

國立中正大學八十五學年度轉學生考試試題

所別：數學系

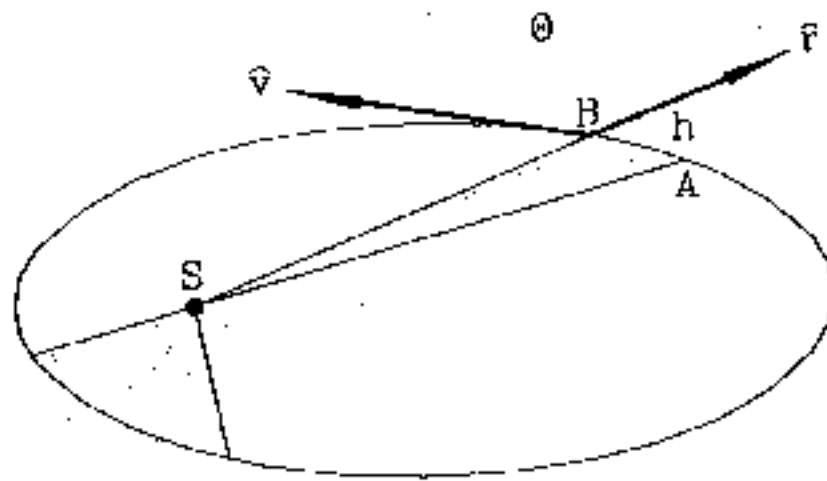
科目：普通物理

02085-1.94

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嘉義縣民雄鄉三興村160

General Physics Examination for the sophomore transfer-students Mathematics Department, Chung Cheng University

1. The earth orbits the sun (S) as shown in the figure at the right. At time 0 the earth is located at point A. In a very small time interval Δt it moves from point A to B with a velocity $v\hat{v}$, v being the magnitude. Θ is defined as the angle between \hat{v} and \hat{r} , h the shortest distance from point A to \hat{r} . The two shaded areas are swept by the earth in the exactly the same time interval Δt . (24 points)



A. Show that the angular motion of the earth follows the conservation of angular momentum (\vec{L}). Hints: $\vec{L} = \vec{r} \times \vec{p}$, \vec{p} being the linear momentum vector. Equations you put down must be accompanied by proper reasoning with words and/or symbols added in the figure. (8 points)

B. The conservation of angular momentum leads to two very important consequences. One of them is the "law of areas" (Kepler's second law).

What is the other? (2 points)

How does this second result come about? (2 points)

C. Prove the "law of areas". (12 points) Hints: find the area ΔA swept by the earth in Δt .

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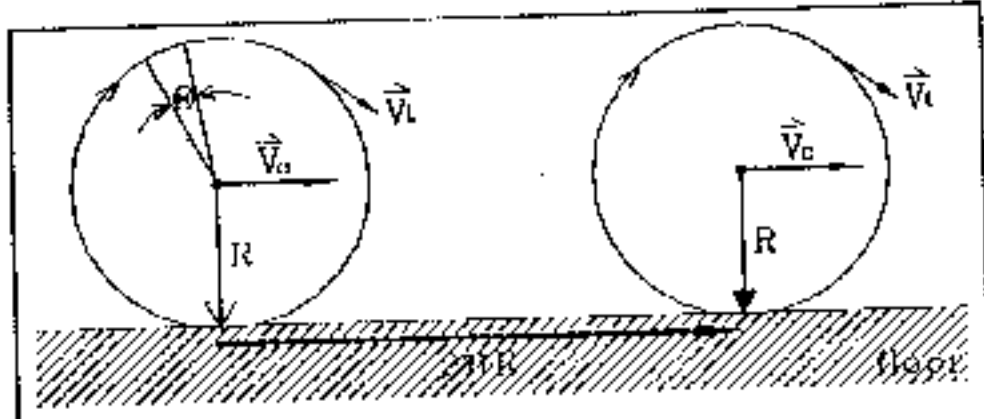
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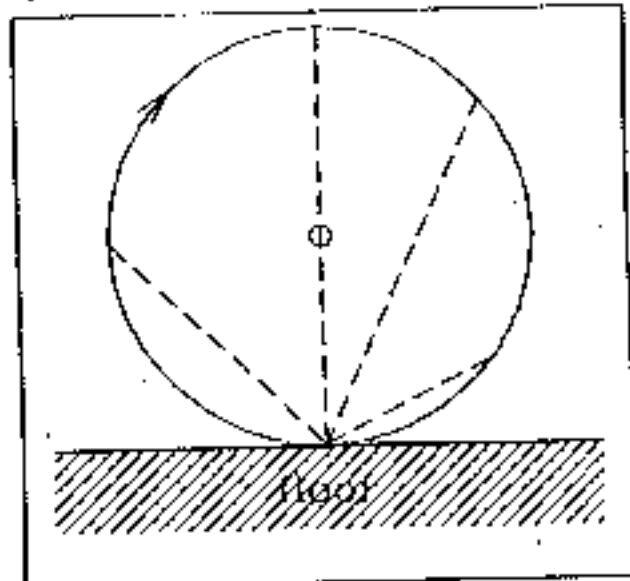
2. Shown in the figure at the right is a bicycle wheel (big circle) that has rotated in one revolution ($2\pi R$) without slipping, and that has traveled a distance of $2\pi R$ with a velocity of \vec{V}_c . R is the radius of the wheel. Let us define $\Theta \equiv \frac{S}{R}$, S being the arc



length of the wheel rim. Also define the angular frequency of the wheel rotation as ω . (18 points)

A. Show that the tangential velocity of any mass point on the wheel rim, \vec{V}_t , equals \vec{V}_c . (10 points)

B. For a wheel that rolls reasonably fast on the floor, one can see the spokes clearly when he looks at the wheel where it touches the floor. However, the spokes look blurred when he look at the top of the wheel. Explain (8 points). Hints: use can be made of the figure at the right as well as \vec{V}_t and \vec{V}_c .



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3. Consider the figure at the right.
(18 points)

A. If the hump on the straight line represents a transverse wave (or a pulse) traveling to the right on a rope attached to a wall.

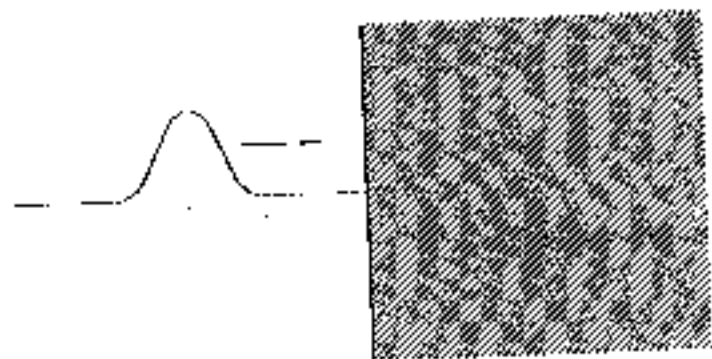
1. If the rope is tightened to the wall, what is the phase of the wave (relative to the incident one) when it is reflected back from the wall? (3 points)

2. If the end of the rope attached to the wall is allowed to rise and fall with the pulse, what is the phase of the wave (relative to the incident one) when it is reflected back from the wall? (3 points)

B. If the hump on the straight line represents a plane optical wave (or a pulse) traveling in a medium of refractive index n_1 to the right (i.e. towards the positive X-axis) into a medium of refractive index n_2 .

1. Give a discussion of the phases and intensities of the incident and reflected waves in terms of n_1 and n_2 . (8 points)

2. Write down an expression for the incident wave. (4 points)



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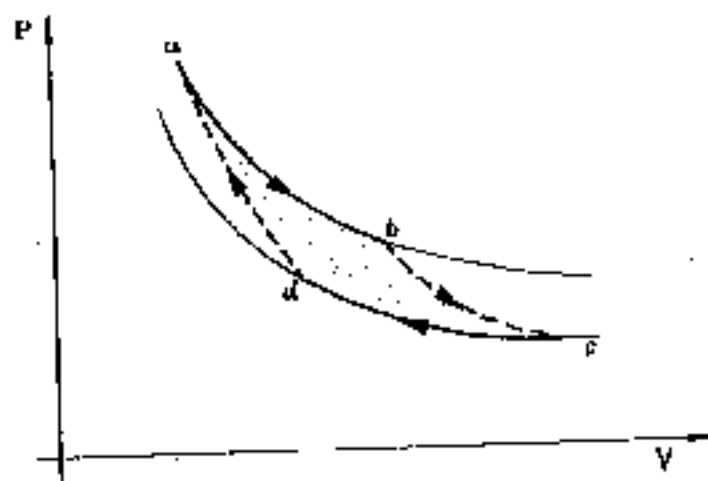
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4. One complete Carnot cycle for an ideal gas in a cylinder with frictionless piston is consisted of four thermodynamical processes, in order: $a \rightarrow b \rightarrow c \rightarrow d \rightarrow a$, as shown in the figure below.
(20 points)

A. Identify the isothermal processes. (4 points)

B. Identify the adiabatic processes (4 points)



C. Why are the processes involved in a Carnot cycle either isothermal or adiabatic? (4 points)

D. Identify the process that generates useful work. (2 points)

E. How do you find the net work, W , done by the gas on the piston in terms of the heat involved? Explain! (6 points)

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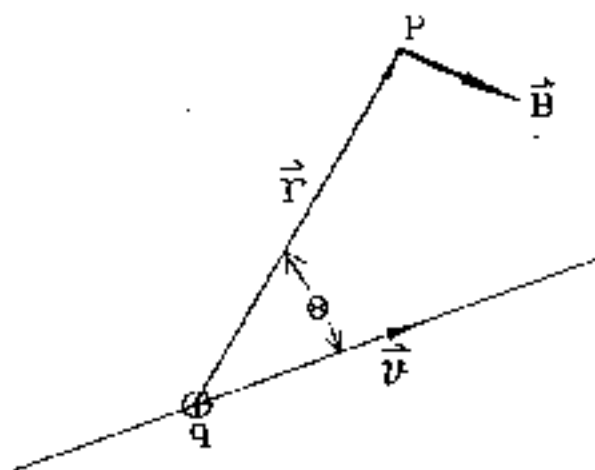
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5. A positive charge q moves with velocity \vec{v} as shown in the figure below. The magnetic field at point P is formulated from experimental observation,

$$\vec{B} = k' \frac{q\vec{v} \times \hat{r}}{r^2}$$

where $k' = \frac{\mu_0}{4\pi}$. Explain how is this expression obtained. (6 points). Compare this expression with that of the electric field. (2 points)



6. Show that the work of moving an object from location A to B, and back to A (completing a closed loop) is zero if the force involved is a conservative force. (6 points)

7. In one of the modern general physics textbooks a person is shown holding a cube of "material" at a temperature of 1260°C !!!!. Explain. (4 points)