1. What is the kinetic energy in MeV of a neutron whose mass is double its rest mass? (10%)

2. A measurement establishes the position of a proton with an accuracy of $\pm 1.00 \times 10^{-11}$ m. Find the uncertainty in the proton's position 1.00 s later. Assume $v \ll c$. (15%)

3. The carbon monoxide (CO) molecule has a bond length R of 0.113 nm and masses of the C and O atoms are respectively 1.99×10^{-26} kg and 2.66×10^{-26} kg. Find (a) the energy and (b) the angular velocity of the CO molecule when it is in its lowest rotational state. (15%)

4. Particles with kinetic energy E are incident on a step potential U (U=3/4E), find the reflection probability and the transmission probability of the particles. (15%)

5. How much more likely is a 1s electron in a hydrogen atom to be at the distance a_0 from the nucleus than at the distance $a_0/2$? ($\psi_{100}(r,\theta,\phi) = \frac{1}{\sqrt{\pi a_0^{3/2}}} e^{-r/a_0}$) (10%)

6. An electron in the Coulomb field of a proton is in a state described by the wave function; $\frac{1}{6}\left[4\psi_{100}(\vec{r}) + 3\psi_{211}(\vec{r}) - \psi_{210}(\vec{r}) + \sqrt{10}\psi_{21-1}(\vec{r})\right]$.

(1) What is the probability in each state? (5%)
(2) What is the expectation value of the energy? (5%)
(3) What is the expectation value of L^2? (5%)
(4) What is the expectation value of L_z? (5%)

7. Find the minimum magnetic field needed for the Zeeman effect to be observed in a spectral line of 400nm wavelength when a spectrometer whose resolution 0.010nm is used. (15%)

一、選擇題部份共十題，每題 5 分。將正確答案寫在答案卷上。

(1) A stone is dropped from a cliff. The graph which best represents its motion while it falls is:
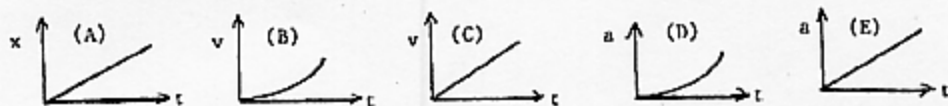
(2) A 5 kg object can move along the x-axis. It is subjected to a force F in the x direction; a graph of F as a function of time t is shown below. The change of velocity of the object is:
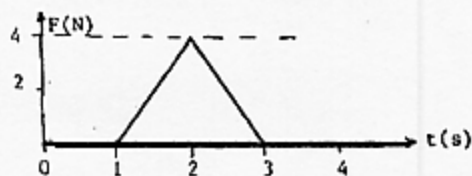
    a. 0.8 m/s
   b. 1.1 m/s
    c. 1.6 m/s
    d. 2.3 m/s
    e. 4.0 m/s

(3) A uniform narrow bar, resting on ice, is given a transverse horizontal impulse J at one end as shown. The center of mass(CM) of the bar will then:
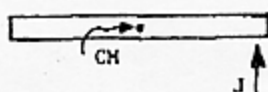
    a. remain at rest
    b. move in a circle
    c. move in a straight line
    d. move in a parabola
    e. move along some other curve

(4) A yo-yo arranged as shown, rests on a frictionless surface. When a force F is applied to the string as shown, the yo-yo:

    a. moves to the left and rotates counterclockwise
    b. moves to the right and rotates counterclockwise
    c. moves to the left and rotates clockwise
    d. moves to the right and rotates clockwise
   e. moves to the right and does not rotate
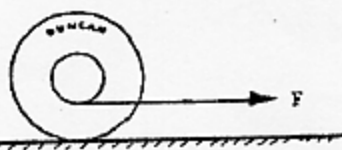
(5) A Carnot cycle

    a. is bounded by two isotherms and two adiabats
    b. is a rectangle on a P-V graph
    c. is any four sided process on a P-V graph
    d. only exists for an ideal gas
   e. has an efficiency equal to the enclosed area on a P-V diagram

(6) A wave is described by $y(x,t) = 0.1 \sin(3x + 10t)$, where x is in meters, y is in centimeters and t is in seconds. The wavelength is

   a. 6π m   b. 3π m   c. $2\pi/3$ m   d. $\pi/3$ m   e. 0.1 cm

(7) Which of the following graphs represents the magnitude of the electric field as a function of the distance from the center of a solid charged conducting sphere of radius R?
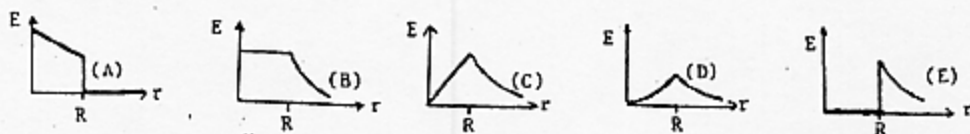
(8) Suppose the current charging a capacitor is kept constant. Which graph below correctly gives the potential difference V across the capacitor as a function of time?
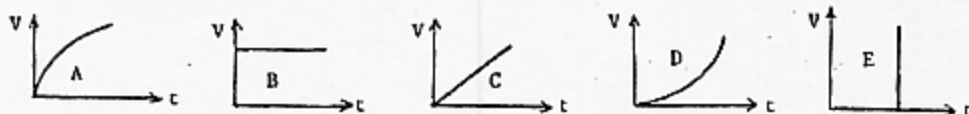

(9) A rectangular loop of wire is placed midway between two long straight parallel conductors as shown. The conductors carry currents i_1 and i_2 as indicated. If i_1 is increasing and i_2 is constant, then the induced current in the loop is:

   a. zero
   b. clockwise
   c. counterclockwise
   d. depends on $i_1 - i_2$
   e. depends on $i_1 + i_2$

(10) A square loop of wire moves with a constant speed v from a field-free region into a region of uniform **B** field, as shown. Which of the five graphs correctly shows the induced current i in the loop as a function of time t?

(A)
b.
(B)
c.
(C)
d.
(D)
e.
(E)
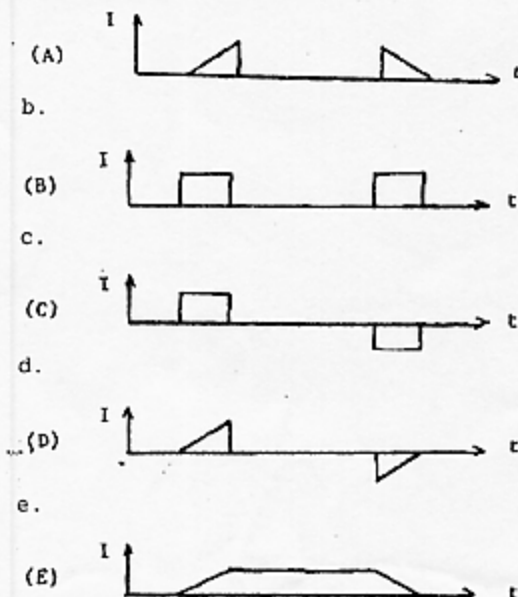
二，計算題部份共 5 題，每題 10 分。

1，An electric dipole with dipole moment **p** put in a region of uniform electric field **E**. Determine its period of small angle oscillation.

2，Find the change in entropy(in cal/k) if 20 kg of water at $50°$ C is mixed with 15 kg of water at $10°$ C.

3，A charge of 0.80 nC is placed at the center of a cube that measures 4.0 m along each edge. What is the electric flux through one face of the cube?

4，The figure below shows the orientation of flat circular loop consisting of 50 closely wrapped turns each carrying a current I. The magnetic field in the region is directed in the positive z direction and has a magnitude of 50 mT. The loop can turn about the y-axis. If $\theta = 20°$, R = 0.50 m, and I = 12 A, what is the magnitude of the torque exerted on the loop?
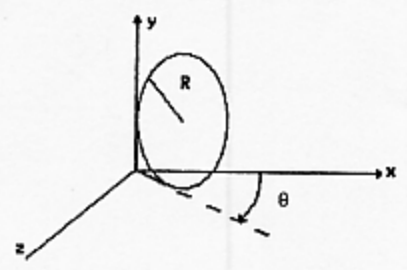
5，The radius of curvature of the convex surface of a plano-convex lens is 120 cm. The lens is placed convex side down on a plane glass plate, and illuminated from above with red light of wavelength 650 nm. Find the diameter of the third bright ring in the interference pattern.