STAEDTLER® No. 937 811E Engineer's Computation Pad

••32 Basilisk lizards can run across the top of a water surface (Fig. 9-53). With each step, a lizard first slaps its foot against the water and then pushes it down into the water rapidly enough to form an air cavity around the top of the foot. To avoid having to pull the foot back up against water drag in order to complete the step, the lizard withdraws the foot before water can flow into the air cavity. If the lizard is not to sink, the average upward impulse on the lizard during this full action of slap, downward push, and withdrawal must match the downward impulse due to the gravitational force. Suppose the mass of a basilisk lizard is 90.0 g, the mass of each foot is 3.00 g, the speed of a foot as it slaps the water is 1.50 m/s, and the time for a single step is 0.600 s. (a) What is the magnitude of the impulse on the lizard during the slap? (Assume this impulse is directly upward.) (b) During the 0.600 s duration of a step, what is the downward impulse on the lizard due to the gravitational force? (c) Which action, the slap or the push, provides the primary support for the lizard, or are they approximately equal in their support?



FIG. 9-53 Problem 32. Lizard running across water. *(Stephen Dalton/Photo Researchers)*

IN ORDER TO WALK ON WATER, THE DOWNWARD IMPULSE OF GRAVITY ON THE LIZARD MUST BE BALANCED BY AN EQUAL UPWARD IMPULSE IN ORDER FOR THE LIZARD TO BE IN A TIME-AVERAGED EQUILIBRIUM STATE IN THE VERTICAL DIRECTION.

DOWNWARD IMPULSE DUE TO GRAVITY:

$\vec{J}_G = \vec{F}_G \Delta t = m_L g \Delta t$ down

Δt = time interval between steps = 0.6 s

b) $\vec{J}_G = (0.0900)(9.80)(0.600) = 0.529$ NS

THE UPWARD IMPULSE

$= \vec{J}_{SLAP} + \vec{J}_{PUSH}$

$\vec{J}_{SLAP} = \Delta \vec{P}_{LIZARD\ FOOT}$

a) $\vec{J}_{SLAP} = \vec{P}^{f}_{Lf} - \vec{P}^{i}_{Lf} = 0 - m_{Lf}\vec{v}^{i}_{Lf} = -(0.003)(1.50)$ down

$= 0.00450$ NS up (NOTE N sec = kg m/s)

$\therefore J_G = J_{Slap} + J_{push} \Rightarrow J_{push} = J_G - J_{Slap} = 0.525$ Nm

c) THE PRIMARY SUPPORT MUST BE THE LIZARD RAPIDLY PUSHING ON THE WATER.

$\vec{J}_{push} = \vec{F}_{on\ foot\ by\ water}\, \Delta t_{push}$ NOTE $\Delta t_{push} < \Delta t = 0.6$ s

= REACTION TO LIZARD'S PUSH ON WATER

$\Rightarrow F_{push} = J_{push}/\Delta t_{push} = 0.525\text{ NS}/(<0.6\text{ s})$

≥ 0.875 N =

NOTE THE LIZARD WEIGHS $0.882\text{ N} = m_L g$