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Physics worksheet solutions – Electric charge, current, potential, energy & power ($e = 1.60\times10^{-19}$ C)

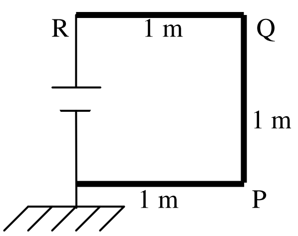
Q1 Write down the SI units for electric charge, current, potential, energy and power.
coulomb (C), *ampere* (A), *volt* (V), *joule* (J), *watt* (W)

Q2 2.00×10^{16} electrons pass through a point in a circuit in 0.25 s. Calculate the electric current through the point.
Amount of charge $Q = (1.60\times10^{-19})(2.00\times10^{16}) = 3.20\times10^{-3}$ C
Electric current $I = \frac{Q}{\Delta t} = \frac{3.20\times10^{-3}}{0.25} \approx 1.3\times10^{-2}\text{ A} = 13\text{ mA}$

Q3 Calculate the potential energy of an electron at a point where the electric potential is 6.0 volts.
Potential energy $= QV = (1.60\times10^{-19})(6.0) = 9.6\times10^{-19}$ J

Q4 Calculate the amount of energy possessed by 1.25×10^{19} electrons at a point where the electric potential is 3.20 volts.
The total amount of charge of 1.25×10^{19} *electrons* $= (1.60\times10^{-19})(1.25\times10^{19}) = 2.00$ C
Energy $= QV = 2.00\times3.20 = 6.4$ J

Q5 A 3-m uniform resistance wire is connected to a 6.0 V battery. The negative terminal of the battery is earthed. Write down the potential at points P, Q and R. What is the potential difference between P and R?

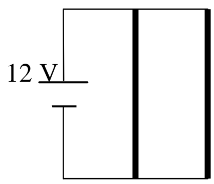


P 2.0 V, Q 4.0 V, R 6.0 V
Potential difference between P *and* R $V_{PR} = 6.0 - 2.0 = 4.0$ V

Q6 Refer to the information in Q5.
(i) 10.0 C of electrons flow in the anticlockwise direction in 2.0 seconds, how much heat is generated in the section QR?
(ii) A current of 5.0 A flows in the clockwise direction for 2.0 seconds, how much heat is generated in the section RQP?
(i) $V_{QR} = 4.0 - 2.0 = 2.0$ V,
heat energy $E = QV_{QR} = 10.0\times2.0 = 20$ J
(ii) *Amount of charge* $Q = I\Delta t = 5.0\times2.0 = 10$ C,
heat energy $E = QV_{PR} = 10\times4.0 = 40$ J

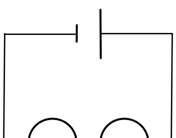
Q7 In a lightning flash the potential difference between a cloud and the ground is 1.5×10^{9} V and the amount of charge transferred is 25 C. (i) What is the change in energy per coulomb of the charge transferred? (ii) What is the total change in energy for the charge transferred in the lightning?
(i) *Change in energy per coulomb of the charge* $= 1.5\times10^{9}$ J
(ii) *Total change in energy for the charge transferred in the lightning* $= QV = 25\times1.5\times10^{9} \approx 3.8\times10^{10}$ J

Q8 A car heater has two identical heating elements. The car battery can send 15000 C through the circuit in an hour.
(i) What is the current in each heating element?
(ii) How much heat is generated by the circuit in an hour?

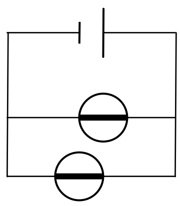


(i) $I = \frac{1}{2}\times\frac{15000}{60\times60} \approx 2.1$ A
(ii) *Heat generated in an hour* $= QV = 15000\times12 = 1.8\times10^{5}$ J

Q9 Two identical lights, each giving 6 W of power, are connected as shown. The current in the battery is 2.0 A.
(i) What is the current in the first light? (ii) What is the potential difference between the terminals of each light?
(iii) What is the voltage of the battery? (iv) How much energy is drained from the battery in a minute?
(i) 2.0 A (ii) $V = \frac{P}{I} = \frac{6}{2.0} = 3.0$ V
(iii) $V_{battery} = 3.0 + 3.0 = 6.0$ V
(iv) $Q = I\Delta t = 2.0\times60 = 120$ C, $E = QV = 120\times6.0 = 720$ J
Alternatively: $E = P\Delta t = (6+6)\times60 = 720$ J



Q10 Two identical lights, each giving 6 W of power, are connected as shown. The current in the battery is 2.0 A.
(i) What is the current in the first light? (ii) What is the potential difference between the terminals of each light?
(iii) What is the voltage of the battery? (iv) How much energy is drained from the battery in a minute?
(i) 1.0 A (ii) $V = \frac{P}{I} = \frac{6}{1.0} = 6.0$ V (iii) 6.0 V
(iv) $Q = I\Delta t = 2.0\times60 = 120$ C, $E = QV = 120\times6.0 = 720$ J
Alternatively: $E = P\Delta t = (6+6)\times60 = 720$ J



Note: These two lights are different from the two lights in Q9. Each one operates at 6.0 V and gives out 6 W. Each one of the two in Q9 operates at 3.0 V and gives out 6 W.