7 razred
Opštinsko takmičenje
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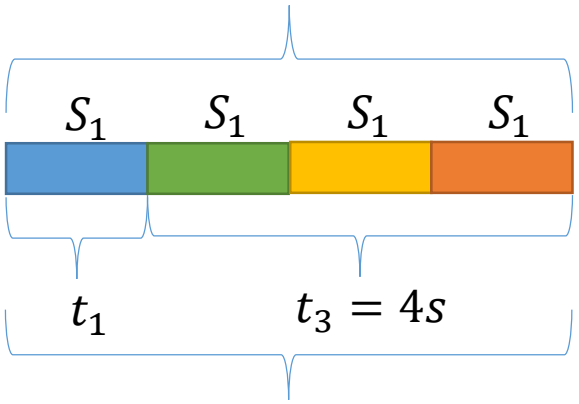
1. Voz je krenuo iz stanice ravnomerno povećavajući svoju brzinu. Putnik koji stoji pored pruge na početku prvog vagona, je izmerio da pored njega za ukupno 4s prođu drugi, treći i četvrti vagon. Koliko vremena je trajao prolazak prvog vagona pored posmatrača? Dužina svih vagona je jednaka.

$t_3 = 4s$

$t_1 = ?$

$S_4 = 4 \cdot S_1$



$t_4 = t_1 + t_3$

$$S_1 = \frac{a \cdot {t_1}^2}{2}$$

$$S_4 = \frac{a \cdot {t_4}^2}{2}$$

$$S_4 = 4 \cdot S_1$$

$$\frac{a \cdot {t_4}^2}{2} = 4 \cdot \frac{a \cdot {t_1}^2}{2}$$

$${t_4}^2 = 4 \cdot {t_1}^2$$

$$\sqrt{{t_4}^2} = \sqrt{4 \cdot {t_1}^2}$$

$$t_4 = 2 \cdot t_1$$

$$t_1 + t_3 = 2 \cdot t_1$$

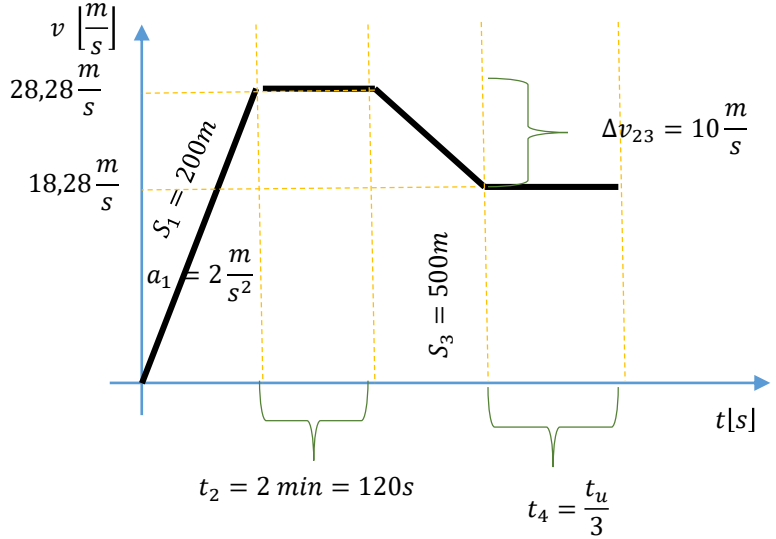
$$t_1 + 4s = 2 \cdot t_1$$

$$4s = 2 \cdot t_1 - t_1$$

$$4s = t_1$$

$$t_1 = 4s$$

2. Automobil se kretao konstanim ubrzanjem $2\frac{m}{s^2}$. Nakon pređenih $200m$, 2 minuta se kretao konstantno dostignutom brzinom, a potom je narednih $500m$ usporavao dok nije smanjio brzinu za $10\frac{m}{s}$. Prestalu trećinu ukupnog vremena kretanja nastavio je kratanje stalnom brzinom. Kolika je srednja brzina automobila na celom putu?



$a_1 = 2\frac{m}{s^2}$
$S_1 = 200m$

$v_1{}^2 = 2 \cdot a \cdot S_1 = 2 \cdot 2\frac{m}{s^2} \cdot 200m = 800\frac{m^2}{s^2}$

$v_1 = \sqrt{800\frac{m^2}{s^2}} = 28{,}28\frac{m}{s}$

$t_1 = \frac{v_1}{a_1} = \frac{28{,}28\frac{m}{s}}{2\frac{m}{s^2}} = 14{,}14s$

$t_2 = 2\,min = 120s$

$v_2 = 28{,}28\frac{m}{s}$

$S_2 = v_2 \cdot t_2 = 28{,}28\frac{m}{s} \cdot 120s = 3393{,}6m$

$\Delta v_{23} = 10\frac{m}{s}$

$v_3 = v_2 - \Delta v_{23} = 28{,}28\frac{m}{s} - 10\frac{m}{s} = 18{,}28\frac{m}{s}$

$v_{03} = 28{,}28\frac{m}{s}$

$S_3 = 500m$

$v_3{}^2 = v_{0\,3}{}^2 - 2 \cdot a_3 \cdot S_3$

$a_3 = \frac{v_{0\,3}{}^2 - v_3{}^2}{2 \cdot S_3} = \frac{(28{,}28\frac{m}{s})^2 - (18{,}28\frac{m}{s})^2}{2 \cdot 500m}$

$t_3 = \frac{\Delta v_{23}}{a_3} = \frac{10\frac{m}{s}}{0{,}4656\frac{m}{s^2}} = 21{,}48s$

$a_3 = \frac{799{,}7584\frac{m^2}{s^2} - 334{,}1584\frac{m^2}{s^2}}{1000\,m} = 0{,}4656\frac{m}{s^2}$

$t_4 = \frac{t_u}{3}$

$v_4 = 18{,}28\frac{m}{s}$

$t_4 = \frac{233{,}43s}{3} = 77{,}81s$

$S_4 = v_4 \cdot t_4 = 18{,}28\frac{m}{s} \cdot 77{,}81s = 1422{,}4m$

$v_{sr} = \frac{S_u}{t_u} = \frac{S_1 + S_2 + S_3 + S_4}{t_u} = \frac{200m + 3393{,}6m + 500m + 1422{,}4m}{233{,}43s} = \frac{5516m}{233{,}43s} = 23{,}63\frac{m}{s}$

$t_u = t_1 + t_2 + t_3 + t_4$

$t_u = 14{,}14s + 120s + 21{,}48s + \frac{t_u}{3}$

$t_u = 155{,}62s + \frac{t_u}{3}$

$t_u - \frac{t_u}{3} = 155{,}62s$

$\frac{2t_u}{3} = 155{,}62s$

$t_u = 155{,}62s\frac{3}{2} = 233{,}43s$

3. Kamen A se baci vertikalno naviše sa visine H = 5 m . Kamen B se istovremeno baci sa zemlje početnom brzinom 13 m/s. Ako je poznato da oba kamena dostignu istu maksimalnu vusinu naći:
a) Koji kamen prvi dođe u najvišu tačku svoje putanje i nakon kog vremena posle njega drugi kamen dođe u najvišu tačku?
b) Brzinu koju ima kamen B kada prolazi kroz tačku iz koje je bačen kamen A.
v) Brzinu kojom kamen A udara u zemlju.

$H = 5m$

$v_{B\,0} = 13\frac{m}{s} \Rightarrow h_{B\,max} = \frac{{v_{B\,0}}^2}{2 \cdot g} = \frac{(13\frac{m}{s})^2}{2 \cdot 10\frac{m}{s^2}} = \frac{169\frac{m^2}{s^2}}{20\frac{m}{s^2}} = 8{,}45\ m$

b)
$${v_{B\,A}}^2 = {v_{B\,0}}^2 - 2 \cdot g \cdot H = (13\frac{m}{s})^2 - 2 \cdot 10\frac{m}{s^2} \cdot 5m = 169\frac{m^2}{s^2} - 100\frac{m^2}{s^2}$$

$${v_{B\,A}}^2 = 69\frac{m^2}{s^2} \qquad v_{B\,A} = \sqrt{69\frac{m^2}{s^2}} = 8{,}3\frac{m}{s}$$

a)

$h_{A\,max} = h_{B\,max} - H$

$h_{A\,max} = 8{,}45\ m - 5m$

$h_{A\,max} = 3{,}45\ m$

$${v_{A\,max}}^2 = {v_{A\,0}}^2 - 2 \cdot g \cdot h_{A\,max}$$

$${v_{A\,0}}^2 = 2 \cdot g \cdot h_{A\,max}$$

$${v_{A\,0}}^2 = 2 \cdot 10\frac{m}{s^2} \cdot 3{,}45\ m$$

$${v_{A\,0}}^2 = 69\frac{m^2}{s^2}$$

$$v_{A\,0} = \sqrt{69\frac{m^2}{s^2}} = 8{,}3\frac{m}{s}$$

$v_{A\,max} = v_{A\,0} - g \cdot t_{A\,max}$

$v_{A\,0} = g \cdot t_{A\,max}$

$t_{A\,max} = \frac{v_{A\,0}}{g}$

$t_{A\,max} = \frac{8{,}3\frac{m}{s}}{10\frac{m}{s^2}} = 0{,}83s$

$v_{B\,max} = v_{B\,0} - g \cdot t_{B\,max}$

$v_{B\,0} = g \cdot t_{B\,max}$

$t_{B\,max} = \frac{v_{B\,0}}{g}$

$t_{B\,max} = \frac{13\frac{m}{s}}{10\frac{m}{s^2}} = 1{,}3s$

v)

$${v_{A1}}^2 = 2 \cdot g \cdot h_{B\,max}$$

$${v_{A1}}^2 = 2 \cdot 10\frac{m}{s^2} \cdot 8{,}45\ m$$

$${v_{A1}}^2 = 169\frac{m^2}{s^2}$$

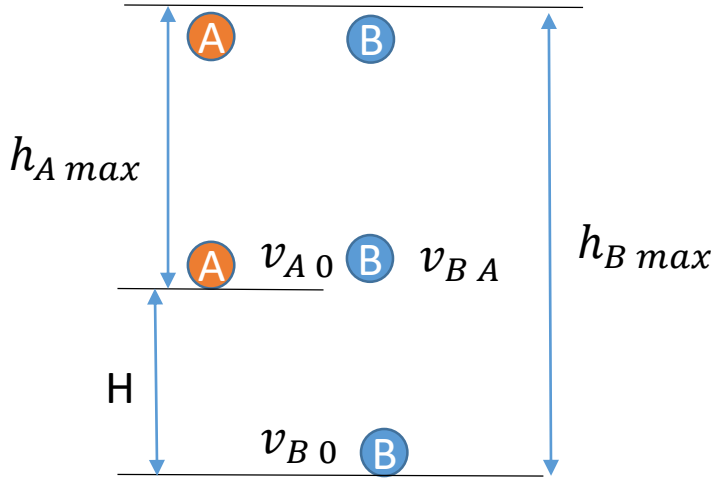
$$v_{A1} = \sqrt{169\frac{m^2}{s^2}} = 13\frac{m}{s}$$

a)
Pre će u najvišu tačku stići kamen A.

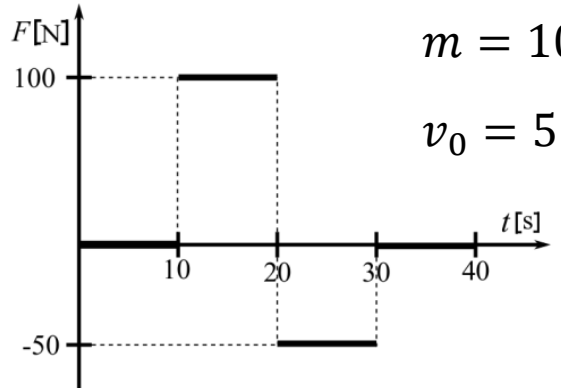
$\Delta t = t_{B\,max} - t_{A\,max}$

$\Delta t = 1{,}3s - 0{,}83s = 0{,}47s$

$v_{A\,max} = 0\frac{m}{s}$ $\qquad$ $v_{B\,max} = 0\frac{m}{s}$

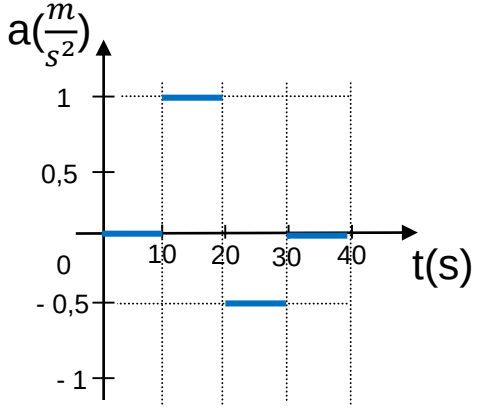


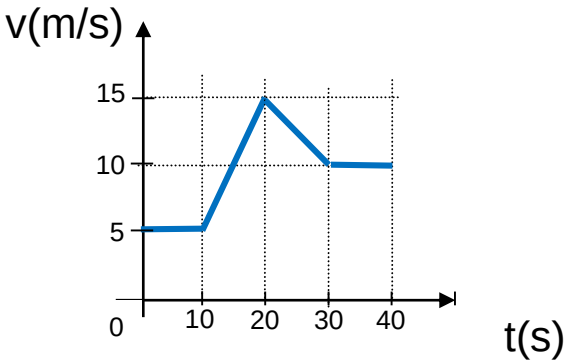
4. Na telo mase $100\ kg$ deluje sila čija je zavisnost sile od vremena prikazana na slici. Nacrtati grafike zavisnosti ubrzanja i brzine od vremena ako se zna da se pre početka delovanja sile telo kretalo brzinom $v_0 = 5\frac{m}{s}$.



$$m = 100\ kg$$

$$v_0 = 5\frac{m}{s}$$





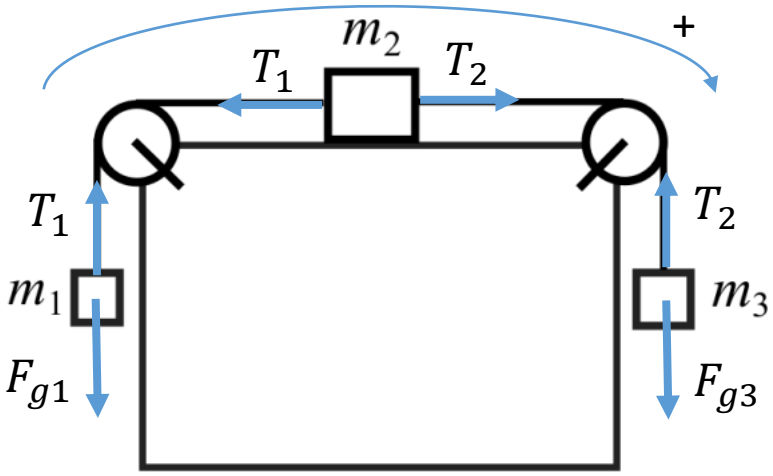
I	II	III	IV
$F_1 = 0N$	$F_2 = 100N$	$F_3 = -50N$	$F_4 = 0N$
$t_1 = 10s$	$t_2 = 10s$	$t_3 = 10s$	$t_4 = 10s$
$a_1 = 0\frac{m}{s^2}$	$a_2 = 1\frac{m}{s^2}$	$a_3 = -0{,}5\frac{m}{s^2}$	$a_4 = 0\frac{m}{s^2}$
$\Delta v_1 = 0\frac{m}{s}$	$\Delta v_2 = 10\frac{m}{s}$	$\Delta v_3 = -5\frac{m}{s}$	$\Delta v_4 = 0\frac{m}{s}$
$v_{01} = 5\frac{m}{s}$	$v_{02} = 5\frac{m}{s}$	$v_{03} = 15\frac{m}{s}$	$v_{04} = 10\frac{m}{s}$
$v_1 = 5\frac{m}{s}$	$v_2 = 15\frac{m}{s}$	$v_3 = 10\frac{m}{s}$	$v_4 = 10\frac{m}{s}$

$$F = m \cdot a \Rightarrow a = \frac{F}{m}$$

$$v = v_{01} + \Delta v$$

$$\Delta v = a \cdot t$$

5. Na stolu koji miruje nalazi se sistem koji se sastoji od tri tela čije su mase $m_1 = 2\ kg, m_2 = 5\ kg$ i $m_3 = 3\ kg$ (slika). Ako tela pustimo da se slobodno kreću iz mirovanja, odredi intenzitete sila zatezanje niti. Mase neistegljivih niti, mase koturova i trenje zanemariti.



$$m_1 = 2\ kg \qquad F_{g1} = m_1 \cdot g = 2kg \cdot 10\frac{N}{kg} = 20N$$

$$m_2 = 5\ kg$$

$$m_3 = 3\ kg \qquad F_{g3} = m_3 \cdot g = 3kg \cdot 10\frac{N}{kg} = 30N$$

$$m_1 \cdot a = T_1 - F_{g1} \Rightarrow T_1 = F_{g1} + m_1 \cdot a = 20N + 2kg \cdot 1\frac{N}{kg} = 20N + 2N = 22N$$

$$m_2 \cdot a = T_2 - T_1$$

$$m_3 \cdot a = F_{g3} - T_2 \Rightarrow T_2 = F_{g3} - m_3 \cdot a = 30N - 3kg \cdot 1\frac{N}{kg} = 30N - 3N = 27N$$

$$m_1 \cdot a + m_2 \cdot a + m_3 \cdot a = T_1 - F_{g1} + T_2 - T_1 + F_{g3} - T_2$$

$$a \cdot (m_1 + m_2 + m_3) = -F_{g1} + F_{g3}$$

$$a = \frac{-F_{g1} + F_{g3}}{m_1 + m_2 + m_3} = \frac{-20N + 30N}{2kg + 5kg + 3kg} = \frac{10N}{10kg} = 1\frac{N}{kg} = 1\frac{m}{s^2}$$

PROVERA

$$m_2 \cdot a = T_2 - T_1$$

$$5kg \cdot 1\frac{N}{kg} = 27N - 22N$$

$$5N = 5N$$