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普物英语书写习题集

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福州大学物理系

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(一) measurement

(18) Assuming that the length of the day uniformly increases by 0.001 S in a century, calculate the cumulative (累积) effect on the measure of time over twenty centuries. Such a slowing down of the earth's (rotation) is indicated by observations of the occurrence (资料) of solar eclipses (日食) during this period. (answer: 2.30)hours)

(二) vectors 矢量 P26

(4) A car is driven east for a distance of 50 Km, then north for 30 Km, and then in a direction 30° east of north (北偏东) for 25 Km. Draw the vector diagram and determine the total displacement of the car from its starting point. (answer: 81.0 Km. Q = 39.6 north of east)

(34) Three vectors are given by $\vec{a} = 3\vec{i} + 3\vec{j} - 2\vec{k}$, $\vec{b} = -\vec{i} - 4\vec{j} + 2\vec{K}$ and $\vec{c} = 2\vec{i} + 2\vec{j} + \vec{K}$. Find (a) $\vec{a} \cdot (\vec{b} \times \vec{c})$, (b) $\vec{a} \cdot (\vec{b} + \vec{c})$, (c) $\vec{a} \times (\vec{b} + \vec{c})$ (answer: (a) -21, (b) -9, (c) $5\vec{i} - 11\vec{j} - 9\vec{K}$)

(三) motion in one dimension—维运动 P49

(9) An electron, starting from rest, has an acceleration that increase linearly with the time, that is,

a = Kt, the change in acceleration being K = (1.5 m/s^3)

9. (a) plot (画) a versus (prep 对) t during the first 10.S interval (期间), (b) From the curve (曲线) of prat (a) plot the corresponding (对应) V versus t curve and estimate the electron's velocity 5.0s after its motion starts. (c) From the V versus t curve of part (d) plot the corresponding X versus t curve and estimate how far the electron moved during the first 5.0s of its motion. (answer: (b) V = 19 m/s, (c) X = 31m)

(10) The position of a particle moving along the X-axis depends on the time, accoreding to the reltion

$$X = \frac{V_{xo}}{K}\left(1 - e^{-kt}\right)$$

in which V_{xO} and K are constants. (a) plot a curve of X versus t. Notice that X = 0 at t = 0 and that (X = V_{xo} / K) at t=∞ that is, the total distance through which the particle moves is V_{xo} / K, (b) Show that the Velocity V_x s given by

$$V_x = V_{xo}\, e^{-kt}$$

so that the Velocity decreases exponentially (指数地) with time from its initial (最初的) Value of V_{xo}, coming to rest only in infinite time. (c) show that the acceleration ax is given by

$$a_x = -KV_x$$

so that the acceleration is directed opposite to the velocity and has a magnitude proportional to the speed. (d) This particular motion is one with variable acceleration. Give a plausible (好象有理) physical argument (议论) explaining how it can take an infinite time to bring to rest a particle that travels a finite distance.

(四) motion in a plane 平面运动 P67

(2) A particle moves so that its position as a function of time is $\vec{r}(t) = \vec{i} + 4t^2\vec{j} + t\vec{K}$

(a) write expressions for its velocity and acceleration as functions of time.

(b) what is the shape of the particle's trajectory? (answer: (a) $\sqrt{64t^2+1}$, 8. (b) $y = 4z^2$

(30) (a) write an expression for the position vector $\vec{r}$ for a particle describing uniform circular

motion, using rectangular coordinates(直角坐标) and the unit vectors $\vec{i}$ and $\vec{j}$.

(b) From (a) derive vector expression for the velocity $\vec{V}$ and the acceleration $\vec{a}$. (c) prove that the acceleration is directed toword the center of the circular motion. (answer: (a) X= rcoswr, y = rsinwt (b) V_x = - rwsinwt V_y = rwsinwt

(c) $\vec{a} = -w2\vec{r}$)

(31) (a) Express the unit vectors $\vec{ur}$ and $\vec{uq}$ in terms of $\vec{i}$, $\vec{j}$, and the angle θ in Fig 4 - 31. (b) write an expression, using the unit vector $\vec{uQ}$ and $\vec{ur}$. for the position vector $\vec{r}$ for a particle describing uniform circular motion and from it derive Eg.

$\vec{V} = \vec{V} u Q$

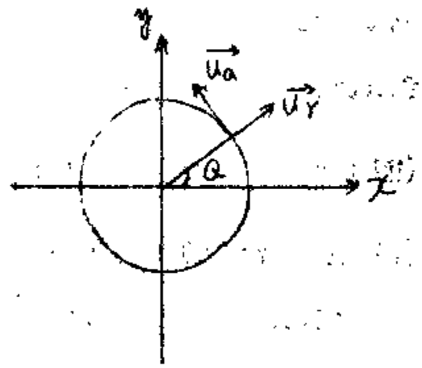

Figure 4 - 31

(33) A particle moves in a plane according to X = -R sin ωt + ω Rt

Y = Rcos ωt + R

where ω and R are constants. This curve, called a cycloid (摆线) is the path traced (追踪) out by

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a point on the rim of a wheel which rolls without slipping along the x - axis. (a) Sketch (草圖) the path. (b) Calculate the instantaneous velocity and acceleration when the particle is at its maximum and minimum value of y.

(answer: (b) At maximum $V_x = 2\omega R$, $V_y = 0$, $ax = 0$

$ay = - R\omega^2$

(a) At minimum $V_x = 0$ $V_y = 0$ $ax = 0$ $ay = R\omega^2$)

(39) An airplane has a speed of 135 mi/h (1mi =1.61Km) in still air. It is flying straight north so that it is at all times directly above a northsouth highway. A ground observer tells the pilot by radio radio that a 70 mi/h wind is blowing, but neglects to tell him the wind direction. The pilot observes that in spite of the wind he can travel 135 miles along the highway in one hour. In other words, his ground speed is the same as if there were no wind. (a) what is the derection of wind? (b) what is the heading of the plane, that is, the angle between its axis and the highway?

(answer: (a) From 75 E of S. (b) 30° E of N. substituting (代替) w for E gives a second solution)

(五) particle dynamics – (I) 質点動力学 – (I)   P92

(33) Terminal velocity. The resistance of the air to the motion of bodies in free fall depends on many facters, such as the size of the body and its shape, the density and temperature of the air, and the velocity of the body through the air. A useful assumption, only approximately true, is that the resisting force $\vec{f}_R$ is proportional to the velocity and oppositely directed; that is $\vec{f}_R = -K\vec{V}$, where K is a constant whose value in any particular case is determined by factor other than velocity, consider free fall of an object from rest through the air.

(a) show that Newton's second law gives

$$mg - KV = ma \quad \text{or} \quad \left(mg - K\frac{dy}{dt} = m\frac{d^2y}{dt^2} \right)$$

(b) Show that the body ceases (仃止) to accelerate when it reachesa velocity $V_T = mg/K$, called the terminal velocity (收尾速度)

(c) prove, by substituting (代替) it in the equation of motion of part (a), that the velocity varies with time as

$$V' = V_T (1 - e^{-Kt}/m)$$

and plot V versust.

(d) Sketch (草图) qualitatively curves of y versus t and a versus t for the motion, noting that the initial acceleration is g and the final acceleration is zero.

(35) A block, mass m, slides down a frictionless incline (倾斜) making an angle θ with an elevator (升降机) floor, Find it acceleration relative to the incline in the following cases.

(a) Elevator descends at constant speed V.

(b) Elevator ascends at constant speed V.

(c) Elevator descends with acceleration a.

(d) Elevator descends with deceleration a .

(e) Elevator cable breaks.

(f) In part (c) above, what is the force exerted on the block by the incline ?

(answer: (a) $g \sin\theta$ down the incline. (b) $g \sin\theta$ down the incline. (c) $(g - a) \sin\theta$ down the incline. (d) $(g+a) \sin\theta$ down the incline. (e) Zero. (f) $m(g-a) \cos\theta$.)

(六) particle dynamics 质点动力学 (II) P 111

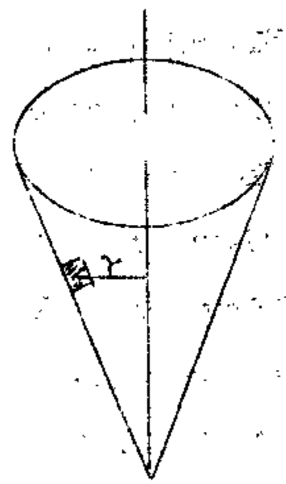
(36) Because of the rotation of the earth, a plumb

bob (垂直的锤) may not hang exactly along the direction of the earth's gravitational pull (its weight) but deviate (越轨) slightly from the direction. Calculate the deviation (a) at 40° latitude (纬度), (b) at the poles, and (c) at the equator

(answer: (a) $\sin\theta = 1.71\times10^{-3}$ $\theta = 6'$.

(b) $\theta = 0$ (c) $\theta = 0$)

(38) A very small cube of mass m is placed on the inside of a funnel (Fig 6-2?) rotating about a vertical axis at a constant rate of ν rev/s. The wall of the funnel makes an angle θ with the horizontal. If the coefficient (系数) of static friction between the cube and the funnel is μ and the center of the cube is a distance r from the axis of rotation, what are (a) The largest and (b) the smallest values of γ for which the cube will not move with respect to (关于) the funnel;



(answer : $\gamma = \frac{1}{2\pi}\sqrt{\frac{g(\sin\theta - \mu\cos\theta)}{\gamma(\cos\theta + \mu\sin\theta)}}$)

(七) Work and energy 功与能 P 130

7. A single force acts on a body in rectilinear (直线) motion. A plot of velocity versus time for the body is shown in Fig 7-10. Find the sign (positive or negative) of the work done by the force on the body in each of the intervals (间隔) AB. BC. CD and DE.

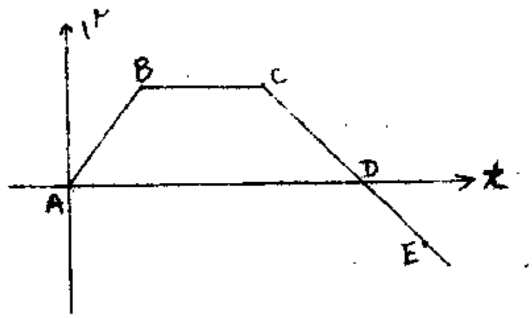


Fig 7-10

19. The block of mass M shown in Fig 7-12 initially has a velocity v_0 to the right and its position is such that the spring exerts no force on it, that is, the spring is not stretched or compressed. The block moves to the right a distance ℓ before

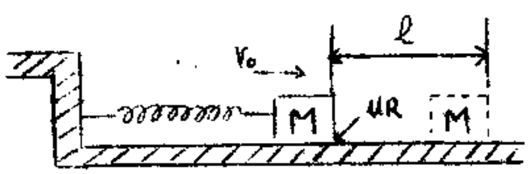


figure 7-12

stopping in the dotted (虚线) position shown. The spring constant is K and the coefficient of Kinetic friction between block and the table is μk. As the block moves the distance ℓ. (a) what is the work done on it by the friction force ? (b) what is the work done on it by the spring force ? (c) Are there other forces acting on the block, and, if so, what work do they do ? (d) what is the total work done on the block ? (e) Use the work - energy theorem to find the value of ℓ in terms of M, V_0, μk, g, and k.

(answer: (a) $-\mu k\, mgl$. (b) $-k\ell^2/2$. (c) Gravity and the vertical thrust of the table, which do no work. (d) $-(\mu k Mgl + Kl^2/2)$

(e) $(\sqrt{\mu k^2 M^2 g^2 + V_0\ 2KM} - \mu k Mg)/k$.

29. A force acts on a 3.0Kg particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in meters and t is in seconds.

(a) Find the work done by the force during the first 4.0S. (b) At what instantaneous rate is the force doing work on the particle at the instant = 1.0s?

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Answer: (a) 530J. (b) 12W.

31. A body of mass m accelerates uniformly from rest to a speed V_f in time t_f. (a) show that the work done on the body as a function of time t, in terms of V_f and t_f, is $\frac{1}{2} m \frac{V_f^2}{t_f^2} t^2$). (b) As a function of time t, what is the instantaneous power delivered to the body ? (c) what is the instantaneous power at the end of 5.0S delivered to a 1kg body which accelerates to 76 km/h in 10S ?

Answer: (a) $V_f = at_f$ (b) $m(mv_f t/t_f)$

(c) 70 h_p (马力).

(八) the conservation of energy 能量守恆 P 155

1. A body moving along the x-axis is subject to a force repelling it from the origin, given by $F = kx$. (a) Find the potential energy function U(x) for the motion and write down the conservation of energy condition. (b) Describe the motion of the system and show that this is the kind of motion we would expect near a point at unstable equilibrium (平衡)

Answer: (a) $-KX^2/2$

3. A chain is held on a frictionless table with one-fifth of its length hanging over the edge. If the chain has a length l and a mass m, how much work is required to pull the hanging part bart back on the table ?

answer: $mg^{l}/50$

16. what force corresponds to a potential energy?

$$U(x) = -ax^2 + bxy + Z.$$

answer: $-(-2ax + by)\vec{i} + bx\vec{j} + \vec{k}$

17. The potential energy corresponding to a certain two-dimensional force field is given by $U(x,y)= \frac{1}{2}k(x^2 + y^2)$. (a) Derive Fx and Fy and describe the vector force at each point in terms of its coordinates x and y. (b) Derive Fr and FO and describe the vector force at each point in terms of the polar coordinates r and O of the piont. (c) Can you think of a physical model of such a force?

answer: (a) $F_x = -kx$, $F_y = -ky$, $\vec{F}$ points toward the origin

(b) $F_r = -kr$, $F_\theta = 0$

(c) 有心力场

18. The so-called Yukawa potential (汤川势)

$$U(r) = -\frac{r_o}{r} U_o e^{-r/r_o}$$

gives a fairly accurate description of the interaction between nucleons (i.e neutrons and protons, the constituents of the nucleus), The constant ro is about 1.5×10^{-15} meter and the constant U_o is about 50 Mev. (a) Find the corresponding expression for the force of attraction. (b) To show the short range of this force (短程力) compute the ratio (比率) of the force at $r = 2r_o$, $4r_o$ and $10r_o$ to the force at $r = r_o$.

answer: (a) $F = -\frac{1}{r} U_o e^{-r/r_o} (1 + \frac{r_o}{r})$

(b) 0.162, 0.0078, 6.7×10^{-6}

26. The particle m in Fig 8-18 is moving in a vertical circle of radius R inside a track, There is no friction. When m is at its lowest position, its speed is V_o. (a) what is the minimum value Vm of V_o for which m will

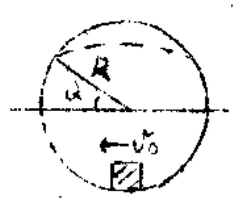

Figure 8-18

go completely around the circle without losing contact with the track ?

(b) Suppose V_o is 0.775 Vm. The particle will move up the track to some point at p at which it will lose contact with the track and travel along a path shown roughly by the dashed line. Find the angular position θ of point P..

answer: (a) $V_{min} = \sqrt{5Rg}$ (b) $\theta = 19.5^\circ$

(九) Conservation of linear momentum 动量守恒 P181

4. The masses and coordinates of four particle are as follows: 5.0kg x = y = 0.0cm; 3.0kg x = y = 8.0 cm; 2.0kg x = 3.0cm, y = 0.0cm; 6.0kg x = -2.0cm y = -6.0cm. Find the coordinates of the center of mass of this collection of particles.

answer: $X_c = 0.375cm$, $y_c = 0.75cm$.

6. Find the center of mass of a homogeneous (同种的 a) semicircular plate. Let a be the radius of the circle.

answer: $X_c = \frac{4a}{3\pi}$ $y_c = 0$.

22. A very flexible (a. 柔软的) uniform chain of mass M and length L is suspended from one end so that it hangs vertically, the lower end just

touching the surface of a table. The upper end is suddenly released so that the chain falls onto the table and coils up in a small heap. each link coming to rest the instant (n.瞬间) it strikes the table. Find the force exerted by the table on the chain at any instant, in terms of the weight of chain already on the table at that moment.

answer: $F = 2\frac{M}{L}gx = 2w$

29. A block of mass m rests on a wedge (楔 xiē)of mass M which, in turn, rests on a horizontal t table, as show in Fig 9 - 19 . All surface are frictionless. If the system starts at rest-with

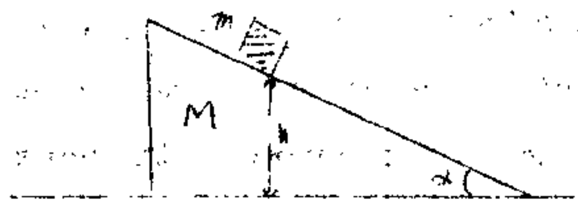

Fig 9 - 19

point P of the block a distance h above the table, find the velocity of the wedge the instant point P touches the table.

Answer: $\sqrt{2m^2gh\ \cos^2\alpha\ /(M+m)(M+m\ \sin^2\alpha\ )}$

31. A rocket is moving away from the solar system at a speed of 6.0×10^3 m/s. It fires its rocket engine, which ejects (发出) exhaust with a re relative velocity of 3.0×10^3 m/s. The mass of the rocket at this time is 4.0×10^4 kg, and it experiences an acceleration of $2.0m/s^2$. (a) what is the velocity of the exhaust relative to the solar system ? (b) At what rate was exhaust ejected during the firing?

Answer: (a) $u = 3.0\times10^3 m/s$.

(b) $\frac{dm}{at} = 27$ kg/s.

33. A 6000-kg rocket is set for vertical firing . If the exhaust speed is 1000m/s, how much gas must be ejected each second to supply the thrust (推力) needed (a) to overcome the weight of the rocket, and (b) to give the rocket an initial upward acceleration of $20m/s^2$?

Answer: (a) 59kg/s (b) 180kg/s.

(十) Collisions 碰撞 P 208

7. The force on a 10-kg object increases uniformly

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