Exercises for College Physics

大学物理习题册

陈 俊 贾力源 李重要 主编

Edited by
CHEN Jun
JIA Liyuan
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前　言

This exercises is for English language lecturing demonstration course for foreign students "College Physics in English". The book are divided into two parts, which are corresponding to the College Physics in English A(1), College Physics in English A(2). The types of problems are multiple choice, fill in blank, calculation problem. The topics can be chosen to use according to the actual situation of foreign students. The purpose of this book is to help foreign students learn and master College Physics in English curriculum content.

This exercise book was edited by Chen Jun, Jia Liyuan, Li Zhongyao, reviewed by Chen Bin, Shen Jianqi.

"College Physics in English" course construction team

April 2019

英文大学物理 A(1)习题目录

Contents in Exercise of College Physics in English A(1)

英文大学物理 A(2)习题目录

Contents in College Physics in English A(2)

Chapter 1 Kinematics

Part Ⅰ: Multiple Choices

[ ] 1. As shown in Fig. 1-1, there is a boat in the lake, someone pulls the boat on the bank with a rope around a fixed pulley at the uniform rate $\boldsymbol{v}_0$ and the bank is at a certain height h from lake. The rope has no elongation and the water in the lake is static. The motion of the boat is

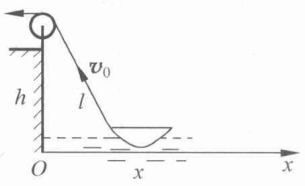

Fig. 1-1

(A) uniform acceleration motion.

(B) uniform deceleration motion.

(C) non-uniform acceleration motion.

(D) non-uniform deceleration motion.

(E) uniform motion in a straight line.

[ ] 2. A particle is in linear motion along the x axis, the v-t curve is shown in Fig. 1-2. At $t=0$, the particle is located at the origin. When $t=4.5$s, the position of particle on the x axis is

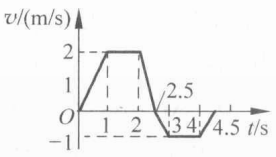

Fig. 1-2

(A) 5m. (B) 2m. (C) 0.

(D) −2m. (E) −5m.

[ ] 3. A particle moves in a curve. If $\boldsymbol{r}$ represents the position vector, v represents magnitude of velocity, $\boldsymbol{a}$ represents acceleration, s represents distance, a_t represents the tangential component of acceleration, the following expressions,

(1) $\mathrm{d}v/\mathrm{d}t=\boldsymbol{a}$; (2) $\mathrm{d}r/\mathrm{d}t=v$; (3) $\mathrm{d}s/\mathrm{d}t=v$; (4) $|\mathrm{d}v/\mathrm{d}t|=a_t$.

(A) Only (1), (4) are right. (B) Only (2), (4) are right.

(C) Only (2) is right. (D) Only (3) is right.

[ ] 4. In a straight line on a river bank side, there are two docks 1 and 2, which are 1km apart. Two persons A and B need go from dock 1 to dock 2 and back to dock 1. A goes boating, relative speed to water is 4km/h; and B walks along the bank side, walking speed is 4km/h. If the speed of water flow is 2km/h, and its direction is from 1 to 2, then

(A) A is 10 minutes later than B back to dock 1.

(B) A and B back to dock 1 at the same time.

(C) A is 10 minutes earlier than B back to dock 1.

(D) A is 2 minutes earlier than B back to dock 1.

[ ] 5. A particle is in circumferential uniform motion of radius R. It would complete a circle each T seconds. In $2T$ time interval, the magnitude of the average velocity and the magnitude of the average speed are respectively

(A) $2\pi R/T$, $2\pi R/T$. (B) 0, $2\pi R/T$.

(C) 0, 0. (D) $2\pi R/T$, 0.

[ ] 6. A particle moves in plane, its position vector can be represented by $\boldsymbol{r}=at^2\boldsymbol{i}+bt^2\boldsymbol{j}$, where a and b are constants. Then, the motion of the particle is

(A) linear motion with uniform velocity.

(B) linear motion with non-uniform velocity.

(C) projectile motion.

(D) the general curvilinear motion.

[ ] 7. The motion of an object is $dv/dt=-kv^2t$, where k is a positive constant. If the initial speed is v_0, the speed as a function of time is

(A) $v=\frac{1}{2}kt^2+v_0$. (B) $v=-\frac{1}{2}kt^2+v_0$.

(C) $\frac{1}{v}=\frac{kt^2}{2}+\frac{1}{v_0}$. (D) $\frac{1}{v}=-\frac{kt^2}{2}+\frac{1}{v_0}$.

Part Ⅱ: Fill in Blanks

8. As shown in Fig. 1-3, the position of lamp is height h_1 from ground, a person with height h_2 is walking under the lights at a constant speed v along horizontal straight line. The velocity of his vertex point in the shadow on ground is _____.

9. An object is in projectile motion as shown in Fig. 1-4, the magnitude of the velocity at point A is measured as v, the direction is angle 30° from horizontal, the tangential acceleration of object at point A $a_t=$ _____, the radius of curvature of the track is _____. (The gravity acceleration is g)

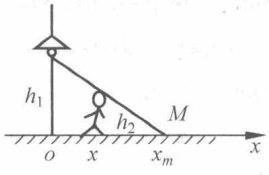

Fig. 1-3

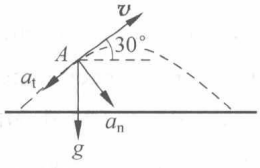

Fig. 1-4

10. A particle moves in a circle with radius R, the speed as a function of time is given by $v=ct^2$ (where c is a constant), the distance, which the particle traveled from $t=0$ to t, is $s(t)=$_____; tangential acceleration of particle at instant t, $a_t=$ _____; normal acceleration of particle at instant t, $a_n=$_____.

11. A particle moves in the xOy plane. The kinematic equation of the particle is $x=2t$ and $y=19-2t^2$ (SI). The magnitude of the average velocity within 2nd second is $\bar{v}=$_____. The instantaneous velocity of particle at the end of 2nd second is $v_2=$_____.

Part Ⅲ: Calculation Problems

12. A particle moves in a straight line along x axis, its coordinate at time t is $x=$

4. $5t^2-2t^3$ (SI). Find:

(1) the average velocity within 2nd second;

(2) the instantaneous velocity at the end of 2nd second;

(3) the distance travelled within 2nd second .

Solution:

13. A particle is in circular motion with a radius of R. If the angle φ, between acceleration and velocity, remains constant, and the initial velocity of the particle is v_0, find the velocity of particle as a function of time.

Solution:

Chapter 2 Newton's Law of Motion

Part Ⅰ: Multiple Choices

[ ] 1. As shown in Fig. 2-1, object A and B have the same mass, B on a smooth horizontal table. The mass of pulley and rope and the air resistance are neglected; the friction of the pulley is also neglected. System release with zero initial speed, falling acceleration of object A is

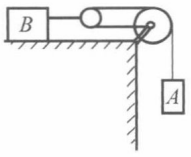

Fig. 2-1

(A) g. (B) $4g/5$. (C) $g/2$. (D) $g/3$.

[ ] 2. As shown in Fig. 2-2, assuming that an object slides down along smooth circular track in vertical plane. In the process from A to C, which of the following statements is true?

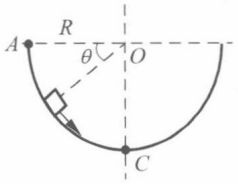

Fig. 2-2

(A) The magnitude of its acceleration is constant; the direction of its acceleration always points to the center of the circle.

(B) The speed is increasing uniformly.

(C) The magnitude of its resultant force changes but the direction of its resultant force always points to the center of the circle.

(D) The magnitude of its resultant force is unchanged.

(E) The orbital supporting force gradually increases in the process.

[ ] 3. A ball with mass m is placed between smooth wooden board and smooth wall, the ball is in equilibrium, as shown in Fig. 2-3. When the angle α between the board and the wall increases, the pressure that the ball exerts on the board

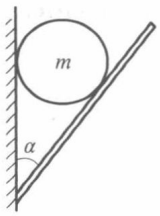

Fig. 2-3

(A) increases.

(B) decreases.

(C) maintains constant.

(D) increases first, then decreases. The boundary angle $\alpha=45°$.

[ ] 4. A heavy object is in lower end of a light rope that is tied to the ceiling of an elevator. When the elevator rises with acceleration a_1, the tension of rope is exactly half of the maximum tension that rope can bear. When the elevator rises, what is the magnitude of its acceleration that the rope would be just broken?

(A) $2a_1$. (B) $2(a_1+g)$. (C) $2a_1+g$. (D) a_1+g.

[ ] 5. The sliding blocks A and B have the mass m and M, respectively. They are stacked up on smooth horizontal table, as shown in Fig. 2-4. The static friction coefficient between A and B is μ_s; and the coefficient of sliding friction is μ_k. The system is static. If there is a horizontal force, which exerts on A, and A and B are still relatively

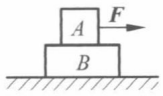

Fig. 2-4

static, then

(A) $F \leqslant \mu_s mg$.

(B) $F \leqslant \mu_s \left(1+\frac{m}{M}\right) mg$.

(C) $F \leqslant \mu_s (m+M) mg$.

(D) $F \leqslant \mu_k \left(1+\frac{m}{M}\right) mg$.

[ ] 6. As shown in Fig. 2-5, a string strides over a smooth fixed pulley, one end of string hangs an object with mass M, the other end is hauled by a person with mass $m=\frac{1}{2}M$. If the person climbs up with a relative acceleration of a_0 to the rope, the relative acceleration of person to the ground (assuming the vertical upward direction is positive) is

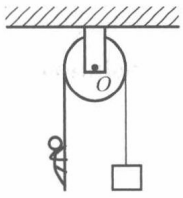

Fig. 2-5

(A) $(2a_0+g)/3$.

(B) $-(3g-a_0)$.

(C) $-(2a_0+g)/3$.

(D) a_0.

Part Ⅱ: Fill in Blanks

7. Two objects A and B with equal masses are fixed on the two ends of spring respectively. It is vertically placed on a smooth horizontal surface C, as shown in Fig. 2-6. Compared with object A and B, the mass of spring can be ignored. In the instant that the supporting surface C is quickly removed away, then, the acceleration of object A, $a_A=$_____; the acceleration of object B, $a_B=$_____.

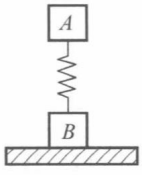

Fig. 2-6

8. A ball with mass m is connected with the light rope AB and BC, as shown in Fig. 2-7. In the moment before and after cutting the rope AB, the ratio of the tensions in BC rope, $T : T'=$_____.

9. A small bead can be slipping without friction on a vertical ring with radius R, as shown in Fig. 2-8. Now, the ring rotates with angular velocity ω around the vertical diameter. To make bead stay at certain point on ring apart from bottom, the angular velocity ω should be greater than _____.

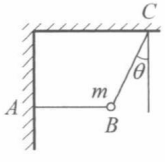

Fig. 2-7

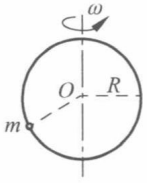

Fig. 2-8

Part Ⅲ: Calculation Problems

10. As shown in Fig. 2-9. An object A of mass $M=2\text{kg}$ is placed on a plane turntable. The static friction coefficient between object A and the turntable $\mu_s=0.2$. The object A is tied at one end of a light rope. The light rope is across a small hole at the center of the

turntable. Another end of the rope is a hanging object B with a mass of $m = 0.8\text{kg}$. The turntable is rotating around the vertical central axis with a angular velocity of $\omega = 4\pi\text{rad/s}$. Find: the maximum r_{max} and the minimum r_{min} of the turning radius of the object A when it is relatively static to the turntable.

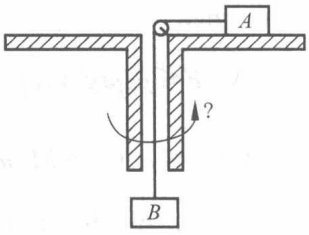

Fig. 2-9

Solution:

11. As shown in Fig. 2-10. The mass of a ball is m; the buoyancy force in water is constant $\boldsymbol{F}$. When the ball is dropping from rest, the viscous resistance from water is $\boldsymbol{f} = k\boldsymbol{v}$ (k is a constant). Prove that the relationship between the vertical speed of ball in water, v, and the dropping time, t, is $v = \dfrac{mg - F}{k}(1 - e^{-kt/m})$, where t is calculated from the instant of dropping.

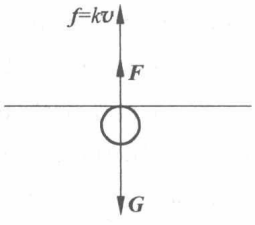

Fig. 2-10

Solution:

12. As shown in Fig. 2-11. A ring belt with radius R is fixed on a smooth horizontal table, an object is sliding along the inner of the belt. The sliding friction coefficient between the object and the belt is μ; the speed of object in a moment passing point A is v_0. Find: the speed and the distance S of the object at instant t after leaving A.

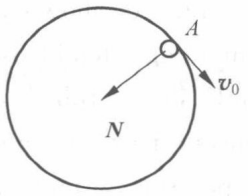

Fig. 2-11

Solution:

13. A light rope is across a pulley; the friction between pulley and shaft can be ignored. At one end of the rope, an object with mass of m_1 is hanging; on the other side, there is a ring with mass of m_2, as shown in Fig. 2-12. When the ring is sliding down with a relative acceleration of constant $\boldsymbol{a}_2$ to the rope, what are the accelerations of object and ring relatively to the ground? What is the friction between ring and rope?

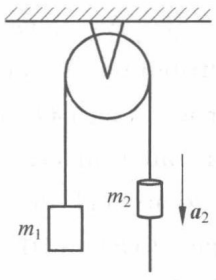

Fig. 2-12

Solution:

14. As shown in Fig. 2-13. A vertical fine U-shaped tube is containing a liquid with uniform density. The cross sectional area of the U-shaped tube is constant; the two vertical pipes are l apart; the beneath part of communicating pipe is horizontal. When the U-shaped tube is moving in horizontal direction with acceleration a as shown in Fig. 2-13, find the height difference, h, between two vertical pipes. Assuming the liquid level is still horizontal in the vertical pipes.

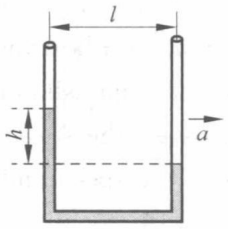

Fig. 2-13

Solution:

15. As shown in Fig. 2-14. A rope has uniform mass distribution. Its mass is m; and its length is L. It is tied to a vertical axis OO' with constant angular velocity ω rotating in horizontal plane. Assuming the rope is always straight in rotation; and the gravity is ignored. Find the tension in the rope, $T(r)$, at the location r apart from the spindle.

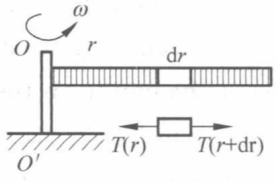

Fig. 2-14

Solution:

Chapter 3 Momentum and Angular Momentum

Part Ⅰ: Multiple Choices

[ ] 1. An inclined plane with mass m_0 is originally static in a horizontal smooth plane. A wood block with mass m is gently placed on the inclined plane, as shown in Fig. 3-1. If the block can be resting on the inclined plane, the inclined plane will

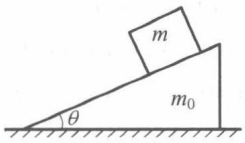

Fig. 3-1

(A) remain rest.

(B) accelerate towards right.

(C) uniformly motion towards right.

(D) accelerate towards left.

[ ] 2. As shown in Fig. 3-2. the mass of swing ball in conical pendulum is m, the speed of motion is v; the radius of the circle is R. When the ball travels half circle in the track, the magnitude of the impulse on the ball given by gravity is

(A) $2mv$. (B) $\sqrt{(2mv)^2+(mg\pi R/v)^2}$

(C) $\pi Rmg/v$. (D) 0.

[ ] 3. As shown in Fig. 3-3. A particle is moving along a horizontal smooth triangle orbit ABC with mass m and constant speed v. When it is crossing the corner A, the impulse on the particle from the orbit is

(A) mv. (B) $\sqrt{2}mv$. (C) $\sqrt{3}mv$. (D) $2mv$.

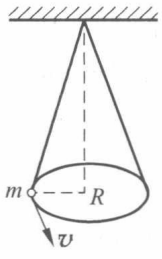

Fig. 3-2

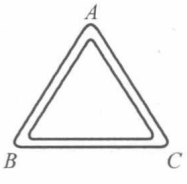

Fig. 3-3

[ ] 4. A bullet with mass of 20g shoots into an originally static swing ball with a speed of 400m/s along the direction shown in Fig. 3-4. The mass of the swing ball is 980g. If the length of string is not flexible, find the initial speed that bullet and swing ball moving together.

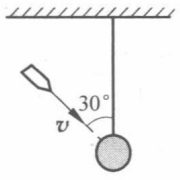

Fig. 3-4

(A) 2m/s. (B) 4m/s.

(C) 7m/s. (D) 8m/s.

Part Ⅱ : Fill in Blanks

5. The force exerted on a 1kg object is $F=6t+3$(SI). If the object is moving along a straight line from rest under the action of this force, the magnitude of the impulse acted on the object by the force in the time interval 0 to 2 s, $I=$_____.

6. Two boats with equal mass m_0 is rest on static water. The first boat is on the left, in which there is a person with mass m. The person jumps to the second boat with horizontal velocity $\boldsymbol{v}$ towards the right, and jumps back to the first boat with the same horizontal speed towards the left. Then, find: (1) the velocity of first boat $\boldsymbol{v}_1=$ _____; (2) the velocity of second boat $\boldsymbol{v}_2=$_____. (The water resistance can be ignored; all speed is relative to ground.)

7. A ball with mass m is projected from height y_0 along the horizontal direction with speed v_0; the maximum height after collision with ground is $\frac{1}{2}y_0$ with a horizontal speed of $\frac{1}{2}v_0$, as shown in Fig. 3-5. (1) The magnitude of the vertical impulse on ball from ground is _____; (2) the magnitude of the horizontal impulse on ball from ground is _____.

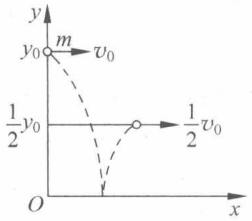

Fig. 3-5

8. Two balls are moving on smooth horizontal desktop. Their masses are $m_1=2$g and $m_2=5$g, respectively. Using the Cartesian coordinate xOy to describe the motion of balls, the velocity of two balls are $\boldsymbol{v}_1=10.0\boldsymbol{i}$cm/s and $\boldsymbol{v}_2=(3.0\boldsymbol{i}+5.0\boldsymbol{j})$cm/s, respectively. If two balls join together after collision, then, the speed of the balls after collision, $v=$ _____; the angle between the direction of velocity and the x axis, $\alpha=$_____.

9. As shown in Fig. 3-6. A small ball with mass m freely falls from height h to a smooth fixed inclined plane of slope angle 30°. If the collision is perfectly elastic, the magnitude of the impulse on the inclined surface from ball is _____; its direction is _____.

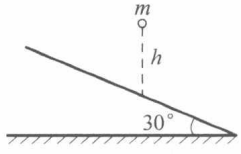

Fig. 3-6

10. On a smooth horizontal plane, there is a rope with length $L=2$m. One end of the rope is fixed at point O, the other end is attached to an object of mass $m=0.5$kg. At the beginning, the object is located at position A; the rope is slack; and the distance OA, $d=0.5$m, as shown in Fig. 3-7. If the object slides towards right with initial velocity $v_A=4$m/s perpendicular to OA. When the object is moving to position B, the direction of its velocity is perpendicular to the rope. At this moment, the magnitude of the angular momentum of the object at point B to the point O is $L_B=$_____; the magnitude of the velocity of the object, $v_B=$_____.

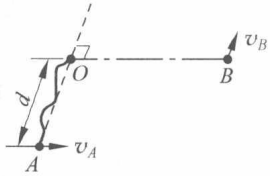

Fig. 3-7

Part Ⅲ: Calculation Problems

11. A ball with mass m collides with desktop, and the speed of ball is v before and after collision. Both angles from the incoming and the outgoing directions to the desktop normal are α, as shown in Fig. 3-8. If the duration of the collision between ball and desktop is t, find the average force on the desktop from the small ball.

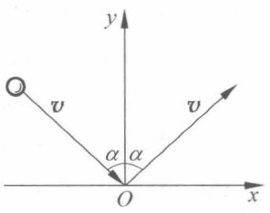

Fig. 3-8

Solution:

12. As shown in Fig. 3-9. A homogeneous chain has mass m and length L. Its upper end is handheld, and the height of its lower end is h from desktop. Now that the chain is released from rest down to the desktop, calculate the force on chain from the desktop when the length of the part of chain fell on the desktop is l.

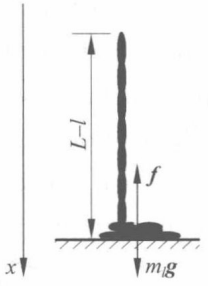

Fig. 3-9

Solution: