浙江大学 2008－2009 学年 春、夏 学期

《 PHYSICS Ⅰ 》课程期末考试试卷

请考生仔细阅读以下注意事项：

1. 诚信考试，沉着应考，杜绝违纪。
2. 开课学院： 理学院
3. 考试形式： 闭 卷，允许带 计算器、字典 入场
4. 考试日期： 2009 年 06 月 24 日,考试时间： 120 分钟

考生姓名：_____学号：_____所属院系：_____

题序	一	二	三	四	五	六	七	八	总 分
得分									
评卷人									

When the frame *S'* moves relative to the frame *S* with velocity *u* along *xx'* direction,

$$x'=\frac{x-ut}{\sqrt{1-u^2/c^2}},\quad y'=y,\quad z'=z,\quad t'=\frac{t-ux/c^2}{\sqrt{1-u^2/c^2}},$$

$$v'_x=\frac{v_x-u}{1-uv_x/c^2},\quad v'_y=\frac{v_y\sqrt{1-u^2/c^2}}{1-uv_x/c^2},\quad v'_z=\frac{v_z\sqrt{1-u^2/c^2}}{1-uv_x/c^2}$$

The mass, momentum and kinetic energy of a particle, with velocity *v*, are

$$m'=\frac{m}{\sqrt{1-v^2/c^2}},\quad p=\frac{mv}{\sqrt{1-v^2/c^2}},\quad K=\frac{mc^2}{\sqrt{1-v^2/c^2}}-mc^2$$

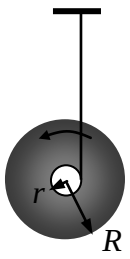
I. Multiple choices (one correct answer only, score of 2.5 for each):

1. An object travels dependent on a formula of $\vec{r}=t^2\hat{i}-3t\hat{j}$ (*m*), the magnitude of its tangent acceleration is 1.6 m/s^2 at

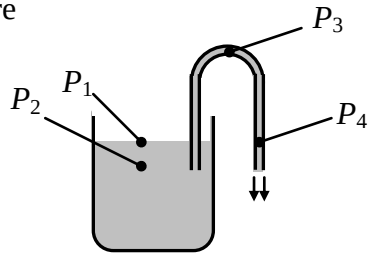
   A. t =2.0s. B. t =1.5s. C. t =1.0s. D. t =0.5s.

2. A toy yo-yo, with a disk of mass *M* and radius *R*, connected by a thin shaft of radius *r*. The mass of the shaft is much less than *M* and r =0.1*R*. A string is wrapped around the shaft, as show in the figure. The yo-yo starts its motion from rest. The ratio of rotational kinetic energy to translational kinetic energy is

   A. 25 B. 50 C. 1/25 D.1/50



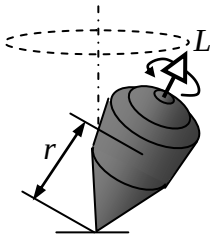
3. A container holds a quantity of a liquid whose top surface is open to the atmosphere. A syphon is a device for removing liquid from the container. The pressure at different points is shown in the figure, they are



A. $P_2 > P_1 > P_4 > P_3$ B. $P_1 > P_2 > P_3 > P_4$

C. $P_3 > P_4 > P_1 > P_2$ D. $P_2 > P_1 > P_3 > P_4$

4. A spinning top, with a mass *m*, makes a processional motion about a vertical axis. The angular momentum of the top is *L*. The separation between the mass center of the top and the contact point is *r* as shown in the figure. The angular speed of processional motion is



A. $\frac{L}{mgr}$ B. $\frac{mgr}{L}$

C. $\frac{mgL}{r}$ D. $\frac{rL}{mg}$

5. A rocket is moving at speed 0.8c relative to the earth. A light emits from the end of the rocket. By an earth observer, the time interval of light from the end to the head of the rocket is 0.1 μs. The rest length of the rocket is

A. 100 *m* B. 50 *m* C. 10 *m* D. 5 *m*

6. A particle, with mass *m* at rest, adsorbs a photon with kinetic energy *K*. The rest mass of the resulting particle is

A. $m\sqrt{1-\frac{2K}{mc^2}}$ B. $m\sqrt{1-\frac{K}{2mc^2}}$ C. $m\sqrt{1+\frac{K}{2mc^2}}$ D. $m\sqrt{1+\frac{2K}{mc^2}}$

7. An electron, with mass *m* at rest, is accelerated with kinetic energy *K*. The momentum of the electron is

A. $\sqrt{2mK+\frac{K^2}{c^2}}$ B. $mc\sqrt{1+\frac{K}{2mc^2}}$ C. $mc(1+\frac{K}{2mc^2})$ D. $mc+\frac{K}{c}$

8. The mass of two particles is *m* and 2*m* respectively. The interaction between them is a massless spring with the force constant *k*. During the oscillation, the difference between the maximum and minimum separation of two particles is *D*, the maximum of the relative velocity between them is

A. $\frac{2}{3}\sqrt{\frac{k}{6m}}D$ B. $\frac{3}{2}\sqrt{\frac{k}{6m}}D$ C. $\frac{3}{2}\sqrt{\frac{2k}{3m}}D$ D. $\frac{2}{3}\sqrt{\frac{2k}{3m}}D$

9. The displacement of an object oscillating on a spring is given by $x(t)=x_m\cos(\omega t+\varphi)$. If the object is initially at $x_m/2$ and given a negative velocity, then the phase constant φ is

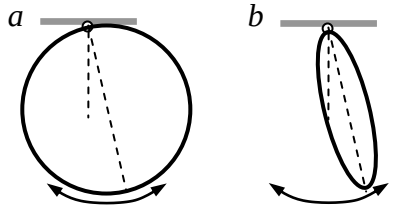
A. $\pi/3$. B. $2\pi/3$. C. $-\pi/3$. D. $-2\pi/3$.

10. In the case as above, if the object comes back its original position in 1 second, the angular frequency is

A.$5\pi/3$ B. $4\pi/3$ C. $2\pi/3$ D. $\pi/3$

11. A pendulum is made of a uniform hoop. In the case *a*, it oscillates with small displacements in the plane of the hoop. In the case *b*, it oscillates in the plane perpendicular to the hoop. Find the ratio of angular frequency of oscillation in the cases of *a* and *b*.

A. $\sqrt{\frac{5}{6}}$. B. $\sqrt{\frac{2}{3}}$. C. $\sqrt{\frac{3}{4}}$ D. $\sqrt{\frac{4}{5}}$

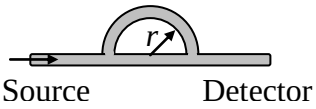


12. A violin string is fixed between two screws. The tension force of the string is *F*. Now the separation between two screws is twice as before, but the fundamental frequency is not change. The tension force of the string is

A. $\sqrt{2}F/2$ B. $\sqrt{2}F$ C. $2F$ D. $4F$

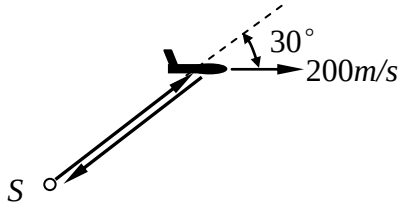
13. A sound wave of 1.14 *m* wavelength enters a tube as shown in the figure. What is the smallest radius *r*, such that a minimum will be heard at the detector?

A. 2.0*m* B. 1.0*m* C. 0.5*m* D. 0.25*m*



14. A student in Chu Kochen Honors College asked me a question what is the Doppler Effect in the case of an observer or sound source moving away from the line between observer and source? If you can answer the question, please look at follows: a sound, with a frequency of 1000 *Hz* and speed of 340 *m/s*, is set to a plane. The plane moves with speed of 200*m/s*, its direction is 30° away from the line between the observer and source. The frequency of the sound come back to the source is

A.276 *Hz* B. 300 *Hz*
C.326 *Hz* D. 362 *Hz*



15. One mole of ideal gas undergoes in a reversible adiabatic process. The temperature is *T* and the volume is *V*, which one is not constant:

A. $TV^{\gamma-1}$ B. $T^{C_V}V^R$ C. $T^{C_V}V^{C_P}$ D. TV^{R/C_V}

16. A chamber filled with nitrogen molecule, the mean free path of nitrogen molecule in the chamber is λ. If the temperature of the chamber increases from T to $2T$, the mean free path of the nitrogen molecule in the chamber is
A. 2λ B. λ C. $\lambda/2$ D. $\lambda/4$

17. In the case *a*, six identical molecules are in two boxes, three are in each box. In the case *b*, two boxes are brought together and the molecules mix together. In the case *c*, two boxes are brought together one molecule in a box and five in another box. The entropy ranking from large to small is
A. *c, b, a* B. *b, c, a* C. *c, a, b* D. *b, a, c*

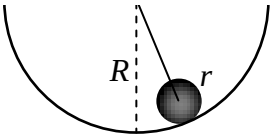
18. One mole of an ideal gas undergoes in a constant pressure process. When the volume increases from V to $2V$, the increase in entropy is
A. $C_v \ln 2$ B. $C_p \ln 2$ C. $(C_p+R) \ln 2$ D. $R \ln 2$

19. One mole of an ideal gas is expanded freely from V_o to $2V_o$ which one is not changed
A. pressure B. temperature C. entropy D. temperature and entropy

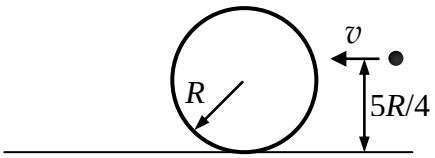
20. A Carnot refrigerator operates between 500 and 400 *K*. If it extracts heat from the low-temperature reservoir is 500 *J*, then the work is done on the refrigerator is
a) 100 *J* b) 125 *J* c) 150 *J* d) 400 *J*

Ⅱ.Calculation problems (score of 10 for each):

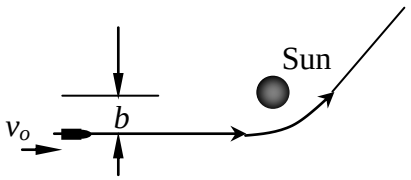
1. A solid ball, with radius *r*, can roll without slipping near the bottom of a bowl. The radius of the bowl is *R*, $R>>r$. What is the angular frequency of the ball oscillated near the bottom of a bowl?



2. A solid cylinder, with mass $4m$ and radius R, is at rest on a rough surface of a table. A bullet of mass m, moving with speed v, collides with the cylinder at the height of $5R/4$, as shown in the figure. After collision, the bullet moves back with speed $v/2$. During the collision the internal force between the cylinder and the bullet is much larger than the friction force between the cylinder and the table. When the cylinder starts its rotational motion without slipping, what is its velocity?



3. A spaceship is far away from the sun, it moves with a velocity of $v_0 = \sqrt{\frac{GM}{b}}$, where G is the gravitational constant, M is the mass of the sun which is much larger than that of the spaceship, and b is the separation between the sun and the line along which the spaceship moves. (1)Under the gravitational force between the sun and the spaceship, what is the minimum separation between the sun and the spaceship? (2)What is the velocity of spaceship when the separation between the sun and the spaceship is the minimum?



4. The speed distribution of particle in a chamber is $a(vv_0 - v^2)$ in the region of $0<v<v_0$, (1) To determine the constant a with N and v_o, where N is the total number of the particle; (2) To calculate the most probable speed v_p, the average speed v_{av} and the root-mean-square speed v_{rms}; (3) To find the distribution of kinetic energy, if the mass of one particle is m; (4) To calculate the average energy.

5. One mole of monatomic ideal gas initially at a volume of V_o and a temperature T is allowed to expand to $2V_o$ isothermally. Then the gas reduces its temperature to T' in a constant pressure process, and finally compressed to its original state in a reversible adiabatic process.
   (1) To determine T' with T
   (2) To calculate the change in entropy in the constant pressure process
   (3) To plot the cycle on a p-V diagram.
   (4) To plot the cycle on a T-S diagram.