# Midterm Exam

**Student Name:**                              **Class Account Username:**

**Instructions: *Read them carefully!***

*The exam begins at 1:10pm and ends at 2:30pm. You must turn your exam in when time is announced or risk not having it accepted.*

*Make sure you fill in your name and the above information, and that you sign below. Anonymous tests will not be graded.*

***Write legibly***. *If the person grading the test cannot read something, he/she will simply assume that you meant the illegible portion as a note to yourself and they will ignore it. If you lose points because part of your answer could not be read, you will not be given the opportunity to explain what it says.*

***Be clear and concise***. *The answers to most questions should be short. If you find yourself writing an excessively long response, you may want to think more carefully about the question. Long rambling answers generally get fewer points that short ones do because there are more opportunities to mark something wrong.*

*You may use one page of notes while taking the exam. You may not ask questions of other students, look at another student's exam, use a textbook, use a phone or calculator, or seek any other form of assistance. In summary: do not cheat. Persons caught cheating will be subject to disciplinary action.*

***Do not ask questions during the exam***. *Most questions are unnecessary and they disturb other students. Figuring out what the exam question is asking is part of the test. If you think you have to make some unusual assumption to answer a problem, note what that assumption is on the test.*

***I have read these instructions, I understand them, and I will follow them.***

*Your Signature:* _____

*Date:* _____

*Student ID:* _____

*Total Points: 95   You Scored:* _____

**1. Answer the following questions with True (T) or False (F)**     *1 point each, 47 Total*
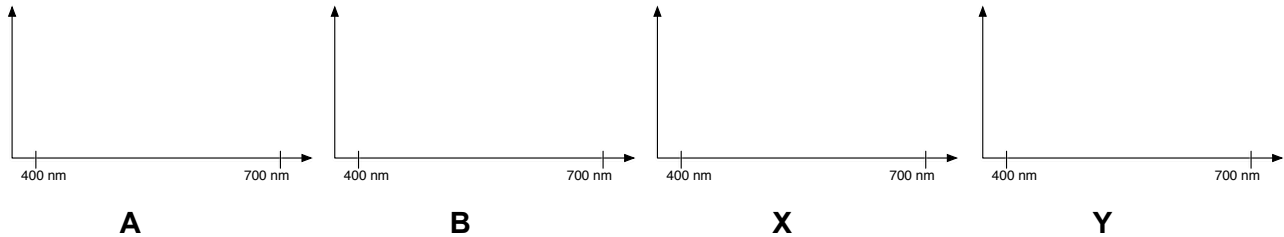
_____     Visible light corresponds to wavelengths between 1000 and 10,000 nano meters.

_____     Spectral colors have a very "washed out" appearance.

_____     Most colors observed in the real world correspond to a single wavelength of light..

_____     Your eyes contain four types of receptors that are sensitive to light.  Three of these are sensitive to color and function best in well-lit conditions.  The fourth receptor is specialized for low-light conditions.

_____     The number of color receptors in the human eye is determined by the fundamental physics of light and illumination.

_____     Subtractive color mixing only works if the three primary colors used are cyan, magenta, and yellow.  (Black is not needed and is only added to save ink when printing text.)

_____     Given a set of primary colors, the color gamut for linear mixing is defined by the convex hull of the colors plotted in the CIE color space.

_____     The HSV color space is equivalent to the RGB color space with a different parameterization

_____     The color appearance of iridescent  materials depends on interference phenomena and as a result is dependent of the angle of incoming light.

_____     The term *black-body radiation* refers to energy emitted by hot objects.  Some portion of this energy may be in the visible part of the spectrum causing hot objects to glow.

_____     The BRDF describes how light is reflected from the surface of a material.

_____     Local shading models include direct illumination effects and inter-reflection.

_____     Scattering is a phenomena that plays a key role in the appearances of milk and the sky.

_____     Ideal Lambertian materials have weak specular highlights.

_____     The exponent in the Phong specular model is sometimes referred to as an "ambient" parameter.

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_____ The specular term in a local model is a crude approximation for indirect illumination.

_____ Directional lights behave like lights located infinitely far away. (And that are also unaffected by falloff with distance.)

_____ A one-over-distance-squared falloff tends to create warm, evenly lit scenes when used with a local shading model.

_____ Polygonal models can be made to appear reasonably smooth using interpolation methods originally published by Leonardo da Vinchi.

_____ By commonly used convention, rotations in the plane are measured so that positive rotations are in a clockwise direction.

_____ Rotation matrices have determinant of +1.

_____ Any arbitrary matrix can be decomposed into a series of rotations and scales.

_____ In general, transformation matrices behave in an associative fashion.

_____ Among other benefits, pasteurized coordinates allow translation to be expressed using matrix multiplication.

_____ Any non-axis-aligned scaling in 3D can be expressed as the composition of two rotations and an axis-aligned scale.

_____ Exponential maps suffer from problems with gimbal-lock.

_____ Algorithms using axis-angle representations (also called exponential maps) should be avoided as they lead to O(exp(n)) algorithms.

_____ The rotation matrices derived using Rodriguez's formula and the consecutive rotations approach in the text are different approaches to deriving the same final rotation matrices.

_____ Raytracing algorithms can be used to easily produce clear, focused <u>refraction</u> caustics.

_____ Raytracing algorithms can be used to easily produce clear, focused <u>reflection</u> caustics.

_____ Implementing specular reflection in a raytracer is NP-hard.

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_____ Area light sources can be well approximated using a pair of point-lights.

_____ Motion blur effects can be modeled using a raytracer.

_____ Computing the intersection of a ray with a sphere requires solving a quadratic equation.

_____ BSP-Trees grow best in damp soil with full sunlight.

_____ Perspective transformation matrices are invertible.

_____ Orthographic viewing is a special case of perspective.

_____ In linear perspective projection, straight lines project to curved arcs.

_____ When specifying a perspective camera, the vector from the center of projection through the centerline of the view frustum must always be perpendicular to the viewing projection plane.

_____ In a perspective projection, <u>every</u> line in 3D space corresponds to a point in the viewing plane.

_____ When drawing curves, the midpoint test described in class guarantees that the rendered image will match the true shape of the curve.

_____ Near and far clipping planes are used to, among other things, construct the perspective matrix for a scene.

_____ When scan converting complex polygons, one can ignore diagonal edges.

_____ Most modern algorithms for drawing polygons first triangulate the polygons, then draw them.

_____ The video game "Doom" was developed in the 1950s, before most students in CS184 were born.

_____ Gouraud shading was developed by a student of Ivan Sutherland's who had been originally assigned to work on a different problem.

_____ Cake, and grief counseling will be available at the conclusion of the test.

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_____ You have two pieces of opaque *purple* plastic, pieces "A" and "B." When viewed under light source "X" they look identical in color, but when viewed under sunlight (light source "Y") they look different. Draw a set of curves showing the spectral reflectance for A and B and spectral emissions for X and Y that could provide a reasonable explanation for this situation.    *7 points*

400 nm          700 nm     400 nm          700 nm     400 nm          700 nm     400 nm          700 nm

**A**                      **B**                      **X**                      **Y**

2. **What is the term that describes two colors that appear the same to the human eye but that have different spectral distributions?**    *2 points*

3. **A perspective camera has its center of projection at** $[3,4,-5]$**, and it's image plane is defined by** $z = +7$**. What set of lines vanish at the same point as does the line** $x(t) = [3,2,1] + t\,[2,1,-1]$ **?**
    *5 points*

    **What lines do not vanish to any finite point in the image?**    *3 points*

4. **Place an** $\times$ **through the matrices that could not be valid rotation matrices. Explain your decisions.**    *4 points*
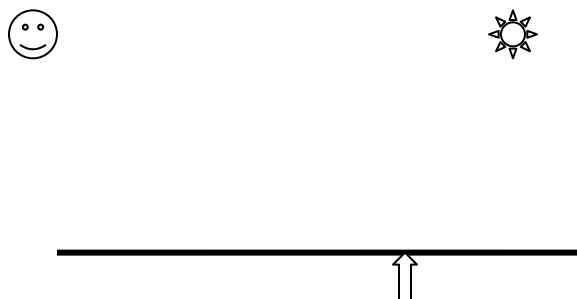
$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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5.  **This diagram shows a triangle with vertices labeled** a, b, **and** c.  **Several locations have been indicated with circles.  The list of numbers to the right contains triples of numbers representing the barycentric coordinates of these circles.  Draw a line connecting each triple with the correct circle.**          *5 points*
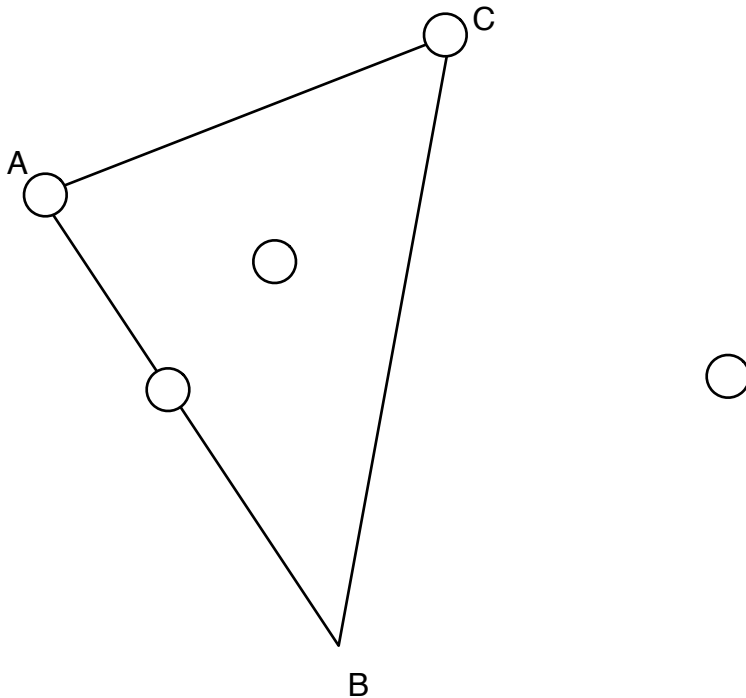


· [1,0,0]

· [0,0,1]

· [1/3,1/3,1/3]

· [1/2,1/2,0]

· [-1,1.5,1.5]

6.  **Given the following diagram showing two-dimensional "surface" and the location of the eye, light source, and shading point, annotate the diagram with the** *light*, *view*, *normal*, **and** *reflected* **vectors.  Draw the specular lobe assuming a reasonable value for the specular exponent.**  (If you are concerned about what "reasonable" means, simply indicate the value you have used.)          *6 points*

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7. The following diagram shows the the x-y plane of the CIE color space.  Mark and label the approximate locations of <u>spectral red</u>, <u>spectral green</u>, <u>spectral blue</u>, <u>spectral orange</u>, <u>pink,</u> and <u>white</u>. *6 points*
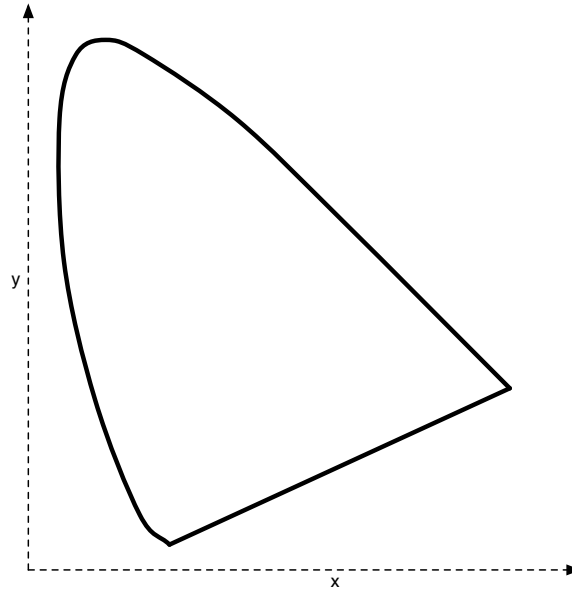


8. Where does black occur in the CIE color space? *2 points*

9. Given a rotation encoded as a axis-angle (a.k.a. exponential map), in general how is the rotation changed when the representation is doubled? *2 points*

10. Name a physical phenomena that causes the appearance of color on a surface, and that typically causes the color to change <u>dramatically</u> as the location of the light is changed. *2 points*

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11. **The following line segments will be inserted into a BSP Tree in the order indicated. As discussed in class, the lines themselves will be used to define the split planes. The numbers are on the positive side of each line.**
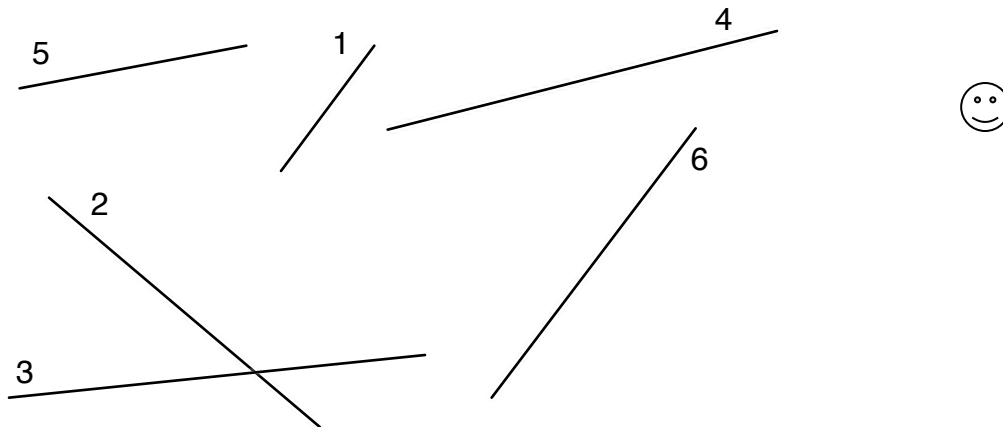


**Diagram the resulting tree below. If needed, show where line segments need to be split by marking on the above figure. Also, indicate the names of the split parts by writing labels on the figure above.** (For example, if there were a segment 9 and it was to be split, you would draw a mark showing where it would be split and label the resulting pieces 9a and 9b.) *10 points*

**List the <u>front-to-back</u> traversal order that would result for the location indicated by the viewer icon.** *3 points*