

1. You need some fabric that matches the colour of your room. You take a small chip of paint from your wall to the store and find some fabric that looks the same at the store. When you get home, you discover that the fabric doesn't actually match. Give an explanation as to what possibly happened.
2. The *Portable Gray Map* (PGM) image format (described at [http://subsurfwiki.org/wiki/Portable\\_gray\\_map](http://subsurfwiki.org/wiki/Portable_gray_map)) is an extremely simple image format.
  - (a) Why must the file format include the image dimensions (i.e., the line after the comments)?
  - (b) If the maximum grey level value is 65535 how much memory would you need to hold store a decoded  $800 \times 600$  pixel PGM image assuming the pixel data is packed as tightly in memory as possible.
  - (c) Assuming there are no comments and that each ASCII character occupies one byte, how much space would the same  $800 \times 600$  image take up in PGM format in the worst case?
3. What is the value of the ray parameter  $s$  at the intersection points between the ray  $[1, 1, 1] + s[1, 1, 1]$  and the sphere centred at the origin with radius 1?
4. Using a diagram, explain why a finite aperture camera produces blurry images.
5. Explain the purpose of each of the following transformations in the graphics pipeline: (a) modelling, (b) view, (c) perspective. If you wanted to show the scene from a different point of view, which transform would you need to modify?
6. What is the effect of applying each of the following  $4 \times 4$  transformation matrices to a 3-D object with vertices given in homogeneous coordinates?

$$\begin{bmatrix} -3 & 0 & 0 & 0 \\ 0 & -3 & 0 & 0 \\ 0 & 0 & -3 & 0 \\ 0 & 0 & 0 & -2 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 4 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

7. (a) What is a *scene graph*? What problem are scene graphs intended to help solve?
- (b) Consider the following 2-D scene of a person standing on a boat rolling in the waves. There are three objects in the scene: the boat, the person, and the person's hat. The origin of the boat is at  $(x, y)$  in the scene.  $\theta$

represents the amount the boat is rolling.  $a$  is the horizontal position of the person on the deck of the boat and  $b$  is the height of the deck.  $h$  is the height of the person and  $w$  is the distance from the origin of the person to the midpoint of the person's body. The hat sits on top of the middle of the person's head and is tilted with angle  $\varphi$ .

Draw the scene graph for this scene. Write out the transforms that need to be composed in order to obtain the model transform for the person's hat.

