

### **Task 1 – Pipeline**

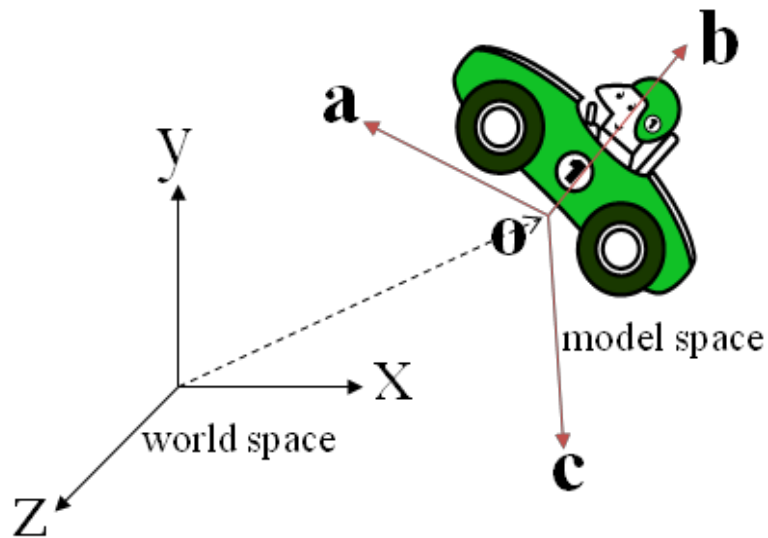
- a) [1p] The real-time graphics **pipeline** consists of three major block. Name them.
  
- b) [1.5p] Give examples of what is done in each part.
  
  
  
  
  
  
  
  
  
  
- c) [1.5p] For each part, describe how you can determine if this step is the performance bottle-neck for the rendering.

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### **Task 2 – Transforms**

- a) [2p] Which two classes of transformations are part of Rigid Body Transformations?

b) [2p] Give the object's model-to-world matrix.



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### Task 3 - Illumination and Visual Appearance

a) [1p] Which are the 3 components in the real-time illumination model? It is sufficient to just state the names. (**Emission** is often included as the fourth component.)

- b) [2p]** Compute the reflection ray,  $\mathbf{r}$ , given  $\mathbf{n}$  and  $\mathbf{l}$ , where  $\mathbf{n}$  is the surface normal and  $\mathbf{l}$  is the incoming ray with direction towards the surface.
- c) [1p]** Is alpha channel in the color buffer required for correct rendering of transparent objects? Motivate your answer.
- d) [1p]** Is the rendering of transparent objects order dependent? Motivate.