Name: ______________________

Date: ______________________

Collaborators: ______________________________________

(Collaborators submit their individually written assignments together)

Question:	1	2	3	Total
Points:	25	15	30	70
Score:				

Instructor/grader comments:

Dimensional analysis. Limiting cases.

1. A truncated square pyramid with bottom base size a, top base size b, and height h is shown in Fig. 1.

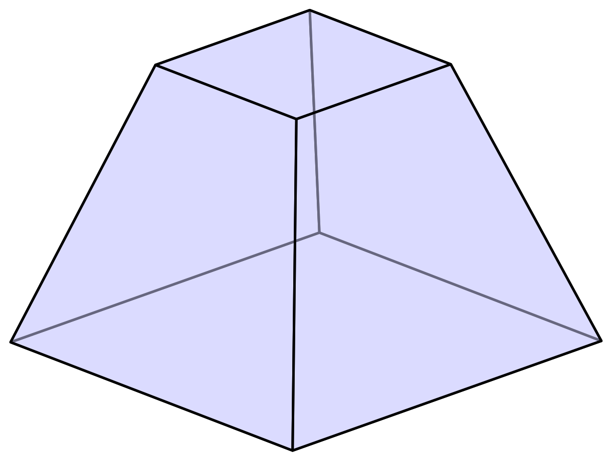

Figure 1: Truncated square pyramid.

Explain briefly but clearly why neither of the formulas below can be the correct expressions for for the volume of this pyramid:

(a) (5 points) $V = a\,b\,h$

(b) (5 points) $V = a\,h + b^2$

(c) (5 points) $V = 2h(a^2 + b^2)$

(d) (5 points) $V = \log(h^3 + a^3 + b^3)$

(e) (5 points) $V = h^3\,\frac{a}{b}$

Provide just one reason for each answer.

2. (15 points) Basilisk lizards, a group of reptiles found in Central America, are unique in that they are capable of running across water using only their feet as a source of both lift and thrust.

   https://blog.nationalgeographic.org/2014/06/19/amazing-animals-that-walk-on-water/

   > "Since the basilisk's weight is too great to be supported by the water's surface tension, animals cannot simply reside at rest on the water surface, but must be in a constant state of motion. As the lizards' feet push down on, the water beneath their feet pushes back. This keeps them up just long enough to take their next step and stops them from sinking."

   Use the dimensional analysis to estimate the vertical speed of the lizard's foot required for running across water. Assume that the relevant physical parameters are the weight of the lizard, W, the area of its foot, A, and the density of the water, ρ. For your numerical estimate use the following values: $W = 1\,N$, $A = 10^{-2}\ m^2$, $\rho = 10^3\ kg/m^3$.

Chase problems

3. In class we solved the following problem:

   > A smart fly noticed a drop of honey on the table, while flying horizontally exactly above the drop with the speed v_0 at the height H. The fly is able to move with the acceleration not more than a in any direction. Find the minimal time required for the fly to get to the honey.
   >
   > Hint: think about the reference frame where the trajectory of the fly is particularly simple.

   (a) (15 points) Starting from the class solution, find the parametric equation of the trajectory of the fly, $X(t), Y(t)$ in the reference frame at rest relative to the table. Chose the origin of the coordinate system at the initial position of the fly, direct x axis parallel to the initial direction of the flight and direct y axis up vertically (such that the position of the honey is $(0, -H)$.

   (b) (15 points) Use a software of your choice to plot (on the same graph) two different trajectories for the parameters $H = 1.0\ a.u.$, $v_0 = 1.0\ a.u.$, $a = 1.0\ a.u.$ and $a_2 = 2.0\ a.u.$. Attach the printout of your graph and the printout of your plotting code.