

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (A) Show that the Equations of motion of a particle with respect to cylindrical coordinates  $(r, \theta, z)$  can be expressed as: (15 %)

$$\sum \vec{F} = m \left\{ \left[ \frac{d^2 r}{dt^2} - r \left( \frac{d\theta}{dt} \right)^2 \right] \vec{u}_r + \left( 2 \frac{dr}{dt} \frac{d\theta}{dt} + r \frac{d^2 \theta}{dt^2} \right) \vec{u}_\theta + \frac{d^2 z}{dt^2} \vec{u}_z \right\}$$

- (B) If the coefficient of static friction between the conical surface and the block A of mass  $m$  is  $\mu_s$ , determine the range of the constant angular velocity  $\dot{\theta}$  so that the block does not slide downwards and upwards. (20 %) (refer to Fig. 1)

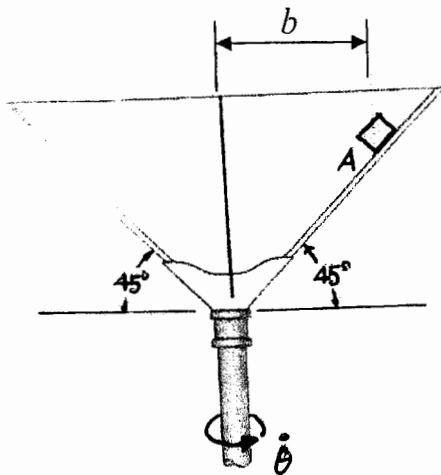


Fig. 1

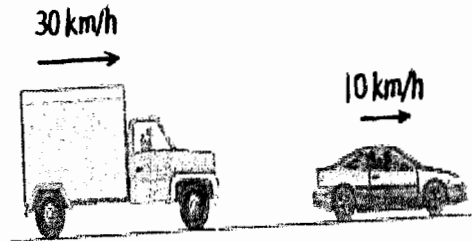


Fig. 2

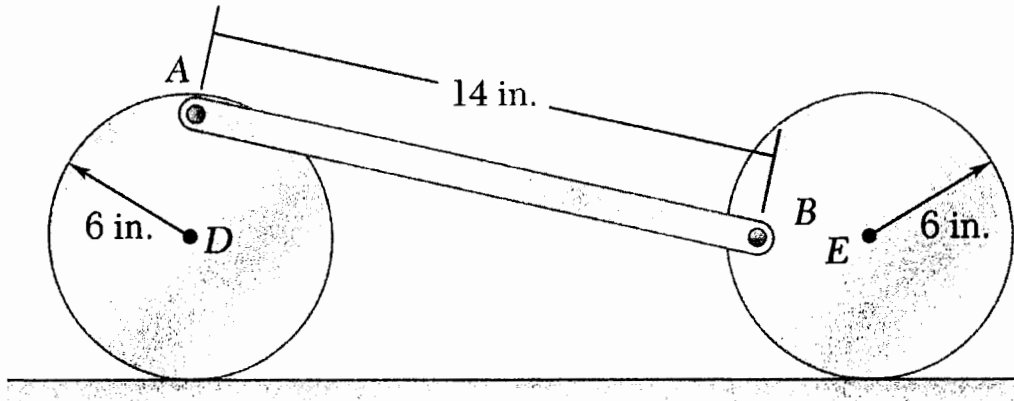
2. The 10-Mg truck and 2-Mg car are traveling with the free-rolling velocities just before they collide, as shown in Fig. 2. After the collision, the car moves with a velocity of 15 km/hr to the right relative to the truck. Determine the coefficient of restitution between the truck and car and the loss of energy due to collision. (15 %)

[Note]: All the diagrams (such as free-body diagram and diagram of coordinates) required to solve the problems or derive the equations should be plotted.

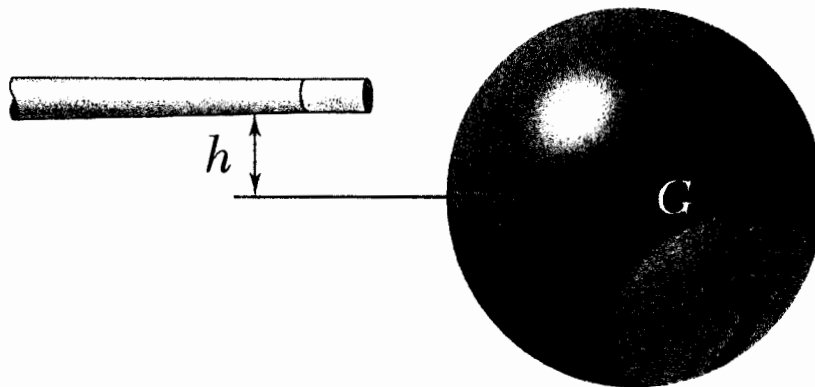
(背面仍有題目,請繼續作答)

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3. Both wheels with radii of 6 in. roll with slipping on the horizontal surface. Knowing that the distance  $AD$  is 5 in., the distance  $BE$  is 4 in. and  $D$  has a velocity of 6 in./s to the right, determine the velocity of point  $E$ . (15%)



4. At what height  $h$  above its center  $G$  should a billiard ball of radius  $r$  be struck horizontally by a cue if the ball is to start rolling without sliding? Please also determine the moment of inertia for the billiard ball. (15%)



5. A square plate of mass  $m$  is held by eight springs, each of constant  $k$ . Knowing that each spring can act in either tension or compression, determine the frequency of the resulting vibration if (a) the plate is given a small vertical displacement and released, (b) the plate is rotated through a small angle about  $G$  and released. (20%)

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