# ELECTRICITY

*Items 1-10 are multiple-choice with a single correct answer, and each is scored with 0.9 points (1 point awarded from start for this section).*
*Items 11 and 12 are scored independently with 4.5 points each (1 point awarded from start for this section)*
*Final score is calculated as: $N=0.6N_1+0.4N_2$, unde*
*$N_1$=score for the first section (items 1-10) +1 point from start,*
*$N_2$=score for the second section (items 11-12) +1 point from start .*
*Working time – two hours.*

**1.** At the terminals of a battery with electromotive voltage $E$ and internal resistance $r$, an ideal ammeter is connected, indicating the current intensity $I_0$. By disconnecting the ideal ammeter and connecting an ammeter with internal resistance $R_A$ across the battery terminals, it shows the current intensity $I$. The expressions for these two quantities are:

| | | | |
|---|---|---|---|
| a) $I_0=I=\frac{E}{r}$ | b) $I_0=\frac{E}{r}$ $I=\frac{E}{r+R_A}$ | c) $I_0=\frac{E}{r}$ $I=\frac{E}{R_A}$ | d) $I_0=I=\frac{E}{r+R_A}$ |

**2.** What expression represents the maximum power delivered by a voltage source to a resistor with variable resistance? The electromotive voltage $E$ of the source and its internal resistance $r$ are known.

| | | | |
|---|---|---|---|
| a) $P_{max}=\frac{E^2}{r}$ | b) $P_{max}=\frac{2E^2}{r}$ | c) $P_{max}=\frac{E^2}{4r}$ | d) $P_{max}=\frac{4E^2}{r}$ |

**3.** Which statement is correct?

| | | | |
|---|---|---|---|
| a) The current intensity is a vector quantity | b)The electric power is a vector quantity | c)The electric charge is a vector quantity | d) The force is a vector quantity |

**4.** A student conducts an experiment in which he measures the voltage across a metallic resistor through which a current is flowing and finds a value of 2V. Knowing that the power dissipated in the conductor is 2W, determine the electric current intensity through the conductor.

| | | | |
|---|---|---|---|
| a) $I=1A$ | b) $I=2A$ | c) $I=3A$ | d) $I=4A$ |

**5.** Three identical light bulbs are connected in parallel across the terminals of an ideal battery. If a fourth light bulb, identical to the first three, is added in parallel across the battery terminals, then:

| | | | |
|---|---|---|---|
| a)The voltage across the battery terminals decreases | b)The current intensity through the battery decreases | c) The voltage across the battery terminals does not change | d) The current intensity through the battery does not change |

**6.** On a resistor with a resistance of 5Ω, a voltage of 10V is applied. What is the current intensity through the conductor?

| | | | |
|---|---|---|---|
| **a**) $2A$ | **b**)$50A$ | **c**) $0{,}5A$ | **d**) $15A$ |

**7.** A cylindrical conductor with a cross-sectional area of $1mm^2$ carries a intensity of 1A. The concentration of conduction electrons is $n=10^{28}m^{-3}$, and the elementary electric charge is $e=1.6x10^{-19}$ C. What average speed has the ensemble of conduction electrons?

| | | | |
|---|---|---|---|
| **a**) $0{,}625\ mm\cdot s^{-1}$ | **b**) $1{,}6\times10^8 m\cdot s^{-1}$ | **c**) $3\times10^8 m\cdot s^{-1}$ | **d**) $100\,km\cdot h^{-1}$ |

**8.** A cylindrical resistor made of a material with the electrical resistivity $\rho$, has length $l$ and cross-sectional area $S$. Its electrical resistance can be expressed as follows:

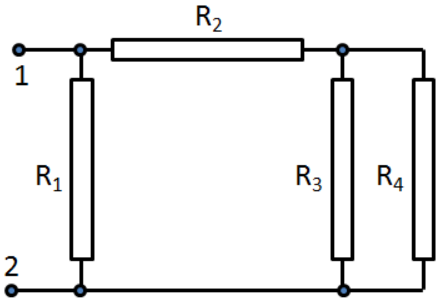
| | | | |
|---|---|---|---|
| a) $R=\rho Sl$ | b) $R=\frac{\rho l}{S}$ | c) $R=\frac{\rho S}{l}$ | d) $R=\frac{1}{\rho lS}$ |

**9.** The electrical energy consumed during ✎$t$=1s by a resistor of 1 $\Omega$ traversed by a current of 1 $A$ is:

| | | | |
|---|---|---|---|
| a) $W=RI\Delta t=1J$ | b) $W=R^2I\Delta t=1J$ | c) $W=I^2R\Delta t^2=1J$ | d) $W=UI\Delta t=1J$ |

**10.** During a time of 1s, an arbitrary section of some conductor is traversed by an electric charge of 1C. The average current flowing in the conductor is:

| | | | |
|---|---|---|---|
| a) $I=Q\Delta t=1A$ | b) $I=\frac{Q}{\Delta t}=1A$ | c) $I=\frac{\Delta t}{Q}=1A$ | d) $I=\sqrt{\frac{Q}{\Delta t}}=1A$ |




**11**. (**4.5p**) The setup in the figure has $R_1=n_1\Omega$, $R_2=n_2\Omega, R_3=n_3\Omega$ , $R_4=n_4\Omega$, with $n_1, n_2, n_3$ and $n_4$ integers, solutions to the quadratic equations $x^2-b_1x+21=0$ or $x^2-b_2x+21=0$.

(a) What minimum value $R_{min}$ can the equivalent resistance between terminals 1 and 2 have? (**1p**)

(b) What maximum value $R_{max}$ can the equivalent resistance between terminals 1 and 2 have? (**1p**)

(c) Under the conditions of (a), an ideal dc voltage source with e.m.f. $E=10\text{V}$ is connected to terminals 1 and 2. What intensities $I_3, I_4$ flow through $R_3, R_4$? (**1.5p**)

(d) What is the minimum value $R_{min}^{\square}$ of the equivalent resistance of a setup (different from the one in the figure) in which all four resistances are mandatory used? (**1p**)

**12**. (**4.5p**) Some amount of water with the initial temperature $T_0$ is brought to a boil after $\Delta t_1=10$ min. using an electric kettle with the electric resistance $R_1$ and its efficiency $\eta_1=0.5$.

(a) What is $R_2$ of a kettle with an efficiency $\eta_2=0.8$ that boils the same amount of water in $\Delta t_2=20$ min.? (**1p**)

(b) If both kettles are used *simultaneously* to boil the water, what is the *time interval* $\Delta t_3$?(**1p**)

(c) If both kettles are used *simultaneously*, their resistors being connected in parallel, *how long* $\Delta t_4$ will it take to bring the water to a boil? (**1p**)

(d) What is the *efficiency* $\eta$ of using kettles under the conditions of point (c)?

Note: The initial temperature $T_0$ of the water is always the same. (**1.5p**)