



6. (a) For the circuits shown in Fig. 1 and Fig. 2 below the resistors represent the internal resistance of the batteries. In each case find:

- (i) the total e.m.f. across XY (4 marks)
- (ii) the total equivalent internal resistances of the batteries. (4 marks)

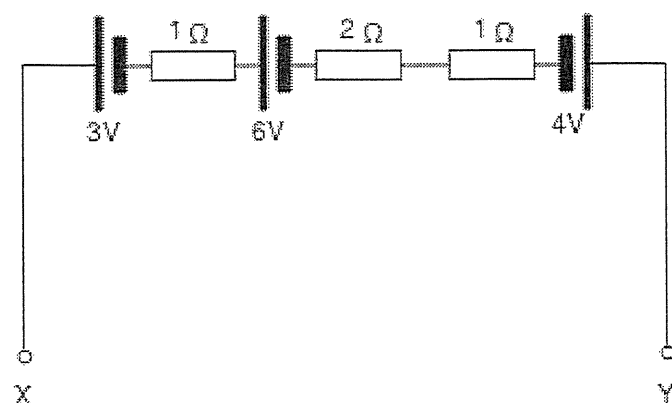


Fig.1

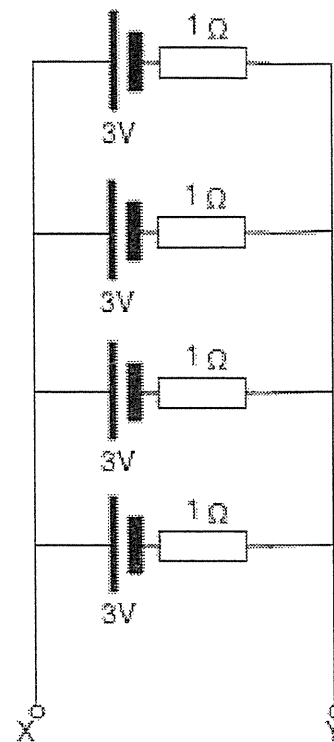


Fig. 2

b.

- (i) Using diagrams show what happens to voltage and current when connecting batteries in series and in parallel. (4 marks)
- (ii) List at least two types of batteries. (4 marks)
- (iii) Ten 1.5 volts cells, each having an internal resistance of 0.2 ohms are connected in series to a load of 58 ohms. Determine
 - the current flowing in the circuit, and (2 marks)
 - the potential difference at the battery terminals. (2 marks)

Total: 100 marks

Examination for Authorisation A

Paper 1: Theory

Date: 2 July 2019

Time: 09:00 – 12:00 (Three hours)

This examination paper contains six questions. Candidates are requested to answer any FIVE (5) questions. Candidates are also requested to include all their work in the booklet provided. Every answer should include all workings, any necessary diagrams and formulae. Use a fresh page for each different question. Each question carries 20 marks.

1. A 200 litre solar water heater tank contains water at a temperature of 24° C. It is a cloudy day and it is assumed that the sun is not effective to heat water, therefore a 2 kW electric heater is used to raise the temperature of water to 60° C.

If the efficiency of the water tank is 90%, and that the heater is connected across a 230V supply, calculate:

- a) The total amount of energy required to heat the water. (3 marks)
- b) The time in hours taken for the water to heat up. (4 marks)
- c) If the cost of energy is 10c per kWh, what is the cost of heating the water? (4 marks)
- d) The heater is connected through a fused control unit (FCU). There are three fuses available 6A, 10A and 13A and the length of wire to the heater is short. Select the fuse that is most appropriate to protect the heater. (4 marks)
- e) If the heater remains on for 6 hours per day what is the cost of heating water for 8 weeks. (5 marks)

Assume:

- 1 litre of water is 1 kg
- Specific heat capacity of water is 4200 kJ/°C.

2. Two spiral heating elements one 100 Watts and the other 750 Watts are connected in parallel across a 240 volts supply. Calculate:
- a. i. The current in each heater. (5 marks)
- ii. The resistance of each heater when switched on. (5 marks)
- iii. The total current from the mains. (5 marks)
- b. If the heater resistance was measured when cold, would the resistance be greater or less than when found in (a) above? Give reasons for your answer. (5 marks)

3. A coil of inductance 0.15 Henries and resistance 10 ohms is wired in series with a 60 micro farad capacitor to a 240 volts 50 Hz supply.
- i. Draw the circuit diagram. (2 marks)
- ii. Find the impedance in the circuit. (6 marks)
- iii. Find the current in the circuit. (6 marks)
- iv. Find the voltage drop across the capacitor. (6 marks)

4. (a) Explain the meaning of the following terms as applied to an illumination scheme:
- i. Coefficient of Utilisation factor (2 marks)
- ii. Maintenance factor (2 marks)
- iii. Spacing to Mounting Height ratio (2 marks)

- (b) An office measuring 45m by 45m requires an illumination at desk level of 660 lux. The lighting fittings selected to illuminate the office contains 80 watts fluorescent tubes. The manufacture catalogue specifies that when the fittings are new, each fitting provides 4800 lumens. The mounting height of the fittings above desk level will be 3 m. Assuming a Utilisation factor of 0.7 and a Maintenance factor of 0.85. Calculate:
- i. The number of lighting fitting required to illuminate the office. (5 marks)
- ii. The annual cost of electricity if the lighting fittings are used on average 6 days a week and 10 hours daily. Assume that the office is supplied from a single phase supply and that the cost of electricity is 17 cents per kWh. (9 marks)

5. (a) Mention and briefly explain five types of capacitors that are commonly used. (5 marks)
- (b) Capacitance of 6µF, 12µF, and 24µF are connected in series to a direct voltage supply of 350V. Determine:
- i. The equivalent circuit capacitance (5 marks)
- ii. The charge on each capacitor (5 marks)
- iii. The potential difference across each capacitor. (5 marks)