

1. Two moles of helium (He) are initially at 20°C and a pressure of 1 atm. What is the work done by the gas if the volume is doubled (a) at constant pressure, or (b) isothermally? (10%)
2. Calculate the efficiency of the (idealized) Otto cycles? (10%)
3. The electron and the proton in a hydrogen atom are 0.53×10^{-10} m apart. Compare the electrostatic and gravitational forces between them. (10%) (Coulomb Constant; $k = 9.0 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$, Constant of gravitation; $G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$,
4. A point charge $Q_1 = 20\mu\text{C}$ is at $(-d, 0)$ while $Q_2 = -10\mu\text{C}$ is at $(+d, 0)$. Find the resultant field strength at a point with coordinates (x, y) Take $d = 1.0$ m and $x = y = 2$ m (10%)
5. A 2-kg block is attached to a spring for which $k = 200$ N/m. It is held at an extension of 5 cm and then released at $t = 0$. Find: (a) the displacement as a function of time; (b) the velocity when $x = +A/2$; (c) the acceleration when $x = +A/2$. (A is the amplitude of the oscillation) (10%)
6. At $t = 0$ a pulse is described by $y(x) = A / (B + x^2)$ What is the function that describes it at an arbitrary time given that it moves in the $+x$ direction at 3 m/s? Sketch the pulse at $t = 0, 1$ sec, and 2 sec. (10%)
7. Light of wavelength 600 nm in air is incident at an angle of 35° to the normal of a plate of heavy flint glass of refractive index 1.6. Assume the refractive index of air is 1. Find: (a) the angle of refraction, (b) the wavelength of the light in the glass, (c) the speed of light in the glass. (10%)
8. A 50-kg woman is on a ferris wheel (摩天輪) of radius 9 m that rotates in a vertical circle at 6 rev/min. What is the magnitude of her apparent weight when she is halfway up? (10%)
9. A crate of mass m is dropped onto a conveyor belt that moves at a constant speed v . The coefficient of kinetic friction is μ_k . (a) What is the work done by friction? (b) How far does the crate move before reaching its final speed? (c) When the crate reaches its final speed, how far has the belt moved? (10%)

(背面仍有題目,請繼續作答)

10. A flywheel of mass $M = 2$ kg and radius $R = 40$ cm rotates freely at 600 rpm. Its moment of inertia is $0.5MR^2$. A brake applies a force $F = 10$ N radially inward at the edge. If the coefficient of friction is $\mu_k = 0.5$, how many revolutions does the wheel make before coming the rest? (10%)