Часть 1

Олимпиада: **Физика, 9 класс (1 часть)**

Шифр: **21206362**

ID профиля: **808821**

Вариант 1

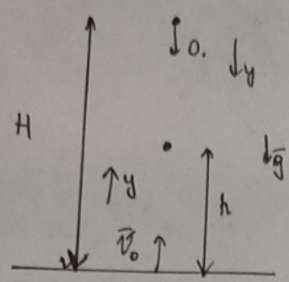
Черновик.

№1

Дано:
τ

1) H - ?
2) h - ?
3) $\frac{S_1}{S_2}$ - ?

Решение:



$$\frac{mv_0^2}{2} = mgH \; ; \; v_0 = \sqrt{2gH}$$

$$\vec{S} = \vec{v}_0\tau + \frac{\vec{g}\tau^2}{2}$$

$$H - h = \frac{g\tau^2}{2}.$$

$$h = v_0\tau - \frac{g\tau^2}{2}$$

$$H - v_0\tau + \cancel{\frac{g\tau^2}{2}} = \cancel{\frac{g\tau^2}{2}} \; ; \; H = v_0\tau$$

$$H = \sqrt{2gH}\,\tau \; ; \; H^2 = 2gH\tau^2 \; ; \; \boxed{H = 2g\tau^2}$$

$$h = H - \frac{g\tau^2}{2} = 2g\tau^2 - \frac{g\tau^2}{2} = \frac{4g\tau^2 - g\tau^2}{2} = \frac{3}{2}g\tau^2$$

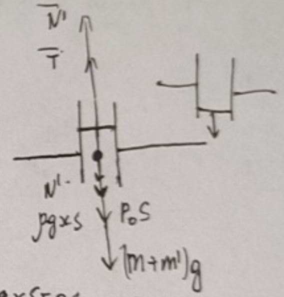
$$\boxed{h = \frac{3}{2}g\tau^2}$$

$$S_1 = H + H - h = 2H - h =$$

$$= 4g\tau^2 - 1{,}5g\tau^2 = 2{,}5g\tau^2. \quad S_2 = h = 1{,}5g\tau^2$$

$$\frac{S_1}{S_2} = \frac{2{,}5g\tau^2}{1{,}5g\tau^2} = \frac{2{,}5}{1{,}5} = \frac{25}{15} = \frac{5}{3}$$

Ответ: $H = 2g\tau^2$; $h = 1{,}5g\tau^2$; $\frac{S_1}{S_2} = \frac{5}{3}$



$$N' + T = P_0S + mg + m'g$$

$$T = Mg$$

$$N' = P_0S + mg + m'g - Mg$$

$$N' + \rho g x S = P_0S \; ; \; mg + m'g - Mg + \rho g x S = 0 \; ; \; \rho g x S = Mg - mg - m'g$$

$$x = \frac{M - m - m'}{\rho S} = \frac{-40}{98}\,\text{с}$$

$\boxed{-50\text{см}}$

№2

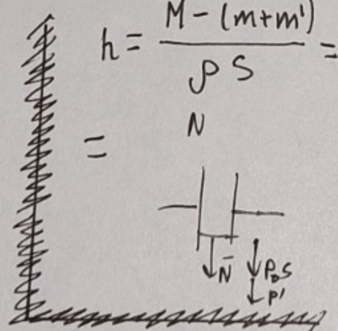
Дано:
$S = 8\,\text{см}^2$
$m = 50\,\text{г}$
$H = 10\,\text{см}$
$P_0 = 100\,\text{кПа}$
$\rho = 1000\,\frac{\text{кг}}{\text{м}^3}$
$g = 10\,\frac{\text{м}}{\text{с}^2}$
$m' = 120\,\text{г}$

1) P - ?
2) M - ?
3) h - ?

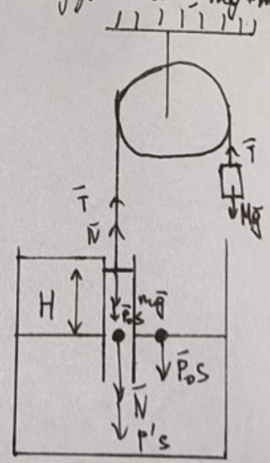
Решение:

$$h = \frac{M - (m+m')}{\rho S} =$$

$$=$$



$$T = Mg$$



$$N + T = mg + P_0S$$

$$N = mg + P_0S - T$$

$$P_0S = N + P'S = N + \rho gHS$$

$$N = (P_0 - \rho gH)S =$$

$$= (100000 - 10000 \cdot 0{,}1) \cdot 8 \cdot 10^{-4} =$$

$$= 79{,}2\,\text{Н}. \quad \boxed{P = P_0 - \rho gH = 99000\,\text{Па}}$$

$$P_0S - \rho gHS = mg + P_0S - Mg \; ; \; Mg = mg + \rho gHS \; ; \; M = m + \rho SH =$$

$$= 0{,}05 + 1000 \cdot \frac{8}{10000} \cdot 0{,}1 = 0{,}05 + 0{,}8 \cdot 0{,}1 = 0{,}13\,\text{кг} = 130\,\text{г}. \quad \boxed{M = 130\,\text{г}}$$

$$P_0S = \rho ghS + N' \; ; \; T + N' = P_0S + (m+m')g \; ; \; N' = P_0S + (m+m')g - Mg.$$

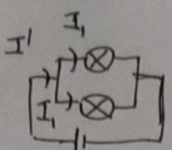
$$\cancel{P_0S} = \rho ghS + \cancel{P_0S} + (m + m' - M)g \; ; \; (M - m - m')g = \rho ghS \; ; \; M - (m+m') = \rho hS$$

№3 Черновик

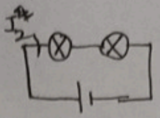
Дано:
$U_0 = 12B$
$P_1 = 20\,Вт$
$P_2 = 6,6\,Вт$

1) $I_1 - ?$
2) $I_2 - ?$
3) $P - ?$

Решение:



$P_1 = I_1^2 \cdot r \quad I_1 = \frac{I'}{2}$

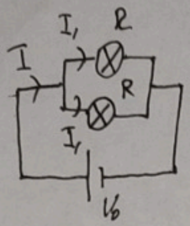


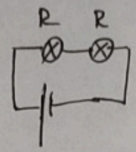
$P_2 = I_2''^2 r.$

$U_0 = \frac{r}{2} \cdot I'; \; I' = \frac{2U_0}{r}; \; I_1 = \frac{I'}{2} = \frac{U_0}{r}$

$P_1 = \frac{U_0^2}{r}; \; U_0 = 2r I_2''; \; I_2'' = \frac{U_0}{2r}$

$P_2 = \frac{U_0^2}{4r}; \; r = \frac{U_0^2}{P_1} = \frac{U_0^2}{4P_2} \Rightarrow P_1 = 4P_2$, но это не так.





$P_1 = \frac{U_0^2}{R}; \; R = \frac{U_0^2}{P_1}$

$I \cdot R_1' = U_0; \; IR = 2U_0$

$R_1' = \frac{R}{2} \qquad I = \frac{2U_0}{R}$

$I = 2I_1; \; I_1 = \frac{I}{2} = \frac{U_0}{R} = \frac{U_0}{1} \cdot \frac{P_1}{U_0^2} = \frac{P_1}{U_0} = \boxed{1,67A.}$

$\cancel{U_0 = 2RI_2} \quad \cancel{I_2 = \frac{U_0}{2R}}.$

$P_2 = \frac{U'^2}{R} \qquad R = \frac{U_0^2}{P_1}$

$P_2 R = U'^2 \qquad U'^2 = I_2^2 R^2$

$P_2 \cancel{R} = I_2^2 R^{\cancel{2}}; \; P_2 = I_2^2 R = I_2^2 \cdot \frac{U_0^2}{P_1}$

$P_1 P_2 = I_2^2 U_0^2 \qquad I_2^2 = \frac{P_1 P_2}{U_0^2}; \; I_2 = \frac{\sqrt{P_1 P_2}}{U_0} = \boxed{0,96A.}$

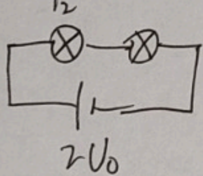
$P^2 = P_1 P_2$

$P = \sqrt{P_1 P_2} = \sqrt{\frac{U_0^2}{R} \cdot \frac{U_0^2}{4R}} =$

$= \sqrt{\frac{U_0^2}{4R^2}} =$

$= \frac{U_0}{2R} =$

$=$



$P_2' = \frac{U''^2}{R}$

$U'' = I_2' R. \quad I_2' = \frac{2U_0}{2R} = \frac{U_0}{R}$

$U'' = U_0$

$P_2' = \frac{U_0^2}{R} = \frac{U_0^2}{1} \cdot \frac{P_1}{U_0^2} = P_1 = 20\,Вт.$

$P' = \frac{4U_0^2}{2R} = \frac{2U_0^2}{R}$

$P' = \frac{U_0^3}{R}$

$I_1 = \frac{U_0 P_1}{U_0^2} =$

$= \frac{P_1}{U_0}$

$P = I^2 R$

$\frac{P_1}{2}$

$\frac{P_1}{2} = \frac{2U_0^2}{R}$

$P_1 = \frac{4U_0^2}{R}$

$R = \frac{4U_0^2}{P_1}$

$I = \frac{2U_0}{R}$

$P_2 = \frac{\frac{U_0^2}{4}}{R} = \frac{U_0^2}{4R}$

$I \cdot 2R = 2U_0$

$I = \frac{U_0}{R} = I_1$

$P_2 = \frac{P_1}{4}$

$P_1 = I_1^2 R \quad I_1^2 = \frac{P_1}{R}$

$P_2 = I_2^2 R$

$2I_1 \cdot \frac{R}{2} = U_0$

$I_1 = \frac{U_0}{R}$

$\sqrt{\frac{P_1}{R}} = \frac{U_0}{R}; \; \frac{P_1}{\cancel{R}} = \frac{U_0^2}{R^{\cancel{2}}}; \; R = \frac{U_0^2}{P_1}$

$I_2^2 = \frac{P_2}{R} = \frac{P_2 P_1}{U_0^2}; \; I_2 = \frac{\sqrt{P_1 P_2}}{U_0}$

Чистовик

№1

Дано:

τ

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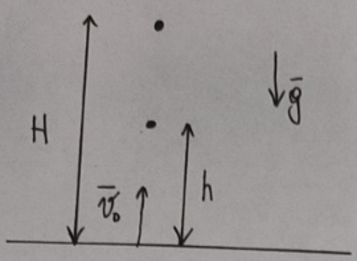
1) H - ?

2) h - ?

3) $\frac{S_1}{S_2}$ - ?

Решение:



$\frac{mv_0^2}{2} = mgH$; $v_0^2 = 2gH$; $v_0 = \sqrt{2gH}$

$\bar{S} = \bar{v}_0\tau + \frac{\bar{g}\tau^2}{2}$.

Для первого мяча начальная скорость = 0, т.к. высота максимальная.

Для первого мяча:

$H - h = \frac{g\tau^2}{2}$.

Для второго мяча:

$h = v_0\tau - \frac{g\tau^2}{2}$.

$H - v_0\tau + \frac{g\tau^2}{2} = \frac{g\tau^2}{2}$; $H = v_0\tau$; $H = \sqrt{2gH}\,\tau$; $H^2 = 2gH\tau^2$; $\boxed{H = 2g\tau^2.}$

$h = H - \frac{g\tau^2}{2} = 2g\tau^2 - 0{,}5g\tau^2 = 1{,}5g\tau^2$. $\boxed{h = 1{,}5g\tau^2}$

$S_1 = H + H - h = 2H - h = 4g\tau^2 - 1{,}5g\tau^2 = 2{,}5g\tau^2$

$S_2 = h = 1{,}5g\tau^2$; $\frac{S_1}{S_2} = \frac{2{,}5g\tau^2}{1{,}5g\tau^2} = \frac{5}{3}$.

Ответ: $H = 2g\tau^2$; $h = 1{,}5g\tau^2$; $\frac{S_1}{S_2} = \frac{5}{3}$

Чистовик.

№2

Дано:

$S = 8\,см^2$

$m = 50\,г$

$H = 10\,см$

$m' = 120\,г$

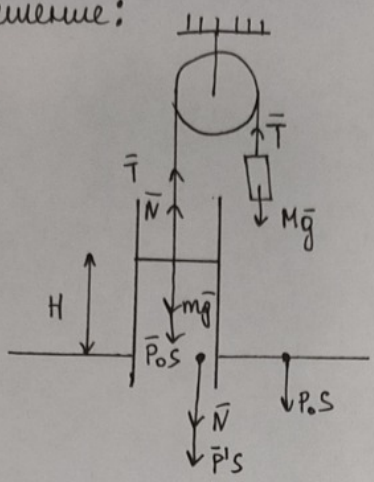
$P_0 = 100\,кПа$

$\rho = 1000\,\frac{кг}{м^3}$

$g = 10\,\frac{м}{с^2}$

1) P-?
2) M-?
3) x-?

Решение:



$T + N = mg + P_0S.$

$T = Mg.$

$Mg + N = mg + P_0S.$

$P_0S = P'S + N;\ P' = \rho gH$

$N = (P_0 - P')S = (P_0 - \rho gH)S$

$P = \frac{N}{S} = P_0 - \rho gH = 99\,000\ Па$

$Mg = mg + P_0S - N = mg + \cancel{P_0S} - \cancel{P_0S} + \rho gHS$

$Mg = mg + \rho gHS;\ M = m + \rho SH = 0{,}13\,кг = 130\,г.$

Когда поставили гирю: $T + N' = P_0S + mg + m'g$

$P_0S = \rho gxS + N';\ T = Mg$

$Mg + \cancel{P_0S} - \rho gxS = \cancel{P_0S} + mg + m'g\ ;\ \rho gxS = Mg - mg - m'g$

$x = \frac{M - m - m'}{\rho S} = -50\,см.$ „−" значит, что поршень будет ниже поверхности воды. => $x = 50\,см$

Ответ: $P = 99000\,Па;\ M = 130\,г;\ x = 50\,см.$

Чистовик.

№3

Дано:

$U_0 = 12\,В$

$P_1 = 20\,Вт$

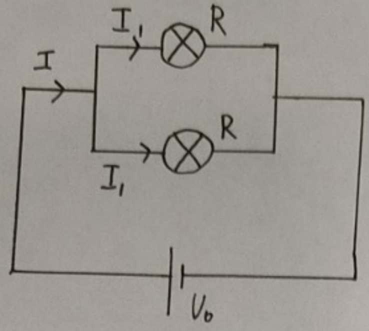
$P_2 = 6{,}6\,Вт$

1) I_1 – ?

2) I_2 – ?

3) P – ?

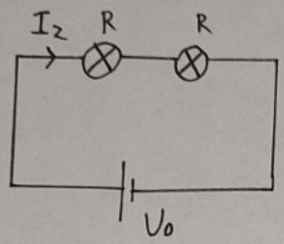
Решение:



$P_1 = \frac{U_0^2}{R}$; $R = \frac{U_0^2}{P_1}$

$U_0 = I_1 R$

$I_1 = \frac{U_0}{R} = \frac{U_0}{1} \cdot \frac{P_1}{U_0^2} = \frac{P_1}{U_0} = 1{,}67\,А$



$P_2 = I_2^2 R$; $I_2^2 = \frac{P_2}{R} = \frac{P_2}{1} \cdot \frac{P_1}{U_0^2} = \frac{P_1 P_2}{U_0^2}$.

$I_2 = \frac{\sqrt{P_1 P_2}}{U_0} = 0{,}96\,А$.

$P = I'^2 R$. $I' \cdot 2R = 2U_0$; $I' R = U_0$; $I' = I_1$

$P = I_1^2 R = \frac{P_1^2}{U_0^2} \cdot \frac{U_0^2}{P_1} = P_1 = 20\,Вт$.

Ответ: $I_1 = 1{,}67\,А$; $I_2 = 0{,}96\,А$; $P = 20\,Вт$.

Часть 2

Олимпиада: **Физика, 9 класс (2 часть)**

Шифр: **21206362**

ID профиля: **808821**

Вариант 1

Черновик

N5

Дано:

H, S

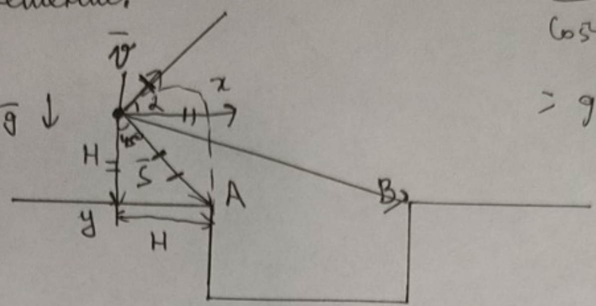
$v = \sqrt{0{,}5gH}$

1) t - ?

2) α - ?

3) β - ?

Решение:



$\frac{g}{\cos\beta} = g \cdot \frac{1}{\cos\beta} =$

$= g(1 + tg\beta) =$

$V = S \cdot 2H. \quad S = \pi r^2 \quad r = \frac{H}{2}$

$S = \pi \cdot \frac{H^2}{4}; \; V = \pi \cdot \frac{H^2}{4} \cdot 2H = \frac{\pi H^3}{2}.$

$\frac{м}{с}.$

за 1с — $V_1 = Sv$.

за tс — V.

$t = \frac{V}{Sv} = \frac{\pi H^3}{2Sv} = \frac{\pi H^3}{2S\sqrt{0{,}5gH}}.$ ✓

$\bar{S} = \bar{v_0} t + \frac{\bar{g}t^2}{2}$; $ox: H = v\cos\alpha t.$ $\quad t = \frac{H}{v\cos\alpha}$

$oy: H = -v\sin\alpha t + \frac{gt^2}{2}$

$v\cos\alpha \cancel{t} = \frac{gt^{\cancel{2}}}{2} - v\sin\alpha \cancel{t}$

$2v\cos\alpha = gt - 2v\sin\alpha = g \cdot \frac{H}{v\cos\alpha} - 2v\sin\alpha \,|\cdot v\cos\alpha$

$2v^2\cos^2\alpha = gH - 2v^2\sin\alpha\cos\alpha.$

$2v^2\cos\alpha(\cos\alpha + \sin\alpha) = gH$

$\cancel{2 \cdot 0{,}5g\cancel{H}}\cos\alpha(\cos\alpha + \sin\alpha) = \cancel{gH}$

$1 = \cos\alpha(\cos\alpha + \sin\alpha)$; $1 = \cos^2\alpha + \sin\alpha\cos\alpha$

$1 - \cos^2\alpha = \sin\alpha\cos\alpha$

$\sin^{\cancel{2}}\alpha = \cancel{\sin\alpha}\cos\alpha$

$\sin\alpha = \cos\alpha \Rightarrow \alpha = 45^\circ.$

$\sin\beta \cdot \cos\beta =$

$= \frac{\sin\beta}{\cos\beta} \cdot \cos^2\beta =$

$= tg\beta\cos^2\beta$

$g = \cos^2\beta$

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Черновик

№4

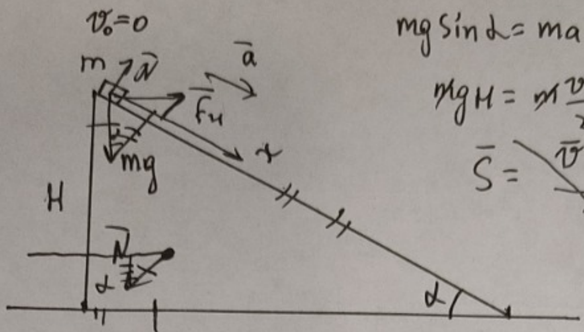
Дано:

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

H, m

1) t – ?
2) a_1 – ?
3) T – ?

Решение:



$mg\sin\alpha = ma$; $a = g\sin\alpha$.

$mgH = \frac{\cancel{m}v^2}{2}$; $v = \sqrt{2gH}$

$\cancel{\bar S = \frac{\bar v^2 - \bar v_0^2}{2\bar a}}$

ox: $S = \frac{v^2}{2a} = \frac{v^2}{2g\sin\alpha}$

$\cancel{2Sg\sin\alpha = v^2}$

$\bar v = \bar v_0 + \bar a t$; ox: $v = at$

$\sqrt{2gH} = g\sin\alpha\, t$; $t = \frac{\sqrt{2gH}}{g\sin\alpha}$; $\sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{3}{5}$

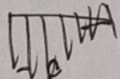
$t = \frac{5\sqrt{2gH}}{3g} = \frac{5\sqrt{2H}}{3\sqrt{g}} = \frac{5}{3}\sqrt{\frac{2H}{g}}$.

$N = mg\cos\alpha$. $N\sin\alpha = 3ma_1$; $a_1 = \frac{N\sin\alpha}{3m} = \frac{mg\cos\alpha\sin\alpha}{3m} = \frac{g}{3}\cos\alpha\sin\alpha =$

$= \frac{g}{3}\cdot\frac{4}{5}\cdot\frac{3}{5} = \frac{4}{25}g$.

~~$\bar a$ → тела относительно подвижной~~

~~$\bar a_1$ → подвижной относительно неподвижной~~



Чистовик

№4

Дано:

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

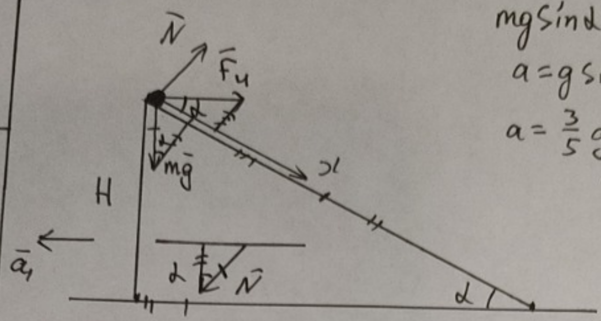
H, m

1) t - ?

2) a_1 - ?

3) T - ?

Решение:



$mg\sin\alpha = ma$

$a = g\sin\alpha$; $\sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{3}{5}$

$a = \frac{3}{5}g$; $\bar{v} = \bar{v}_0 + \bar{a}t$.

$v_0 = 0$. $\frac{mv^2}{2} = mgH$

$v^2 = 2gH$; $v = \sqrt{2gH}$

ox: $v = at$; $\sqrt{2gH} = \frac{3}{5}gt$

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

$N\sin\alpha = 3ma_1$; $a_1 = \frac{N\sin\alpha}{3m}$; $N = mg\cos\alpha$

$$a_1 = \frac{mg\cos\alpha\sin\alpha}{3m} = \frac{g}{3}\cdot\frac{4}{5}\cdot\frac{3}{5} = \frac{4}{25}g.$$

Остановим клин. $\bar{N} + \bar{F}_u + m\bar{g} = m\bar{a}_2$

ox: $F_u\cos\alpha + mg\sin\alpha = ma_2$; $F_u = ma_1$

$\cancel{m}a_1\cos\alpha + \cancel{m}g\sin\alpha = \cancel{m}a_2$; $a_2 = \frac{4}{25}\cdot\frac{4}{5}g + \frac{3}{5}g = \frac{16}{125}g + \frac{3}{5}g = \frac{91}{125}g$

$\bar{v} = \bar{v}_0 + \bar{a}_2 T$; ox: $v = a_2 T = \sqrt{2gH}$

$\frac{91}{125}gT = \sqrt{2gH}$; $T = \frac{125\sqrt{2gH}}{91g} = \frac{125}{91}\sqrt{\frac{2H}{g}}$

Ответ: $t = \frac{5}{3}\sqrt{\frac{2H}{g}}$; $a_1 = \frac{4}{25}g$; $T = \frac{125}{91}\sqrt{\frac{2H}{g}}$

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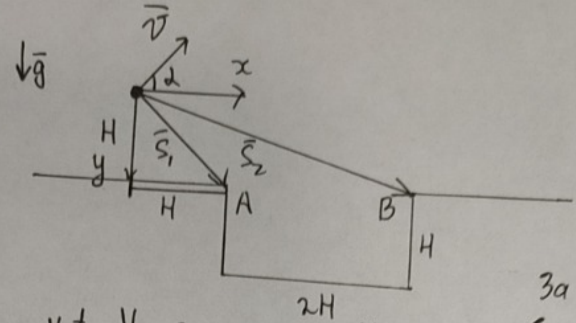
Чистовик.

№5

Дано:
H, S
$v = \sqrt{0{,}5gH}$

1) t - ?
2) α - ?
3) β - ?

Решение:



Объём бака:

$V = S_1 \cdot 2H$; $S_1 = \pi R^2$

$R = \frac{H}{2}$; $S_1 = \pi \frac{H^2}{4}$

$V = \pi \frac{H^2}{4} \cdot 2H = \frac{\pi H^3}{2}$.

За единицу времени шланг выпускает: $V_1 = Sv$

$V_1 t = V = Svt$; $t = \frac{V}{Sv} = \frac{\pi H^3}{2Sv} = \frac{\pi H^3}{2S\sqrt{0{,}5gH}}$.

$\bar{S} = \bar{v}t_1 + \frac{\bar{g}t_1^2}{2}$. Ox: $H = v\cos\alpha\, t_1$

Oy: $H = \frac{gt_1^2}{2} - v\sin\alpha\, t_1$; $t_1 = \frac{H}{v\cos\alpha}$; $v\cos\alpha\, t_1 = \frac{gt_1^2}{2} - v\sin\alpha\, t_1$

$v\cos\alpha = \frac{gt_1}{2} - v\sin\alpha$; $\frac{gt_1}{2} = v(\cos\alpha + \sin\alpha) = \frac{g}{2} \cdot \frac{H}{v\cos\alpha} = \frac{gH}{2v\cos\alpha}$.

$2v^2\cos\alpha(\cos\alpha + \sin\alpha) = gH = 2 \cdot 0{,}5gH\cos\alpha(\cos\alpha + \sin\alpha)$.

$1 = \cos^2\alpha + \cos\alpha\sin\alpha$; $1 - \cos^2\alpha = \sin^2\alpha = \cos\alpha\sin\alpha$; $\sin\alpha = \cos\alpha \Rightarrow \alpha = 45^\circ$. $(\operatorname{tg}\alpha = 1)$

Ox: $3H = v\cos\beta\, t_2$; Oy: $H = \frac{gt_2^2}{2} - v\sin\beta\, t_2$; $\frac{3}{2}gt_2^2 - 3v\sin\beta\, t_2 = v\cos\beta\, t_2$

$\frac{3}{2}gt_2 - 3v\sin\beta = v\cos\beta = \frac{3}{2}g \cdot \frac{3H}{v\cos\beta} - 3v\sin\beta$; $v(\cos\beta + 3\sin\beta) = \frac{9gH}{2v\cos\beta}$

$2v^2\cos\beta(\cos\beta + 3\sin\beta) = 9gH = 2 \cdot 0{,}5gH\cos\beta(\cos\beta + 3\sin\beta)$

$9 = \cos^2\beta + 3\sin\beta\cos\beta$. $\sin\beta\cos\beta = \frac{\sin\beta}{\cos\beta} \cdot \cos^2\beta = \operatorname{tg}\beta\cos^2\beta$.

$9 = \cos^2\beta + 3\operatorname{tg}\beta\cos^2\beta = \cos^2\beta(1 + 3\operatorname{tg}\beta)$. $\frac{9}{\cos^2\beta} = 1 + 3\operatorname{tg}\beta = 9(1 + \operatorname{tg}^2\beta)$

$1 + 3\operatorname{tg}\beta = 9 + 9\operatorname{tg}^2\beta$; $9\operatorname{tg}^2\beta - 3\operatorname{tg}\beta + 8 = 0$. $D = 9 - 4 \cdot 9 \cdot 8 = -279 \Rightarrow$

$\Rightarrow$ струя не может попасть в точку B. $\Rightarrow$ Если угол меньше 45°, то струя всегда попадет в бак. $0 \le \alpha < 45^\circ$

Ответ: $t = \frac{\pi H^3}{2S\sqrt{0{,}5gH}}$; $\alpha = 45^\circ$; $0 \le \alpha < 45^\circ$. $(0 \le \operatorname{tg}\alpha < 1)$
$(\operatorname{tg}\alpha = 1)$

Конечно $\operatorname{tg}\alpha = 0$, при том, что $\bar{v}$ направлена горизонтально вправо.

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