

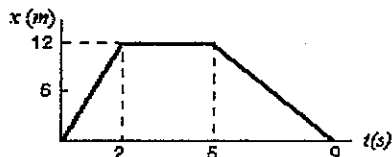
※ 注意：請於試卷上「非選擇題作答區」內依序作答，並應註明作答之大題及其題號。

填充題不需計算過程，請將答案寫於答案卷 1-14 題號空格中，一格 5 分；

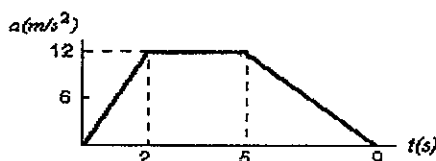
計算問答二題，須詳列式子及推導過程，一題 15 分。

I. 填充題

1. A particle is at rest at  $t = 0$  and starts moving along the  $x$  axis from the origin. Based on the following figure, the displacement at  $t = 9$  s is (1) (m).



2. A particle is at rest at  $t = 0$  and starts moving along the  $x$  axis from the origin. Based on the following figure, the displacement at  $t = 9$  s is (2) (m).



3. A particle is moving along a circular path with radius  $r$ . If its angular velocity and angular acceleration are  $\omega$  and  $\alpha$ , respectively, its acceleration is (3) in the radial direction and is (4) in the tangential direction.
4. What is the maximum power transfer of a spring with force constant  $k$  to an attached object in a simple harmonic oscillation with amplitude  $A$  and frequency  $f$ ?  
(5)
5. The following metal objects, a **disk**, a **solid sphere**, a **hollow sphere**, and a **loop** have the same radius and mass. Assuming they are released from the same point on a ramp at rest and start rolling down, which one will take the shortest time to reach the bottom of this ramp? (6)
6. Write down the Kepler's 3<sup>rd</sup> law (7), the law of periods, for a planet circulating around its sun (mass  $M$ ) with a radius  $r$ . Use  $T$  and  $G$  to denote its period and the gravitational constant, respectively.
7. A planetary nebula is a cloud of mainly hydrogen gas with density  $\rho$  of 1000.0 molecules per cubic centimeter, and a temperature  $T$  of 10,000 K. What is the pressure of the gas in the nebula? (8) (Pa)
8. A Carnot engine takes 5000 J of heat from a thermal reservoir with a temperature  $T_H = 500$  K and discards heat to a thermal reservoir with a temperature  $T_L = 325$  K. How much work does the Carnot engine do in this process? (9) (J)
9. A weightlifter snatches a barbell with mass  $m = 180.0$  kg and lifts it up 1.25 m vertically. If we consider the weightlifter to be a thermodynamic system, how much heat must he give off if his internal energy decreases by 4000 J? (10) (J)
10. 0.5 mole of  $N_2$  is confined in a volume of  $1.0$  m<sup>3</sup> and undergoes free expansion to a new volume of  $2.0$  m<sup>3</sup>. What is the change in entropy of the gas? (11) (J/K)
11. A spherically symmetrical but non-uniform charge distribution is given by  $\rho(r) = \rho_0(1 - r/R)$  for  $r \leq R$ ;  $\rho(r) = 0$  for  $r > R$ , where  $\rho_0 = 10$   $\mu\text{C}/\text{m}^3$  and  $R = 0.250$  m. What is the electric field produced by this charge at  $r = 0.500$  m? (12) (N/C)
12. Suppose a thundercloud with a width of 2.0 km and a length of 3.0 km hovers at an altitude of 500 m over a flat area. The cloud carries a charge of 160 C, and the ground has no charge. What is the potential difference between the cloud and the ground? (13) (V)
13. Suppose the unpolarized light with intensity  $I_0$  is initially incident on the first of two polarizer in a line. The first polarizer has a polarizing direction that is vertical. The second polarizer has a polarizing angle of  $45^\circ$  with respect to the vertical. What is the intensity of light after passing through the two polarizers? (14) ( $I_0$ )

## II. 計算題

1. A baseball player knows the fact that when he hits a baseball on the so called "sweet spot", the ball can get a maximum momentum to fly away. Strangely, the baseball player can feel almost no force exerted from this perfect hit. Based on the above no force exerted statement and using a uniform stick with length  $L$  to model a baseball bat, find the sweet spot on this stick. You should assume the baseball player holding the bat at its one end and the swing of the bat is like a rotation about this end.
2. A long solenoid has 220 turns/cm and carries a current  $I = 1.5$  A; its diameter  $D$  is 3.2 cm. At its center, we placed a 130-turn closely packed coil C of diameter  $d = 2.1$  cm. The current in the solenoid is reduced to zero in a steady rate in 0.025 s. What is the magnitude of emf that is induced in coil C while the current in the solenoid is changing?