26. All groups found that the discharge is about 5% larger when the upstream velocity head is not neglected.

27. Several groups had trouble on parts c and d. The key principle for part c is that, if losses are neglected between the upstream section and the top of the bump, the total heads are equal: $H_1 = H_2$, or $E_1 + z_1 = E_2 + z_2$. Then since $\Delta h = z_2 - z_1$,

$$\Delta h = E_1 - E_2.$$  

The upstream specific energy $E_1$ is computed from the normal flow conditions, while the limiting condition for a choke is critical flow at the top of the bump. (If you don’t know why, ask me.) When a choke will not occur (part d), the depth over the bump will be smaller than the depth upstream because the flow is subcritical. One can use the specific energy (i.e., $E-y$) diagram to show that.

28. For the best hydraulic section of a triangle, geometry gives $A = h^2$, $P = 2\sqrt{2}h$, and $R = h/2\sqrt{2}$. Then, through the magic of algebra, one can get an explicit formula for the normal depth

$$h = \left(\frac{2nQ}{S_0^{1/2}}\right)^{3/8}$$

A few groups computed the mean velocity but did not verify that it was between 0.6 m/s and 3 m/s. A few groups computed freeboard incorrectly by substituting the depth in meters instead of feet. The side slope of 1:1 is steeper than that recommended by the U. S. Bureau of Reclamation.

29. Few groups solved this problem completely correctly. The analysis in this problem requires both the energy principle (Bernoulli) and the momentum principle. Use Bernoulli between the section upstream of the sluice gate and the vena contracta (not the gate opening) because losses can be neglected; the momentum principle is difficult to apply in part a because the force of the sluice gate on the control volume is unknown. Computing the normal and critical depths shows that the flow will follow an $M_3$ profile downstream of the vena contracta. The flow will jump when the conjugate depth of normal depth is reached. The momentum principle is best for determining the conjugate depth because losses in the jump are unknown. I wanted groups to compute the flow profile with the direct step method in part b. For part c, the new normal depth is below critical depth; therefore, the flow will follow an $S_3$ profile until normal depth is reached.