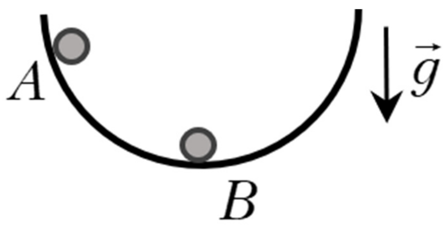
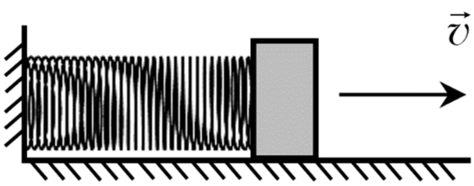
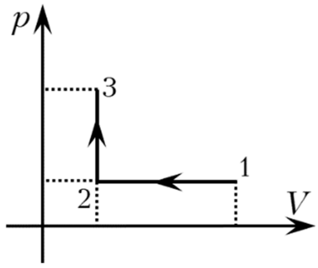
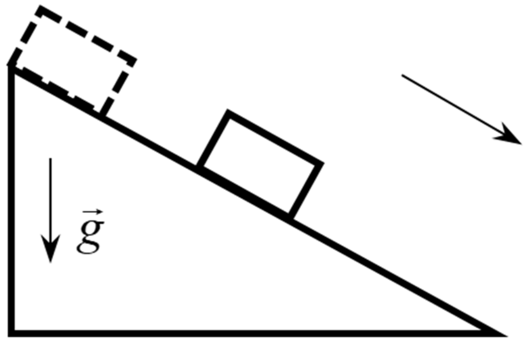
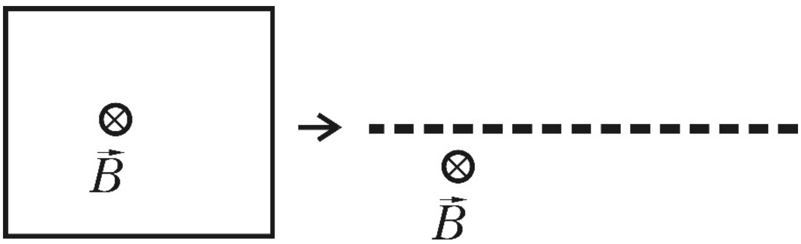
No.	Item	Score	
	I. FOR ITEMS 1-3 PROVIDE SHORT ANSWERS ACCORDING TO THE GIVEN REQUIREMENTS		
1	**Complete the following sentences as to make true statements:** **a)** The ....vector of the body is constant and not zero for uniform rectilinear motion. **b)** At isochoric heating the work performed by the ideal gas is .... **c)** The interaction force between two point charges ....with decreasing distance between bodies. **d)** The intensity of the current flowing through a conductor is greater if the electrical power dissipated as heat on it is .... **e)** The maximum velocity of photoelectrons pulled out during the photoeffect is higher if the wavelength of the incident radiation is........................	L 0 2 4 6 8 10	L 0 2 4 6 8 10
2	**Indicate (by using arrows) the correspondence between the following physical quantities and the physical units they represent:** Length m/s^2 Acceleration K Absolute temperature mC Electrical charge J Work function m °C	L 0 2 4 6 8 10	L 0 2 4 6 8 10
3	**State whether the following statements are true or false and circle the right answer:** **a)** A non-zero force always produces positive mechanical work, no matter its orientation. **T F** **b)** In uniform rotational motion the velocity vector is oriented along the radius of the circle described by a point body. **T F** **c)** In isothermal expansion of a quantity of ideal gas, the work done by the ideal gas is equal to the amount of heat transferred to the gas. **T F** **d)** When a current flows through a metallic conductor, the dissipated quantity of heat is proportional to the current flow duration. **T F** **e)** When an electron passes from a higher to a lower level of an atom, radiation is emitted. **T F**	L 0 2 4 6 8 10	L 0 2 4 6 8 10
	II. IN EXERCISES 4-9 ANSWER THE QUESTIONS OR SOLVE THE TASKS, AND PROVIDE ARGUMENTS IN THE SPACES BELOW:		
4	A point-like body moves in a gravitational field with no initial velocity on the inner surface of a smooth sphere from point A. Plot the forces acting on the body, the acceleration and velocity vectors of the body, at the second pass of the body through position B (the lowest position). The drag force from the air is negligible. 	L 0 1 2 3 4	L 0 1 2 3 4
5	Determine the energy of the electron on the fundamental energy level of an atom if the photon absorbed by the electron as it passes from the fundamental energy level to the higher energy level $-5.5\cdot10^{-19}$ J, has a wavelength of 120 nm. SOLUTION	L 0 1 2 3 4 5	L 0 1 2 3 4 5

6	Two flat air capacitors with equal plate areas are connected in series. The distance between the plates of the second capacitor is 3 times smaller than the distance between the plates of the first. Determine the voltage at the terminals of the first capacitor if the voltage at the terminals of the second capacitor is 120 V. SOLUTION	L 0 1 2 3 4 5 6	L 0 1 2 3 4 5 6
7	A compressed spring fixed at one end communicates a velocity of 2 m/s to a body at the other free end. What is the mass of the body if the spring was initially compressed by 2.0 cm and the spring constant of the spring is 100 N/m? Neglect the frictional and drag forces.  SOLUTION	L 0 1 2 3 4 5 6	L 0 1 2 3 4 5 6

8	One mole of an ideal monoatomic gas was cooled isobarically to a volume 3 times smaller than the initial volume, then heated isochorically until the initial temperature coincided with the final temperature. Determine the maximum temperature of the gas in these transformations if the heat giving off the ideal gas is -8.31 kJ.  SOLUTION	L 0 1 2 3 4 5 6 7 8	L 0 1 2 3 4 5 6 7 8
9	The small oscillations of a gravitational pendulum occur according to the law $x = 5\cos\left(t\sqrt{10}\right)$ (mm), where t is expressed in seconds and the axis *Ox* is horizontal in the plane of the oscillations. Determine: a) the length of the wire suspending the body. b) the distance travelled by the pendulum in one period. The free fall acceleration $g = 10$ m/s^2. SOLUTION	a) L 0 1 2 3 4 5 6 b) L 0 1 2 3	a) L 0 1 2 3 4 5 6 b) L 0 1 2 3

III. FOR ITEMS 10-12 PROVIDE FULL SOLUTION TO THE GIVEN PROBLEMS			
10	A body in the rest start slipping from top of an inclined plane towards the bottom. The coefficient of friction between the body and the plane is equal to $\frac{1}{2\sqrt{3}}$ and the plane forms an angle of 30° with the horizontal line. a) Represent the forces acting on the body as it moves along the plane downwards. b) Determine the difference between the initial height and the height that the body will reach 4.0 seconds after launch. Free fall acceleration g=10 m/s^2, $\sin 30° = 0{,}5$, $\cos 30° = \sqrt{3}/2$. SOLUTION 	a) L 0 1 2 3 b) L 0 1 2 3 4 5 6 7 8 9	a) L 0 1 2 3 b) L 0 1 2 3 4 5 6 7 8 9
11	A metal frame with electrical resistance equal to 0,5 Ω and area equal to 300 cm^2 is in a homogeneous magnetic field with inductance equal to 0,2 T with field lines perpendicular to the plane of the frame. a) What electric charge will pass through the cross-section of the conductor if the frame is deformed by stretching so that its area becomes zero and the plane of the frame remains perpendicular to the field lines? b) Indicate on one side of the original frame (left drawing) the direction of the current induced in the frame when stretched.		

	SOLUTION  	a) L 0 1 2 3 4 5 6 7 8 b) L 0 2	a) L 0 1 2 3 4 5 6 7 8 b) L 0 2
12	You have a metal wire with known electrical resistivity, a DC source, an ideal ammeter and voltmeter, a ruler and connecting wires. You need to determine the diameter of the metal wire. The wire diameter is small and cannot be measured with the ruler! a) Describe how you are going to proceed, show the circuit diagram. b) Derive the calculation formula for the wire diameter. SOLUTION	a) L 0 1 2 3 4 5 6 b) L 0 1 2 3 4	a) L 0 1 2 3 4 5 6 b) L 0 1 2 3 4

ANNEX
Physical constants

Elementary charge $e = 1,60\cdot10^{-19}$ C	Avogadro's constant $N_A = 6,02\cdot10^{23}$ mol^{-1}
Electron rest mass $m_e = 9,11\cdot10^{-31}$ kg	Boltzmann's constant $k = 1,38\cdot10^{-23}$ J/K
Light speed in vacuum $c = 3,00\cdot10^{8}$ m/s	Ideal gas constant $R = 8,31$ J/(mol·K)
Gravitational constant $K = 6,67\cdot10^{-11}$ N·m^2/kg^2	Planck's constant $h = 6,63\cdot10^{-34}$ J·s
Electric constant $\varepsilon_0 = 8,85\cdot10^{-12}$ F/m	Coulomb's force constant $k_e = 9,00\cdot10^{9}$ N·m^2/C^2

MECHANICS

$$x = x_0 + v_{0x}t;\ x = x_0 + v_{0x}t + \frac{a_x t^2}{2};\ v_x = v_{0x} + a_x t;\ v_x^2 - v_{0x}^2 = 2a_x s_x;\ \nu = \frac{1}{T};\ \omega = \frac{2\pi}{T};\ v = \omega r;\ \omega = 2\pi\nu;\ a_c = \frac{v^2}{r}.$$

$$\vec{F} = m\vec{a};\ \vec{F}_{12} = -\vec{F}_{21};\ F = K\frac{m_1 m_2}{r^2};\ \vec{F}_e = -k\Delta\vec{l};\ F_f = \mu N;\ F_A = \rho_0 V g;\ p = \frac{F}{S};\ p = \rho g h;\ M = Fd.$$

$$\vec{p} = m\vec{v};\ \Delta\vec{p} = \vec{F}\Delta t;\ L_{mec.} = Fs\cos\alpha;\ P = \frac{L}{t};\ E_c = \frac{mv^2}{2};\ L_{12} = E_{c2} - E_{c1};\ E_p = mgh;\ E_p = \frac{kx^2}{2};\ L_{12} = -\left(E_{p2} - E_{p1}\right);$$

$$x = A\sin\left(\omega t + \varphi_0\right);\ T = 2\pi\sqrt{\frac{l}{g}};\ T = 2\pi\sqrt{\frac{m}{k}};\ \lambda = vT;$$

MOLECULAR PHYSICS AND THERMODYNAMICS

$$p = \frac{1}{3}m_0 n\overline{v^2} = \frac{2}{3}n\bar{\varepsilon}_{tr.};\ \bar{\varepsilon}_{tr.} = \frac{3}{2}kT;\ p = nkT;\ v_T = \sqrt{\frac{3RT}{M}};\ pV = \nu RT;\ \nu = \frac{m}{M} = \frac{N}{N_A};\ R = kN_A;\ M = m_0 N_A;$$

$$pV = const.,\ T = const.;\ \frac{p}{T} = const.,\ V = const.;\ \frac{V}{T} = const.,\ p = const.;\ \frac{pV}{T} = const.,\ m = const.$$

$$U = \frac{3}{2}\frac{m}{M}RT;\ L = p\Delta V;\ Q = cm\Delta T;\ Q = C_M \nu\Delta T;\ c_p - c_V = \frac{R}{M};\ Q_V = \lambda_V m;\ Q = qm;\ Q = \Delta U + L;\ \eta = \frac{Q_1 - |Q_2|}{Q_1};$$

$$\eta_{\max.} = \frac{T_1 - T_2}{T_1};\ \varphi = \frac{\rho_a}{\rho_s} = \frac{p_a}{p_s};\ \sigma = \frac{F_s}{l};\ h = \frac{4\sigma}{\rho g d};\ \frac{F}{S} = E\frac{\Delta l}{l};\ l = l_0\left(1 + \alpha t\right);$$

ELECTRODYNAMICS

$$F = \frac{k_e}{\varepsilon_r}\frac{|q_1 q_2|}{r^2};\ E = \frac{k_e}{\varepsilon_r}\frac{|q|}{r^2};\ k_e = \frac{1}{4\pi\varepsilon_0};\ \vec{E} = \frac{\vec{F}}{q_0};\ E = \frac{U}{d};\ \varphi = \frac{W}{q_0};\ \varphi = \frac{kq}{r};\ U = \frac{L}{q_0};$$

$$C = \frac{q}{U};\ C = \frac{\varepsilon_0\varepsilon_r S}{d};\ C_P = \sum_{i=1}^{n} C_i;\ \frac{1}{C_S} = \sum_{i=1}^{n}\frac{1}{C_i};\ W_e = \frac{CU^2}{2}$$

$$I = \frac{\Delta q}{\Delta t};\ I = \frac{U}{R};\ I = \frac{\varepsilon}{R + r};\ I_{s.c.} = \frac{\varepsilon}{r};\ R = \rho\frac{l}{S};\ R_s = \sum_{i=1}^{n} R_i;\ \frac{1}{R_P} = \sum_{i=1}^{n}\frac{1}{R_i};\ L = IUt;\ Q = I^2 Rt;\ P = IU;\ \eta = \frac{L_u}{L_t};$$

$$F_m = IBl\sin\alpha;\ F_L = qvB\sin\alpha;$$

$$\Phi = BS\cos\alpha;\ \varepsilon_i = -\frac{\Delta\Phi}{\Delta t};\ \Phi = Li;\ \varepsilon_{ai} = -L\frac{\Delta i}{\Delta t};\ W_m = \frac{LI^2}{2};\ q = q_m\cos\left(\omega t + \varphi_0\right);\ I = \frac{I_m}{\sqrt{2}};\ U = \frac{U_m}{\sqrt{2}};$$

$$\frac{I_2}{I_1} \approx K = \frac{N_1}{N_2} = \frac{U_1}{U_2};\ X_C = \frac{1}{\omega C};\ X_L = \omega L;\ T = 2\pi\sqrt{LC};$$

$$\Delta_{\max} = \pm 2m\cdot\frac{\lambda}{2};\ \Delta_{\min} = \pm\left(2m + 1\right)\cdot\frac{\lambda}{2};\ d\sin\varphi = \pm m\lambda;\ d = \frac{l}{N} = \frac{1}{n}$$

MODERN PHYSICS

$$\tau = \frac{\tau_0}{\sqrt{1 - v^2/c^2}};\ l = l_0\sqrt{1 - v^2/c^2};\ m = \frac{m_0}{\sqrt{1 - v^2/c^2}};\ \vec{p} = \frac{m_0\vec{v}}{\sqrt{1 - v^2/c^2}} = \frac{E}{c^2}\vec{v};\ E = mc^2;\ E_c = (m - m_0)c^2;$$

$$\varepsilon_{ph} = \frac{hc}{\lambda};\ p_{ph} = \frac{h}{\lambda};\ h\nu = L_e + \frac{mv_{\max}^2}{2};\ \nu = \frac{c}{\lambda};\ h\nu = E_n - E_m;\ N = N_0 e^{-\lambda t};\ \lambda = \frac{\ln 2}{T_{1/2}};\ N = N_0 2^{-\frac{t}{T_{1/2}}}$$

$${}^{A}_{Z}X \to {}^{A-4}_{Z-2}Y + {}^{4}_{2}He;\ {}^{A}_{Z}X \to {}^{A}_{Z+1}Y + {}^{0}_{-1}e;\ 1\text{ eV} = 1,60\cdot10^{-19}\text{ J};\ 1\text{ u} = 1,66\cdot10^{-27}\text{ kg}.$$