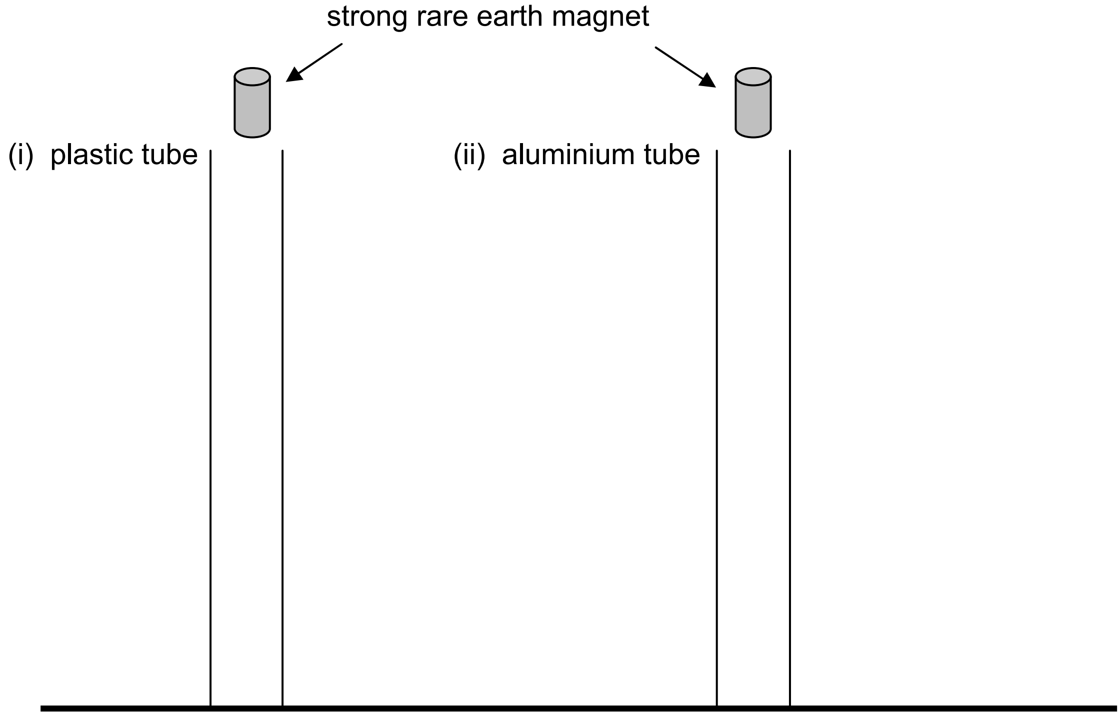
Question 10 **(4 marks)**

A physics teacher set up the equipment shown below.

One tube was made of plastic and the other of aluminium. The teacher dropped a strong rare earth permanent magnet down each tube.



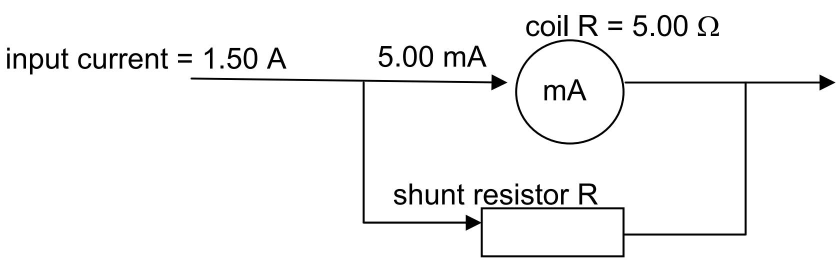
The magnet falling through the plastic tube travelled much faster than the magnet falling through the aluminium tube.

Explain, indicating clearly the physics principles involved. (4 marks)

Question 11 **(5 marks)**

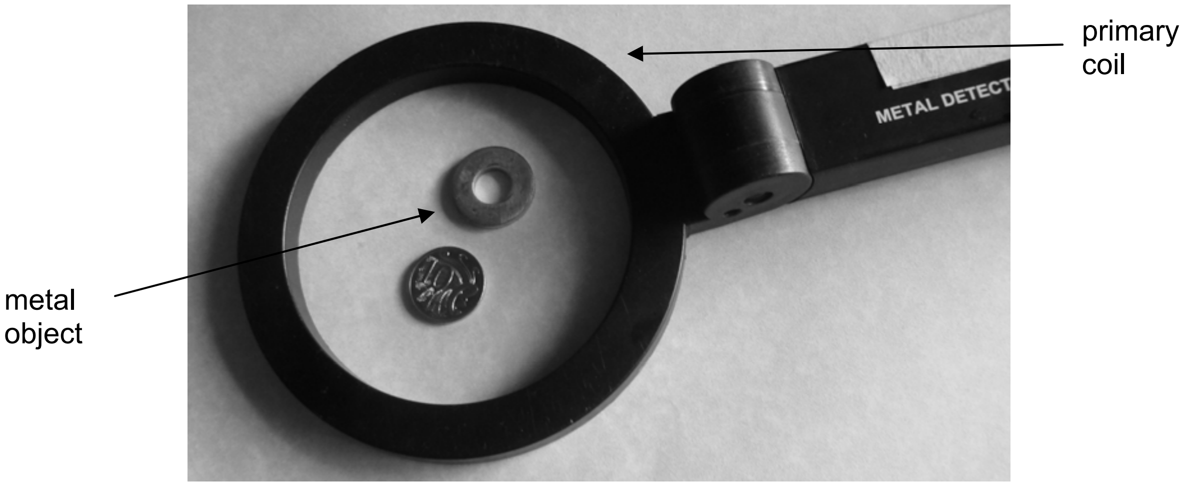
The ammeter shown below can be used to measure a range of electric currents up to 500 mA by selecting the appropriate terminals.

The coil inside the meter is not designed to take large currents. If the ammeter is required to measure a maximum reading of 1.50 A, an additional resistor called a *shunt* has to be added as shown below. The meter has a coil resistance of 5.00 Ω. This arrangement is shown here:



Find the value of the shunt resistor R.

Question 15 **(12 marks)**



Above is a picture of a metal detector and a metal object. A ten cent coin has been added to give a sense of scale. The detector consists of a DC battery connected to a primary coil. There is a secondary coil connected to a buzzer that makes a sound when the primary coil moves over a metal object.

(a) Explain the principle of operation of this metal detector. In your answer, explain why the coil has to be moved while locating metal objects. (4 marks)

(b) What type of metal can the detector find? Circle the correct answer. (1 mark)

copper and tin iron and steel any metal

(c) Use the following data to **estimate** the voltage in the secondary buzzer circuit. (5 marks)

Magnetic field strength within primary coil = 0.0500 Wb

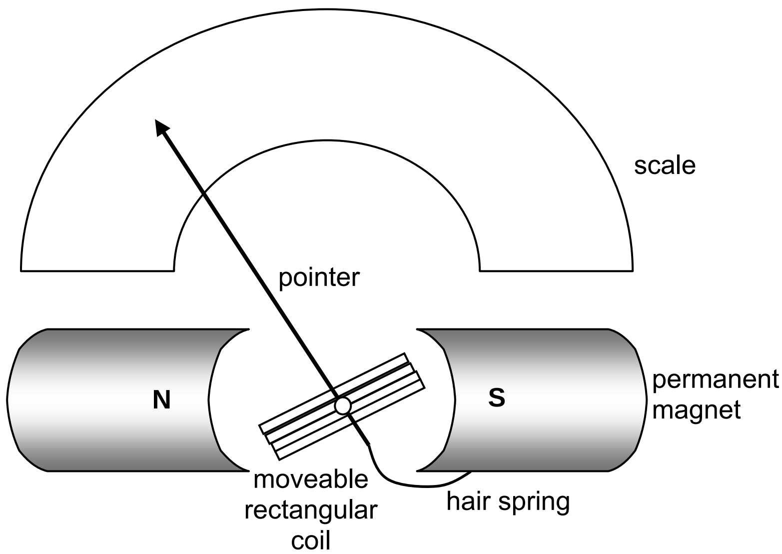
Number of turns in secondary coil = 10

Time of sweep = 0.5 s

(d) How would the sound change if the metal detector was held stationary near a nail? Give a brief reason for your answer. (2 marks)

Question 16 **(13 marks)**

Analogue meters, like the one shown in the diagram below, have many applications: for example, in pool chlorination systems. The interaction of the electric current in the coil and the permanent magnet creates a torque. A fine spring (hair spring) provides a restoring torque.



(a) When a current flows in the rectangular coil, a force is produced on each side of the coil that interacts with the magnetic field. Explain the reason for this force and comment on its direction. You must draw a diagram to illustrate your explanation. (3 marks)

(b) The coil has a length of 0.100 m and a width of 0.0800 m and has 50.0 turns. There is a current of 4.00 A in the coil and it is in a uniform magnetic field of 0.0100 T.

(i) Calculate the force on one of the long sides of the coil. (4 marks)

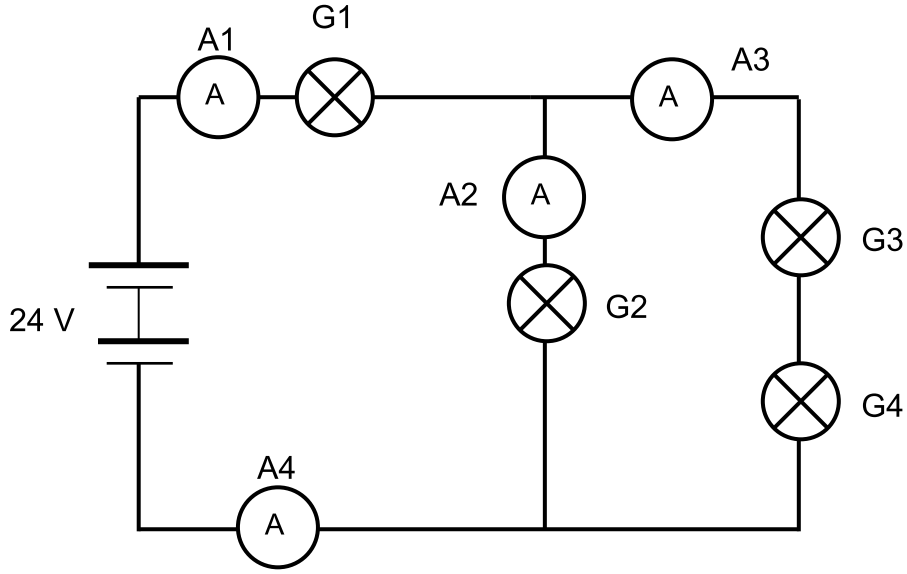
(ii) Hence determine the torque acting on the coil. (3 marks)

(c) Why will the coil rotate? (2 marks)

(d) The loosely-coiled spring provides a torque that opposes the coil's rotation. When the coil is stationary, with a current flowing in it, state the relationship between the torque acting on the coil because of the magnetic field, and the torque provided by the spring. (1 mark)

Question 18 **(14 marks)**

Four identical light globes, G1, G2, G3 and G4, are connected in a circuit as shown below. The DC supply voltage is 24.0 V and ammeter A3 connected in the circuit reads 0.096 A.



(a) Calculate the current in each of the ammeters A1, A2 and A4. (3 marks)

(b) Calculate the resistance of each light globe. (3 marks)

(c) Which light globe will be the brightest? Justify your answer. (2 marks)

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(d) Calculate the total power consumed by all four light globes. If you were unable to determine an answer to part (a) you should assume the current in ammeter A4 is 0.300 A. (2 marks)

(e) If globe G3 is broken, describe how the brightness of each of the light globes G1 and G2 changes. Give a reason in each case. (4 marks)

The brightness of G1 will ______________________________

because ____________________________________

The brightness of G2 will ______________________________

because ____________________________________

Question 22 **(13 marks)**

Generation and Transmission of Electricity

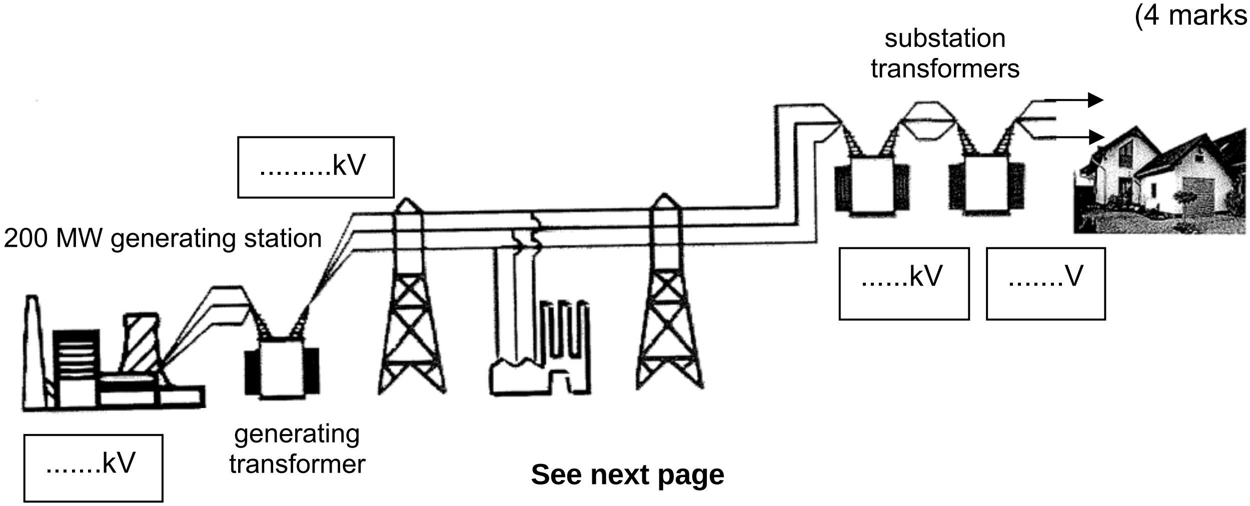
Approximately 30 per cent of the energy used in Australia is generated by power stations. The largest power station in Western Australia is Muja, which is situated close to the coalmining town of Collie.

At Muja coal is ground to the consistency of powder and then burned to heat water until it turns to steam. Steam at a temperature of 540°C and pressure of 16 MPa is used to drive turbines at a rate of 3000 revolutions per minute.

Muja power station generates at a total rate of 1040 MW from its 8 generators. There are four 60 MW generators and four 200 MW generators. The 60 MW generators produce power at 11.8 kV and the 200 MW generators produce power at 16 kV. Generators feed the electricity produced into transformers where the voltage can be increased or decreased.

Before the electricity is distributed, transformers are used to step up the voltage to 330 kV. High voltage transmission has advantages in reducing energy lost due to the resistance of the transmission lines. On the outskirts of Perth there is a substation that reduces the voltage to 11 kV and in the local park is a further small transformer that reduces the voltage to 240 V.

(a) On the diagram below show the voltages at the different stages of the transmission. (4 marks)



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(b) Explain why the generator is designed to produce alternating current and not direct current. (2 marks)

(c) Calculate the current generated in one of the 200 MW generators. (2 marks)

(d) Explain why the voltage is increased to 330 kV before it is distributed to users. (2 marks)

(e) Calculate the turns ratio of a transformer used to increase the voltage from a 60 MW generator to 330 kV. (2 marks)

(f) Suggest a possible difference between the 60 MW and the 200 MW generators that would result in a difference in output voltage. (1 mark)