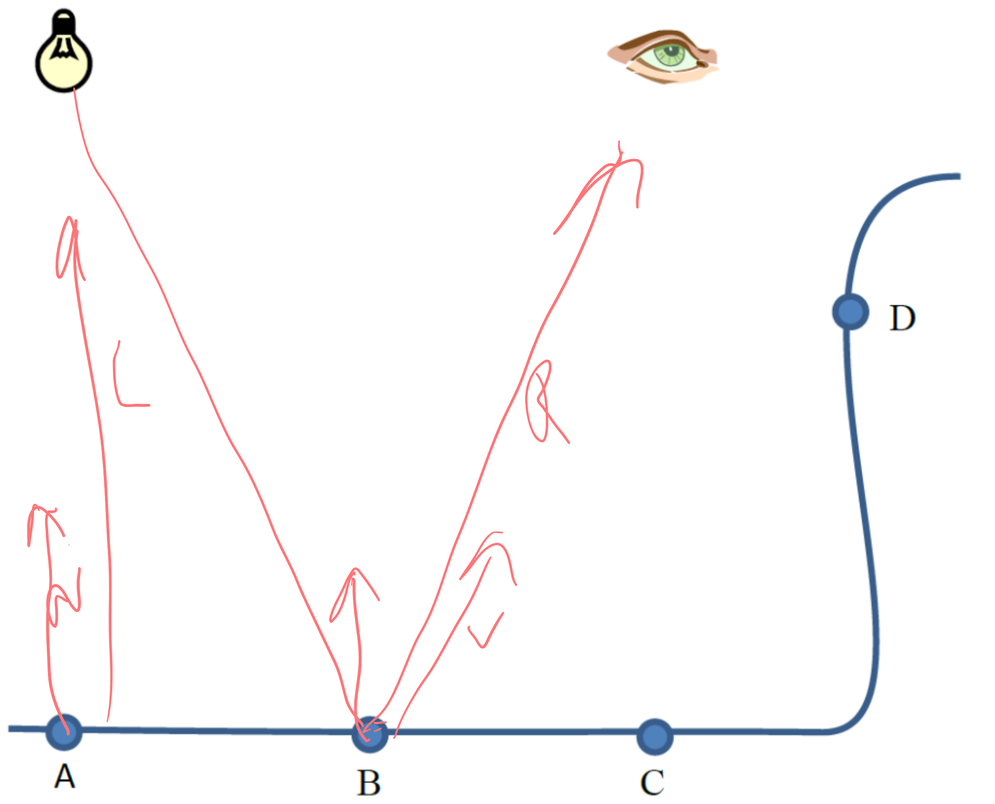
Lighting

For the following questions, please refer to the 2-D scene depicted in this figure.



Which point (A, B, C or D) reflects the most diffuse light using the Phong reflection model?

- (a) Point A
- (b) Point B
- (c) Point C
- (d) Point D

Which point (A, B, C or D) reflects the most specular light using the Phong reflection model?

- (a) Point A
- (b) Point B
- (c) Point C
- (d) Point D

When Do We Do the Shading Calculation?

Shading can be done at different stages of the rendering process...what we call the process depends on when the shading calculation occurs. Match the correct label to each of these three algorithms

```
For each light:
  For each object affected by the light:
      framebuffer += object * light
```

- (a) Single Pass Lighting
- (b) Multi-pass Lighting
- (c) Deferred Shading
- (d) Deferred Lighting

```
For each object:
  Render to multiple targets
For each light:
  Apply light as a 2D postprocess
```

- (a) Deferred Lighting
- (b) Single Pass Lighting
- (c) Multi-pass Lighting
- (d) Deferred Shading

```
For each object:
  Render mesh, applying all lights in one shader
```

- (a) Deferred Lighting
- (b) Single Pass Lighting
- (c) Deferred Shading
- (d) Multi-pass Lighting

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Start of Deferred Lecture

Deferred Complexity

Suppose we render a scene with n_L lights and n_T polygons. Which function best describes the algorithmic complexity of rendering when using *deferred shading*.

- ○ (a) $O(n_L^{n_T})$
- ○ (b) $O(n_L \times n_T)$
- ○ (c) $O(n_T^{n_L})$
- ○ (d) $O(n_L + n_T)$

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Deferred Shading Drawbacks

Which of the following effects are non-performant when implemented with deferred shading?

- [ ] (a) The Blinn-Phong reflection model
- [ ] (b) A full-scene directional light source
- [ ] (c) Multi-Sample Anti-Aliasing (MSAA)
- [ ] (d) Ambient Occlusion
- [ ] (e) Transparency

Select all possible options that apply.

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Last slide of Deferred lecture

Light Volumes

When using *deferred shading* one opimization is to render a *light volume* mesh enclosing the world space that the light hits, and only shade the pixels that within that light volume. Assuming the light volume is convex and does not intersect the near or far clip planes, which of the following is true?

- (a) The light volume is not large enough.
- (b) None of the above are true.
- (c) Backfacing polygons should be culled.
- (d) Backfacing polygons should be rendered.

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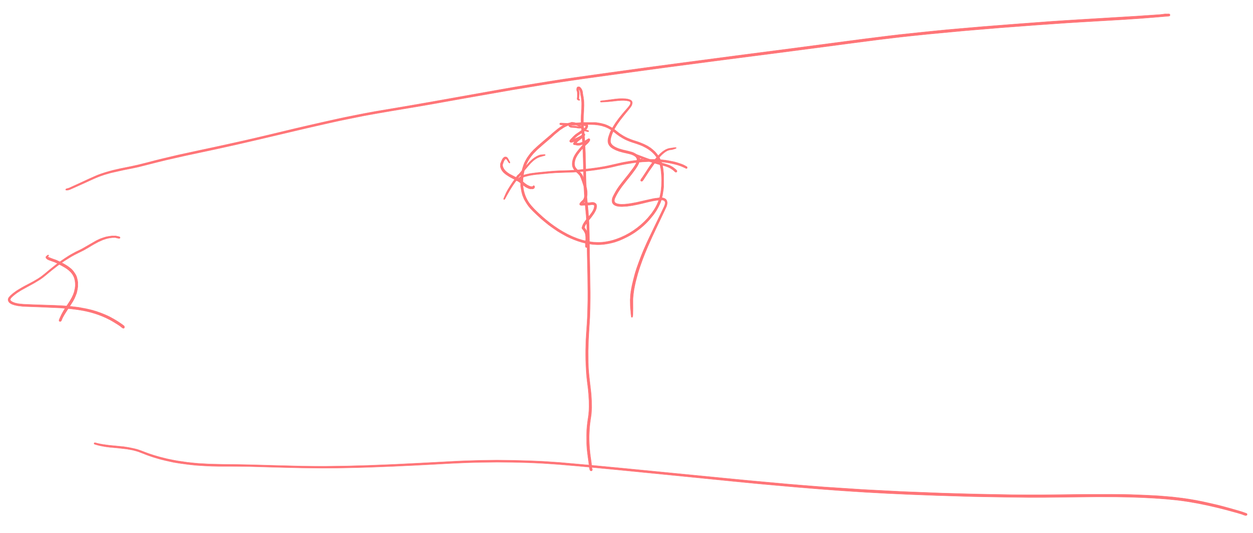
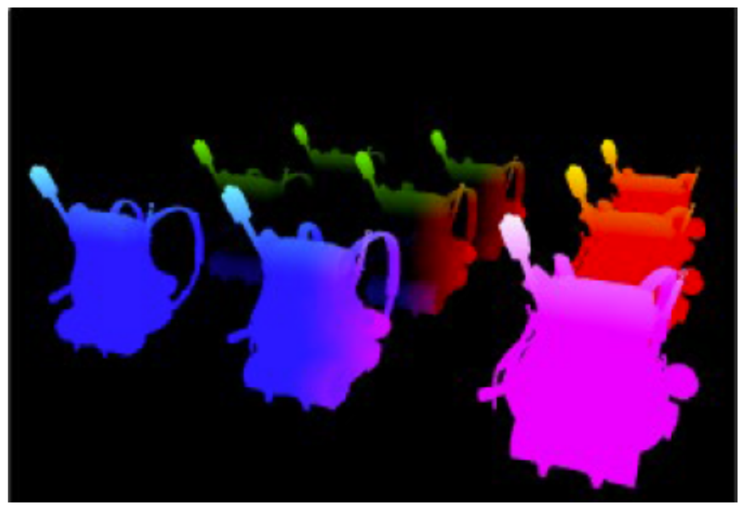
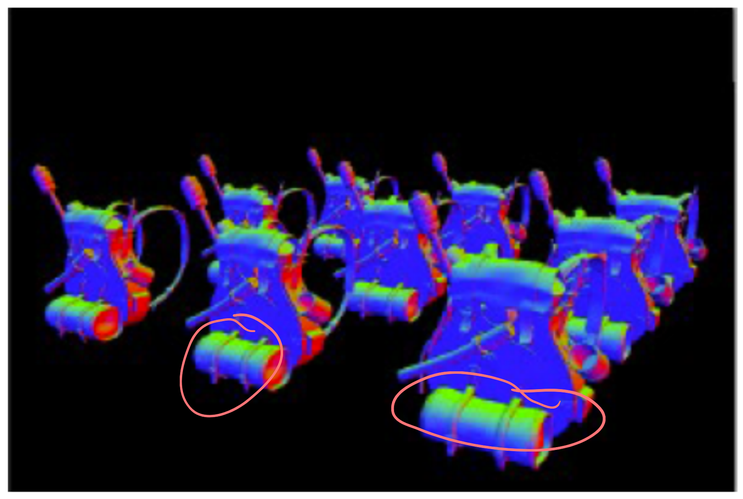


Geometry Buffers for Deferred Shading

Deferred shading uses geometry buffers to store information needed for a final lighting computation over a scene. Each image below is a geometry buffer that stores a different kind of data. Match each image to the label that most likely describes the kind of data in the buffer.

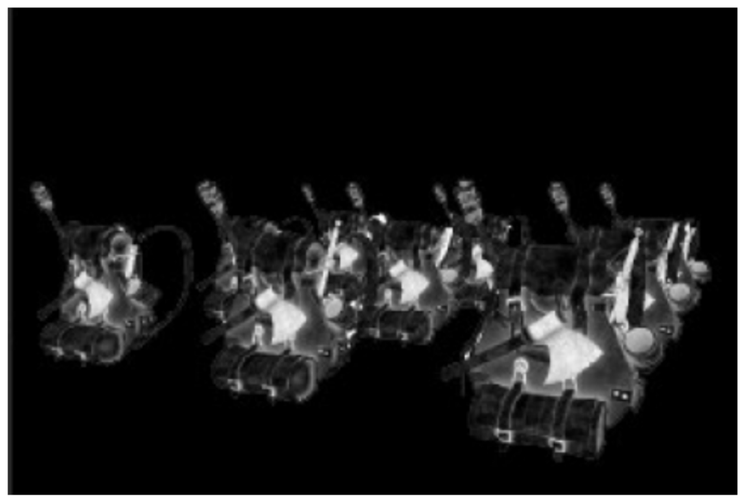


- (a) Normals
- (b) Light Intensity
- (c) Albedo (Diffuse Material)
- (d) Position
- (e) Specular Material



- (a) Specular Material
- (b) Position
- (c) Albedo (Diffuse Material)
- (d) Normals
- (e) Light Intensity

- (a) Light Intensity
- (b) Specular Material
- (c) Normals
- (d) Position
- (e) Albedo (Diffuse Material)



- (a) Normals
- (b) Albedo (Diffuse Material)
- (c) Position
- (d) Specular Material
- (e) Light Intensity

Ray Calculation

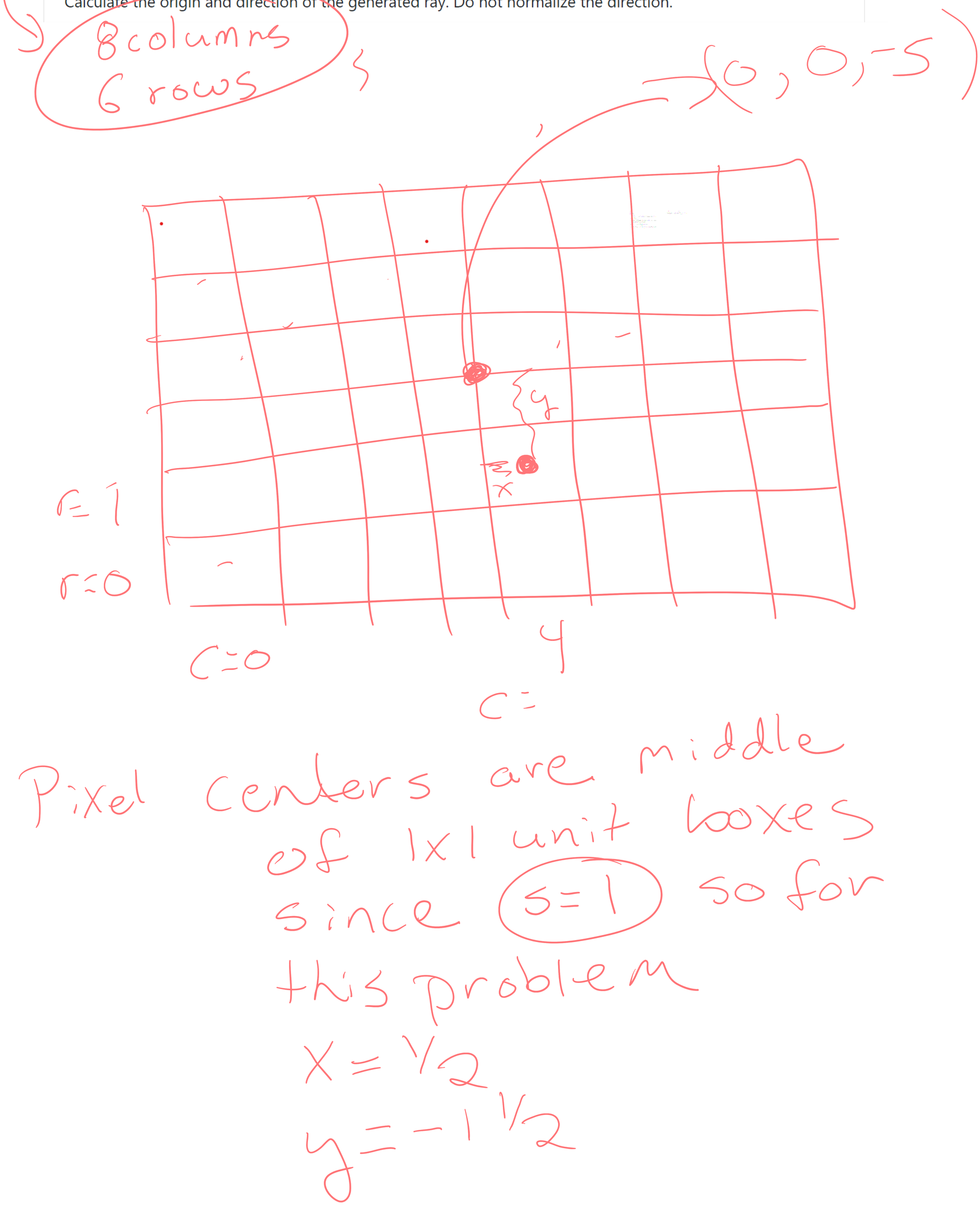
Imagine that we generate a ray from the camera to the viewplane through the center of a pixel (c, r) where $c = 4$ and $r = 1$.

The viewplane is a distance $d = 5$ away from the camera, located at $z = -d$. You can assume that the camera is set at $(0, 0, 0)$ and the viewplane is perpendicular to the z axis.

Assume an 8×6 pixel grid centered at $(0, 0, -d)$ and a pixel extent $s = 1$.

To be clear, c is the column of the pixel and r is the row. Assume that indexing starts at $(0, 0)$ at the lower left corner pixel.

Calculate the origin and direction of the generated ray. Do not normalize the direction.



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Calculate the origin and direction of the generated ray. Do not normalize the direction.

$Origin(x, y, z) =$ [0 | 0 | 0] ? ✓ 100%

$Direction(x, y, z) =$ [0.5 | -1.5 | -5] ? ✓ 100%

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Correct answer

$Origin(x, y, z) = [0 \quad 0 \quad 0]$ $Direction(x, y, z) = [0.5 \quad -1.5 \quad -5]$

Submitted answer **correct: 100%**

Submitted at 2022-10-06 12:14:26 (CDT)

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$Origin(x, y, z) = [0 \quad 0 \quad 0]$ ✓ 100% $Direction(x, y, z) = [0.5 \quad -1.5 \quad -5]$ ✓ 100%

Direction of ray is pixel center - origin

The Ray Parameter

We shoot a ray $r(t) = O + t\vec{d}$ from the eyepoint e through a point p on the viewplane so that $\vec{d} = p - e$

For $t \leq b_1$ the ray is not in front of the eyepoint. What is b_1?

$b_1 =$	0	? ✓ 100%

For $b_2 < t < b_3$ the ray is in between the eyepoint and viewplane. What are b_2 and b_3?

$b_2 =$	0	? ✓ 100%
$b_3 =$	1	? ✓ 100%

Suppose we make $\vec{d} = \frac{\vec{d}}{\|\vec{d}\|}$ so that $\vec{d}$ is unit length.

Let $e = (0, 0, 0)$ and $p = (10.5, 5.5, -5)$.
If the ray hits an object at $t = 45.9$ what is the Euclidean distance r from the hitpoint to the eyepoint?

If it is impossible to determine r from the given information, answer that $r = 0$.

$r =$	45.9	? ✓ 100%

If our ray fails to hit an infinite plane with normal $\vec{n}$, what is the value of $\vec{d} \cdot \vec{n}$

$\vec{d} \cdot \vec{n} =$	0	? ✓ 100%

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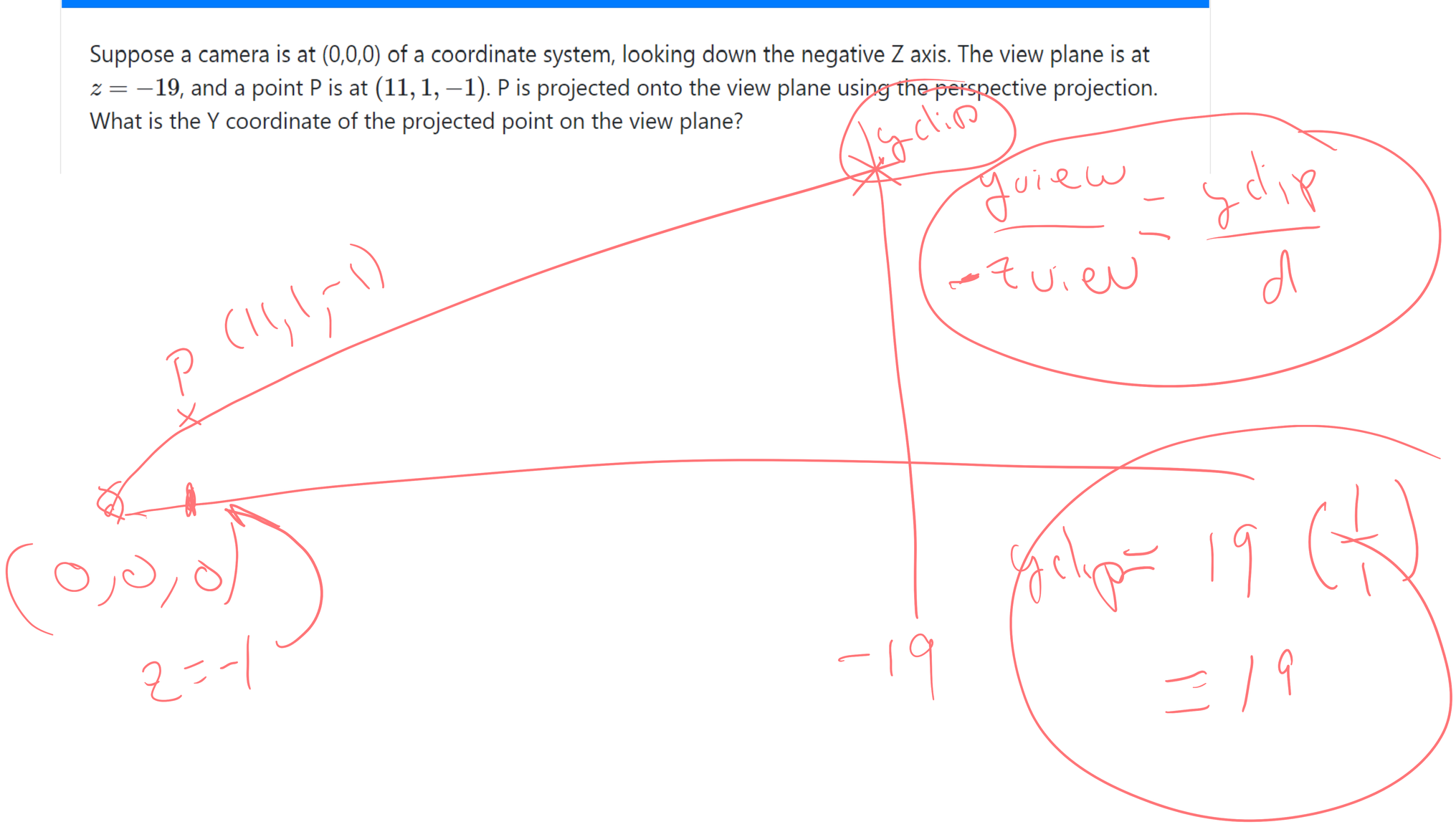
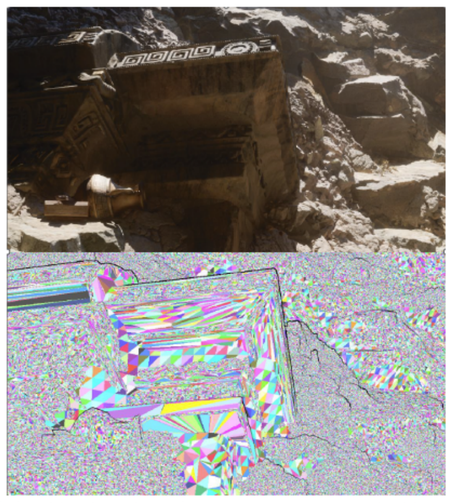
Perspective Projection 1 1

Suppose a camera is at (0,0,0) of a coordinate system, looking down the negative Z axis. The view plane is at $z = -19$, and a point P is at $(11, 1, -1)$. P is projected onto the view plane using the perspective projection. What is the Y coordinate of the projected point on the view plane?



Nanite Facts



Which of the following are true of the Nanite virtual geometry system in Unreal Enghine 5?

- [ ] (a) Nanite uses a software visibility buffer to do hidden surface removal.
- [x] (b) For a triangle mesh, Nanite builds a level-of-detail hierarchy using the quadric error metric.
- [ ] (c) Nanite uses software rasterization, which means triangles are rasterized by the CPU of a computer system.
- [ ] (d) In Nanite all triangles are processed using hardware rasterization on the GPU.
- [ ] (e) Nanite Micropoly rasterization is very similar to that used in REYES, Pixar's first renderer from the 1980 used in Star Trek II: The Wrath of Khan.

Select all possible options that apply.

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