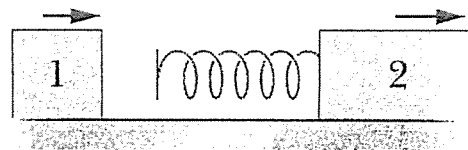


NOTE: You need to write down the details of your steps solving the problems.

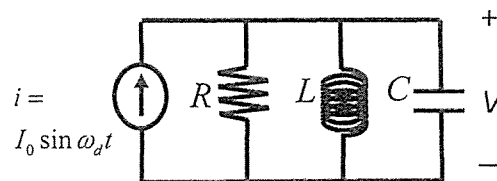
- Two objects, one with mass $2m$ at a higher temperature T_h and one with mass m at a lower temperature T_c , have identical heat capacity c . If the heat exchange between the two objects is solely from a Carnot heat engine running between them, (a) what is the final temperature of the two objects? (10%); (b) what is the total extracted work from the heat engine? (5%)
- A mole of ideal monoatomic gas is in thermal equilibrium and its temperature is T . The gas is confined in a potential $V(\vec{r})$. What is the constant volume heat capacity of the gas if (a) $V(\vec{r}) = V_0$, where V_0 is constant (4%); (b) $V(\vec{r}) = \frac{1}{2} k\vec{r}^2$, where \vec{r} is the position vector (x,y,z) (4%); (c) $V(\vec{r}) = mg|z|$ (7%). Please calculate part (c) explicitly and ignore any quantum effect.

- Block 1 (mass 2.0 kg) is moving rightward at 10 m/s and block 2 (mass 5.0 kg) is moving rightward at 3.0 m/s. The surface is frictionless, and a spring with a spring constant of 1120 N/m is fixed to block 2. When the blocks collide, the compression of the spring is maximum at the instant the blocks have the same velocity. Find the maximum compression. (15%)



- A banked circular highway curve is designed for traffic moving at 60 km/h. The radius of the curve is 200 m. Traffic is moving along the highway at 40 km/h on a rainy day. What is the minimum coefficient of friction between tires and road that will allow cars to take the turn without sliding off the road? (Assume the cars do not have negative lift.) (15%)

- Find V as a function of I_0, ω_d, L, R, C . You have to use the method of phasor and describe all the detailed steps, including the relationships between the voltages and the currents across all three circuit components, of your approach. (20%)



- Obtain, with detailed steps, the angular diffraction intensity pattern by a double slit. You need the following parameters: the light source is coherent and with wavelength λ ; the distance between the center of the two slits is d and the slit width is a ; the central intensity of the pattern is I_m . (20%)

