國 立 清 華 大 學 命 題 紙

丁組(設計、製造組)

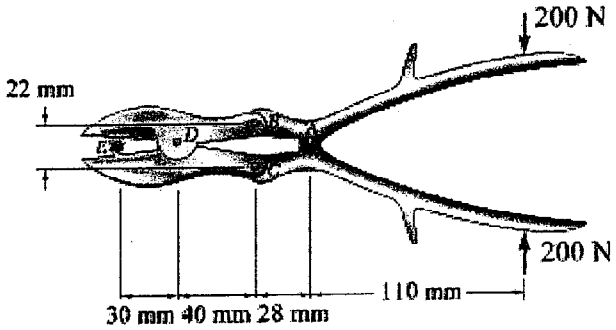
99 學年度 動力機械工程學系丙組(固體與奈微米力學組) 碩士班入學考試

科目 應用力學(含靜力學、動力學) 科目代碼 1002 共 3 頁，第 1 頁

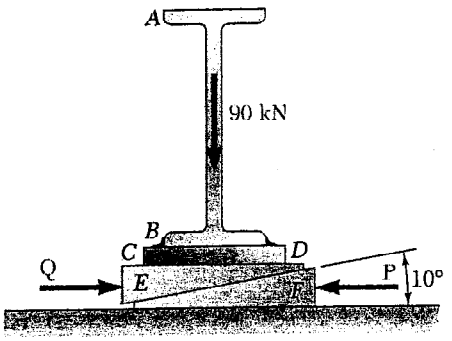
110乙

*請在【答案卷卡】作答

1. The bone rongeur shown is used in surgical procedures to cut small bones. Determine the magnitude of the forces exerted on the bone at *E* when two 200-N forces are applied as shown. **(15%)**



2. The elevation of the end of a steel beam supported by a concrete floor is adjusted by means of the steel wedges *E* and *F*. The base plate *CD* has been welded to the lower flange of the beam, and the end reaction of the beam is known to be 90 kN. The coefficient of static friction is 0.30 between the two steel surfaces and 0.50 between the steel and the concrete. If horizontal motion of the beam is prevented by the force **Q**, determine (*a*) the force **P** required for impending upward motion of the beam, (*b*) the corresponding force **Q**. **(15%)**



3. A car of mass 1000 kg requires a power of magnitude 8000 Watts to maintain a uniform speed of 20 m/s on the horizontal road. The total resistance to motion is given by $P = c + kv$ where P is the resistance in newtons, c and k are constants, and v is the speed in m/s. If while running at 20 m/s, the car starts to climb a plane inclined at an angle 30° with the horizontal. How soon will the speed drop to 10 m/s, assuming that the torque applied to the wheels is unchanged, and that the constant c has a value of 100 N? **(15%)**

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科目 應用力學(含靜力學、動力學) 科目代碼 1002、1102 共 3 頁，第 2 頁

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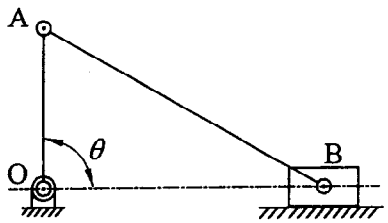
4. In the slider-crank mechanism shown below, OA = 30 mm, AB = 60 mm, and the crank rotates with constant angular velocity of ω rad/s, counterclockwise. At the position where angle $\theta = 90°$, the slider is measured to have an acceleration of 173.2 m/s^2. Find the magnitude of ω. **(20%)**



5. Indicate **true** or **false** for each of the following statements. (No proof is needed. The wrong answer will be given no score but will be deducted 2 points. 每小題 2 分答錯倒扣 2 分) **(20 %)**

(a) A hoop, cylinder, and sphere, each having the same mass and radius, are released from rest on an incline. After it has rolled through a distance corresponding to a change of elevation h, the velocities: Vsphere > Vcylinder >Vhoop.

(b) (Continued) The velocity of the cylinder is $0.845\sqrt{2gh}$

(c) Consider two bodies which collide, and denote by v_A and v_B the velocities before impact of the two points of contact A and B (Fig. 5-1). Under the impact, the two bodies will deform, and at the end of the period of deformation the velocities are u_A and u_B as shown in Fig. 5-2. A period of restitution will then take place, at the end of which A and B will have velocities v'_A and v'_B (Fig. 5-3). Then $[(u_A)_n - (v'_A)_n] = e[(v_A)_n - (u_A)_n]$, where e is the coefficient of restitution.

(d) (Continued) Also, $e[(v_A)_n - (v_B)_n] = (v'_B)_n - (v'_A)_n$

(e) (Fig. 5-4) If a rigid uniform plate rotates about a fixed axis through O, and the axis is perpendicular to the plate, then the kinetic energy is $\frac{1}{2}mV^2 + \frac{1}{2}\left(\sum r_i^2 \Delta m_i\right)\omega^2$.

(f) (Fig. 5-5) Consider a slender rod AB, of 1 m length and 1 kg mass, whose extremities are connected to blocks of negligible mass sliding along horizontal and vertical tracks. The rod is released with no initial velocity from a horizontal position. If the angle between the rod and the horizontal is 30 degree, then $\omega = 1.5g$

(g) The height at which a billiard ball (solid sphere with radius R) is struck should be 7R/5 so that the ball will roll with no initial slipping.

(h) (Fig. 5-6) The external forces acting on a rigid body are equivalent to the effective forces of the various particles forming the body, and the system of the external forces is equipollent to the system consisting of the vector $m\bar{a}$ attached at any fixed point and the couple of moment of that point.

(continued)

(i) Uniform sphere of mass m and radius r is projected along a rough horizontal surface with a linear velocity V and no angular velocity. If the coefficient of kinetic friction is μ, then the time at which the sphere will start rolling without sliding is $t = \frac{2}{7}\frac{V}{\mu g}$.

(j) (Continued) The angular velocity at that instant is $\frac{5}{7}\frac{V}{r}$

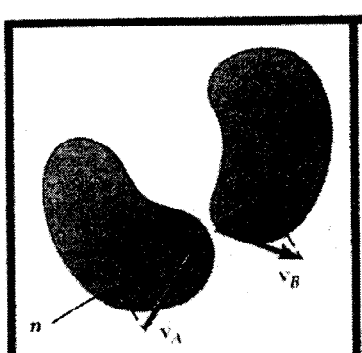


Fig. 5-1

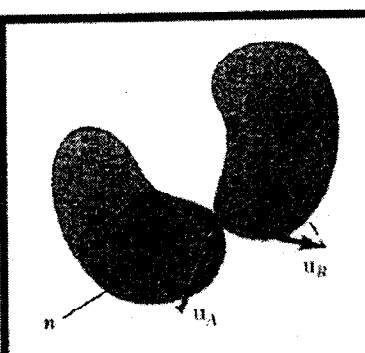


Fig. 5-2

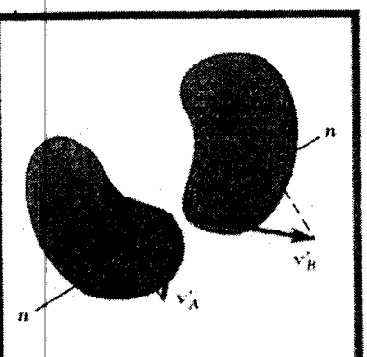


Fig. 5-3

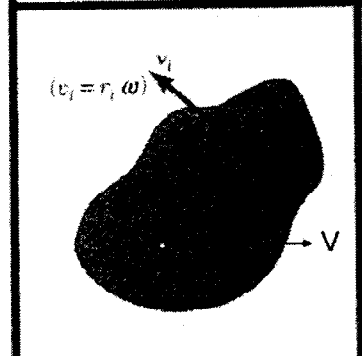


Fig. 5-4

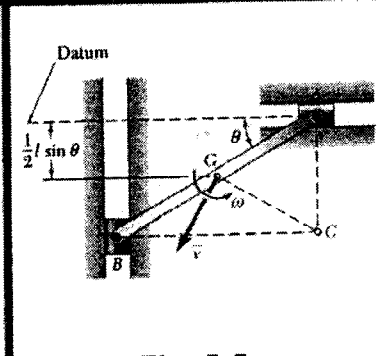


Fig. 5-5

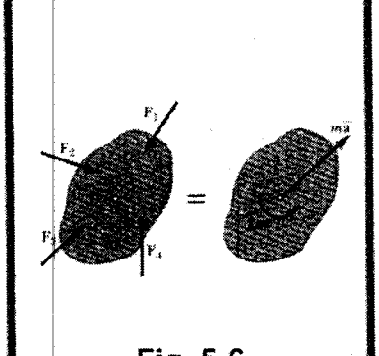


Fig. 5-6

6. Gear A has a mass of 20 kg and a radius of gyration of 400 mm, and gear B has a mass of 6 kg and a radius of gyration of 160 mm. The system is at rest when a couple M of magnitude 12 Nm is applied to gear B. Neglecting friction, (a) determine the number of revolutions of gear B before its angular velocity reaches 1200 rpm; (b) determine the time required in (a); (c) determine the tangential force exerted by gear B on gear A. **(15 %)**