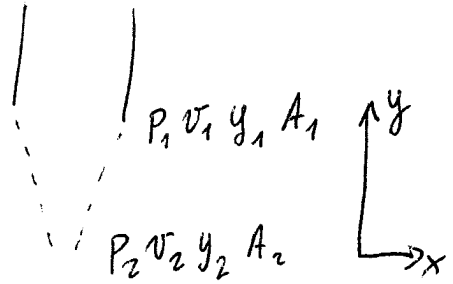
SUMMER 2009 - FINAL PHYSICS 2 - SOLUTION

(1) Pressure is larger at the bottom **A**

(2)



$P_2 = P_0$ $v_1 = 4\,m/s$ $y_1 = ?$ $A_1 = A$

$P_2 = P_0$ $v_2 = ?$ $y_2 = 0$ $A_2 = \frac{2}{3}A$

$A_1 v_1 = A_2 v_2$ $\quad v_2 = \frac{A_1}{A_2} v_1 = \frac{3A}{2A} 4\,m/sec = \underline{6\,m/sec}$

$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$ $\quad (P_1 = P_2 = P_0)$ $(y_2 = 0)$ **B**

$\frac{1}{2}v_1^2 + g y_1 = \frac{1}{2}v_2^2$ $\quad y_1 = \frac{1}{2g}(v_2^2 - v_1^2) = \frac{1}{20}(36 - 16)\,m = \underline{\underline{1\,m}}$

(3) $Q = mc\Delta T \Rightarrow$ **A**

(4) **C** See Section 17.6 also figure 17.21

(5) $\varepsilon_{MAX} = \frac{T_H - T_C}{T_H} = \frac{31}{116+273} = 8\%$ **B** (Careful: T in Kelvin)

(6) Isothermal, ideal gas $\Rightarrow \Delta U = 0$ **C**

(7) ΔU is the same for all paths

$\Delta U = Q - W$ $\quad Q$ = heat absorbed W = work done by system

$Q = \Delta U + W$ $\quad Q$ is larger when $\underline{W}$ is larger

(i) $I \to A \to F$ $W > 0$
(ii) $I \to B \to F$ $W = 0$
(iii) $I \to C \to F$ $W < 0$

$\Rightarrow$ W larger for (i) than (ii). All other possibilities are wrong **C**

(8) First go from F to C

$$C = (F-32)\times\frac{100}{180} = (98.6-32)\frac{5}{9} = 37$$

C

Then go from C to K $\quad K = C + 273 = 310$

(9) Av = constant $\Rightarrow$ if A gets larger, v gets smaller

$\frac{1}{2}\rho v^2 + p$ = constant $\Rightarrow$ if v gets smaller, p gets larger

C

(10) $P_1 = 1\,atm \quad V_1 = ? \quad T_1 = 293 \quad n = 1\,mole$

$P_2 = ? \quad V_2 = V_1 = ? \quad T_2 = 473$

$P_3 = 1\,atm \quad V_3 = ? \quad T_3 = ?$

$$\begin{cases} P_1V_1 = nRT_1 \\ P_2V_2 = nRT_2 \end{cases} \Rightarrow \begin{cases} P_1V_1 = nRT_1 \\ P_2V_1 = nRT_2 \end{cases} \Rightarrow \frac{P_1}{P_2} = \frac{T_1}{T_2} \Rightarrow P_2 = P_1\frac{T_2}{T_1} = \frac{473}{293}\,atm$$

$$P_2 = 1.61\,atm$$

$$P_2V_2 = nRT_2 \Rightarrow V_2 = \frac{nRT_2}{P_2} = \frac{1\cdot 8.314\ 473}{1.61\ 10^5}\,m^3 = 0.024\,m^3$$

$P_2V_2^\gamma = P_3V_3^\gamma \qquad V_3^\gamma = \frac{P_2}{P_3}V_2^\gamma \qquad V_3 = \left(\frac{P_2}{P_3}\right)^{1/\gamma}V_2$

Solved

$$V_3 = 1.61^{\frac{1}{1.4}}\ 0.024\,m^3 = 0.034\,m^3$$

$$P_3V_3 = nRT_3 \qquad T_3 = \frac{P_3V_3}{nR} = \frac{10^5\ 0.034}{1\cdot 8.314}\,K = 409\,K = 136\,C$$

D

(11) Each collision $\Delta P = 2mv\sin 45 = \sqrt{2}\,mv$

$N = 500 \quad \Delta t = 30\ sec$

$$F = \frac{N\Delta P}{\Delta t} = \frac{500\sqrt{2}\ 5\times10^{-3}kg\ 8\ m/sec}{30\ sec} = \underline{\underline{0.943\ N}}$$

$$P = F/A = \frac{0.943\ N}{0.600\ m^2} = \underline{\underline{1.57\ Pa}}$$

D

(12) $\Delta U = Q - W \quad \Delta U = 0$ means $Q = W$ C

(13) T_H, $Q \rightarrow W$, T_C impossible C

(14) Adiabatic means no heat exchanged C

(15) $F_b = \rho_{H_2O} V g$

V = volume of H_2O displaced

V = volume of object = m/ρ_{Fe} or m/ρ_{Al}

~~$F_b = \rho_{H_2O} m g$~~

$$F_b = \frac{\rho_{H_2O}\, m\, g}{\rho}$$

F_b is larger if ρ is smaller $\Rightarrow$ B

(16) $$e = \frac{W}{|Q_H|} = \frac{|Q_H| - |Q_C|}{|Q_H|} = \frac{10{,}000 - 6{,}000}{10{,}000} = 0.4$$ C

17 $m_1 = 550g$ $T_1 = 75°C$ $c_1 = 4190\ J/kgK$

$m_2 = 855g$ $T_2 = 11°C$ $c_2 = 900\ J/kgK$

Water: $T_1 \to T_x$, releases heat Q

Aluminum $T_2 \to T_x$, absorbes heat Q

$$\begin{cases} Q = m_1 c_1 (T_1 - T_x) \\ Q = m_2 c_2 (T_x - T_2) \end{cases} \qquad \begin{cases} m_2 c_2 Q = m_1 m_2 c_1 c_2 (T_1 - T_x) \\ m_1 c_1 Q = m_1 m_2 c_1 c_2 (T_x - T_2) \end{cases}$$

Add the two equations

$$(m_2 c_2 + m_1 c_1) Q = m_1 m_2 c_1 c_2 (T_1 - T_2)$$

$$Q = \frac{m_1 m_2 c_1 c_2 (T_1 - T_2)}{m_1 c_1 + m_2 c_2} = \frac{0.55\ 0.855\ 4190\ 900\ 64}{0.55\ 4190 + 0.855\ 900}\ J$$

$$Q = \frac{113492016}{3074}\ J = \underline{37{,}000\ J} \qquad \boxed{C}$$

18 $P_1 = P$ $V_1 = 5V$ $\longrightarrow$ $P_1 = P_x$ $V_1 = V_{1x}$

$P_2 = 10P$ $V_2 = V$ $\longrightarrow$ $P_2 = P_x$ $V_2 = V_{2x} = 6V - V_{1x}$

$$\begin{cases} P(5V) = P_x V_{1x} \\ (10P) V = P_x V_{2x} \end{cases}$$ Divide the two $\frac{1}{2} = \frac{V_{1x}}{V_{2x}}$

$V_{2x} = 2V_{1x}$

$6V - V_{1x} = 2V_{1x} \Rightarrow \underline{V_{1x} = 2V}$ and $\underline{V_{2x} = 4V}$ $\boxed{A}$