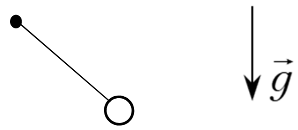
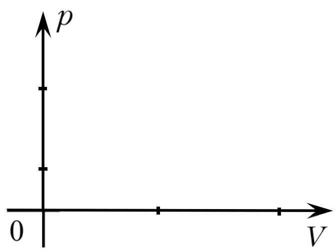
No.	Item	Score	
	I. FOR ITEMS 1-3 PROVIDE SHORT ANSWERS ACCORDING TO THE GIVEN REQUIREMENTS		
1	**Complete the following sentences as to make true statements:** **a)** When throwing a body vertically upwards, its acceleration is ....to the initial velocity. **b)** Two identical bodies at thermal equilibrium have ....particle thermal speeds. **c)** The electric charge sign of an electron is .... **d)** An electron is acted by a non-zero force from a magnetic field if its velocity is not ....to the magnetic field induction. **e)** The photon charge 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:** Force — pF Momentum — C Amount of substance — kg Electric charge — mN Relativistic mass — kg·m/s mol	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)** In uniform circular motion the velocity (vector) does not change direction. **T F** **b)** The duration of an oscillation is more than twice the period of oscillations. **T F** **c)** Molecules of ideal gas do not interact until they collide. **T F** **d)** Light interference does not occur for coherent white light. **T F** **e)** The mass of a particle does not change when passing from a moving to a fixed reference frame, even if the speeds are relativistic. **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 small ball attached to a wire rotates in a vacuum in a vertical plane. Indicate on the figure the forces acting on it, the resultant of the forces and the acceleration of the ball in the given position. 	L 0 1 2 3 4	L 0 1 2 3 4
5	Determine the energy of a photon that has wavelength 0.663 μm. SOLUTION	L 0 1 2 3 4 5	L 0 1 2 3 4 5

6	An air parallel plate capacitor is connected to a constant voltage source. How will the accumulated charge on the capacitor plates change if the distance between them doubles? SOLUTION	L 0 1 2 3 4 5 6	L 0 1 2 3 4 5 6
7	A body moves under the action of a constant force, so its kinetic energy changes from 100 J to 400 J. Determine the value of the force if the distance travelled by the body is 20 m. SOLUTION	L 0 1 2 3 4 5 6	L 0 1 2 3 4 5 6
8	A constant amount of ideal gas was cooled isobarically from its initial temperature of 500 K, so that its volume decreased twofold. a) Represent this process in the pV diagram; b) Determine the final temperature of the gas. SOLUTION  	a) L 0 1 2 3	a) L 0 1 2 3

		b) L 0 1 2 3 4 5	b) L 0 1 2 3 4 5
9	An elastic pendulum performs 60 small oscillations in 1.0 min. When the mass of the suspended body changed, the period decreased twofold. Neglecting air resistance determine: a) the initial frequency of the oscillations; b) how many times has the mass of the pendulum changed, if the spring has the same elastic constant? SOLUTION	a) L 0 1 2 3 4 5 b) L 0 1 2 3 4	a) L 0 1 2 3 4 5 b) L 0 1 2 3 4

III. FOR ITEMS 10-12 PROVIDE FULL SOLUTION TO THE GIVEN PROBLEMS

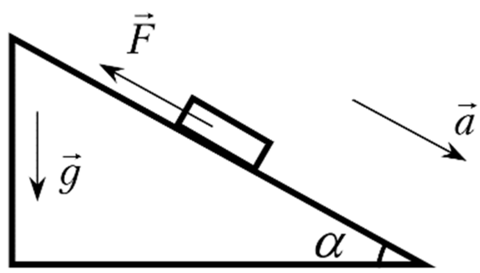
10 A body with a mass of 1.0 kg descends along an inclined plane, without initial velocity, under the action of a constant force of 1.0 N, as shown in the figure. The coefficient of friction between the body and the inclined plane is $1/(5\sqrt{3})$, and the plane forms an angle of 30° with the horizontal line.The acceleration of the free fall is 10 m/s^2 , oriented as in the figure. The dimensions of the body are negligible.

a) Represent the forces acting on the body during motion on the inclined plane.

b) Determine the distance the body will travel for 2.0 s.

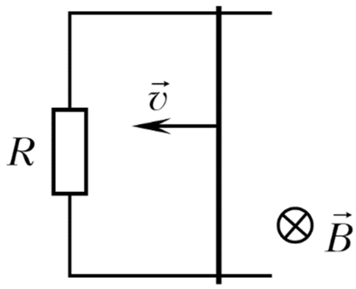
$\sin 30^\circ = 0,5; \quad \cos 30^\circ = \sqrt{3}/2$

SOLUTION



a)	a)
L	L
0	0
1	1
2	2
3	3

b)	b)
L	L
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

11	A rod moves on two parallel rails with constant speed under the action of a horizontal force of 3.0 N in a homogeneous vertical magnetic field of inductance 300 mT (see figure above). What is the speed of movement of the rod if its length is 1.0 m and the resistance is R=0.03 Ω. You will neglect the electrical resistance of the rails, the rod and the connecting wires, the frictional force between the rails and the rod. Indicate the direction of the electric current in the moving rod. SOLUTION  	L 0 1 2 3 4 5 6 7 8 9 10 11 12	L 0 1 2 3 4 5 6 7 8 9 10 11 12

12	You have a voltage source with unknown internal resistance and emf, a resistor with known resistance, an ideal ammeter and connecting wires. You need to determine the value of the internal resistance of the source, if the ammeter can also measure large current values including short circuit. a) Draw the circuit diagram and describe how to determine the internal resistance of the source; b) Derive the calculation formula. SOLUTION	a) L 0 1 2 3 4 5 6 7 b) L 0 1 2 3	a) L 0 1 2 3 4 5 6 7 b) L 0 1 2 3

ANNEX
Physical constants

Elementary charge $e = 1{,}60 \cdot 10^{-19}\,\mathrm{C}$	Avogadro's constant $N_A = 6{,}02 \cdot 10^{23}\ \mathrm{mol^{-1}}$
Electron rest mass $m_e = 9{,}11 \cdot 10^{-31}\,\mathrm{kg}$	Boltzmann's constant $k = 1{,}38 \cdot 10^{-23}\ \mathrm{J/K}$
Light speed in vacuum $c = 3{,}00 \cdot 10^{8}\ \mathrm{m/s}$	Ideal gas constant $R = 8{,}31\ \mathrm{J/(mol \cdot K)}$
Gravitational constant $K = 6{,}67 \cdot 10^{-11}\ \mathrm{N \cdot m^2/kg^2}$	Planck's constant $h = 6{,}63 \cdot 10^{-34}\ \mathrm{J \cdot s}$
Electric constant $\varepsilon_0 = 8{,}85 \cdot 10^{-12}\ \mathrm{F/m}$	Coulomb's force constant $k_e = 9{,}00 \cdot 10^{9}\ \mathrm{N \cdot m^2/C^2}$

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

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

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

$${}_Z^A X \to {}_{Z-2}^{A-4}Y + {}_2^4 He;\ {}_Z^A X \to {}_{Z+1}^{A}Y + {}_{-1}^{0}e;\ 1\ \mathrm{eV} = 1{,}60 \cdot 10^{-19}\ \mathrm{J};\ 1\ \mathrm{u} = 1{,}66 \cdot 10^{-27}\ \mathrm{kg}.$$