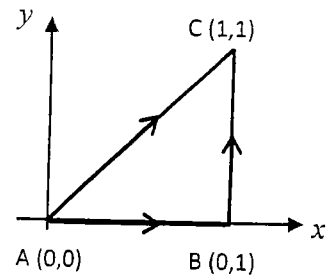


※請在答案卷內作答

除第 7 題為問答題之外全部是計算題。計算題請寫出過程。

1. (10%) A force $\mathbf{F} = y\mathbf{i} + x^2\mathbf{j}$ acts on a particle moving in the xy plane as shown by the figure on the right hand side, where \mathbf{i} and \mathbf{j} are unit vectors in the x and y directions, respectively. Here, \mathbf{F} is in newtons and x and y are in meters. The coordinates of points A, B, and C are also in meters.



What is the work done by \mathbf{F} on the particle when that particle moves (a) (3%) along AC and (b) (3%) along AB and then BC? (c) (4%) Is \mathbf{F} conservative or nonconservative and why?

2. (10%) A satellite of mass m , originally on the surface of the Earth, has an initial speed the same as the tangential speed of the Earth's surface (i.e., the satellite is initially at rest relative to the Earth). What is the minimum energy required to place that satellite into a circular orbit at an altitude h . Express this energy in terms of the mass M and radius R of the Earth, the angular frequency ω of the daily rotation of the Earth, and the gravitational constant G .
3. (15%) When a geyser (熱噴泉) erupts, the height of its water column can reach 50.0 m. Use Bernoulli's equation to estimate the pressure (above atmospheric pressure) in the heated underground chamber of the geyser if its depth is 150 m.
4. (15%) An ideal gas goes through four processes as shown in Fig. a. From A to B is an adiabatic process; from B to C is an isobaric process with energy $q_1 > 0$ entering the system by heat; from C to D is an isothermal process; and from D to A is an isobaric process with energy $q_2 > 0$ leaving the system by heat. What is (a) (8%) the change of internal energy from A to B and (b) (7%) the work done from A to B?

※請在答案卷內作答

5. (10%) A dust particle with mass of 0.05 g and a charge of 2.0×10^{-6} C is moving in a region of space where the potential is given by $V(x) = 2x^2 - 3x^3$. Here x is in meters and the potential V is in volts. If the particle starts at $x = 4$ m, what is initial acceleration of the charge?
6. (15%) Two identical capacitors are connected in parallel and each acquires a charge Q_0 when connected to a source of voltage V_0 . The voltage source is disconnected and then a dielectric with a dielectric constant $K = 2.5$ is inserted to fill the space between the plates of one of the capacitors. Determine (a) (8%) the charge now on each capacitor, and (b) (7%) the voltage now across each capacitor.
7. (10%) What is **Lorentz contraction** in special relativity?
8. (15%) Consider the circuit shown in **Fig. b**, where the switch is closed at $t = 0$ and the internal resistance of the battery is r . (a) (5%) Find the currents in the circuit as functions of t . (b) (5%) Calculate the currents in the circuit at $t = 0.2$ ms assuming that the emf of the battery is 36 V, $r = 2 \Omega$, $L = 4.0$ mH, and $R = 18.0 \Omega$. (c) (5%) When the currents in **Fig. b** have reached the equilibrium values, what is the magnetic field energy stored in the inductor?

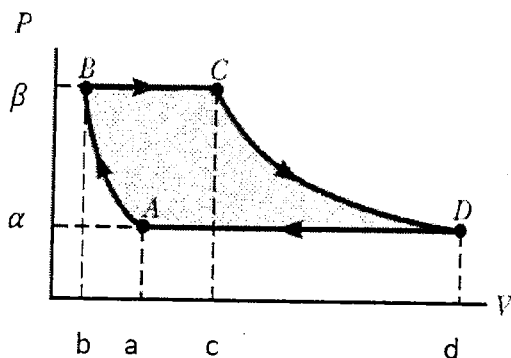


Fig. a (for problem 4)

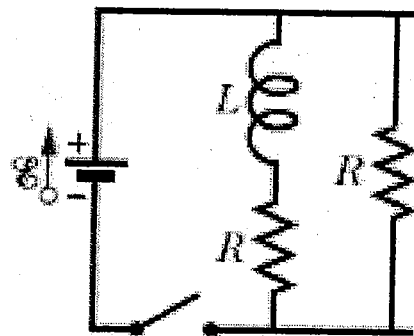


Fig. b (for problem 8)