

State Examinations Commission – Physics Higher Level, 2004.

Question 11

Read the following passage and answer the following questions.

Your home is supplied with electricity at 230 volts, 50 Hertz. At the electrical supply intake position is your main consumer unit or fuse board. At that position you will find your main switch. Your sockets, immersion group and bathroom heater (or shower) are protected by Residual Current Devices (RCD) installed in your fuse board. These provide a high degree of safety on these circuits and it is important that they are tested at least every 3 months. The final circuits are protected by Miniature Circuit Breakers (MCB). It is advisable to contact your local ESB about cheaper night tariffs, these could make significant savings to your electricity bill. Storage heaters may be used to avail of these cheaper rates. Each plug top contains a small cartridge fuse. Cartridge fuses are supplied with a rating of 1A, 2A, 3A, 5A and 13A. A fuse should never be replaced by anything other than a suitable fuse.

(Adapted from “Home Safety”, Register of Electrical Contractors of Ireland. RECI)

- (a) Name and give the colour of the wire that should be connected to the fuse in a standard three-pin plug. (7)
- (b) Explain why replacing a fuse with a piece of aluminium foil is dangerous. (7)
- (c) A table lamp has a power rating of 100 W. What is the most suitable fuse for the lamp? (7)
- (d) Some electrical appliances are supplied with two-pin plugs. Why is an earth wire not required in these devices? (7)
- (e) Sketch a voltage-time graph of the 230 V supply. (7)
- (f) Explain how a Residual Current Device (RCD) operates. (7)
- (g) Give one advantage of a Residual Current Device (RCD) over a Miniature Circuit Breaker (MCB) (7)
- (h) Storage heaters have a large heat capacity. Explain why. (7)

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- (a) Name and give the colour of the wire that should be connected to the fuse in a standard three-pin plug. (7)

Brown wire – live wire

- (b) Explain why replacing a fuse with a piece of aluminium foil is dangerous. (7)

The fuse is designed to melt when too large a current flows through it, say in the case of a fault, thereby cutting of the current. The aluminium foil would continue to allow an excessively large current to flow possibly causing electric shock.

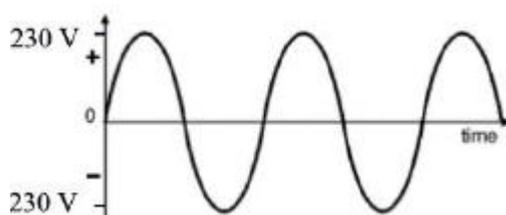
- (c) A table lamp has a power rating of 100 W. What is the most suitable fuse for the lamp? (7)

From $P = VI$ we get $I = 0.45A$. Therefore a 1A fuse is suitable.

- (d) Some electrical appliances are supplied with two-pin plugs. Why is an earth wire not required in these devices? (7)

They have no metal, or other conducting material, on their exterior and do not pose a risk if internal wiring becomes loose.

- (e) Sketch a voltage-time graph of the 230 V supply. (7)



(f) Explain how a Residual Current Device (RCD) operates. (7)

The RCD is a circuit breaker which continuously compares the current in the live with that in the neutral. The difference between the two (the residual current) will be flowing to earth, because it has left the supply through the live and has not returned in the neutral. There will always be some residual current in the insulation resistance and capacitance to earth, but in a healthy circuit such current will be extremely low.

In an RCD live and neutral currents pass through identical coils wound in opposing directions on a magnetic circuit. When there is no residual current, no magnetic flux will be set up in the magnetic circuit. If there is residual current an alternating magnetic flux is produced and the circuit breaker trips, opening the main contacts and interrupting the circuit.

(g) Give one advantage of a Residual Current Device (RCD) over a Miniature Circuit Breaker (MCB) (7)

They are much faster at breaking circuits and respond to very small currents.

(h) Storage heaters have a large heat capacity. Explain why. (7)

So they can store a large amount of heat energy (acquired at cheaper night time rate), for slow release during the day.