

A. MECANICĂ

Subiectul I

1. C ✓
  2. A ✓
  3. D ✓
  4. ~~A~~ B
  5. A ✓
2.  $L_m = F \cdot d = m \cdot a \cdot d = \text{kg} \cdot \text{m/s}^2 \cdot \text{m}$   
 $\Rightarrow L_m = \text{kg} \cdot \text{m}^2/\text{s}^2$
3.  $\frac{F}{S} = E \cdot \frac{\Delta l}{l_0}$  ;  $F = \frac{SE \Delta l}{l_0} = k \cdot \Delta l$   
 $\Rightarrow k = SE \cdot l_0^{-1}$
4.  $m = 0,25 \text{ kg}$  ;  $v_1 = 20 \text{ m/s}$  ;  $v_2 = 10 \text{ m/s}$   
 $\Delta t = 1 \text{ ms} = 10^{-3} \text{ s}$  ;  $\vec{F} = m \cdot \vec{a} = m \cdot \frac{v_1 - v_2}{\Delta t}$   
 $\Rightarrow \vec{F} = 0,25 \cdot \frac{10}{10^{-3}} = 0,25 \cdot 10^4 = 2,500 \text{ kN}$
5.  $E_c = \frac{mv^2}{2}$  ;  $E_{cf} = 0$  ;  
 $E_{ci} = \frac{mv_0^2}{2} = 12 \Rightarrow \frac{m \cdot 60^2}{2} = 12 \Rightarrow m = \frac{12}{30} = \frac{1,2}{3} = 0,4 \text{ kg}$

A S1 (12p) ; S2 (15p) ; S3 (15p)

B S1 (9p) ; S2 (14p) ; S3 (3p)

Gr: (10p)

-3p

-1p

78p / 82p



# Subiectul al II-lea

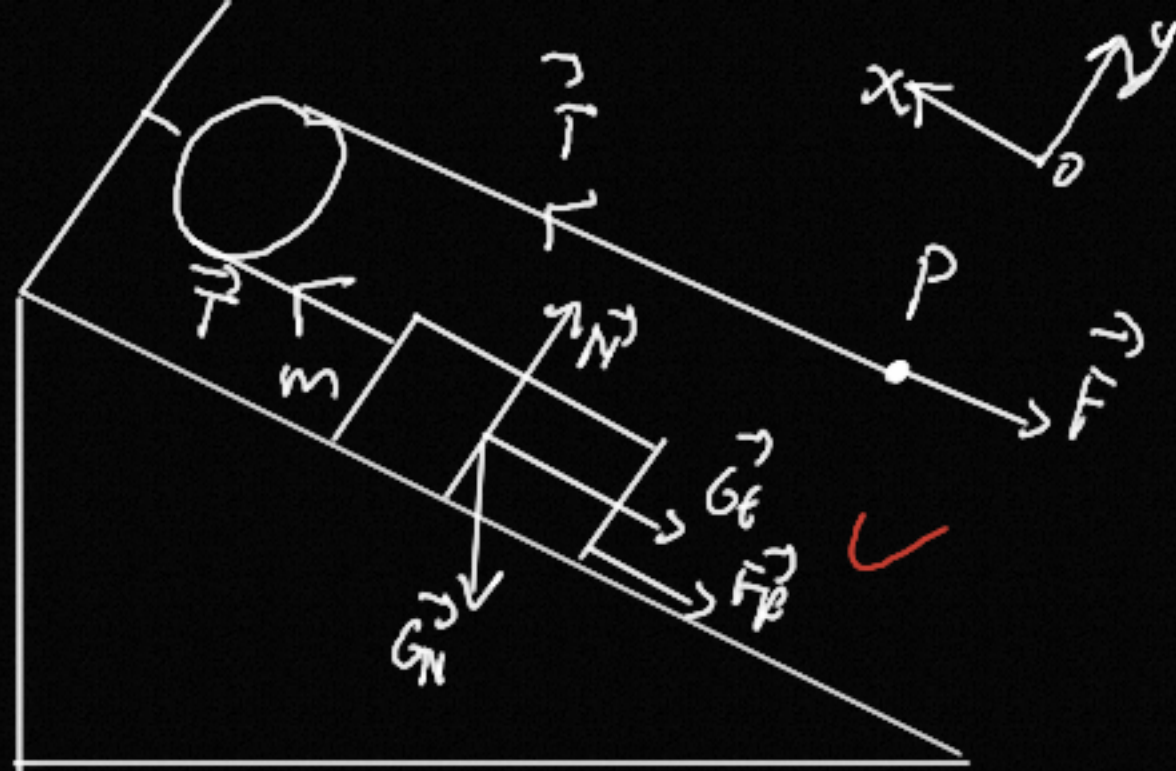
$$a = 0,4 \text{ m/s}^2$$

$$m = 2 \text{ kg}$$

$$\sin \alpha = 0,6 \Rightarrow \cos \alpha = 0,8$$

$$\mu = 0,2 ; v_0 = 0$$

15p



$$P: \text{Pe } ox: \vec{F} + \vec{T} = m \cdot a$$

$$\Rightarrow F + T = m \cdot a \Rightarrow F = T$$

$$m: \text{Pe } ox: T - mg \sin \alpha - \vec{F}_f = m \cdot a$$

$$\vec{F}_f = \mu N \Rightarrow T - mg \sin \alpha - \mu N = m \cdot a$$

$$\text{Pe } oy: T - mg \cos \alpha = 0 \Rightarrow T = mg \cos \alpha$$

$$\Rightarrow T - mg \sin \alpha - \mu mg \cos \alpha = ma$$

a)

$$\Rightarrow T = ma + mg(\sin \alpha + \mu \cos \alpha) \Rightarrow F = m \cdot a + mg(\sin \alpha + \mu \cos \alpha)$$

$$\Rightarrow F = 2 \cdot 0,4 + 2 \cdot 10 \left( 0,6 + \frac{1}{5} \cdot \frac{8}{10} \right) \Rightarrow F = 1,6 + 20 \cdot \left( 0,6 + \frac{8}{50} \right) = 1,6 + 20 \cdot (0,6 + 0,16) = 1,6 + 20 \cdot 0,76$$

$$\Rightarrow F = 0,8 + 15,2 = 16 \text{ N}$$

c)  $\vec{R} = ?$  ;  $R = \sqrt{T^2 + T^2 + 2T \cdot T \cdot \cos(\vec{T} \cdot \vec{T})}$  ;  $T = ma + mg(\sin \alpha + \mu \cos \alpha) = 0,8 + 20(0,6 + 0,2 \cdot 0,8) = 0,8 + 20(0,6 + 0,16)$

$$\Rightarrow T = 0,8 + 20 \cdot 0,76 = 0,8 + 15,2 \Rightarrow T = 16 \text{ N}$$

i  $\vec{E}_\theta$   $\beta = (\vec{T} \cdot \vec{T}) \Rightarrow \beta = 0 \Rightarrow R = \sqrt{2T^2 + 2T^2 \cdot \cos \beta} = 2T \Rightarrow R = 32 \text{ N}$

d)  $\Delta t = 3 \text{ s}$ ;  $d = ?$  ; conform legii coordonatei:  $d = d_0 + v_0 t + \frac{at^2}{2} \Rightarrow d = \frac{at^2}{2} \Rightarrow d = \frac{0,4 \cdot 4}{2} \Rightarrow d = 0,8 \text{ m}$



Subiectul al III-lea a)  $P=?$ ;  $P = \frac{L_m}{\Delta t} = \frac{L_F}{\Delta t} = \frac{375000}{5} \text{ W} \Rightarrow P = 75000 \text{ W} = 75 \text{ kW} \Rightarrow P = 75 \text{ kW}$

$$m = 1,2 \text{ t} = 1200 \text{ kg}$$

$$v_1 = 18 \text{ km/h} = 5 \text{ m/s}$$

$$v_2 = 72 \text{ km/h} = 20 \text{ m/s}$$

$$\Delta t = 5 \text{ s}$$

$$L_F = 375 \text{ kJ} = 375000 \text{ J}$$

b)  $L_{FR}=?$ ;  $\bar{F}_R$  este  $\bar{F}_R$  forța de rezistență;  $L_{FR} = \bar{F}_R \cdot d$ ;  $\Delta E_c = L_{\text{total}} = L_F + L_{FR}$

$$\Rightarrow \Delta E_c = \frac{mv_2^2}{2} - \frac{mv_1^2}{2} = \frac{m}{2} (v_2^2 - v_1^2) = L_F + L_{FR} \Rightarrow L_{FR} = \frac{m}{2} (v_2^2 - v_1^2) - L_F$$

$$\Rightarrow L_{FR} = \frac{1200}{2} (400 - 25) - 375000 = 900 \cdot 375 - 375000 = 375(900 - 1000)$$

$$\Rightarrow L_{FR} = -375000 \text{ J}$$

rsp

c)  $F_t=?$ ;  $L_F = F_t \cdot d$ ;  $v_2^2 = v_1^2 + 2ad \Rightarrow 2ad = v_2^2 - v_1^2 \Rightarrow d = \frac{v_2^2 - v_1^2}{2a} = \frac{(v_2^2 - v_1^2)/2at}{v_2 - v_1} = \frac{(v_2 - v_1)(v_2 + v_1) \cdot \Delta t \cdot 2}{v_2 - v_1}$

$$\Rightarrow F_t = \frac{L_F}{d} = \frac{L_F}{(v_1 + v_2) \cdot \Delta t} = \frac{375000}{25 \cdot 5} \Rightarrow F_t = 6000 \text{ N}$$

d)  $v_2 = 20 \text{ m/s}$ ;  $F = 0$ ;  $F_R = f \cdot G$ ;  $f = 0,04 \Rightarrow \bar{F}_R = F_{mg}$ ;  $v_3 = 0 \text{ m/s}$ ;  $\Delta E_{c23} = E_3 - E_2 = \frac{m}{2} (v_3^2 - v_2^2)$

$$\Rightarrow \Delta E_{c23} = \frac{m}{2} \cdot (v_2)^2 = -\frac{mv_2^2}{2} = L_{FR} \Rightarrow -\frac{mv_2^2}{2} = -F_{mg}d \Rightarrow d = \frac{+v_2^2}{2fg} = \frac{+400}{0,8} = \frac{4000}{8} = 500 \text{ m} \Rightarrow d = 500 \text{ m}$$

$$\Rightarrow d = 0,5 \text{ km}$$



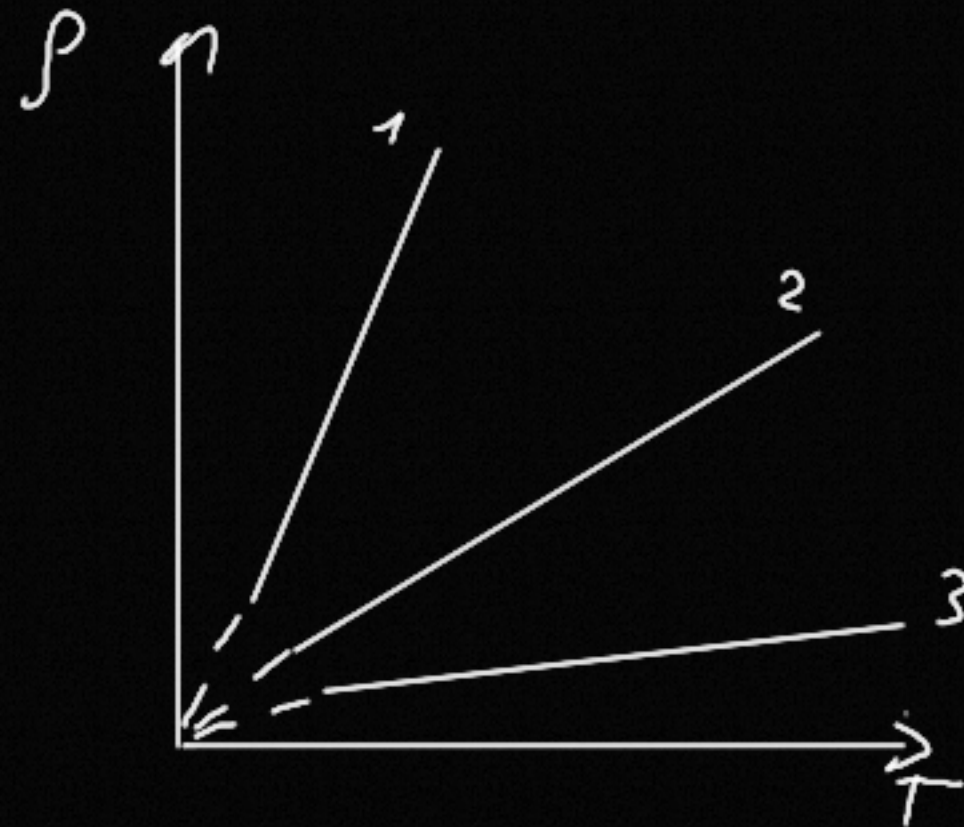
## B. Elemente de termodinamică

### Subiectul 1

- |        |   |  |
|--------|---|--|
| 1. —   | 2. $\frac{p_0 \cdot V_0}{\gamma R}$   | 3. $pV = \gamma RT \Rightarrow \frac{V}{T} = \frac{\gamma R}{p}$ |
| 2. C ✓ |   |  |
| 3. C ✓ | 5. $V = L^3 \Rightarrow pV = \gamma RT \Rightarrow p = \frac{\gamma RT}{L^3}$ |  |
| 4. —   | $V_2 = 8L^3 \Rightarrow p_2 = \frac{\gamma RT}{8L^3} = \frac{p}{8}$           |  |
| 5. A ✓ |   |  |

3p

$$pV = \gamma RT$$





Subiectul al 5-lea

$$V_1 = 24,93 \cdot 10^{-3} \text{ m}^3$$

$$\mu_1 = 32 \cdot 10^{-3} \text{ kg/mol}$$

$$T_1 = 300 \text{ K}$$

$$p_1 = 2 \cdot 10^5 \text{ Pa}$$

$$V_2 = 16,62 \cdot 10^{-3} \text{ m}^3$$

$$\mu_2 = 4 \cdot 10^{-3} \text{ kg/mol}$$

$$T_2 = 400 \text{ K}$$

$$p_2 = 10^5 \text{ Pa}$$

$$a) \nu_1 = ? \quad p_1 V_1 = \nu_1 R T_1 \Rightarrow \nu_1 = \frac{p_1 V_1}{R T_1} = \frac{2 \cdot 10^5 \cdot 24,93 \cdot 10^{-3}}{8,31 \cdot 300}$$

$$\Rightarrow \nu_1 = \frac{2 \cdot 10^3 \cdot 24,93 \cdot 10^{-3}}{8,31 \cdot 300} \Rightarrow \nu_1 = 2 \text{ mol}$$

$$b) p_2 = ? \quad \nu_2 = \frac{p_2 V_2}{R T_2} \quad ; \quad \frac{p_2 V_2}{R T_2} = \frac{m_2}{\mu_2} \Rightarrow m_2 = \frac{\mu_2 p_2 V_2}{R T_2} \quad ; \quad \rho = \frac{m_2}{V_2} = \frac{\mu_2 p_2}{R T_2}$$

$$\Rightarrow \rho = \frac{\mu_2 p_2}{R T_2} = \frac{4 \cdot 10^{-3} \cdot 10^5}{8,31 \cdot 400} = \frac{400}{8,31 \cdot 400} \Rightarrow \rho = \frac{1}{8,31} \text{ kg/m}^3 \Rightarrow \rho \approx 0,12 \text{ kg/m}^3$$

$$c) T_2 \rightarrow T_1 \quad p_2' V_2 = \nu_2 R T_1 \Rightarrow p_2' = \frac{\nu_2 R T_1}{V_2} \quad ; \quad \nu_2 = \frac{p_2 V_2}{R T_2} = \frac{10^5 \cdot 16,62 \cdot 10^{-3}}{8,31 \cdot 400}$$

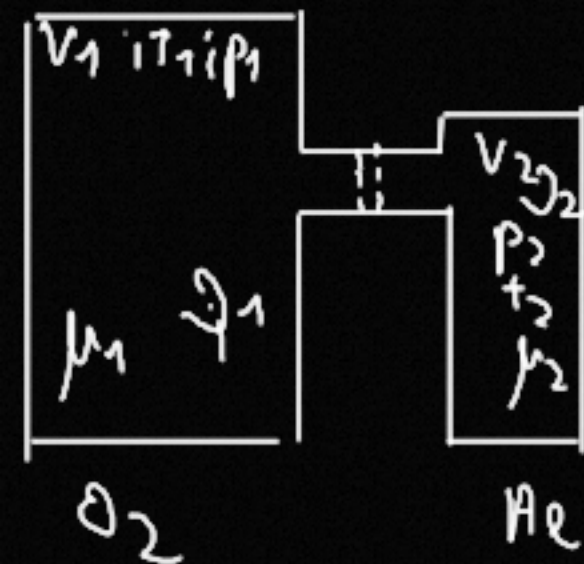
$$\Rightarrow \nu_2 = 0,25 \text{ mol} \quad ; \quad p_2' = \frac{p_2 V_2 T_1}{V_2 T_2} \Rightarrow p_2' = \frac{p_2 T_1}{T_2}$$

$$p(V_1 + V_2) = (\nu_1 + \nu_2) R T \Rightarrow p = \frac{(\nu_1 + \nu_2) R T}{V_1 + V_2} = \frac{1,25 \cdot 8,31 \cdot 300}{4 \cdot 8,31 \cdot 10^{-3}} = 1,25 \cdot 25 \cdot 8,000$$

$$\Rightarrow p = 1,5 \cdot 10^5 \text{ Pa}$$

$$d) \mu = ? \quad ; \quad \nu_{\text{am}} = \nu_1 + \nu_2 = 2,25 \text{ mol} \quad ; \quad m_1 = \nu_1 \cdot \mu_1 = 64 \cdot 10^{-3} \text{ kg} \quad ; \quad m_2 = \nu_2 \cdot \mu_2$$

$$\Rightarrow m_2 = \nu_2 \cdot \mu_2 = \frac{1}{4} \cdot 4 \cdot 10^{-3} \Rightarrow m_2 = 10^{-3} \text{ kg} \Rightarrow \mu = \frac{m_1 + m_2}{\nu_1 + \nu_2} = \frac{65 \cdot 10^{-3}}{2,25} = 24,44 \cdot 10^{-3} \text{ kg/mol}$$





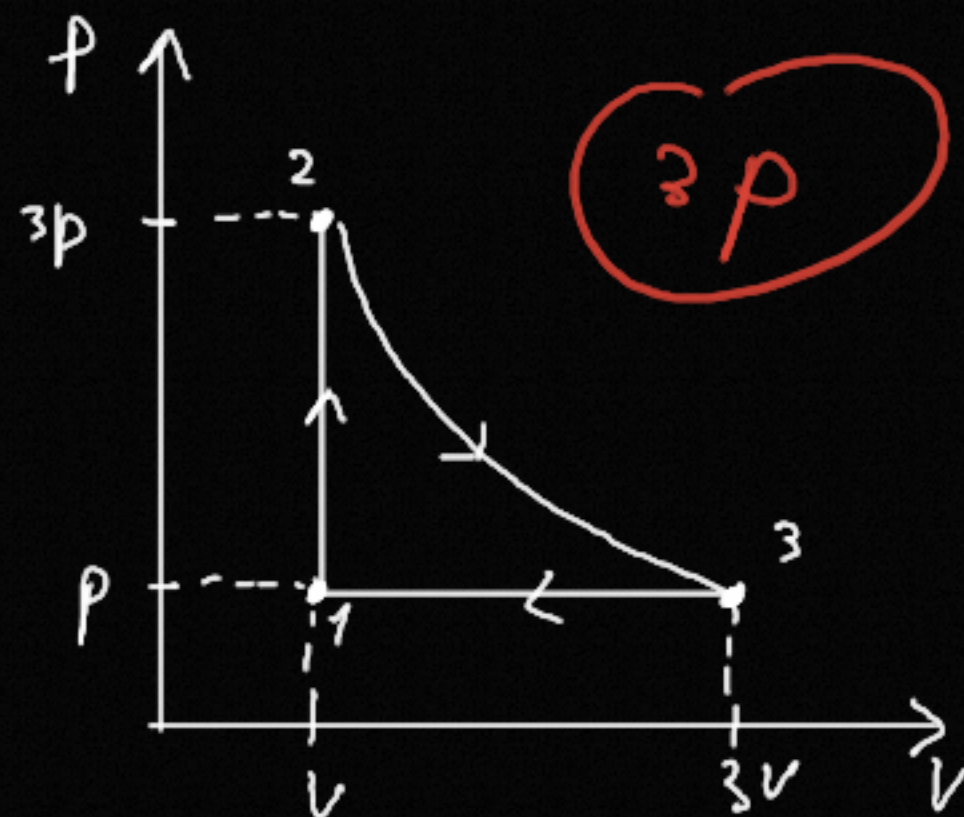
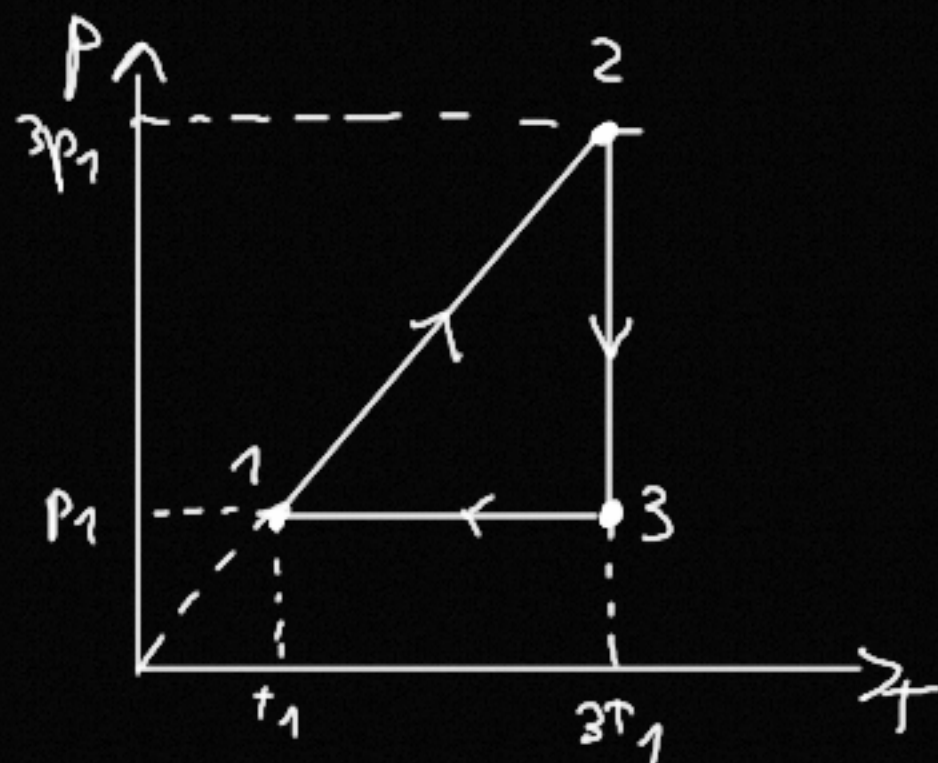
## Subiectul al 11-lea

$$C_V = 2.5R$$

$$p_1 = 10^5 \text{ Pa}$$

$$Q_{12} = 3300 \text{ J}$$

$$\ln(3) \approx 1.1$$



$$\begin{cases} p_1 = p \\ v_1 = v \\ T_1 = T \end{cases} \quad \begin{cases} p_2 = 3p \\ v_2 = v \\ T_2 = 3T \end{cases} \quad \begin{cases} p_3 = p \\ v_3 = 3v \\ T_3 = 3T \end{cases}$$

12: izocoră  $\Rightarrow v_1 = v_2$  ;  $pV = \nu R T \Rightarrow \frac{p_1}{T_1} = \frac{p_2}{T_2} \Rightarrow p_2 = 3p_1 = 3p$

23: izotermă  $\Rightarrow T_2 = T_3 = 3T \Rightarrow p_2 v_2 = p_3 v_3 \Rightarrow v_3 = \frac{p_2 v_2}{p_3} = \frac{3p v_2}{p} = 3v_2$

