

t_1 - время гр.
 $t - t_1 - T$
 t - время



40182 км.
 86400 с.

$$S = ut_1 - at_1^2$$

$$t_1 = \frac{2}{a}$$

$$t = \frac{v_0}{a}$$

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

$$v_0 = 2 + at - at_1$$

S
 t
 t₁
 a
 v₀



$v_{0p} = 0,965 \frac{км}{с} = \frac{8}{a} - a(\frac{2}{a})^2$
 $= 465 \frac{м}{с}$

$$S = \frac{8}{a} - a \frac{4}{a^2}$$

$$S = \frac{8}{a} - \frac{4}{a} = \frac{4}{a}$$

$$S = \frac{at^2}{2} = \frac{4}{a}$$

$$a^2 t^2 = 8$$

$$at = \sqrt{8} = 2\sqrt{2}$$

$$\frac{M_3 \cdot v}{(R+h)^2} = \frac{v^2}{R+h}$$

$$v = \sqrt{\frac{M_3}{R+h}}$$

$$\frac{M_3}{R+h} = v^2$$

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$$M_3 = v^2(R+h)$$

$$M_3 = v^2 R + v^2 h$$

$$h = \frac{M_3}{v^2} - R$$

$$h = \frac{6,67 \cdot 10^{-11} \cdot 6 \cdot 10^{24} \text{ кг}}{(465 \frac{м}{с})^2} - R = \frac{40 \cdot 10^{13}}{216225} - R =$$

$$= 18,5 \cdot 10^8 \text{ м} = 64000000 \text{ м} =$$



Олимпиада школьников
Звезда - таланты
на службе обороны
и безопасности

Шифр М-09-1

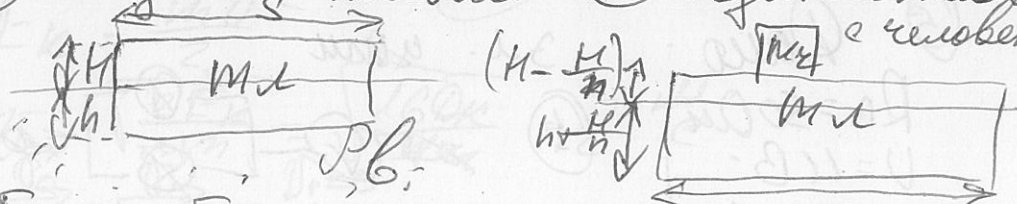
Задание	1	2	3	4	5	6	7	Всего
Баллы	15	0	20	5	20			60

③ Дано: табачные листья.

$m_c = 80 \text{ кг}$
 $M = 4 \text{ см}$
 $n = 2$
 $\rho_b = 1000 \frac{\text{кг}}{\text{м}^3}$

 $S = ?$

① Листья табача. ② Листья табача с человека



$F_{гем} = F_A$
 $m_c g = \rho_b h S$
 $m_c = \rho_b h S$

$F_{гем} = F_A$
 $(m_c + m_c) g = \rho_b (h + \frac{h}{n}) S$
 $m_c = \rho_b S (h + \frac{h}{n}) - m_c$

$\rho_b h S = \rho_b h S + \frac{\rho_b S h}{n} - m_c$

$S = \frac{m_c \cdot n}{\rho_b h} = \frac{80 \text{ кг} \cdot 2}{1000 \frac{\text{кг}}{\text{м}^3} \cdot 0,04 \text{ м}} = 4 \text{ м}^2$

Ответ: $S = 4 \text{ м}^2$.

④ Дано:

$m_b = 20 \text{ кг}$
 $m_{св} = 15 \text{ кг}$
 $\rho_b = 200 \text{ кг}$
 $T_{мб} = 373 \text{ К}$
 $T_{мсв} = 600 \text{ К}$
 $4m_1 = 0,1 \text{ кг}$
 $c_b = 4186 \frac{\text{Дж}}{\text{кг} \cdot \text{К}}$
 $c_{св} = 130 \frac{\text{Дж}}{\text{кг} \cdot \text{К}}$
 $n = 2,25 \cdot 10^6 \frac{\text{Дж}}{\text{м}^2}$
 $\lambda = 30 \cdot 10^3 \frac{\text{Дж}}{\text{м}^2}$

- 1 Плавящиеся свинца
- 2 Отпавание свинца
- 3 Нагревание воды
- 4 Образование пара

$Q_{мб} + Q_{от} = Q_{нагр} + Q_{нагр.м.} + Q_{исп.}$

$Q_{мб} = \lambda \cdot m_{св} = 30 \cdot 10^3 \frac{\text{Дж}}{\text{м}^2} \cdot 15 \text{ кг} = 450 \text{ кДж}$

$Q_{нагр.м.} = 4m_1 \cdot c_b (T_{мб} - T_b) = 0,1 \text{ кг} \cdot 4186 \frac{\text{Дж}}{\text{кг} \cdot \text{К}} \times 75 \text{ К} = 31,425 \text{ кДж}$

$Q_{исп.} = 4m_1 \cdot n = 0,1 \text{ кг} \cdot 2,25 \cdot 10^6 \frac{\text{Дж}}{\text{м}^2} = 225 \text{ кДж}$

$450 \text{ кДж} + Q_{от} = Q_{нагр} + 31,425 \text{ кДж} + 225 \text{ кДж}$
 $193,575 \text{ кДж} + c_{св} m_{св} (T_{мб} - T) = c_b m_b (T - T_b)$

$193,575 \text{ кДж} + c_{св} m_{св} T_{мб} - c_{св} m_{св} T = c_b m_b T - c_b m_b T_b$
 $193,575 \text{ кДж} + c_{св} m_{св} T_{мб} + c_b m_b T_b = c_b m_b T + c_{св} m_{св} T$

$$\begin{cases} s = vt_1 - at_1^2 \\ t_1 = \frac{2}{a} \\ t = \frac{v_0}{a} \\ s = \frac{at^2}{2} \end{cases}$$

$$s = 4 \frac{2}{a} - a \left(\frac{2}{a} \right)^2$$

$$s = \frac{8}{a} - a \frac{4}{a^2}$$

$$s = \frac{8}{a} - \frac{4}{a} = \frac{4}{a}$$

$$\begin{cases} s = \frac{4}{a} \\ s = \frac{at^2}{2} \end{cases}$$

$$\frac{at^2}{2} = \frac{4}{a}$$

$$a^2 t^2 = 8$$

$$at = \sqrt{8} = 2\sqrt{2} \approx 2,82$$

$$at = v_0 \approx 2,82 \frac{m}{s}$$

$$\text{Ответ: } 2,82 \frac{m}{s}$$

② Дано: спутник вокруг Земли

$$L = 6,67 \cdot 10^{-11} \frac{m^3}{kg \cdot s^2}$$

$$t = 24 \text{ ч.}$$

$$R = 6400 \text{ км.}$$

$$g = 10 \frac{m}{s^2}$$

$$k = \frac{R+h}{R} - ?$$

Решение:

$$v = \frac{L}{t} = \frac{2\pi R}{t} = \frac{2 \cdot 3,14 \cdot 6400000 \text{ м}}{86400 \text{ с}}$$

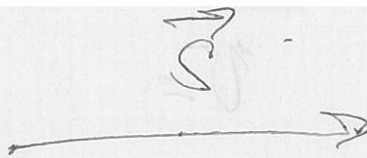
$$\approx 465 \frac{m}{s}$$

$$\sqrt{\frac{M_3 \cdot L}{(R+h)^2}} = R+h$$

$$h = \frac{L \cdot M_3}{v^2} - R \quad \text{т.к. знаем}$$

L, M_3, v, R то найдем $h \Rightarrow$

$$k = \frac{R + \frac{L M_3}{v^2} - R}{R} = \frac{L M_3}{v^2 R} \quad (M_3 \text{ не известно})$$



$$E_k = \frac{mV^2}{2}$$

$$V = \frac{2\sqrt{E_k}}{m}$$

① $S = V_0 t - \frac{at^2}{2}$

$$V = V_0 - at$$

② $\frac{S}{2} = V_0 t_1 - \frac{at_1^2}{2}$

$$V = V_0 - at_1$$

$$V_0 = V + at_1$$

$$at = \frac{2\sqrt{E_k}}{m} + at_1$$

$$a(t - t_1) = \frac{2\sqrt{E_k}}{m}$$

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

$$S = 2V_0 t_1 - at_1^2$$

$$S = 2t_1(V + at_1) - at_1^2$$

$$S = at_1^2 + 2t_1V = at_1^2 + 4t_1$$

$$at_1^2 + 4t_1 = \frac{at^2}{2}$$

$$(V_0 - at - t_1) \cdot 2at_1^2 + 8t_1 - at^2 = 0$$

$$\Delta = 64 - 4 \cdot 2a \cdot (-at^2) = 64 + 8a^2 t^2 =$$

$$= 64 + 8\sqrt{E_k} \cdot 2 + 8a^2 t^2 - 8\sqrt{E_k} \cdot 2 =$$

$$= (8 + \sqrt{E_k})^2 - 4506 =$$

$$= 64 + 8V_0^2$$

$$2 = V_0 - at + at_1$$

$$V_0 = 2 + at - at_1$$

$$V_0 = 2 + V_0$$



(2)

$$m_1 = 20 \text{ кг}$$

$$V =$$

$$T_1 = 292 \text{ К}$$

$$m_2 = 15 \text{ кг}$$

$$T_{\text{пл}} = 600 \text{ К}$$

$$\Delta m_1 = 0,5 \text{ кг}$$

$$T_{\text{пл}} = 343 \text{ К}$$

$$c_b = 4190 \frac{\text{Дж}}{\text{кг} \cdot \text{К}}$$

$$c_{\text{пл}} = 130 \frac{\text{Дж}}{\text{кг} \cdot \text{К}}$$

$$v = 2,25 \cdot 10^8 \frac{\text{Дж}}{\text{м}^3}$$

$$\lambda = 30 \cdot 10^3 \frac{\text{Дж}}{\text{м}}$$

$$Q_1 = Q_{\text{пл}} = m_1 \lambda = 20 \text{ кг} \cdot 30 \cdot 10^3 \frac{\text{Дж}}{\text{кг}} = 600000 \text{ Дж}$$

$$Q_{\text{нагр б}} = c m \Delta t$$

$$\textcircled{1} S = \frac{at^2}{2}$$

$$\Delta t = \frac{600000 \text{ Дж}}{20 \text{ кг} \cdot 4190 \frac{\text{Дж}}{\text{кг} \cdot \text{К}}}$$

$$Q_{\text{пл}} + Q_{\text{ост}} = Q_{\text{нагр п}} + Q_{\text{нагр б}}$$

$$Q_{\text{пл}} + \Delta m c_b (T_{\text{пл}} - T) = c_b m_b (T - T_1)$$

150+

$$450000 \text{ Дж} + 442650 \text{ Дж} = 6285000$$



$$\textcircled{1} \quad m = 4m$$

$$F_k = \frac{mv^2}{r}$$

$$\vec{s} = \vec{v}_0 t + \frac{\vec{a} t^2}{2}$$

$$\vec{v} = \vec{v}_0 + \vec{a} t$$

$$F_k = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{2F_k r}{m}} = \sqrt{\frac{1800m}{4m}} = 2 \frac{m}{c}$$

$$\textcircled{1} \quad \text{по формуле:}$$

$$0 = v_0 - at$$

$$v_0 = at$$

$$2 \frac{m}{c} = v_0$$



K.

по формуле:

$$s = v_0 t - \frac{at^2}{2}$$

$$v_0 = at$$

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

по 1/2 пути:

$$\frac{1}{2} s = v_0 t_2 - \frac{at_2^2}{2}$$

$$2 \frac{m}{c} = v_0 - at_2$$

$$s = 2v_0 t_2 - at_2^2$$

$$v_0 = at_2 + 2 \frac{m}{c}$$

$$s = 2t_2 \left(at_2 + 2 \frac{m}{c} \right) - at_2^2 =$$

$$= 2at_2^2 + 4t_2 \frac{m}{c} - at_2^2 = at_2^2 + 4t_2 \frac{m}{c}$$

② $R = 6400000 \text{ m}$

$$h = \frac{M_3 \cdot \omega}{(R+h)^2} = \frac{M_3 \omega^2}{2}$$

$$v = \sqrt{2 \frac{M_3}{(R+h)^2}}$$

$$\frac{R+h}{R} = 1 + \frac{h}{R}$$

$\lambda = c = 2\pi R = 40132 \text{ m}$ *Экв Земли*

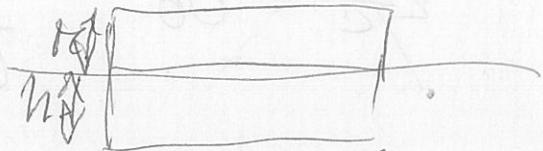
$$v = \frac{c}{t} = \frac{40132 \text{ m}}{244} \approx 1645 \frac{\text{m}}{\text{s}}$$

Т.к. высота h несущественна

$$v = \sqrt{gR} = \sqrt{10 \frac{\text{m}}{\text{s}^2} \cdot 6400000 \text{ m}} \approx 8000 \frac{\text{m}}{\text{s}}$$

③

$M = 4000 \text{ kg}$ ①



$$m_1 = \rho V_1 = \rho b h S$$

$$\textcircled{2} (m_1 + m_2)g = g \rho b (h + \frac{M}{\rho b}) S$$

$$m_1 = \rho b h S$$

$$m_2 = \rho b (h + \frac{M}{\rho b}) S - m_1$$

$$\rho b h S = \rho b h S + \frac{\rho b M S}{2} - m_1$$

$$m_1 = \frac{\rho b M S}{2}$$

$$S = \frac{2 m_1}{\rho b h} = \frac{2 \cdot 8000 \text{ kg}}{1000 \frac{\text{kg}}{\text{m}^3} \cdot 0,02}$$