July 09, 2015

General Instructions

- The theoretical examination lasts for 5 hours and is worth a total of 30 marks.
- You must not open the envelope containing the problems before the sound signal indicating the beginning of the competition.
- Dedicated IPhO Answer Sheets are provided for writing your answers. Enter the final answers into the appropriate boxes in the corresponding Answer Sheet (marked **A**). There are extra blank pages for carrying out detailed work/rough work (marked **B**). If you have written something on any sheet which you do not want to be graded, cross it out.
- Fill out all the entries in the header (Contestant Code, Q - T1,T2 or T3 and Page number).
- You may often be able to solve later parts of a problem without having solved the previous ones.
- You are not allowed to leave your working place without permission. If you need any assistance (malfunctioning calculator, need to visit a restroom, etc), please draw the attention of the invigilator using one of the two cards (red card for help and green card for toilet).
- The beginning and end of the examination will be indicated by a sound signal. Also there will be sound signals every hour indicating the elapsed time. Additionally there will be a buzzer sound, fifteen minutes before the end of the examination (before the final sound signal).
- At the end of the examination you must stop writing immediately. Sort and number your Answer Sheets and detailed work sheets, put it in the envelope provided, and leave it on your table. You are not allowed to take any sheet of paper out of the examination area.
- Wait at your table till your envelope is collected. Once all envelopes are collected your student guide will escort you out of the examination area.
- A list of physical constants is given on the next page.

General Data Sheet

Acceleration due to gravity on Earth	g	$9.807\ \mathrm{m\ s^{-2}}$
Atmospheric pressure	P_{atm}	$1.013 \times 10^{5}\ \mathrm{Pa}$
Avogadro number	N_{A}	$6.022 \times 10^{23}\ \mathrm{mol^{-1}}$
Boltzmann Constant	k_{B}	$1.381 \times 10^{-23}\ \mathrm{J\ K^{-1}}$
Binding energy of hydrogen atom	$-$	$13.606\ \mathrm{eV}$
Magnitude of electron charge	e	$1.602 \times 10^{-19}\ \mathrm{C}$
Mass of the electron	m_{e}	$9.109 \times 10^{-31}\ \mathrm{kg}$
Mass of the proton	m_{p}	$1.673 \times 10^{-27}\ \mathrm{kg}$
Mass of the neutron	m_{n}	$1.675 \times 10^{-27}\ \mathrm{kg}$
Permeability of free space	μ_0	$1.257 \times 10^{-6}\ \mathrm{H\ m^{-1}}$
Permittivity of free space	ϵ_0	$8.854 \times 10^{-12}\ \mathrm{F\ m^{-1}}$
Planck's constant	h	$6.626 \times 10^{-34}\ \mathrm{J\ s}$
Speed of sound in air (at room temperature)	c_{s}	$3.403 \times 10^{2}\ \mathrm{m\ s^{-1}}$
Speed of light in vacuum	c	$2.998 \times 10^{8}\ \mathrm{m\ s^{-1}}$
Stefan-Boltzmann constant	σ	$5.670 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}$
Universal constant of Gravitation	G	$6.674 \times 10^{-11}\ \mathrm{N\ m^{2}\ kg^{-2}}$
Universal gas constant	R	$8.315\ \mathrm{J\ mol^{-1}\ K^{-1}}$