

Part 1
Physics. Questions 1–10

Write your answer on Answer Sheet No. 1 to the right of the corresponding question number. Where applicable, include the units of measurement. If you need to correct an answer, cross out the incorrect one, enter the question number in the table below, and write the correct answer in the field to the right.

1. A cyclist riding along a road began to decelerate at a constant rate of 5 m/s^2 after applying the brakes and came to a stop after 3 s. Find the speed of the cyclist at the moment the brakes were applied.
2. A scooter moves at a constant speed of 54 km/h under the action of a driving force of 80 N . Find the power of the scooter.
3. A gas occupies a volume of 5 L at a temperature of 280 K . The gas is heated at constant pressure until its volume becomes 8 L . Find the final temperature of the gas.
4. A gas receives 30 J of heat. During the process, the gas performs 12 J of work. By how many joules does the internal energy of the gas increase?
5. Two point charges, $q_1 = 2 \cdot 10^{-6} \text{ C}$ and $q_2 = 5 \cdot 10^{-6} \text{ C}$, are placed in a vacuum 3 cm apart. Find the magnitude of the Coulomb force between the charges.
6. When a charge of $q = 5 \text{ C}$ moves through a section of an electric circuit, the electric field performs $A = 60 \text{ J}$ of work. Find the voltage across this section of the circuit.
7. The table below shows the dependence of the current I on time t in an oscillating LC circuit. Using these data, determine how many milliseconds after the beginning of the measurements the capacitor is fully discharged for the first time.

$t, \text{ ms}$	0	4	8	12	16	20	24
$I, \text{ mA}$	0	3	0	−3	0	3	0

8. Monochromatic light with a wavelength of 500 nm produces the first-order diffraction maximum at an angle $\sin \theta = 0.20$. Determine the period of the diffraction grating.
9. The frequency of a photon is $5.0 \times 10^{14} \text{ Hz}$. Determine the wavelength of the photon. Give your answer in nanometers.
10. The half-life of a mercury isotope is 20 min .
If the initial mass of the isotope is 40 mg , determine its approximate mass after 1 hour.

Part 2

Physics. Questions 11–14

Use Answer Sheets No. 2 to write your solutions and answers to questions 11–14. Write your solution as completely and in as much detail as possible. Remember that even if you are unable to solve the problem completely, you may still receive some points for significant progress according to the marking criteria.

11. (2 points) A spring is stretched by 5 cm when a force of 20 N is applied. The force is then increased to 40 N. Determine the spring constant of the spring.
12. (3 points) A sample of 0.2 mol of helium is initially at a temperature of 22°C. The internal energy of the gas increases by 49.86 J. Determine:
 1. To what temperature was the helium heated?
 2. If the heating was carried out at constant volume, how much heat was supplied to the gas?
 3. Can it be stated that the gas was heated in an isobaric process? Explain your answer.
13. (2 points) A resistor with resistance $R = 6\ \Omega$ is connected to a DC voltage source. Two parallel plates are connected across the resistor. The distance between the plates is $d = 0.03\text{ m}$. The current flowing through the resistor is $I = 2\text{ A}$. Determine the electric field strength between the plates.
14. (3 points) Monochromatic light with wavelength $\lambda = 500\text{ nm}$ is incident normally on a diffraction grating with spacing $d = 2.0\ \mu\text{m}$. Determine the angle at which the first-order diffraction maximum is observed.

