A flexible helium balloon has a volume of 1.5 m^3 when it is launched at sea level and a temperature of 20 °C. At a high altitude, where the air pressure has dropped to 0.25 atm, and the temperature has dropped to -80°C, the volume of the balloon will be [1F]_____ m^3.
$P_1V_1/T_1 = P_2V_2/T_2$. $V_2 = V_1 (P_1/P_2) (T_2/T_1)$ = 1.5 m^3 (1atm/0.25atm) (193 K/293K) = 3.96 m^3

(If a balloon doubles (2x) its radius due to expansion, its volume increases by a factor of [2F]_____ . Volume is proportional to r^3. So 2^3= 8.

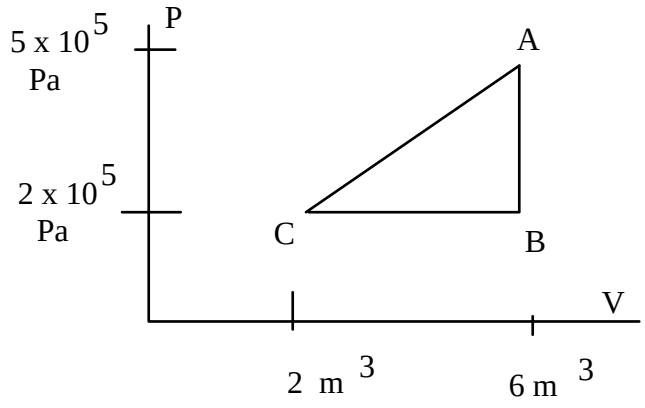
A 30 g piece of metal is at 20°C. It then absorbs 700 J of heat and ends up at 50°C. The specific heat of this metal is [3F]_____ J/kg°C Q = mcΔT C = 700 J/0.03 kg /30°C = 778 J/kg/°C

The temperature of boiling water is the same for slowly boiling water and rapidly boiling water.
[4]_____ 1) true 2) false
true.

The work done by a gas going from state A to state B in the diagram is [5F]_____ J.
zero (no change in V)
The work done by the gas going from state B to state C is [6F]_____ J and it is energy [7F]_____ 1) into the gas 2) out of the gas.
|W| = PΔV = 2 x10^5 Pa (4 m^3)= 8 x10^5 J. This is the magnitude. Since the system contracts, it's like compressing a spring (the gas stores energy somewhat like a spring), and that's energy into the gas.

The net work done by the gas going along a complete cycle ABCA is [8F]_____ J. The magnitude of the net heat exchanged with the gas for the complete cycle ABCA is [9]_____ 1) smaller 2) the same 3) greater than the net work done.
W_{net} for a cycle = Area enclosed = ½ (base) height = ½ (4 m^3) 3x10^5 Pa = 6 x10^5 J.
Net heat exchanged must equal work for a *cycle* because the internal energy change is zero (always come back to the same state in a cycle.

The heat Q is the amount of energy that a system keeps after exchanging energy with its environment.
[10F]_____ 1) true 2) false.
False…it's energy *exchanged* due to T difference. U is kept.



In an adiabatic process the temperature of the gas can change even though no heat is added.
[11]_____ 1)true 2) false. True. The work heats the gas, (or the system does work to cool itself)

An *ideal* heat engine has an efficiency of 0.42. The temperature of the cold reservoir is room temperature, 20°C. The temperature of the hot reservoir in degrees C is [12F]_____ °C. The engine's useful power output is 8000 W. The power absorbed from the hot reservoir by the engine is [13F]_____ W. If the work done during one cycle is 3000 J, the time for one complete cycle of the engine is [14F]_____ sec.

$e_{max} = 1- (T_c/T_h)$, or $T_h = T_c/(1-e) = 293$ K/(1-0.42) = 505 K = 232 C.

$W = e*Q_h$, so the same ratios hold for powers: $P_W = eP_h$, or P_h = 8000 W/ 0.42 = 19 047 W.

P =W/t t = W/P = 3000J/8000W = 0.375 sec.

Carnot told us that for the most efficient gas engine possible, we should keep the interior (pistons) of the engine as cool as possible [15]_____ 1)true 2) false.
False. Hottest possible

Consider a system composed of a mixture of gas vapor and air, such as you might find in your car piston. During part of the engine cycle, the hot gas *expands* and 800 J of work is done, and 600 J of heat flow *out* of the gas. The change in the internal energy of the gas during this time was [16F]_____ J, and was [17]_____ 1) positive 2) negative 3) zero. $\Delta U = Q+W.$ = -600 -800=-1400 J.

Your bedroom wall has dimensions 3 m x 2 m. You decide to make the wall out of rubber, which has a thermal conductivity of 0.2 J/(s m °C). You decide that you want only 500 W of heat to flow through the wall when the inside temperature is 25°C and the outside temperature is 10°C. The thickness of the wall should be [18F]_____cm.
$\Delta Q/\Delta t$ = Power P = 500 W = $kA\Delta T/L$. $L = kA (\Delta T)/P$ = 0.2 /W/mC $6m^2$ (15 C)/500 W = 3.6 cm.

You mix 70 g of water at 100 °C with 20 g of water at 10 °C. The final temperature of the water is [19F]_____ °C. During the mixing process, the entropy of the universe _____ [20] 1) increased 2) decreased 3) remained the same.
$Q_{lost} = Q_{gained}$
$m_h c_w (T_h- T_f) = m_c c_w (T_f- Tc)$. Solving: T_f= (70 g 100 C + 20 g 10 C)/90 g = 80 C.
Entropy of universe increases in any natural process

Fact: In a hydraulic jack you push on a piston which pushes on the fluid in a small cylinder. This fluid flows into a wider piston that holds the car. True or false: The reason that the car is on the wider piston is because the fluid pressure is greater in the large cylinder than in the small cylinder. [21]_____ 1) true 2) false Neglect any height differences in the fluid.
False. P is same for same height. F = PA is larger because A is larger.

A large wood raft is 3 m wide and 6 m long. A man of <u>weight</u> 590 N walks on to the raft from the shore. What is the <u>weight</u> of water the raft must displace to support him? [22F]_____ N. The raft will sink a distance of [23F]_____ m into the water when he walks onto the raft.
W_{water} is same as the change in buoyant force, so it's the man's weight. 590 N. $W = mg = \rho Vg = \rho A\Delta yg$, so $\Delta y = W/(\rho Ag)$ = 590 N/(1000 kg/m^3 18 m^2 9.8 m/s^2) = 3.3 mm.

Suppose you are on the moon. If you try to use a straw to drink a soda from an open cup on the moon, it will be easier than on the earth. [24]_____1) true 2) false (Assume the liquid doesn't evaporate) False. You can't raise any soda at all since there is no atmosphere to push it up the straw.

A large aquarium at Sea World is pool is 4 m deep, 6 m long and 8 m wide. What is the difference in pressure between the top and the bottom of the aquarium? [25F]_____ N/m^2.

$\Delta P = \rho g\Delta y$ = 1000 kg/m^3 9.8 m/s^2 4 m = 39200.

A fluid with density 3150 kg/m^3 flows through a pipe of <u>diameter</u> 15 cm with speed 8 m/s. It opens into another pipe with different diameter, where the speed is 2 m/s. The <u>diameter</u> of the second pipe is [26F]_____ cm. The pressure difference between the fluid in the two pipes is [27F]_____ N/m^2. The pressure is greater in [28]_____ . 1) the smaller pipe 2) the larger pipe 3) neither, P is the same in both.

$A_1v_1 = A_2v_2$. The velocity decreases by four, so the area increased by four, so the diameter increased by 2.

d_2 = 30 cm. For no height change, $\Delta P = \frac{1}{2} \rho(v_1^2 - v_2^2) = \frac{1}{2}$ (3150 kg/m^3)(8^2-2^2) = 94500 Pa.

Airplanes need lift to take off. In the cool morning, the density of air is different than in the hot part of the day. In the cool morning the lift on the wings is [29]_____ 1) smaller 2) same 3) larger than in he hot afternoon, for the same airplane speed.

Air will be denser, so you get more lift for the same speed.

Suppose you are trying to put a metal rod into a hole in another piece of metal. The rod is a little too big to fit in the hole. To make the rod fit, you could cool down the piece with the hole.

[30]_____ 1) true 2) false

False. Heat it up.

A closed, hard-walled cylinder contains a gas at a gauge pressure of -0.5 atm, at a temperature of 200 K. You heat it up until the gauge pressure is + 0.5 atm. The final temperature of the gas is [31F]_____ K.

The absolute pressure is + 0.5 atm at the beginning, and 1.5 at the end, so P has changed by a ratio of 3. Then T must increase by a factor of 3 also. 600 K.

The atomic weight of carbon C is 12. The atomic mass of sulphur S is 32 g/mole. The molecular weight of CS_2 is [32F]_____ g/mole . The mass of <u>one</u> sulphur atom is [33F]_____ g.

12 + 2*32 = 12+64 = 76 g/mole.

m = 32g/mole * 1mole/ 6.02 $x10^{23}$ atoms = 5 $x10^{-23}$ g