of resistance 3,0 Ω) are connected in parallel with this cell. What is the new reading of the current supplied by the cell? (6)

9.4 Four of these cells are connected together in parallel.

9.4.1 What is the emf of this combination of cells? (2)

9.4.2 What is the internal resistance of this combination of cells? (2)

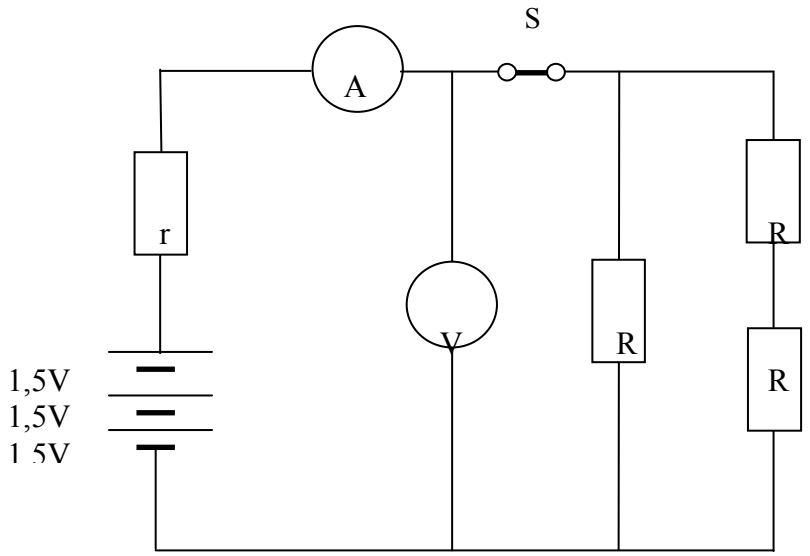
9.5 The single Daniell cell is modified. A zinc cylinder as shown in Diagram 8.2 replaces the zinc rod.

A single light bulb (of resistance 3,0 Ω) is connected in series with the cell.

How does the reading on the milliammeter compare with the initial reading of 2,5 mA? Briefly justify your answer. (3)

[20]

10) Three identical fresh torch cells, each of emf 1,50 V, are connected in series to form a battery. The battery is connected to an ammeter and an arrangement of three resistors as shown in the circuit diagram below.



When switch S is closed, the voltmeter, connected in the circuit as shown, measures the terminal potential difference V. The resistances of the voltmeter and ammeter have negligible effect on the readings taken in this circuit.

The voltmeter reads 4,09 V when the ammeter reading is 0,082 A.

10.1 Define potential difference. (3)

Determine the following:

10.2 the effective resistance of the arrangement of resistors (4)
10.3 the resistance of each resistor (5)
10.4 the emf of the battery (2)
10.5 the average internal resistance of each of the cells in the battery. (6)
[20]