Часть 1

Олимпиада: **Физика, 10 класс (1 часть)**

Шифр: **21206513**

ID профиля: **839115**

Вариант 1

Черновик

№2

Дано:

ω

ρ

3ρ

R

$2R$

$tg\alpha = 2$

N_1 - ?

N_2 - ?

Решение:

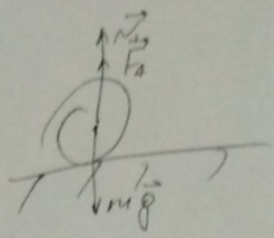
$mg = N_1 + F_A$

$N_1 = mg - F_A$

$F_A = \rho \cdot V_ш g = \rho \cdot \frac{4}{3}\pi R^3 g$

$mg = 3\rho \cdot V_ш g = 3\rho \cdot \frac{4}{3}\pi R^3 g = \frac{12}{3}\rho\pi R^3 g$

$N_1 = \frac{12}{3}\rho\pi R^3 g - \frac{4}{3}\pi R^3 g\rho = \frac{8}{3}\pi R^3 \rho g$



№1

$y_1 = H_{max} - \frac{gt^2}{2} = \frac{\upsilon_0^2}{2g} - \frac{gt^2}{2} = \frac{\upsilon_0^2 - g^2t^2}{2g}$

$y_2 = \upsilon_0 t - \frac{gt^2}{2} = \frac{2\upsilon_0 t - gt^2}{2} = \cancel{\left(\frac{2\upsilon_0 - gt}{2}\right)} t$

$t_2 + y_2(t_2) = H = y_1(t_2) H$

$$\begin{cases} \frac{\upsilon_0^2 - g^2 t_2^2}{2g} = H \\ \frac{2\upsilon_0 t_2 - g t_2^2}{2} = H \end{cases}$$

$2\upsilon_0 - gt_2 = \frac{2H}{t_2}$

$\upsilon_0 = \frac{H}{t_2} + \frac{gt_2}{2} = \frac{2H + gt_2^2}{2t_2}$

$\frac{\left(\frac{2H + gt_2^2}{2t_2}\right)^2 - g^2 t_2^2}{2g} = H$

$\frac{(2H + gt_2^2)^2}{4t_2^2} - g^2 t_2^2 = 2gH$

$4H^2 + 4gHt_2^2 + g^2t_2^4 - 4g^2t_2^4 = 8gHt_2^2$

$u = t_2^2$

$4H^2 + 4gHu + g^2u^2 - 4g^2u^2 = 8gHu$

$3g^2u^2 + 4gHu - 4H^2 = 0$

$0{,}28 \cdot 10^5 \cdot V_1 = \frac{1}{6} \cdot 8{,}31 \cdot 354$

$V_1 \approx 1751 \cdot 10^{-5} = 17{,}51 \cdot 10^{-3}\ м^3$

$V_2 =$

21206513 (U839115 M1279603)

Черновик

Вариант 10-01

№1

Дано:

H

---

t - ?

υ_0 - ?

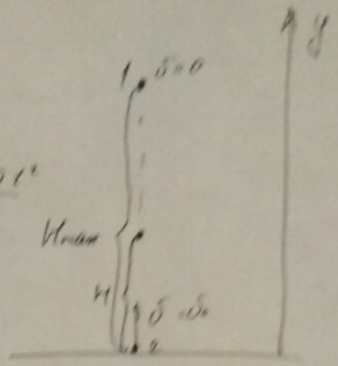
S - ?

Решение:

$x_1 = y_1 = y_0 + \upsilon_{0y} t + \frac{a t^2}{2} = y_0 - \frac{g t^2}{2} = H_{max} - \frac{g t^2}{2}$

$y_2 = y_0 + \upsilon_{0y} t + \frac{a t^2}{2} = \upsilon_0 t - \frac{g t^2}{2}$

$y_1 = y_2 = H$



$$\begin{cases} H_{max} - \frac{g t^2}{2} = H \\ \upsilon_0 t - \frac{g t^2}{2} = H \end{cases}$$

Итого $H_{max} - \upsilon_0 t = 0$

$$H_{max} = \frac{\upsilon^2 - \upsilon_0^2}{2g} = \frac{\upsilon_0^2}{2g} = \frac{\upsilon_0 T}{2}$$

№3

Дано:

$m = 3$ г

$T = 354$ К

$V_1 = 3{,}5 V_2$

$P_2 = 1{,}8 P_1$

$P_{н.п.} = 0{,}5 \cdot 10^5$ Па

$\mu = 18 \cdot 10^{-3} \frac{кг}{моль}$

P_1 - ?

V_2 - ?

$\begin{array}{r} 273 \\ +81 \\ \hline 354 \end{array}$

Решение:

$PV = \nu RT = \frac{m}{\mu} RT$ $\quad P_1 V_1 = P_2 V_2$

$P_1 V_1 = \frac{m}{\mu} RT$ $\quad P_1 \cdot 3{,}5 V_2 = 1{,}8 P_1 \cdot V_2$

$P_2 V_2 = \frac{m}{\mu} RT$ $\quad 3{,}5 \neq 1{,}8 \Rightarrow$ масса уменьшалась $\Rightarrow$

$P_2 = P_{н.п.} = 0{,}5 \cdot 10^5$ Па $= 1{,}8 P_1$

$$\begin{cases} P_1 V_1 = \frac{m_1}{\mu} RT \\ P_2 V_2 = \frac{m_2}{\mu} RT \end{cases} = \begin{cases} P_1 \cdot 3{,}5 V_2 = \frac{m_1}{\mu} RT \\ 1{,}8 P_1 \cdot V_2 = \frac{m_2}{\mu} RT \end{cases}$$

$P_1 = \frac{0{,}5}{1{,}8} \cdot 10^5$ Па

$P_{н.п.} V_2 = \frac{m_2}{\mu} RT$

$\frac{m_1}{m_2} = \frac{3{,}5}{1{,}8}$

$V_2 = \frac{m_2 RT}{\mu \cdot P_{нп}} =$

$m_2 = \frac{1{,}8 m_1}{3{,}5} = \frac{1{,}8 \cdot 3}{3{,}5} = \frac{1{,}8 \cdot 3 \cdot 10^{-3} \cdot 8{,}31 \cdot 354}{18 \cdot 10^{-3} \cdot 3{,}5 \cdot 0{,}5 \cdot 10^{5}} \approx$

$\approx 5843 \cdot 10^{-6} \approx 6 \cdot 10^{-3}$ м³

21206513 (U839115 M1279603)

черновик

$D_1 = 4g^2H^2 + 3g^2 \cdot 4H^2 = 16g^2H^2$

$u_{1,2} = \dfrac{-2gH \pm 4g^2H^2}{3g^2} = \dfrac{-2gH + 4gH}{3g^2} = \dfrac{2gH}{3g^2} = \dfrac{2}{3}\dfrac{H}{g}$

$t_2 = \sqrt{\dfrac{2H}{3g}}$

$v_0 = \dfrac{2H + \dfrac{g \cdot 2H}{3g}}{2\sqrt{\dfrac{2H}{3g}}} = \dfrac{2H + \dfrac{2H}{3}}{\dfrac{2\sqrt{2H}}{\sqrt{3g}}} = \dfrac{(6H+2H)\sqrt{3g}}{2 \cdot 3 \cdot \sqrt{2H}} = \dfrac{8H \cdot \sqrt{3g}}{6 \cdot \sqrt{2H}} = \dfrac{8 \cdot \sqrt{H}^2 \sqrt{3g}}{6\sqrt{2} \cdot \sqrt{H}} =$

$= \dfrac{8\sqrt{3gH}}{6 \cdot \sqrt{2}} = \cancel{\sqrt{2^6}\sqrt{3gH}} \quad \dfrac{\sqrt{2^6}\sqrt{3gH}}{6\sqrt{2}} = \dfrac{\sqrt{32 \cdot 3gH}}{6} = \dfrac{\sqrt{96gH}}{6}$

$S = H_{max} + H_{max} - H = 2H_{max} - H$

$H_{max} = \dfrac{v_0^2}{2g} = \dfrac{96gH}{36g} = \dfrac{8H}{2} = \dfrac{24H}{3} = 8H \quad = \dfrac{16gH}{2 \cdot 6g} = \dfrac{8H}{2 \cdot 3g} - H = \dfrac{4H}{3}H$

$S = 15H$

$S = \dfrac{8H}{3} - H =$

21206513 (U839115 M1279603)

Чистовик

№2

Дано:

w

$\rho_B = \rho$

$\rho_T = 3\rho$

R

$2R$

$tg\alpha = 2$

$N_1 - ?$

$N_2 - ?$

Решение:

$m\vec{g} + \vec{N_1} + \vec{F_A} = m\vec{a} = 0$

O_y:

$-mg + N_1 + F_A = 0$

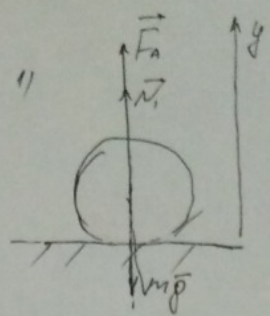
$\cancel{mg=}\ N_1 = mg - F_A$

$mg = V_T \rho_T g = \frac{4}{3}\pi R^3 \cdot 3\rho g = \frac{12}{3}\pi R^3 \rho g$

$F_A = \rho_B V_T g = \rho \cdot \frac{4}{3}\pi R^3 g = \frac{4}{3}\pi R^3 \rho g$

$N_1 = \frac{12}{3}\pi R^3 \rho g - \frac{4}{3}\pi R^3 \rho g = \frac{8}{3}\pi R^3 \rho g$

1)



Ответ: $N_1 = \frac{8}{3}\pi R^3 \rho g$

1(2)

21206513 (U839115 M1279603)

Чистовик

№1

Дано:

H

t_2 - ?

υ_0 - ?

S - ?

Решение:

$y_1 = H_{max} - \frac{gt^2}{2} = \frac{\upsilon_0^2}{2g} - \frac{gt^2}{2} = \frac{\upsilon_0^2 - g^2t^2}{2g}$

$y_2 = \upsilon_0 t - \frac{gt^2}{2}$

при $t = t_2$ $y_1 = y_2 = H$

$$\begin{cases} \frac{\upsilon_0^2 - g^2 t_2^2}{2g} = H \\ \upsilon_0 t_2 - \frac{g t_2^2}{2} = H \end{cases}$$

$$\upsilon_0 = \frac{H}{t_2} + \frac{g t_2}{2} = \frac{2H + g t_2^2}{2t_2}$$

$$\frac{(2H + g t_2^2)^2}{4t_2^2} - g^2 t_2^2 = 2gH$$

$$4H^2 + 4gHt_2^2 + g^2t_2^4 - 4g^2t_2^4 = 8gHt_2^2$$

$$3g^2t_2^4 + 4gHt_2^2 - 4H^2 = 0$$

$$u = t_2^2$$

$$3g^2u^2 + 4gHu - 4H^2 = 0$$

$$D_1 = 4g^2H^2 + 3g^2 \cdot 4H^2 = 16g^2H^2$$

$$u_{1,2} = \frac{-2gH \pm 4gH}{3g^2} = \frac{2gH}{3g^2} = \frac{2H}{3g}, \text{ т.к. } u > 0$$

$$t_2 = \sqrt{\frac{2H}{3g}}$$

$$\upsilon_0 = \frac{2H + \frac{g \cdot 2H}{3g}}{\frac{2\sqrt{2H}}{\sqrt{3g}}} = \frac{8H \cdot \sqrt{3g}}{6\sqrt{2H}} = \frac{4H\sqrt{3g}}{3\sqrt{2H}} = \frac{4\sqrt{3gH}}{3\sqrt{2}} = \frac{4\sqrt{gH}}{\sqrt{6}} = \frac{4\sqrt{6gH}}{6} = \frac{2\sqrt{6gH}}{3}$$

$$S = 2H_{max} - H = \frac{\upsilon_0^2}{g} - H = \frac{16gH}{6g} - H = \frac{8gH}{3g} - H = \frac{8H}{3} - H = \frac{5H}{3}$$

Ответ: $t_2 = \sqrt{\frac{2H}{3g}}$; $\upsilon_0 = \frac{2\sqrt{6gH}}{3}$; $S = \frac{5H}{3}$

2

21206513 (U839115 M1279603)

Чистовик

Вариант 10-01

№3

Дано:

$T = 354 K$

$V_1 = 3,5 V_2$

$P_2 = 1,8 P_1$

$P_{н.п} = 0,5 \cdot 10^5 Па$

$\mu = 18 \cdot 10^{-3} \frac{кг}{моль}$

$m_1 = 3 \cdot 10^{-3} кг$

$R = 8,31 \frac{Дж}{моль \cdot К}$

$P_1 - ?$

$V_2 - ?$

Решение:

$P_1 V_1 \neq P_2 V_2$ => пар конденсируется, а значит

$P_2 = P_{н.п}$

$P_{н.п.} = P_2 = 1,8 P_1$

$P_1 = \frac{P_{н.п}}{1,8} = \frac{0,5 \cdot 10^5 Па}{1,8} \approx 0,28 \cdot 10^5 Па$

$$\begin{cases} P_1 V_1 = \frac{m_1}{\mu} RT = 3,5 P_1 V_2 \\ P_2 V_2 = \frac{m_2}{\mu} RT = 1,8 P_1 V_2 \end{cases}$$

$\frac{m_1}{m_2} = \frac{3,5}{1,8}$

$m_2 = \frac{1,8 m_1}{3,5}$

$P_{н.п.} \cdot V_2 = \frac{m_2}{\mu} RT = \frac{1,8 m_1 RT}{3,5 \mu}$

$V_2 = \frac{1,8 m_1 RT}{3,5 \mu P_{н.п.}} = \frac{1,8 \cdot 3 \cdot 8,31 \cdot 354}{3,5 \cdot 18 \cdot 0,5 \cdot 10^5} \approx 5 \cdot 10^{-3} м^3 = 5 л$

Ответ: $P_1 \approx 0,28 \cdot 10^5 Па$; $V_2 \approx 5 \cdot 10^{-3} м^3$

Часть 2

Олимпиада: **Физика, 10 класс (2 часть)**

Шифр: **21206513**

ID профиля: **839115**

Вариант 1

Чистовик

№5

Дано:

$P_2 = 1{,}02 P_1$

$V_2 = 0{,}99 V_1$

$\Delta T - ?$

$\frac{Q}{A} - ?$

Решение:

$\begin{cases} P_1 V_1 = \nu R T_1 \\ P_2 V_2 = \nu R T_2 = 1{,}02 P_1 \cdot 0{,}99 V_1 \end{cases}$

$\frac{T_1}{T_2} = \frac{1}{1{,}0098}$

$\frac{T_2}{T_1} = 1{,}0098 \Rightarrow$ увеличилась на 0,98%

предположим, что это газ $Q = 0$

тогда должно выполняться

$PV^{\gamma} = const$

$\gamma = \frac{C_p}{C_v} = \frac{i+2}{i} = \frac{5}{3}$ - для одного газа (не смеси)

$\begin{cases} P_1 V_1^{\gamma} = const \\ P_2 V_2^{\gamma} = const \end{cases}$

$\frac{P_1}{P_2} \left(\frac{V_1}{V_2} \right)^{\gamma} = 1$

$\frac{1}{1{,}02} \left(\frac{1}{0{,}99} \right)^{\frac{5}{3}} = 1$

$\left(\frac{1}{0{,}99} \right)^{\frac{5}{3}} \approx 1{,}02 \Rightarrow Q = 0 \Rightarrow \frac{Q}{A} = 0$

Ответ: увеличилась на 0,98%; $\frac{Q}{A} = 0$

3

21206513 (U839115 M1279604)

Чистовик
продолжение решения №4

$mg\sin\alpha - ma_к\cos\alpha = ma$

$g\cdot\frac{3}{5} - \frac{19g}{\cancel{25}\ 42}\cdot\frac{4}{5} = a$

$\frac{3g}{5} - \frac{38g}{105} = a$

$\frac{25g}{105} = a$

$a = \frac{5g}{21}$

$S = \frac{at'^2}{2}$

$t' = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2\cdot H\cdot 5\cdot 21}{3\cdot 5g}} = \sqrt{\frac{14H}{g}}$

Ответ: $t = \frac{5}{3}\sqrt{\frac{2H}{g}}$; $t' = \sqrt{\frac{14H}{g}}$

Чистовик

Дано:

$\cos\alpha = \frac{4}{5}$

H

$m_ш = m$

$m_к = 3m$

$F = 2mg$

$t - ?$

$a_к - ?$

$t' - ?$

Решение: №4

1)

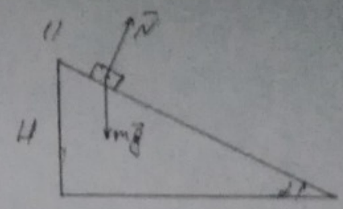
$mg\sin\alpha = ma$

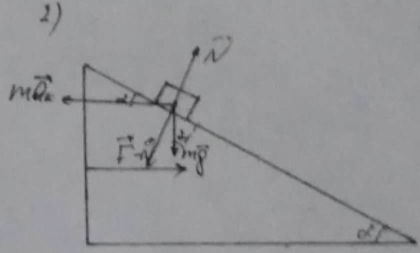
$a = g\sin\alpha$

$S \cdot \sin\alpha = H$

$\sin\alpha = \sqrt{1-\cos^2\alpha} = \sqrt{1-\frac{16}{25}} = \frac{3}{5}$

$S = \frac{H}{\sin\alpha} = \frac{5H}{3}$





~~$S = \frac{at^2}{2} = g \cdot 3 \cdot t$~~

$S = \frac{at^2}{2}$

$t = \sqrt{\frac{2S}{a}}$

$a = g \cdot \frac{3}{5}$

$t = \sqrt{\frac{2 \cdot 5H \cdot 5}{3 \cdot 3g}} = \frac{5}{3}\sqrt{\frac{2H}{g}}$

2) в неисо:

$\Sigma\vec{F} = m\vec{a} + m\vec{a}'$

$3ma_к = F - N \cdot \sin\alpha$

$N = ma_к\sin\alpha + mg\cos\alpha$

$3ma_к = 2mg - (ma_к\sin\alpha + mg\cos\alpha)\sin\alpha$

$3ma_к = 2mg - ma_к\sin^2\alpha - mg\cos\alpha\sin\alpha$

$3a_к = 2g - \frac{9a_к}{25} - \frac{12g}{25}$

$84a_к = 38g$

$a_к = \frac{19g}{42}$

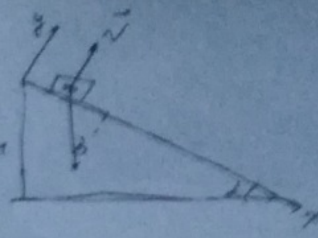
Черновик

№4

Дано:
$\cos\alpha = \frac{4}{5}$
$F = 2mg$
H
m
$3m$

$t - ?$
$a_x - ?$
$t' - ?$

Решение:



$S \cdot \sin\alpha = H$

$$S = \frac{H}{\sin\alpha} = \frac{H}{\sqrt{1-\cos^2\alpha}} = \frac{H}{\sqrt{1-\frac{16}{25}}} = \frac{H}{\frac{3}{5}} = \frac{5H}{3}$$

$$S = \frac{at^2}{2} = \frac{g\sin\alpha\, t^2}{2}$$

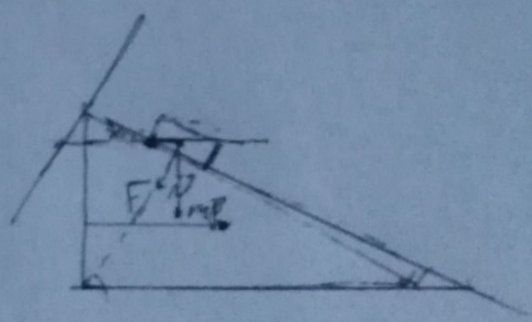
Ox:

$mg\sin\alpha = ma$

$$t^2 = \frac{2S}{g\sin\alpha} = \frac{2H}{g\sin^2\alpha} = \frac{2H}{g\cdot\frac{16}{25}} = \frac{50H}{9g}$$

$$\frac{2S}{g\sin\alpha} = \frac{2\cdot 5H}{3\cdot\frac{3}{5}g} = \frac{50H}{9g}$$

$$t = \frac{5}{3}\sqrt{\frac{2H}{g}}$$



внесло:

$\sum F = ma + ma'$

$N = mg\cos\alpha$

Ox: $3ma' = F - mg\cdot\cos\alpha = 2mg - \frac{4mg}{5} = \frac{10mg - 4mg}{5} = \frac{6mg}{5}$

$a' = \frac{2g}{5}$

21206513 (U839115 M1279604)

Дано:

$i = 3$

$P_2 = P_1 = P_1$

$V_2 = 0,8V_1$

$P_2 = 1,02 P_1$

$V_2 = 0,98 V_1$

$\frac{Q}{A}$ - ?

Решение

$P_1 V_1 = \nu R T_1$

$P_2 V_2 = \nu R T_2$

$\begin{cases} P_1 V_1 = \nu R T_1 \\ 1,02 P_1 \cdot 0,98 V_1 = \nu R T_2 \end{cases}$

$\frac{T_1}{T_2} = \frac{1}{0,9996}$

$\frac{T_2}{T_1} = 0,9996$ => уменьшилась на 0,04 %

$Q = A + \Delta U$

$T_2 = 0,9996 T_1$

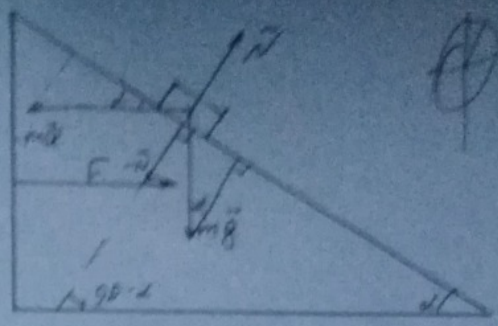
$\Delta U = \frac{i}{2} \nu R \Delta T = \frac{3}{2} \nu R \cdot (0,9996 T_1 - T_1) = -\frac{3}{2} \nu R \cdot 0,0004 = -3\nu R \cdot 0,0002 =$

$= 0,0006 \nu R T$

$A = \int P dV$

$A =$

№5



$\cancel{ma = mg \sin\alpha - ma' \cos\alpha = m(g \sin\alpha - \frac{2g}{5} \cos\alpha) =}$

$\cancel{= g \cdot \frac{3}{5} - \frac{2g}{5} \cdot \frac{4}{5} = \frac{3g}{5} - \frac{8g}{25} = \frac{15g - 8g}{25} =}$

$3ma' = F - N \cos\alpha \sin\alpha = F - (mg \sin\alpha + ma') \sin\alpha$

$\cancel{N = mg \sin\alpha + ma'}$ $\quad N = mg \cos\alpha + ma' \sin\alpha$

$3ma' = F - N \cdot \sin\alpha = F - (mg \cos\alpha + ma' \sin\alpha) \sin\alpha = F - mg \sin\alpha \cos\alpha + ma' \sin^2\alpha$

$= 2mg - mg \cdot \frac{3}{5} \cdot \frac{4}{5} \mp ma' \cdot \frac{16g}{25} = 2mg - \frac{12mg}{25} - \frac{9ma'}{25}$

21206513 (U839115 M1279604)

$$3a' = 2g - \frac{12g}{25} - \frac{9a'}{25}$$

$$3a' + \frac{9a'}{25} = \frac{50g - 12g}{25} = \frac{38g}{25}$$

$$84a' = 38g$$

$$a' = \frac{38g}{84} = \frac{19g}{42}$$

$$\begin{cases} P_1 \cdot 1{,}01 V_1 = T_1 \\ 1{,}02 P_1 V_1 = T_2 \end{cases}$$

$$\frac{T_2}{T_1} = \frac{1{,}02}{1{,}01}$$

$$a = g \sin\alpha = \frac{3g}{5}$$

$$mg \sin\alpha - ma' \cos\alpha = ma$$

$$g \cdot \frac{3}{5} - \frac{19}{42} g \cdot \frac{4}{5} = a$$

$$\frac{3g}{5} - \frac{38g}{105} = a$$

$$\frac{25g}{105} = a = \frac{5g}{21}$$

$$\gamma = \frac{5}{3}$$

$$\frac{P_1}{P_2}\left(\frac{V_1}{V_2}\right)^{\gamma} = 1$$

$$\frac{1}{1{,}02}\left(\frac{1}{0{,}99}\right)^{\frac{5}{3}} = 1$$

$$\left(\frac{1}{0{,}99}\right)^{\frac{5}{3}} = 1{,}02$$

$$S = \frac{at^2}{2} = \frac{H}{\sin\alpha} = \frac{H}{\frac{3}{5}} = \frac{5H}{3}$$

$$t^2 = \frac{2S}{a} = \cancel{2H} \frac{2 \cdot 5H}{3a} = \frac{10H}{3 \cdot \frac{5g}{21}} = \frac{7 \cdot 10H}{5g} = \frac{14H}{g}$$

$$t = \sqrt{\frac{14H}{g}}$$

$$\frac{50H}{9g} \vee 14$$

$$PV^{\gamma} = const$$

$$P_1 \quad \gamma = \frac{C_p}{C_v} = \frac{i+2}{2} \cdot \frac{2}{i} = \frac{i+2}{i}$$

$$\Delta Q = \nu C \Delta T$$

$$C = \frac{\Delta Q}{\nu \Delta T}$$

$$C_p = \frac{A + \Delta U}{\nu \Delta T} = \frac{\nu R \Delta T + \frac{i}{2}\nu R \Delta T}{\nu \Delta T} = \frac{(i+2)\nu R \Delta T}{2\nu \Delta T} = \frac{i+2}{2} R$$

$$C_v = \frac{\Delta U}{\nu \Delta T} = \frac{\frac{i}{2}\nu R \Delta T}{\nu \Delta T} = \frac{i}{2} R$$