A bar *AB* of length *l* rolls on wheels of negligible weight on a circular path of radius *r* (Fig. P 2.11). Determine the frequency of small oscillations of the system. Assume that the bar moves in the vertical plane and is displaced slightly from its equilibrium position.

P.2-13

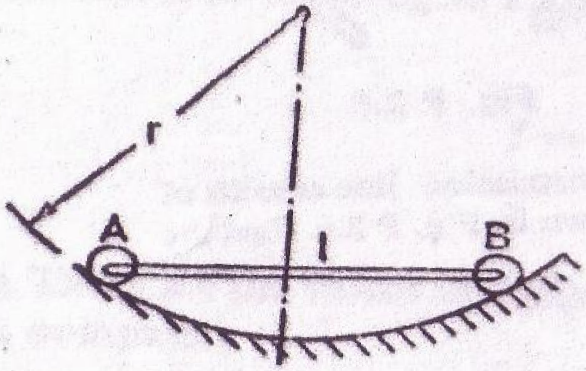
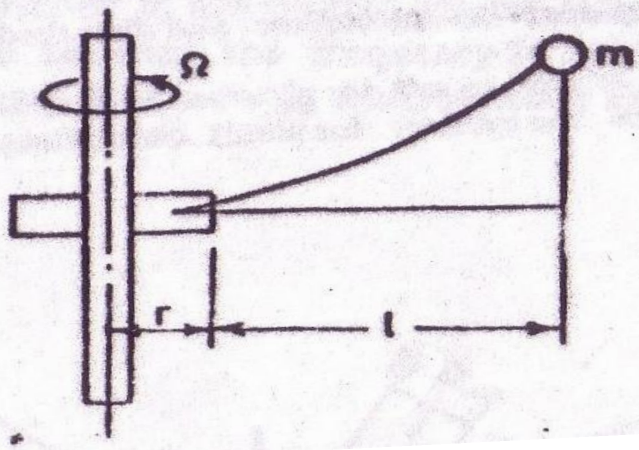


Fig. P 2.11

The system shown in Fig. P 2.13 rotates about the vertical axis with a speed Ω rad/sec. The cantilever spring is stiff in the plane of rotation. Show that the natural frequency is given by

$$p = p_0 \sqrt{1 + \left(\frac{\Omega}{p_0}\right)^2 (1 + r/l)}; \quad p_0 = \sqrt{\frac{3EI}{ml^3}}$$

P.2-15



Two sliders shown in Fig P2.14 are constrained to move within a smooth tube which is rotating in the horizontal plane about the fixed point o. Each of the sliders are elastically supported from identical springs with a modulus k. the unstretched length of the spring is r_0. Determine the natural frequency of vibration for a constant angular velocity ω

P.2-16

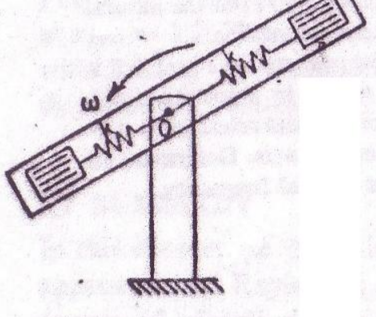


Fig. P 2.14

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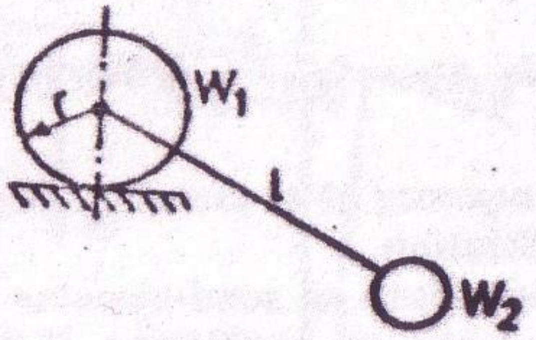
A cylinder W_1 and weight W_2 are rigidly connected by a rod as shown in Fig. P 2.18. If the cylinder rolls without slipping, what is the period of the system for small oscillations?

P.2-20



A thin rectangular plate is bent into a semi-circular cylinder as shown in Fig. P 2.29. Determine the frequency of oscillation if it is allowed to roll on a horizontal surface.

P.2-33

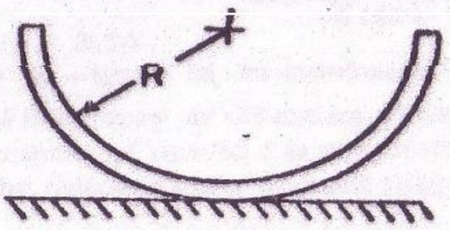


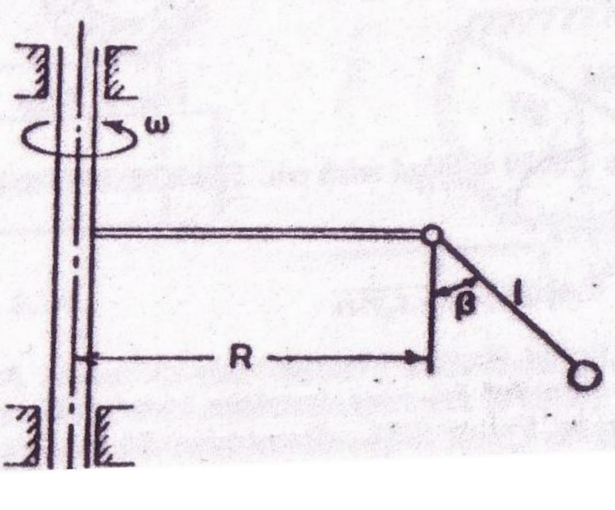
Fig. P 2.29

Find the natural frequency of the pendulum constrained to oscillate in the rotating vertical plane as shown in Fig P2.19, assume small oscillations and show that it can be expressed in terms of its dynamic equilibrium position as

P.2-21

$$p^2 = \frac{g}{l\cos\beta} \times \frac{R+l\sin^3\beta}{R+l\sin\beta} = \frac{\omega^2(R+l\sin^3\beta)}{l\sin\beta}$$

For the particular case of $R = 0$, show that this reduces to $p^2 = g/l - \omega^2$ when $g/l > \omega^2$, $p^2 = \omega^2 - \left(\frac{g}{l\omega}\right)^2$ when $g/l < \omega^2$



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Find the equivalent stiffness for plane motion in the direction N-N and show that it is invariant with θ and equal to 2k.

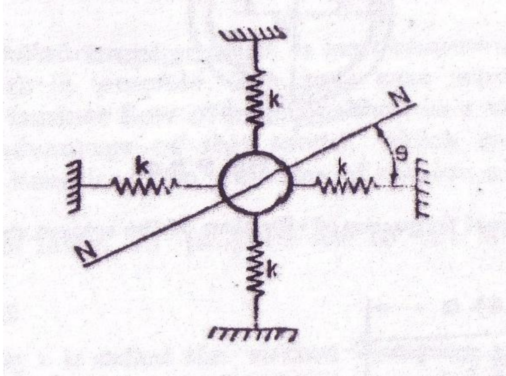
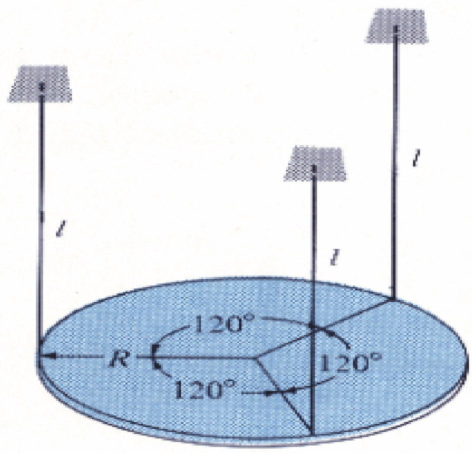


Fig. P 2.39

22–25. The plate of mass m is supported by three symmetrically placed cords of length l as shown. If the plate is given a slight rotation about a vertical axis through its center and released, determine the period of oscillation.



Prob. 22–25

2.46 Find the natural frequency of vibration of the system shown in the Fig. P 2.42.

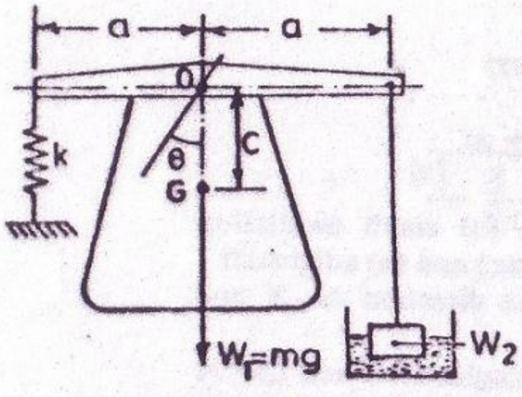


Fig. P 2.42

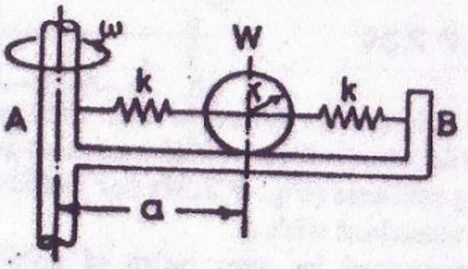
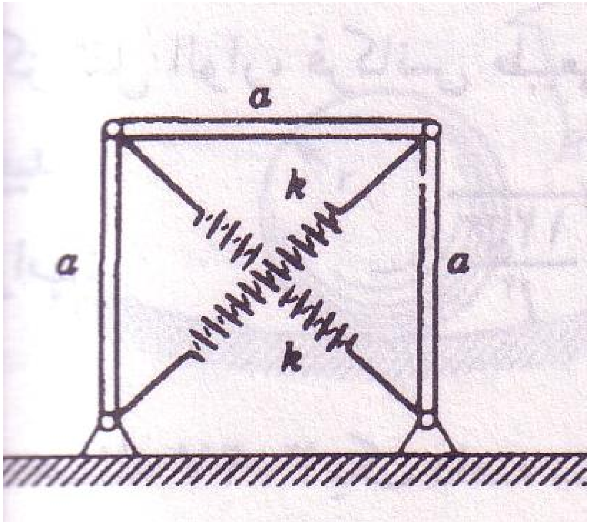


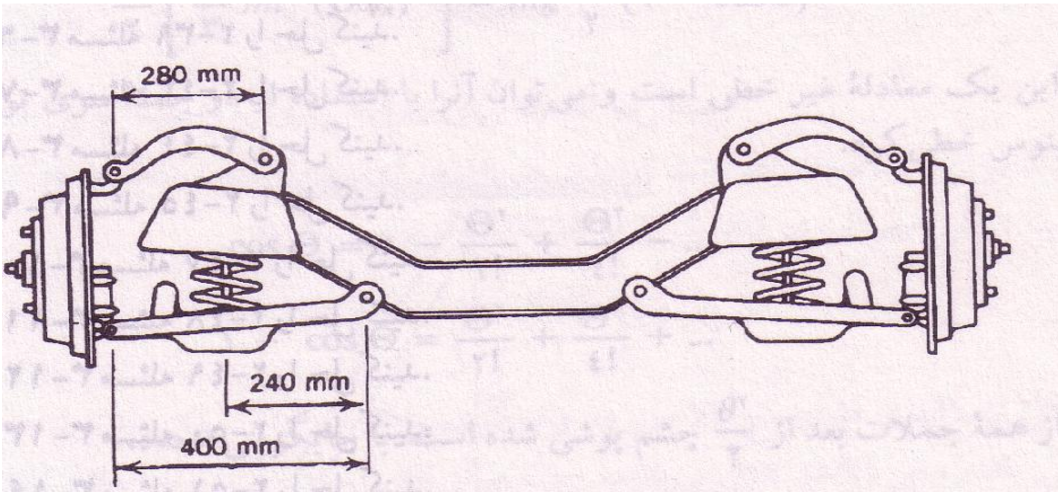
Fig. P 2.43

2.47 A solid cylindrical roller of weight W is mounted on an arm AB and held in position by two springs of spring constant k as shown in Fig. P. 2.43. If the arm revolves at a uniform velocity ω, determine the change in the equilibrium position of the roller and its natural frequency for small oscillations about this position.

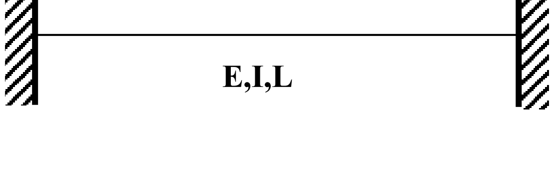
Find the natural frequency of small oscillation in the shown mechanism. Mass of each bar is equal to m and all connections are hinges. Ans: $(3/5(k/m-2g/a))^{0.5}$



Find the natural frequency of vertical motion of the automobile shown below, each spring has stiffness of 50 kN/m and the total body mass is 1420 kg.



- **Find the equivalent mass and stiffness of a clamped-clamped beam at its mid-span in its first natural mode.**



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