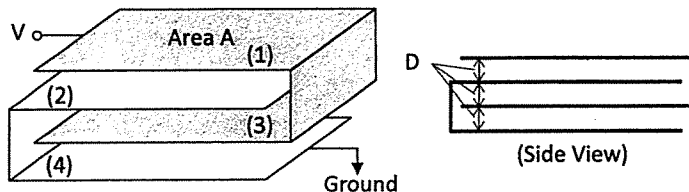
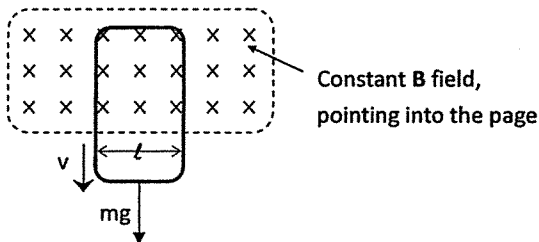


禁止使用計算機

5. (a) What is the capacitance of the device shown below? (5 %) Each metal plate—(1), (2), (3), and (4)—has area A , and the separation between any two adjacent plates is D . Plates (1) and (3) and plates (2) and (4) are electrically connected, respectively. (b) What is the total charge on plates (1) and (3), if the applied voltage is V ? (5 %) (c) What is the magnitude and direction of the electric field in the space between (2) and (3)? (5 %)



6. The upper part of a rectangular wire loop is intercepted by a homogeneous magnetic field B perpendicular to the plane of the paper. The lower part of the loop experiences no field. The wire loop is found to fall with constant speed v , and its ohmic resistance is R . (a) Calculate the magnitude and direction of the current flow in the loop in terms of v , B , ℓ , and R . (5 %) (b) Calculate the Lorentz force on the current in terms of v , B , ℓ , and R . (5 %) (c) The magnitude of v is determined by a balance between the gravitational force mg and the Lorentz force. Obtain a formula for v in terms of m , g , B , ℓ , and R . (5 %) (d) The induced current flow in the loop also produces a magnetic field. If we take this field into account, would v get smaller, larger or remain the same? Why? (5 %)



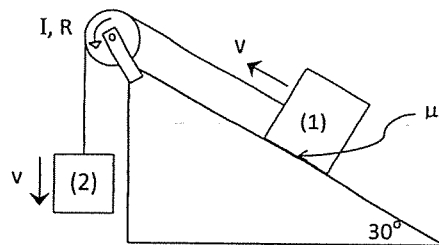
試題隨卷繳回

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※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. A bumper (保險桿) is designed to protect a car of mass $M = 2000$ kg up to a maximum speed of $V_{\max} = 10$ m/s without damage to the car body. There is a critically damped spring inside the bumper which can retract over a maximum distance $D = 10$ cm to absorb the impact. The position of the car after impact (which occurs at $x = 0$, $t = 0$) is given by $x(t) = v_0 t e^{-\lambda t}$, v_0 being the impact velocity ($v_0 < V_{\max}$). (a) Sketch x vs. t to see the motion of the car after impact. (5%) (b) Find the expression for the speed $v(t)$ of the car after impact. (5%) (c) What is the value of λ using the known data of D and V_{\max} ? (5%) (d) Find the maximum force F_{\max} exerted on the car during slow-down. (5%) (Hint: $e \approx 2.7$)

2. Two blocks ((1) and (2)) of equal mass M are connected by a massless rope that runs over a pulley of radius R and rotational inertia I . Block (1) is located on an inclined plane with angle 30° , and the coefficient of kinetic friction between it and the plane is $\mu = \sqrt{3}/2$. Initially ($t = 0$), block (2) has a velocity v downward. When block (2) falls, the rope does not slip over the pulley. (a) How long does it take for block (2) to come to a stop? (5%) (b) What is the angle that pulley I rotates before it stops rotating? (5%) (c) How much energy is dissipated by the friction? (5%)

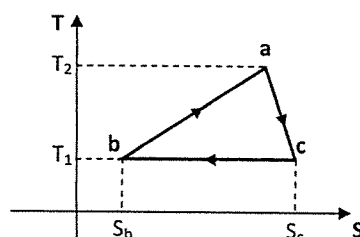


3. At $t = 0$, a transverse wave on a stretched string of tension T and linear mass density ρ has the function form of

$$Ae^{-x^2}$$

(a) What is the wave function $\psi(x, t)$ of this wave, if it is traveling to the positive x (rightward) direction with speed u and without damping? (5%) (b) What is the velocity $v(x, t)$ of an infinitesimal element of the string at position x ? (5%) (c) Calculate the instantaneous power $P(x, t)$ transmitted (from left to right) by the wave at position x ? (5%)

4. The T-S diagram of a reversible heat engine cycle running between temperatures T_1 and T_2 is a triangle as shown in the figure below. (S is the entropy of the engine.) (a) What is the heat rejected by the engine during one engine cycle? (5%) (b) Calculate the work done by the engine in one cycle. (5%) (c) What is the efficiency of this engine? (5%)



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