

SOLUTIONS Mechanics July 2026 – Version 1

1. b) 0,9p

2. c) 0,9p

3. b) 0,9p

4. a) 0,9p

The elastic constant of the entire wire is $k = ES/l_0$. The elastic constant of the fragment of the wire remaining after removing a part whose length is equal to one third of the length of the undeformed wire is $k' = \frac{ES}{(2/3)l_0} = \frac{3}{2} \frac{ES}{l_0} = \frac{3}{2} k \implies k' = \frac{3}{2} \cdot 300 = 450 \text{ N/m}$.

5. d) 0,9p

The law of conservation for mechanical energy applies between point A (located at height H) and point B (located at height h) where the two energies are equal: $E_A = E_B$, so $E_{cA} + E_{pA} = E_{cB} + E_{pB}$. It results $0 + mgH = mgh + mgh = 2mgh$. Therefore $h = H/2$.

6. b) 0,9p

At equilibrium, $F_e = G$, so $k \Delta l = mg \implies \Delta l = \frac{mg}{k}$. The elastic potential energy stored in the spring is $E_p = \frac{k \Delta l^2}{2}$. By replacing the elongation, one obtains $E_p = \frac{k}{2} \cdot \frac{(mg)^2}{k^2} = \frac{(mg)^2}{2k}$.

7. a) 0,9p

$P = Fv$ and $F = ma \implies P = mav \implies a = \frac{P}{mv}$. Calculating, $a = \frac{100 \cdot 10^3}{800 \cdot 20} = 6,25 \text{ m/s}^2$.

8. c) 0,9p

We use the mechanical momentum variation theorem, $\Delta p = F \Delta t$, where $\Delta p = p_f - p_i = 0 - mv_0 = -mv_0$ and $F = -F_f$. It results $-mv_0 = -F_f \Delta t \implies F_f = \frac{mv_0}{\Delta t}$. Calculating, $F_f = \frac{10 \cdot 10^3 \cdot 20}{40} = 5 \text{ kN}$.

9. c) 0,9p

Each spring stretches under the action of the same forces, $G = mg$. The elongations are $\Delta l_1 = \frac{mg}{k_1}$ and $\Delta l_2 = \frac{mg}{k_2}$. The elastic potential energies of the two springs are

$E_1 = \frac{k_1 \Delta l_1^2}{2} = \frac{k_1 (mg)^2}{2k_1^2} = \frac{(mg)^2}{2k_1}$ and $E_2 = \frac{k_2 \Delta l_2^2}{2} = \frac{(mg)^2}{2k_2}$. The ratio of the two elastic potential energies is $\frac{E_1}{E_2} = \frac{k_2}{k_1}$.

10. d)

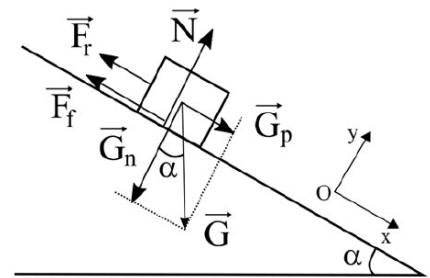
0,9p

When the person is at rest, $\vec{G} + \vec{N}_1 = 0$, where $\vec{N}_1$ is the normal reaction force from the supporting surface of the scale. If the elevator is moving at an accelerated rate, the same thing happens to the man; we can write: $\vec{G} + \vec{N}_2 = m\vec{a}$ that is, taking into account the orientation of the forces and the acceleration vector, $N_2 - G = ma$. It results $N_2 = G + ma = m(a + g)$. To obtain the scale indication, the ratio is made $\frac{N_2}{g} = m \frac{a+g}{g} = m \left(1 + \frac{a}{g} \right) = 70 \cdot (1 + 0,2) = 84 \text{ kg}$.

11. The fundamental law equation is written and projected onto the coordinate axes, obtaining:
 $G_p - F_f - F_r = ma$ and $N - G_n = 0$.

1p

The friction force with the plane is determined, $F_f = \mu N$, resulting $mgsin\alpha - \mu mgcos\alpha - kv^2 = ma$. 1p



The speed of the body is maximum when the acceleration is zero. We obtain

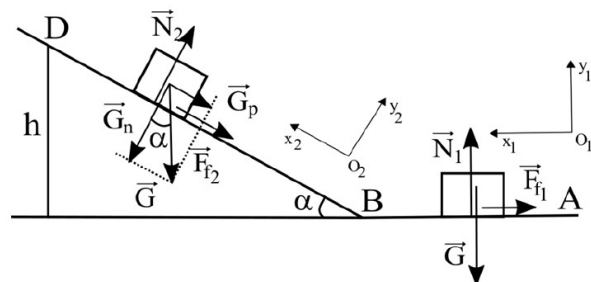
$$v_m = \sqrt{\frac{mg}{k}(\sin\alpha - \mu\cos\alpha)}. \text{ Calculating, } v_m = \sqrt{\frac{80 \cdot 10}{0,8} (1 - 0,1) \frac{\sqrt{2}}{2}} = 25,23 \text{ m/s. } 2p$$

Total exercise 11: 4p

12. We determine the velocity of the body at the launch point, A,

$$v_A = \sqrt{\frac{2 \cdot E_{cA}}{m}} = \sqrt{\frac{2 \cdot 400}{2}} = 20 \text{ m/s. The velocity at point B will be half of } v_A, \text{ that is } v_B = 10 \text{ m/s. } 1p$$

Between points B and D the kinetic energy variation theorem applies, $\Delta E_c = L$, where



$$\Delta E_c = E_{cD} - E_{cB} = 0 - \frac{mv_B^2}{2} = \frac{-mv_B^2}{2} \text{ and } L = L_N + L_G + L_{Ff}. \quad \mathbf{1p}$$

The mechanical work of the normal reaction is zero, $L_N = 0$ and $L_G = -mgh$. The mechanical work of the friction force $L_{Ff} = -F_f d$. But $F_f = \mu N_2 = \mu mg \cos \alpha$, and the distance travelled on the inclined plane between points B and D is $d = \frac{h}{\sin \alpha}$. **1p**

We get $L_{Ff} = -\mu mg \cos \alpha \cdot \frac{h}{\sin \alpha} = -\mu mgh \cdot \operatorname{ctg} \alpha$. The mechanical work $L = -mgh(1 + \mu \operatorname{ctg} \alpha)$. It

results $\frac{mv_B^2}{2} = mgh(1 + \mu \cdot \operatorname{ctg} \alpha)$, that is $h = \frac{v_B^2}{2g(1 + \mu \cdot \operatorname{ctg} \alpha)}$.

We obtain $h = 4 \text{ m}$.

2p

Total exercise 12: 5p