

## 유형 1 - 이미지 크기

1. How many bytes are necessary to store a  $1024 \times 1024$  color image with an alpha channel using 8 bits per channel? (2013)

2. How many bytes are necessary to store a  $1024 \times 1024$  color image without an alpha channel using 8 bits per channel? (2017)

3. How many bytes are necessary to store a  $1024 \times 1024$  color image without an alpha channel using 8 bits per channel? (2023)

## 유형 2 - Implicit Equation

1. What is the implicit equation of the plane through 3D points  $(1,0,0)$ ,  $(0,1,0)$ , and  $(0,0,1)$ ? What is the parametric equation? What is the normal vector to this plane?

2. What is the equation of the plane through 3D points  $(-1,0,0)$ ,  $(0,1,0)$ , and  $(0,0,1)$ ? What is the normal vector to this plane?

3. What is the equation of the plane through 3D points  $p_1$ ,  $p_2$ ,  $p_3$  ? What is the normal vector to this plane?

4. What is the equation of the plane through 3D points  $a, b$ , and  $c$  ?

5. What is the equation of the plane through 3D points  $a$ ,  $b$ , and  $c$ ? What is the normal vector to this plane? You can use any vector operators in the answer.

6. What is the equation of the plane through 3D points  $a$ ,  $b$ , and  $c$ ? What is the normal vector to this plane? You can use any vector operators in the answer.

### 유형3 - 반례

1. Show by counterexample that it is not always true that for 3D vectors  $a, b$ , and  $c$ ,  $a \times (b \times c) = (a \times b) \times c$ .

## 유형4 - Ray-Sphere

1. What are the ray parameters of the intersection points between ray  $(1,1,1)+t(-1,-1,-1)$  and the sphere centered at the origin with radius 1?

2. What are the ray parameters of the intersection points between ray  $(1,1,1)+t(-1,-1,-1)$  and a sphere centered at  $(-2,-2,-2)$  with radius 1?

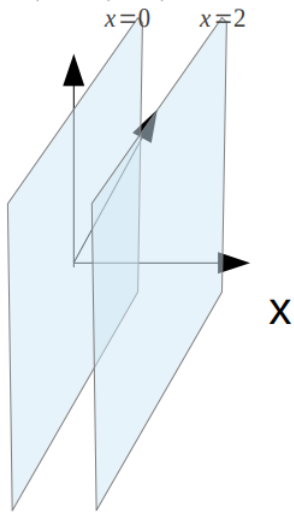
3. What is the equation of the ray that starts from a toward c ?

4. What are the ray parameters of the intersection points between ray  $a+tb$  and a sphere centered at  $c$  with radius 1?

5. What are the ray parameters of the intersection points between ray  $a+bt$  and a sphere centered at  $(0,0,0)$  with radius 2?

## 유형5 - Ray-Slab

1. Calculate the interval of the ray parameters of the intersection points between ray  $(1,1,1) + t(-1,-1,-1)$  and a slab defined by two planes shown below.



2. Calculate the ray parameter of the intersection points between ray  $(-1,-1,1) + t(-1,-1,-1)$  and an arbitrary plane  $ax+by+cz+d=0$  (in terms of  $a$ ,  $b$ ,  $c$ , and  $d$ ).

## 유형6 - Matrix Movement

1. Write down the  $4 \times 4$  3D matrix to move by  $(x_m, y_m, z_m)$ .

2. Write down the  $4 \times 4$  3D matrix to rotate by an angle  $\theta$  about the y-axis.

3. Write down the  $4 \times 4$  3D matrix to rotate by an angle  $\theta$  about the z-axis.

4. Write down the  $4 \times 4$  rotation matrix  $M$  that maps the orthonormal 3D vectors  $u=(x_u, y_u, z_u)$ ,  $v=(x_v, y_v, z_v)$ , and  $w=(x_w, y_w, z_w)$ , to orthonormal 3D vectors  $a=(x_a, y_a, z_a)$ ,  $b=(x_b, y_b, z_b)$ , and  $c=(x_c, y_c, z_c)$ , so  $M u=a$ ,  $M v=b$ , and  $M w=c$ .

5. Describe in words what this 2D transformation matrix does:

1. 
$$\begin{bmatrix} 0 & -1 & 1 \\ 1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

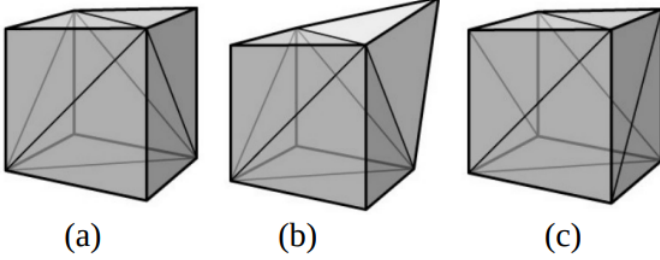
2. 
$$\begin{bmatrix} 3 & 0 & 2 \\ 0 & 3 & 4 \\ 0 & 0 & 1 \end{bmatrix}$$

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



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

**유형7 - top/geo**



## 유형8 - The earth



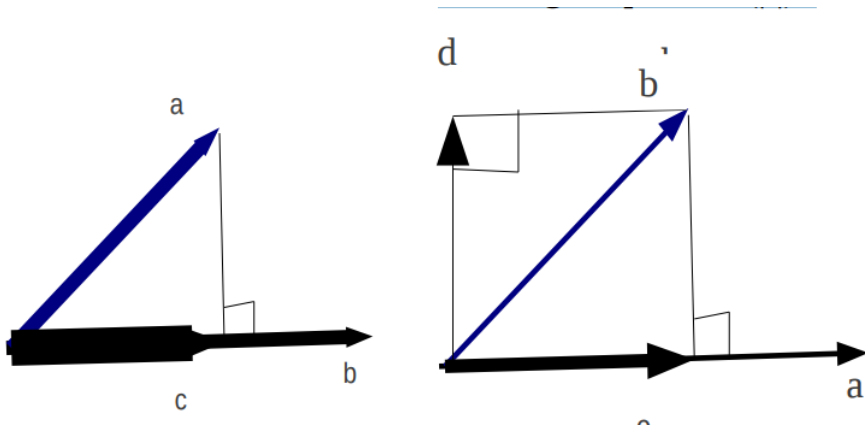
1. Explain what per-vertex attributes need to be passed from the application to the vertex stage.

2. Describe the computations that need to be done at the vertex stage.

3. Explain what attributes are interpolated by the rasterizer for the fragment stage.

4. Describe the computations that need to be done at the fragment stage.

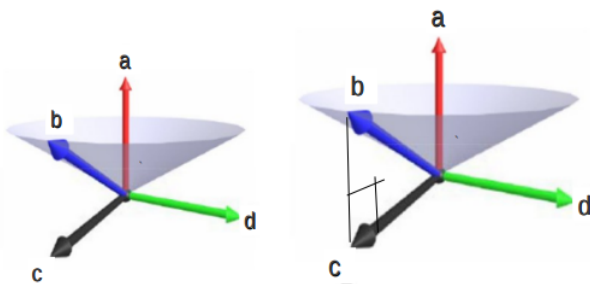
## 유형9 - 각도기



1. Represent vector  $c$  in terms of vector  $a$  and  $b$  using the dot product operator ( $\cdot$ ) and the length operator ( $| |$ ).

2. Represent vector  $c$  and  $d$  in terms of vector  $a$  and  $b$  using the dot product operator ( $\cdot$ ) and the length operator ( $| |$ ).

## 유형10 - 접시



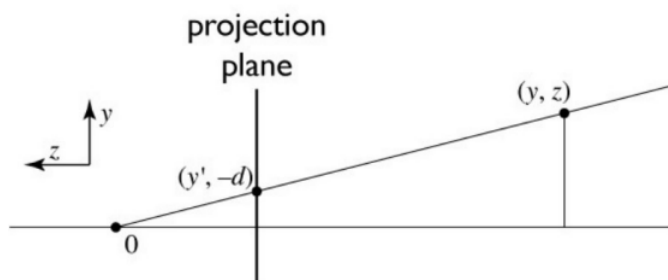
1. Represent vector  $c$  and  $d$  in terms of vector  $a$  and  $b$  using the cross product operator ( $\times$ ) and the length operator ( $| |$ ). Vector  $a$ ,  $b$ ,  $c$  are in the same plane, and  $d$  is orthogonal to the other vectors. All vectors have unit length.

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2. Briefly explain why  $\|d\| = \|c\|$  when  $d = a \times b$  and  $\|a\| = 1$ .

## 유형11 - 저장공간

1. Derive the average storage requirement (bytes per vertex) of the indexed triangle set representation assuming that a vertex contains a position and a normal (4byte float variables) and that the number of triangles is twice the number of vertices on average.
2. Derive the average storage requirement (bytes per vertex) of the indexed triangles representation assuming that a vertex contains a position, a 2D texture coord and a normal (all 4byte float variables) and that the number of triangles is twice the number of vertices on average.

## 유형12 - Projection matrix



1. Write down the  $3 \times 4$  projection matrix that maps a 3d point  $(x, y, z)$  to  $(x', y')$ ? Hint: similar triangles, homogeneous coordinates

2. Write down the  $4 \times 4$  projection matrix that maps a 3d point  $(x, y, z)$  to  $(x', y', z)$ ? Hint: similar triangles, homogeneous coordinates

### 유형13 Briefly explain~

1. Briefly explain why the measured dynamic range of the same display can differ depending on lighting conditions.
2. Briefly explain the main downside of the painter's algorithm, and then explain the alternative algorithm that is unanimously used in real-time applications such as games
3. Explain what the scale factor is, and why the scale factor is designed in such a way.

9. Given two nonparallel, three-dimensional vectors  $u$  and  $v$ , how can we form an orthogonal coordinate system in which  $u$  is one of the basis vectors? Calculate all the basis vectors using the cross product operator ( $\times$ ) and the length operator ( $|\cdot|$ ).

- (b) Why is it important that the vectors  $u, v$  from (a) be non-parallel?

## 유형14 Inverse

1. Given a rigid transformation matrix  $R$  of which the linear part  $Q$  is an orthonormal matrix, derive the inverse of the matrix  $R$

- $R = \begin{bmatrix} Q & u \\ 0 & 1 \end{bmatrix}, R^{-1}$



2. Given a rigid transformation matrix  $R$  of which the linear part  $Q$  is an orthonormal matrix, verify that the inverse of orthonormal matrix is as below.

$$\bullet \quad R = \begin{bmatrix} Q & u \\ 0 & 1 \end{bmatrix}, R^{-1} = \begin{bmatrix} Q^T & -Q^T u \\ 0 & 1 \end{bmatrix}$$