1. (10%) Find the work done in moving a particle in the force field $F = 3x^2y^3 + x^3y^3$ along (a) the straight line from (0, 0) to (2, 1). (b) the curve $x = 2t^2, y = t$ from $t = 0$ to $t = 1$.

2. (15%) A uniform hoop, disk, and sphere, having the same mass $M$ and the same radius $R$, are released simultaneously from rest at the top of a ramp whose length is $L$ and whose ramp angle is $\theta$. Which object reaches the bottom first?

3. (10%) A meter stick, suspended from one end, swings as a physical pendulum. What is its period of oscillation?

4. (15%) One mole of an ideal monatomic gas is taken through the cycle in Fig. 1. (a) How much work is done by the gas in going from state $a$ to state $c$ along path $abc$? What are the changes in internal energy and entropy in going (b) from $b$ to $c$ and (c) through one complete cycle? Express all answers in terms of the pressure $p_0$, volume $V_0$, and temperature $T_0$ of state $a$.

$$\begin{array}{c}
\text{Pressure} \\
\downarrow \\
\text{Volume}
\end{array}$$

![Diagram](image)
5. (10%) A long, straight coaxial cable (Fig. 2) has an inner wire of radius \( a \) with a surface charge density \( \sigma \) and an outer cylindrical shell of radius \( b \) with \(-\sigma\). Find the field in the regions (a) \( a < r < b \), and (b) \( r > b \).

6. (10%) For the circuit shown in Fig. 3, calculate the change in potential \( V_A - V_B \).

7. (10%) A metal rod of mass \( m \) and of length \( l \) slides on frictionless rails of negligible resistance which terminate in a resistor \( R \), as shown in Fig. 4. A uniform magnetic field is directed perpendicular to the plane of the rails. The initial velocity of the rod is \( v_0 \). There is no external agent applying a force to the rod. (a) Show that \( v(t) = v_0 e^{-\frac{t}{R}} \)

where \( r = mR/(Bl)^2 \). (b) Show that the distance traveled before coming to rest is \( v_0 r \). (c) Show that the total electrical energy lost is \( \frac{1}{2}mv_0^2 \).

8. (20%) 請判斷以下陳述的對錯並說明理由。每個子題 2 分。
(a) 磁場可以改變帶電粒子的運動速率，
(b) 磁場可以改變帶電粒子的運動速度，
(c) 均勻磁場中一封閉電流迴路所受磁力一定為 0，
(d) 均勻磁場中一封閉電流迴路所受磁力矩一定為 0，
(e) 電子與光子都是費米子，
(f) 我們用來加熱水份的微波爐，其輻射電磁波的頻率在 10^6 Hz 量級，
(g) 請您向對面的朋友跑過去時，他會覺得您所發出的聲音以較快(相較於您靜止之時)的速度傳播。
(h) 設一單元子氣體與一雙原子氣體有相同的體積、莫耳數與溫度。今分別將此二氣體加熱，使增溫 1°C，則雙原子氣體需熱較多。(設加熱過程中，氣體體積維持不變。)
(i) 設一單元子氣體與一雙原子氣體有相同的體積、莫耳數與溫度。若此二種氣體以等溫方式膨脹，使體積加倍，則環境需提供較多的熱給雙原子氣體分子。
(j) 電力線可以相交。