

General instructions

May 9, 2018

The theoretical examination lasts for 5 hours, consists of 3 problems and is worth a total of 30 points.

Before the exam

- You must not open the envelopes containing the problems before the sound signal indicating the beginning of the examination.
- The beginning of the examination will be indicated by a long sound signal. There will be a short sound signal every hour indicating the elapsed time, as well as fifteen minutes before the end of the examination. At the end of the examination, there will be multiple sound signals. After the collection of the envelopes is completed, a long sound signal will indicate that you are allowed to leave the examination area.

During the exam

- Use only the pen provided. **Do not write with a pencil. If you draw a figure with a pencil please redraw the lines of the figure with a pen. Anything written with a pencil will not be marked.**
- Dedicated Answer Sheets are provided for writing your answers. Enter the final answers into the appropriate boxes in the corresponding answer sheet. There are extra blank sheets (Working Sheets) for carrying out detailed work. Write on the working sheets whatever you think is necessary for solution to the problems and that you wish to be marked.
- It is compulsory for you to fill in your Student Code in the boxes at the top of each sheet of paper to be used. For each problem all Working Sheets should be filled in with the problem number (Problem No.), the progressive number of each sheet (Page No.) and the total number of Working Sheets that you have used and wish to be marked (Total Pages).
- You should use mainly equations, numbers, symbols, logical operators, graphs, diagrams and sketches, and as little text as possible in your answers.
- If you have written something on any sheet which you do not want to be marked, cross it out. If you use Working Sheets that you do not wish to be marked, put a large 'X' across the entire sheet and do not include it in your page numbering. Only use the front side of every page and be sure to write inside the boxed areas.
- Please give an appropriate number of significant digits when stating numbers.
- A table of physical constants is given on a next page.
- You are not allowed to leave your working place without permission. If you need any assistance, please draw the attention of an invigilator by putting one of the flags into the holder attached to your cubicle (Blue flag: Water, please; Yellow flag: I need to go to the toilet, please; Violet flag: I need extra working sheet, please; Red flag: I need help, please).

At the end of the exam

- At the multiple sound signals indicating the end of the examination you must stop writing immediately.
- For every problem, sort the corresponding sheets in the following order.
 1. answer sheets,
 2. working sheets in order,
 3. working sheets not to be marked,
 4. printed problems.



- Put all the sheets belonging to one problem into the appropriate smaller envelope.
- Put the three smaller envelopes together with all unused working sheets and the general instructions into the larger envelope.
- Put your writing equipment as well as the calculator back into the bag.
- An invigilator will come and collect your envelope.
- Wait at your table until the sound signal for exiting the examination area. Take your writing equipment bag.

You are not allowed to take any sheet of paper out of the examination area.

Table of physical constants

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|--|------------------|---|--|
| Acceleration due to gravity | g | = | $9.807 \text{ m} \cdot \text{s}^{-2}$ |
| Atmospheric pressure | P_{atm} | = | $1.013 \times 10^5 \text{ Pa}$ |
| Avogadro number | N_A | = | $6.022 \times 10^{23} \text{ mol}^{-1}$ |
| Boltzmann constant | k_B | = | $1.381 \times 10^{-23} \text{ J K}^{-1}$ |
| Binding energy of hydrogen atom | - | = | 13.606 eV |
| Elementary charge | e | = | $1.602 \times 10^{-19} \text{ C}$ |
| Mass of the electron | m_e | = | $9.109 \times 10^{-31} \text{ kg}$ |
| Mass of the proton | m_p | = | $1.673 \times 10^{-27} \text{ kg}$ |
| Mass of the neutron | m_n | = | $1.675 \times 10^{-27} \text{ kg}$ |
| Permeability of free space | μ_0 | = | $1.257 \times 10^{-6} \text{ Hm}^{-1}$ |
| Molar gas constant | R | = | $8.315 \text{ Jmol}^{-1} \text{ K}^{-1}$ |
| Permittivity of free space (electrical constant) | ϵ_0 | = | $8.854 \times 10^{-12} \text{ F} \cdot \text{m}^{-1}$ |
| Planck's constant | h | = | $6.626 \times 10^{-34} \text{ J} \cdot \text{s}$ |
| Speed of sound in air (at room temperature) | c_s | = | $3.403 \times 10^2 \text{ m} \cdot \text{s}^{-1}$ |
| Speed of light in vacuum | c | = | $2.998 \times 10^8 \text{ m} \cdot \text{s}^{-1}$ |
| Stefan-Boltzmann constant | σ | = | $5.670 \times 10^{-8} \text{ W} \cdot \text{m}^{-2} \cdot \text{K}^{-4}$ |
| Universal constant of gravitation | G | = | $6.674 \times 10^{-11} \text{ N} \cdot \text{m}^2 \cdot \text{kg}^{-2}$ |