

# VRC Shader Dev Entrance Exam

May 2022

## Exam structure

Welcome to the Shader Dev discord server. This entry exam is designed to not only test your knowledge in the topic of shaders, but also in the meme culture within in the discord server. The exam consists of 3 sections, one containing multiple choice questions, one containing open-ended questions, and finally a section where you will implement your own shader. The grade weightings for each section are given in the section titles. You are not at all expected to answer every question, just get as much correct as you can.

Note: Don't take any of this serious, we are just shitposting and having fun. If you can't answer anything, don't feel bad - there may not even be a **real** answer. A good chunk of the questions do actually have serious answers, though.

## Part 1 - Multiple choice (25%)

This section consists of multiple choice questions. Each question has only 1 correct answer, although you may still receive partial points for an incorrect answer, provided that the answer you have selected is sufficiently close to the correct one. If you are completely lost on a specific question, feel free to supply with explanations of your thought process in textual form.

1. What does the `smoothstep` constant function evaluate to?
  - ☐ `smoothstep` is not constant
  - ☐ 15
  - ☐ 0.21582022
  - ☐ 0.65
2. What does `asfloat(-1)` evaluate to?
  - ☐ 0
  - ☐ -1
  - ☐ NaN
  - ☐ Infinity
3. What color does the default error shader, which is used in place of shaders that fail to compile, produce?
  - ☐ `rgb(1, 0, 1)`
  - ☐ `rgb(0, 0, 1)`
  - ☐ `rgb(1, 1, 1)`
  - ☐ No color. The renderer becomes invisible
4. You have sampled a gray texture and instead of the expected value of 0.5, you get back 0.21404114048. What is the cause?

- ☐ Uninitialized memory
  - ☐ Mipmaps
  - ☐ Color space
  - ☐ Texture compression / encoding
5. Which of the following can **not** be used to persist data in a shader between frames?
- ☐ GrabPass
  - ☐ Custom Render Texture
  - ☐ Inline Sampler States
  - ☐ Camera component
6. What is the maximum size in bytes of a constant buffer.
- ☐ 65536
  - ☐ 16384
  - ☐ 2048
  - ☐ Unlimited
7. How are booleans stored in common desktop GPU registers?
- ☐ 32bit signed int, -1 for true 0 for false
  - ☐ 32bit signed int, 1 for true -1 for false
  - ☐ Special 32bit field registers pack 32 booleans each
  - ☐ 32bit float, 1.0 for true 0.0 for false
8. Where does light come from?
- ☐ From above
  - ☐ It is directionless
  - ☐ From below
  - ☐ From within
9. You have written some code using matrices, and it's not working. What should the first step in the debugging process be?
- ☐ Attach RenderDoc and inspect the values
  - ☐ Transpose matrices until it works
  - ☐ Implement a simplified version in C#
  - ☐ Return a color onto the screen so you can get an idea of the values
10. What is the term for when a Shader is rendered on top of another?
- ☐ Render over
  - ☐ Overrender
  - ☐ Overdraw
  - ☐ Topclipping
11. Which of the following is **not** a role in the Shader Dev discord?
- ☐ Lazy
  - ☐ Codelet
  - ☐ Shadur Queen

- ☐ Expert
12. Which of these shader types is run the *earliest*?
- ☐ Fragment shader
  - ☐ Vertex shader
  - ☐ Geometry shader
  - ☐ Tessellation shader
13. Where did the conventionally named `scannerCol` variable come from?
- ☐ Shadertoy
  - ☐ Inigo Quilez's website
  - ☐ bgolus forum thread
  - ☐ A tutorial from Making Stuff Look Good In Unity
14. What is the maximum possible dimension of a vector type in HLSL?
- ☐ 3
  - ☐ 4
  - ☐ 8
  - ☐ There is no maximum.
15. Consider the program snippet below.
- ```
float4 frag() : SV_Target { return -1; }
```
- If the user loads into a world using this shader with no reference camera set, renders the above fragment program fullscreen, and it is captured with `GrabPass{"_GrabTex"}`, what value would be returned from the following function:
- ```
Texture2D<uint4> _GrabTex;  
float4 sample() {  
    return _GrabTex.Load(0);  
}
```
- ☐ 0
  - ☐ 1
  - ☐ 1046162816
  - ☐ 3212836864
16. Now, assuming the setup from the previous question is rendered on a HDR render target and captured with `GrabPass`, what value would be returned from `sample()` function.
- ☐ 0
  - ☐ 1
  - ☐ 1046162816
  - ☐ 3212836864
17. Which of the following is not a practiced use of shaders?
- ☐ Simulated sexual intercourse
  - ☐ Forcibly crashing a GPU
  - ☐ Text recognition and translation
  - ☐ All of the above are practiced uses of shaders

## Part 2 - Open ended questions (35%)

This section contains open ended questions. Each of these questions demand a textual answer, and can have multiple correct answers. For full points, don't just provide a correct answer, but also argue how you arrived to it. If you use any external sources, make sure to write them down.

1. Imagine you want to maintain some state accross multiple frames using *only* shaders. Explain in a step-by-step fashion how you would achieve this.
2. What is understood by the term "Shader locking"?
3. What is the difference between a `sampler2D` and `Texture2D`?
4. You are given the code snippet `tex2Dproj(MainTex, i.projCoords.xyzw)`.  
How would you rewrite this snippet such that the behavior is the same, but you only use `tex2D` instead of `tex2Dproj`?
5. Which of the following keywords are valid keywords in HLSL? (There are multiple correct answers)
  - volatile
  - interface

- packed
- string
- char
- bool2
- globallycoherent

6. In your own words, what is the difference between Raymarching and Raytracing in the context of shaders?

7. What does the following snippet evaluate to?

```
float4 hmm = float4(0.4, 0.6, 0.1, 1.0);
return hmm.zxyw.wxzy.yxzw.zyxw.wxyz.zxwy.garb.gbar.zyxw.yxzw.ywzx;
```

8. How would you determine within a fragment shader if the triangle being shaded is front-facing or not?

9. How would you render a model that normally has smooth normals to instead be flat shaded?

10. How would you get the world position of opaque objects rendered with shaders outside of your control, from within your own shader?
11. Guys pls why shader pink???
12. Write a function to calculate the signed distance from a point `float3 p` to a sphere with radius `r`.
13. Who is bgolus? What has he contributed to your work?
14. Point out one mistake in the default include `UnityCG.cginc` and describe how you would fix it.
15. Describe briefly how you would write a screenspace effect that rotates the screen.

16. Identify and correct the bug in the loop of this raymarching function.

```
float march(float3 ro, float3 rd) {  
    float t = 0;  
    float3 p = ro;  
    for (uint i = 0; i < _Iterations; i++) {  
        p += ro + rd * t;  
        float dist = map(p);  
        if (t > _MaxDist || dist < _MinDist) break;  
        t += dist;  
    }  
    return t;  
}
```

17. What is the difference between a codelet and a graphlet? Is one objectively more intelligent than the other?

18. Describe how lights with a color set to black can be useful. Also, for extra credits, describe how lights producing NaN values can be useful.

19. Write a snippet of code which samples a `tex` field declared as `Texture2D<float4> tex;` at lod level 3, using the uv coordinates `uv`, and without directly using `.Sample` or any member functions like `.Sample`, `.SampleLod` or `.Load`.

*Hint: It might be worth looking at MSDN pages for Texture2D operators for this one.*

## Part 3 - Free form implementation (40%)

For this section, you are tasked with implementing a shader of your own choosing. It should reasonably demonstrate your knowledge of the topic. Raw source code submissions and shaders created with node-based tools such as Amplify are both fine. All sources used in the submission should be credited with comments in the Shader source code. We suggest **not** using surface shaders, though they are permitted.

Below are suggestions meant as inspiration for your own submission:

1. Small toon shader
2. Outline shader
3. Panosphere shader
4. Raytracer
5. Raymarcher
6. Geometry shader cloning
7. GPU particles
8. Literally any HDRP shader
9. A neat compute shader