1 **(a)** State the relationship between

(i) the resistance *R* and the length *L* of a wire of constant cross-sectional area,

.....

(ii) the resistance *R* and the cross-sectional area *A* of a wire of constant length.

.....

[1]

(b) A 60 W filament lamp X is connected to a 230 V supply, as shown in Fig. 9.1.

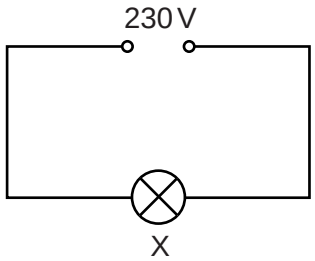

Fig. 9.1

Calculate the current in the filament.

current = ... [2]

(c) Lamp Y has a filament made of the same metal as the filament of lamp X in **(b)**.

This filament has half the length and one-third of the cross-sectional area of the filament of X.

Lamp Y is also connected to a 230 V supply.

Calculate the ratio $\frac{\text{current in filament of Y}}{\text{current in filament of X}}$. Show your working.

ratio = ... [4]

[Total: 7]

2 **(a)** A piece of wire has a resistance of 0.45 Ω.

Calculate the resistance of another piece of wire of the same material with a third of the length and half the cross-sectional area.

resistance = ... [3]

(b) Fig. 8.1 shows a circuit with three resistors, a power supply and four voltmeters.

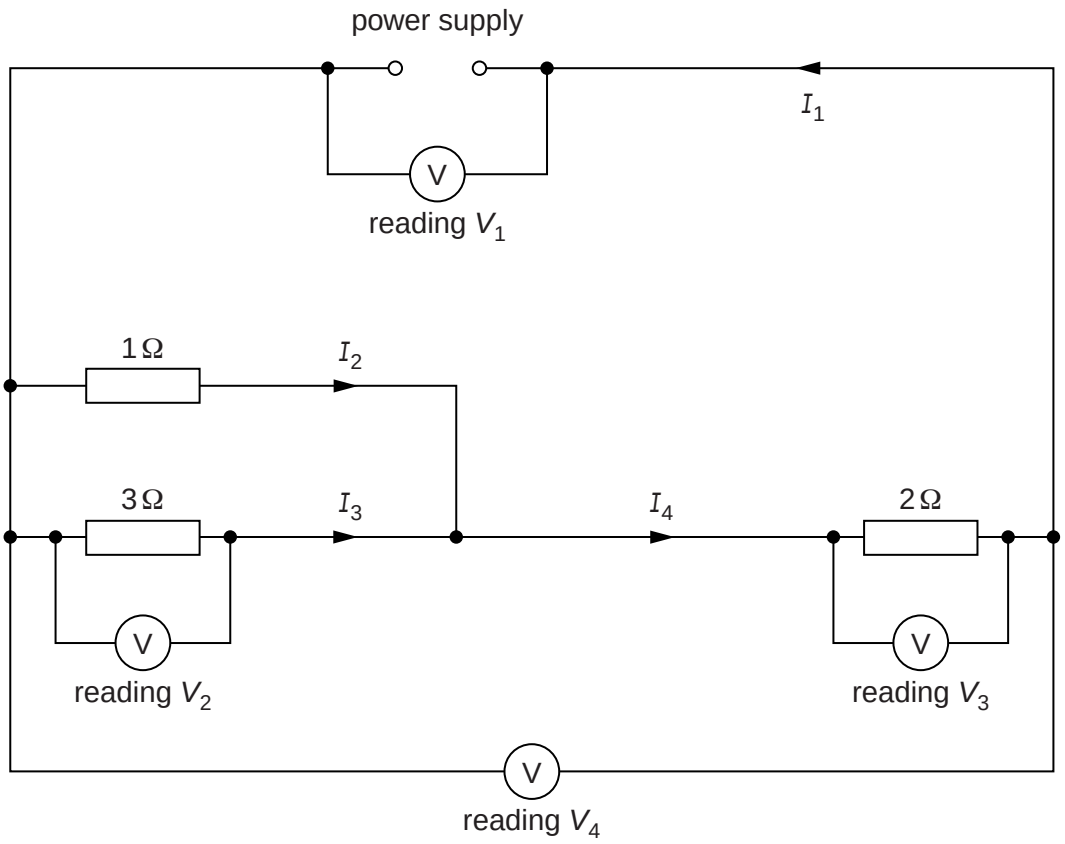

Fig. 8.1

(i) Calculate the combined resistance of the three resistors.

resistance = ...[3]

(ii) Write down **two** relationships for the currents in the circuit.

[2]

(iii) Write down **two** relationships for the voltmeter readings in the circuit.

[2]

[Total: 10]

3 **(a)** In Fig. 8.1, S is a metal sphere standing on an insulating base. R is a negatively charged rod placed close to S.

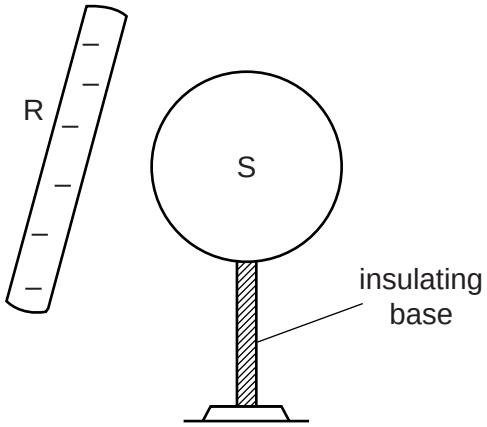

Fig. 8.1

(i) Name the particles in S that move when R is brought close to S.

..... [1]

(ii) On Fig. 8.1, add + signs and – signs to suggest the result of this movement. [1]

(iii) Describe the actions which now need to take place so that S becomes positively charged with the charge distributed evenly over its surface. A positively charged object is **not** available.

.....

.....

..... [3]

(b) During a thunderstorm, the potential difference between thunderclouds and the ground builds up to 1.5×10^6 V. In each stroke of lightning, 30 C of charge passes between the thunderclouds and the ground. Lightning strokes to the ground occur, on average, at 2 minute intervals.

Calculate

(i) the average current between the thunderclouds and the ground,

average current = ... [2]

(ii) the energy transferred in each stroke of lightning.

energy = ... [2]

[Total: 9]

4 **(a)** Fig. 7.1 shows a conducting sphere A, initially uncharged, mounted on an insulating base. The positively-charged, non-conducting sphere B is brought close to sphere A without touching the sphere.

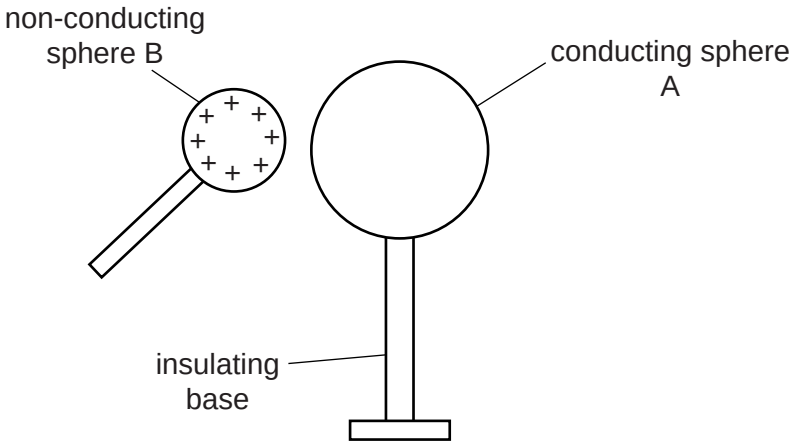

Fig. 7.1

(i) On Fig. 7.1, draw the resulting distribution of any positive and negative charges on sphere A. [2]

(ii) The sphere A is now earthed as shown in Fig. 7.2.

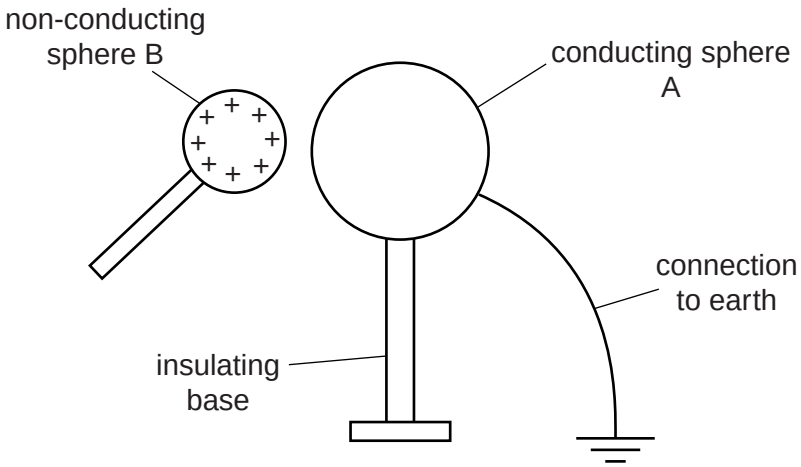

Fig. 7.2

On Fig. 7.2, draw the distribution of any positive and negative charges on sphere A after it is earthed. [1]

(b) (i) On Fig. 7.3, draw lines of force with direction arrows to represent the electric field pattern in the plane of the paper around a negative point charge at point X.

Fig. 7.3

(ii) State what is represented by the directions of the arrows on the lines.

.....

.....
[2]

[Total: 5]

5 **(a)** A student rubs one side of an inflated balloon on her hair. This side of the balloon becomes positively charged. Explain this.

.....

.....

..... [2]

(b) The charged side of the balloon is now brought close to a stream of water flowing from a pipe. The original position of the stream of water is shown in Fig. 8.1.

On Fig. 8.1, write in the boxes to indicate how each side of the stream of water is electrically charged.

Choose your answer in each case from: positive, negative or neutral.

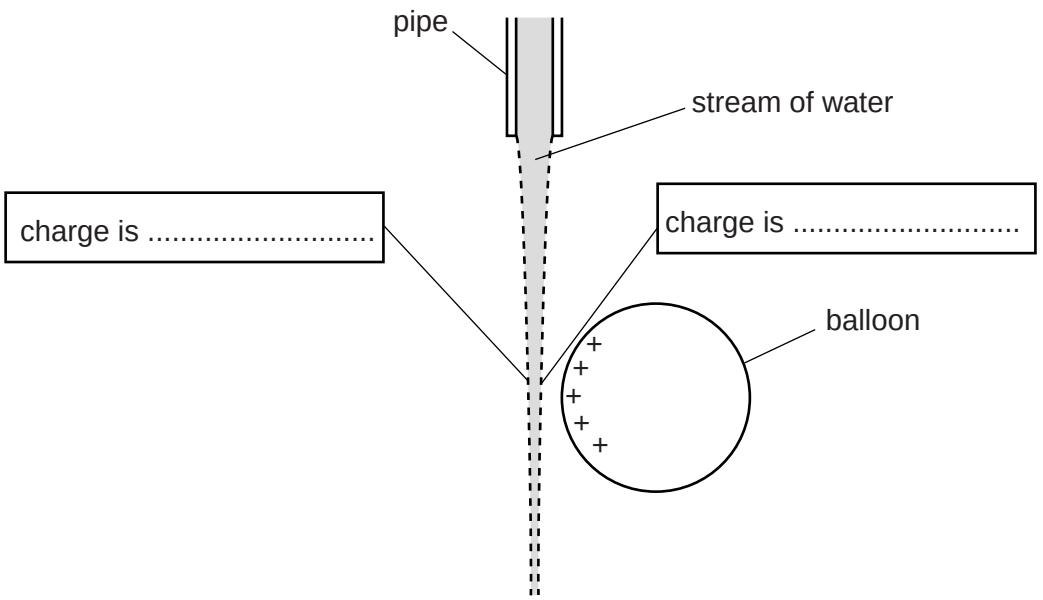

Fig. 8.1

[2]

(c) On Fig. 8.1, draw the new position of the stream of water. Explain this new position.

.....

.....

.....

..... [2]

(d) Explain why rubbing one side of a metal sphere does not cause it to become charged.

.....

..... [1]

[Total: 7]

6 The circuit of Fig. 4.1 is set up to run a small immersion heater from a 6.0V battery.

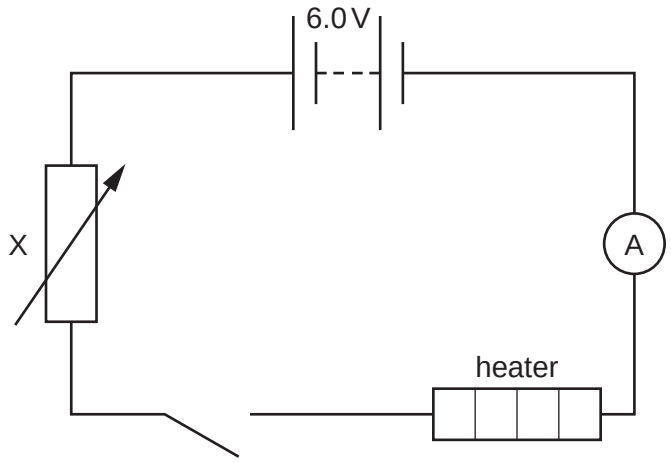

Fig. 4.1

(a) State the name and purpose of component X.

name .....

purpose .....[1]

(b) The heater is designed to work from a 3.6V supply. It has a power rating of 4.5W at this voltage.

(i) Calculate the current in the heater when it has the correct potential difference across it.

current = ...[2]

(ii) Calculate the resistance of component X if there is to be the correct potential difference across the heater. The battery and the ammeter both have zero resistance.

resistance = ...[3]

(c) Some time after the heater is switched on, the ammeter reading is seen to have decreased.

Suggest why this happens.

.....

.....[1]

(d) As an alternative to running the heater from a battery, it is decided to construct a circuit to enable it to be operated from the a.c. mains supply.

Name the electrical component needed to

(i) reduce the potential difference from that of the mains supply down to a potential difference suitable for the heater,

.....[1]

(ii) change the current from a.c. to a current which has only one direction.

.....[1]

[Total: 9]