0.1 Chapters 9-11

1. Density $\rho$, scalar, SI unit, kg/m$^3$

$$\rho \equiv \frac{M}{V}$$

$M$ and $V$ are the mass and the volume of the object.

2. Pressure $P$, scalar, SI unit, Pascal, 1 Pascal = 1N/m$^2$

$$P \equiv \frac{F}{A}$$

$F$ and $A$, force (newton) and area (in unit of square meters). The area is the area that the force acts on.

3. Pressure in liquid

$$P = P_0 + \rho gh$$

$P_0$, $\rho$, $g$, $h$, atmospheric pressure (1.10× 10$^5$ Pa), the density of the liquid, gravity, depth from the top of the liquid.

4. Pascal’s principle

When pressure is applied to an enclosed fluid, the pressure is transmitted undiminished to every point of the fluid and to the walls of the containing vessel.

5. Archimedes’s principle, Buoyant force

The buoyant force is equal to the weight of the fluid displaced by the object.

$$B = \rho V g$$

$\rho$, $V$, $g$, density of the fluid, volume displaced by the object, the gravity (9.8 m/s$^2$).

6. Equation of continuity

$$A_1 V_1 = A_2 V_2$$

$A_1$, $V_1$, $A_2$, $V_2$, the cross section of the pipe at position 1, the velocity at position 1, the cross section of the pipe at position 2, the velocity at position 2.

7. Bernoulli’s equation

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$\rho$ and $g$, density, gravity. $P_1$, $v_1$, $y_1$, pressure, velocity, vertical position along the y-axis at position 1; $P_2$, $v_2$, $y_2$, pressure, velocity, vertical position along the y-axis at position 2.
8. **Zeroth law of thermodynamics**
   If two objects, A and B, are separately in thermal equilibrium with a third object, then A and B are in thermal equilibrium with each other.

9. **Temperature, (Kelvin, Celsius, Fahrenheit)**
   
   \[ T_c = T - 273.15, \quad T_F = \frac{9}{5}T_c + 32 \]

   Three different units, K, °C, F. You need to know the conversion.

10. **Thermal expansion**
    
    \[ \Delta L = \alpha L_0 \Delta T, \quad \Delta A = \gamma A_0 \Delta T \Delta V = \beta V_0 \Delta T \]

    \( \alpha, \gamma, \beta \), average coefficient of linear, surface and volume expansions, with units of \((°C)^{-1}\)

11. **State equation for ideal gas**
    
    \[ PV = nRT \]

    \( P, V, n, R \) and \( T \), the pressure of the gas, its volume, the number of moles of gas, \( R = 8.31 \text{ J/mol·K} \), and temperature (K)

12. **Heat energy (calorie, Cal, or J)**
    
    1 Calorie = 4.186 J
    1 food Calorie = 1000 cal

13. **Heat \( Q \) needed to change the temperature of a substance from \( T_i \) to \( T_f \) is**
    
    \[ Q = mc(T_f - T_i) \]

    \( Q, m, c, T_f \) and \( T_i \), heat, mass of the substance, specific heat\([J/(kg,°C)]\), final and initial temperatures

14. **Latent heat, to change the phase of a substance**
    
    \[ Q = mL \]

    \( m \) is the mass of the substance which involves the phase change, \( L \) is latent heat. There are two kinds of latent heat, one is the latent heat of fusion called \( L_f \), the other is the latent heat of vaporization \( L_v \), both of which have units of \( J/kg \).