MINISTRY OF EDUCATION

T 101

GIMNÁZIUM
May 2005

Written Final Examination in Physics

I. Numerical Problems

1.
A stone is thrown vertically downwards with an initial speed of 5 m/s. How long does it take the kinetic energy of the stone to increase by a factor of four? ($g = 10$ m/s^2) **[10 marks]**

2.
We want a light ray incident normally on one face of a prism to leave through the other face with a 45° angle of refraction. What should be the size of the vertex angle, given that the refractive index of the material of the prism is 1.5 ?
(The vertex angle of the prism is the angle enclosed by its two refracting faces.) **[15 marks]**

3.
2 m^3 of nitrogen gas has a temperature of 77 °C. It absorbs $3.5 \cdot 10^6$ J of heat at a constant pressure of $3 \cdot 10^5$ Pa.
a) Find the final volume and temperature of the gas.
b) Find the change in the energy of the gas owing to the absorption of heat.
c) Find the work done by the gas while being heated.
(The value of the Boltzmann constant is $k = 1.38 \cdot 10^{-23}$ J/K.) **[15 marks]**

4.
An electron accelerated from rest through a potential difference of 1500 V enters a uniform magnetic field in a direction perpendicular to the magnetic induction vector.
a) To what speed is the electron accelerated in the electric field?
b) Find the magnitude of the magnetic induction vector, given that the electron travels in a circle of radius 1 cm in the magnetic field.
(The magnitude of the charge of the electron is $1.6 \cdot 10^{-19}$ C, its mass is $9.1 \cdot 10^{-31}$ kg.) **[20 marks]**

II. Analysis of an Experiment

5. A variable resistor was connected to a battery, and the currents corresponding to the given values of the resistance were measured. The data obtained are shown in the table below.

R (Ω)	2	4	6	8	10	12	14	16	18	20
I (mA)	83.3	71.0	62.2	55.6	50.1	45.4	41.6	38.4	35.7	33.3

a) Using the data, determine the internal resistance and electromotive force of the battery.
b) For the values of the variable resistance given in the table, find the electric power being dissipated on the resistor, and then plot the values obtained in a power versus resistance graph. Use the graph to determine the resistance for which the power drawn by the resistor from the circuit is a maximum. **[20 marks]**

III. Theoretical Question

6. State the law of momentum conservation. (Your response should contain the definition of momentum, the statement of the law, a description of the conditions for the law to be applicable, and the description of at least two particular phenomena where the law is valid.) **[20 marks]**

Evaluation: ***A total of 100 marks can be received on this paper.***
From 0 to 19 inclusive: fail (1); 70 and above: excellent (5).