一、 Multiple Choice：(75%) 每題 5%（單選）

答錯倒扣該題分數的 1/4；不回答則不加分也不扣分。請依順序在答案卷上清楚作答。模糊或錯亂者，結果自行負責。

1. A top spinning at 500 rpm precesses with frequency $\Omega = 5$ rad/s. The mass of the top is 0.4 kg and its rotational inertia is $3 \times 10^{-3}$ kg m$^2$. Where is the center of mass?
   a. 0.1 m from the bottom along the rotational axis
   b. 0.2 m from the bottom along the rotational axis
   c. 0.3 m from the bottom along the rotational axis
   d. 0.4 m from the bottom along the rotational axis
   e. 0.5 m from the bottom along the rotational axis

2. A thin rod of mass $M$ and length $L$ is struck at one end by a ball of clay of mass $m$, moving with speed $v$ as shown in the figure. The ball sticks to the rod. After the collision, the angular momentum of the clay-rod system about A, the midpoint of the rod, is
   a. $(M + m/3)(\frac{vL}{2})$
   b. $(m + M/12)(\frac{vL}{2})$
   c. $(m + M/3)(\frac{vL}{2})$
   d. $(m)(\frac{vL}{2})$
   e. $MvL$

3. If the solution of the wave equation $\frac{\partial^2 y}{\partial x^2} - a \frac{\partial^2 y}{\partial t^2} = 0$ is a traveling wave, the wave velocity is
   a. $a$
   b. $a^2$
   c. $(2a)^{1/2}$
   d. $a^{1/2}$
   e. $2a$

4. The power transmitted by a sinusoidal wave is proportional to
   a. $A$
   b. $A^2$
   c. $\omega$
5. When the amplitude of a simple pendulum becomes large, its period
   a. remains constant
   b. increases
   c. decreases
   d. depends on its weight
   e. none of the above.

6. A refrigerator is set in the middle of an insulated room, is plugged in and running
   with its door open. What happens to the temperature of the room?
   a. It goes up.
   b. It goes down.
   c. It remains the same.
   d. It doubles.
   e. It is cut in half.

7. A Carnot engine has a 0.35 efficiency and an exhaust temperature of 270 K. What
   is the combustion temperature of the engine in K?
   a. 420
   b. 390
   c. 430
   d. 380
   e. 440

8. If the matter or a system becomes more orderly, what can we say about the
   system?
   a. The temperature increases.
   b. The entropy increases.
   c. The entropy decreases.
   d. The thermal energy increases.
   e. Mass was added to the system.

9. What is $E_x$ if $V = -3x^2 + 7x + 3$?
10. There are differences and similarities between electrical charges and magnetic poles. One of the differences is
   a. opposite poles repel.
   b. like poles attract.
   c. magnetic poles don’t produce fields.
   d. a magnetic pole cannot exist alone.
   e. magnetic poles don’t affect each other.

11. Energy is being transported using copper power lines. Which of the following voltage-current combinations would transfer the energy with the least amount of line loss?
   a. 100 V, 100 A
   b. 1000 V, 10 A
   c. $10^4$ V, 1 A
   d. $10^5$ V, 0.1 A
   e. It doesn’t make any difference.

12. The resonance frequency of an $LC$ circuit is
   a. $\frac{2\pi}{\sqrt{LC}}$
   b. $\frac{1}{\sqrt{\varepsilon_0 \mu_0}}$
   c. $\sqrt{L^2 + C^2}$
   d. $\frac{1}{2} \pi \sqrt{L^2 + C^2}$
   e. $\frac{1}{2} \pi \sqrt{L^2 - C^2}$
二、Problems：(25%)

1. A 2.00 liter container has a center partition that divide it into two equal parts, as shown in figure 1. The left side contains H₂ gas, and the right side contains O₂ gas. Both gases are at room temperature and at atmospheric pressure. The partition is removed and the gasses are allowed to mix. What is the entropy increase? (10%)

   \[
   \begin{array}{c|c}
   0.044 \text{ mole} & 0.044 \text{ mole} \\
   \text{H₂} & \text{O₂} \\
   \end{array}
   \]

   Figure 1

2. A battery is used to charge a capacitor through a resistor. Show that in the process of charging the capacitor, half of the energy supplied by the battery is dissipated as heat in the resistor and half is stored in the capacitor. (15%)