

## 《普通物理学 I (H)》课程期中考查试卷

课程号: 061R0060, 开课学院: 物理学系

考试试卷: ☒ A 卷、B 卷 (请在选定项上打  $\checkmark$ )

考试形式: ☒ 闭、开卷 (请在选定项上打  $\checkmark$ ), 允许带 纸质词典 入场

考试日期: 2025 年 5 月 11 日, 考试时间: 120 分钟

诚信考试, 沉着应考, 杜绝违纪。

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 |   |   |   |   |   |   |   |   |    |

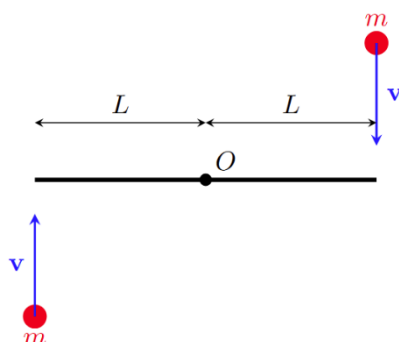
*Enjoy your exam and good luck!*

### I. MULTIPLE CHOICE

[ 15 points ] Choose only ONE correct answer.

1. On a smooth horizontal tabletop, there is a uniform thin rod of length  $2L$  and mass  $m$ , which can freely rotate around its midpoint and perpendicular to the rod, a fixed vertical axis  $O$ . Initially, the rod is at rest. On the tabletop, there are two small balls each with mass  $m$ , each moving towards the rod's end in the direction perpendicular to the rod at the same speed  $v$ . As shown in Figure, when the two small balls simultaneously undergo completely inelastic collisions with the two ends of the rod, the angular velocity of the system's rotation should be \_\_\_\_\_.

- A.  $\frac{2v}{3L}$     B.  $\frac{4v}{5L}$     C.  $\frac{6v}{7L}$     D.  $\frac{12v}{7L}$

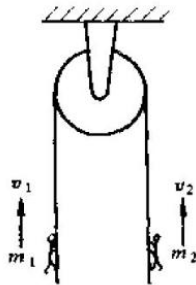


2. The Kepler's Second Law (the area swept by the line connecting a planet and the Sun in the same time interval is equal) reflects the \_\_\_\_\_ of the planetary system with the Sun.

- A. Energy conservation                      B. Momentum conservation  
C. Angular momentum conservation        D. Symmetry conservation.

3. As shown in the Figure, two children with masses  $m_1$  and  $m_2$  respectively are holding the two ends of the rope passing over the pulley. Initially, both children hold the rope still and are stationary relative to the ground. One of the children starts to climb up with effort. If the mass of the pulley and the friction force on the axle can be neglected, and  $m_1 > m_2$ , then the relationship between the velocities  $v_1$  and  $v_2$  of the two children is \_\_\_\_\_.

- A.  $v_1 > v_2$         B.  $v_1 < v_2$         C.  $v_1 = v_2$         D. unsure.



4. When a particle moves under the simultaneous action of several external forces, which of the following statements is correct?

- A. If the particle's momentum changes, its kinetic energy must also change.  
B. If the particle's kinetic energy remains constant, its momentum must also remain constant.  
C. If the work done by the external forces is zero, the external forces' impulse must be zero.  
D. If the external forces' impulse is zero, the external forces' work must also be zero.

5. A disk with a radius of 2m rotates at an angular speed of  $\omega=1\text{rad/s}$ . A particle with a mass of 1kg is placed at 1.5m away from the center of the disk. The coefficients of the static and kinetic friction of the disk are  $\mu_0=0.2$  and  $\mu=0.1$ . The gravity acceleration is assumed to be  $g=10\text{m/s}^2$ . After a long enough time, the particle will:

- A. Being thrown off the wheel  
B. It is stationary relative to the disk at 1m away from the disk center  
C. It is stationary relative to the disk at 1.5m away from the disk center  
D. It is stationary relative to the disk at 2m away from the disk center

## II. BLANK FILLING

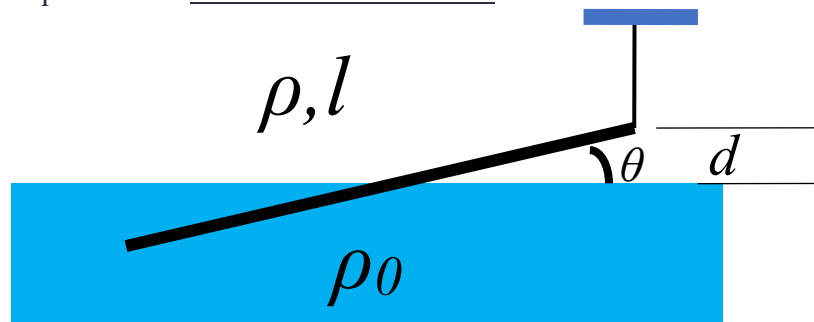
[ 20 points ] Fill in your answers in the blanks.

1. The Coriolis force is a pseudoforce generated in a rotating coordinate system (such as the Earth system). Now, the cannon is fired with the speed  $v$  and the elevation angle  $\alpha$  from the equator towards the north. Please give the deviation distance of the landing position of the artillery shell in the longitude direction due to the Coriolis force \_\_\_\_\_. Assuming that the rotation speed of the Earth is  $\omega$ .

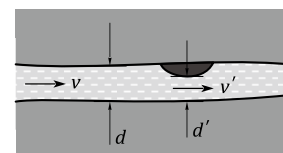
2. A person is running with the speed  $u=3\text{m/s}$  in the east direction and feels that the wind blow from the north direction. When he runs with a double speed, he feels that the wind is from the north-east direction. Please give the speed and the direction of the wind \_\_\_\_\_.

3. A jet plane is flying with the speed  $v=210\text{m/s}$ . The air absorbing rate of its engine is  $a=75\text{kg/s}$ . The burning fuel is ejected with the rate  $a_0=3\text{kg/s}$  and the speed relative to the jet is  $u=490\text{m/s}$ . Giving the force generated by the jet engine \_\_\_\_\_.

4. A uniform rod with the mass density  $\rho$  and the length  $l$  is partly floating on the liquid with the mass density  $\rho_0 (> \rho)$ . The cross-section of the rod is  $S$ . When one end of the rod is hanged above the liquid surface with the height  $d$ . Calculate the angle between the rod and the liquid surface \_\_\_\_\_.



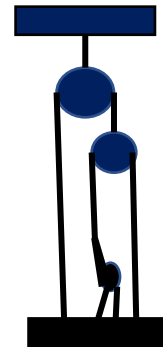
5. A small artery (动脉) with a diameter of  $d = 5.00 \text{ mm}$  is blocked by a hard plaque (斑块). The effective diameter of the narrow (狭窄) part is  $d' = 3.00 \text{ mm}$ , and the average blood flow speed in the narrow part is  $v' = 50.0 \text{ cm/s}$ . At  $37^\circ\text{C}$ , the blood density is  $\rho = 1.05 \text{ g/cm}^3$ . The average blood flow speed in the unchanged part is  $v =$  \_\_\_\_\_.



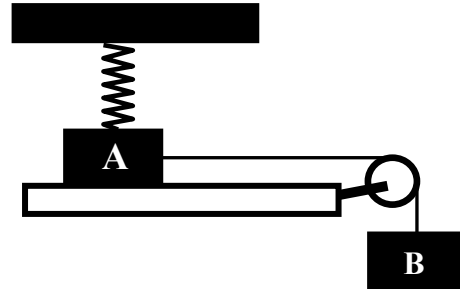
### III. CALCULATION AND ANALYSIS

[ 65 points ] Present the necessary equations and descriptions in your solution.

1. (10points) A person with  $m_p=60$  kg stands on a base plate with  $m_b=30$  kg. They are connected by a rope and pulley as shown in the figure below. Assuming that the mass of the pulley and the rope can be neglected and the friction at the pulley can be disregarded, and the rope is inextensible, if the person and the base plate are to rise with an acceleration of  $1 \text{ m/s}^2$ , what is the force  $F_n$  exerted by the person on the rope? What is the force exerted by the person on the base plate? (Take  $g = 10 \text{ m/s}^2$ .)



2. (15points) Two blocks A and B have the same mass of 320g connected by a light string passing over a smooth light pulley. The block A can slide smoothly on the horizontal surface. The block A is also attached to a spring with the spring constant 40N/m whose another end is fixed to the ceiling with 40cm above the horizontal surface. Initially, the spring is vertical and unstretched when the system is released to move. Find the velocity of the block A at the instant it breaks off the horizontal surface. Take  $g=10\text{m/s}^2$



3. (10points) If you first hold the upper end of a nonuniform soft chain with the length  $L$  while the lower end just touches the floor. After you release, how large force will the chain impose on the floor? Assuming the mass density of the chain linearly increases from  $\mu$  at the lower end to  $2\mu$  at the upper end.

4. (15points) A uniform flexible chain of the length  $l$  with the uniform density  $\lambda = m/l$  passes over a pulley with the radius  $R$  and the mass  $M$ . If there is no relative motion between the chain and the pulley. Initially, there are the same lengths of the chain in two sides of the pulley. If we give a very small downward drag force of one end of the chain, calculate its acceleration speed when the difference of two ends of the chain is  $x$ .



5. (15points) A cylindrical bucket with the cross-section  $A$  and the height  $H$  is filled fully with water. At the bottom of the bucket has a circular hole with radius  $R$  as shown in Figure below.

(1) How much time is needed when all water flows out of the bucket?

(2) The cross-section of the vertical stream of water decreases when it falls. Calculate the radius  $r$  of the stream as a function of the vertical drops  $y$ .

