```
(*  problem 2            *)
ClearAll["Global`*"]

(* 1% salted water -
 1 m^3 of water is 1000 kg,so 1% contains 10 kg salt  by weight.
    A Na Cl molecule atomic weight is 23+
  35.4 (noninteger because of mixture of isotopes)= *)

In[1]:= mN = 1.68 * 10 ^ (-27) * kg
mNaCl = (23 + 35.4) * mN
totalNaCl = 10 * kg
nNaCl = totalNaCl / mNaCl / m ^ 3
10 000 / (23 + 35.4)
```

Out[1]= 1.68×10^{-27} kg

Out[2]= 9.8112×10^{-26} kg

Out[3]= 10 kg

Out[4]= $\frac{1.01924 \times 10^{26}}{m^3}$

Out[5]= 171.233

```
kB = 1.38064852 × 10 ^ (-23) * m ^ 2 * kg / s ^ 2 / K;
(* body temperature here *)
T = (273 + 37) * K
pNaCl = nNaCl * kB * T
```

310 K

$\frac{436\,237.\ kg}{m\ s^2}$

```
atm = 10 ^ 5 * (kg * m / s ^ 2) / m ^ 2
pNaCl / atm
```

$\frac{100\,000\ kg}{m\ s^2}$

4.36237

```
(* this is osmotic pressure in atm *)


(*   problem 3, Otto cycle *)

(* points 1,2,3,4 have respective volumes, pressures and temperatures
 Otto: 12 and 34 are adiabates, dQ=TdS=0
    23 and 41 are fixed volume, dW=pdV=0
   one needs to calculate efficiency using arbitrary Cv, Cp and Cp/Cv=γ

   On fixed volume sides dU=
  dQ so one can simply calculate efficiency from heat-in minus heat-out *)

eta = 1 - (CV * (T4 - T1)) / (CV * (T3 - T2))
V2 = V1 / r1;
V3 = V2;
V4 = V1;
T1 = p1 * V1 / R;
Solve[{T3 * V3 ^ (γ + 1) == T4 * V4 ^ (γ + 1),
  T1 * V1 ^ (γ + 1) == T2 * V2 ^ (γ + 1), T4 == T1 * r2}, {T2, T3, T4}]
```

$$1 - \frac{-T1 + T4}{-T2 + T3}$$

$$\left\{\left\{T2 \to \frac{p1\ r1\ V1^{1+\gamma} \left(\frac{V1}{r1}\right)^{-\gamma}}{R},\ T3 \to \frac{p1\ r1\ r2\ V1^{1+\gamma} \left(\frac{V1}{r1}\right)^{-\gamma}}{R},\ T4 \to \frac{p1\ r2\ V1}{R}\right\}\right\}$$

$$\text{Assuming}\Big[V1 > 0,\ \text{Simplify}\Big[eta\ /.\ \Big\{T2 \to \frac{p1\ r1\ V1^{1+\gamma} \left(\frac{V1}{r1}\right)^{-\gamma}}{R},\ T3 \to \frac{p1\ r1\ r2\ V1^{1+\gamma} \left(\frac{V1}{r1}\right)^{-\gamma}}{R},\ T4 \to \frac{p1\ r2\ V1}{R}\Big\}\Big]\Big]$$

$$1 - \left(\frac{1}{r1}\right)^{1+\gamma}$$