Question 1

All operations in this question occur in 2D space. Given a 2x2 square centered at the origin (see image below), what is the result of the following sequence of transformations? Note that the Scale and Translate functions return a 3x3 transformation matrix given magnitudes on the X and Y axes. The Rotate function returns a 3x3 rotation matrix given a rotation amount in degrees.

Scale(2, 2) * Rotate(90) * Translate(1, 0) * Square_Geometry

A. [Image of RST]
B. [Image of SRT]
C. [Image of TRS]
D. [Image of something that's been rotated by -90]

Question 2

What aspect of homogeneous coordinates makes them useful when transforming 2D and 3D geometry? Explain in **one sentence**.

Homogeneous coordinates allow vectors to be translated by matrices, while using no homogeneous coordinates only allows matrices to scale and rotate vectors.

Question 3

Why is the point of intersection we get when computing the intersection of a ray with *unit geometry* (e.g. a perfect sphere, a perfect cube) usually **not** the point of intersection we want, and how do we obtain the desired point of intersection from this information? Answer in **at most two sentences**.

The point of intersection with unit geometry is found in a space local to the object in question since we transform the ray by the inverse of the object's transformation matrix. To find the desired POI, we premultiply the local-space POI by the object's transformation matrix to bring it into world space.

Question 4

Given a perspective projection camera looking at a single sphere, what happens to the image of the sphere as the camera's field of view angle is increased? Why does this change in appearance occur? Answer in **at most two sentences**. Your answer may be conceptual rather than mathematical.

The sphere appears to shrink, since its distance relative to the frustum's walls increases as the FOV increases. Additionally, if there were other objects in the scene near the sphere, they might come into view as the FOV increases since the frustum would expand to encompass them.

Question 5

You are playing a video game which in one particular level has you search for a key hidden in one of one hundred treasure chests. You only have one attempt to find the key; all other treasure chests are trapped and will cause you to lose a life if you open them. Rather than wasting all of your time on this ill-conceived "puzzle", you decide to make use of one of the game's mechanics, which allows you to manipulate the properties of the 3D camera through which you view the world. How might you alter the camera in order to see inside the treasure chests and know which one contains the key? Note that due to the game's collision system, the camera cannot actually enter any of the chests. Answer in one sentence.

Adjust the near clip plane so it intersects a wall of each chest, allowing the player to see inside.