

# Physics CST (2023-24) Homework 4

Please send the completed file to my mailbox [yy.lam@qq.com](mailto:yy.lam@qq.com) by November 11th, with using the filename format:

student\_number-name-cst-hw4

Please answer the questions by filling on these sheets. Or alternatively, do the homework as usual by using papers, then take the pictures and paste them onto these question sheets.

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1. How much mass of water vapour initially at  $135^{\circ}\text{C}$  is needed to warm 220 g of water in a 130-g glass container from  $20.0^{\circ}\text{C}$  to  $65.0^{\circ}\text{C}$  at thermal equilibrium? (Specific heats of water, steam and glass are  $4.19 \times 10^3$ ,  $2.01 \times 10^3$  and  $837 \text{ J/kg} \cdot ^{\circ}\text{C}$ , respectively. The latent of vaporization of water is  $2.26 \times 10^6 \text{ J/kg}$ .)

- At a distance of 3.5 m from a source the sound level is 74 dB. How far away has the level dropped to 58 dB?
- How does the rate of heat transfer by conduction change of an object when the volume is decreased by half?

4. A box with volume  $V$  contains 16 particles with each of mass  $m$  having various speeds. Four have speed  $v$ ; three have speed  $2v$ ; two have speed  $4v$ ; four have speed half  $v$ ; the other three have speed  $3v$ . (a) Find the root-mean-square speed of the particles. (b) Use the ideal gas law to find the pressure inside the container.
5. A box with 8 cells contains 2 different balls. The balls are allowed to sit on the same cell. What is the change of entropy if it is replaced by a box with only 4 cells?
6. A box contains  $10^{22}$  gas molecules, approximately, under normal room temperature and pressure. Approximate the change of entropy of the system if the volume of the box is double of the original. (For simplicity, assuming the molecules are distinguishable)

7. Ultrasound that has a frequency of 2.44 MHz is sent toward blood in an artery that is moving away the source at 20.0 cm/s. Use the speed of sound in human tissue as 1550 m/s. (a) What frequency does the blood receive? (b) What frequency returns to the source? Take your results to 6 decimal places.

8. Water is pumped into a long vertical cylinder at a rate of  $24 \text{ cm}^3/\text{s}$ . The radius of the cylinder is 5 cm, and at the open top of the cylinder is tuning fork vibrating with a frequency of 200 Hz. As the water rises, how much time elapses between any successive resonances at  $20^\circ\text{C}$ ?

