Congratulations! You passed!

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1. When using photometric stereo, which of the terms in the following equation do we NOT assume we already know? **1 / 1 point**

$$I = \mathcal{F}(s, n, \rho)$$

- ○ I
- ○ s
- ◉ n
- ○ ρ

Correct
In the equation, n refers to the surface normal, which we are trying to find. We assume the image intensity (I), source direction (s), and surface reflectance (ρ) is known.

2. Assume a surface is defined by the equation $z = x^2 + y^2$. What is the surface normal at $x = 5, y = 3$? **2 / 2 points**

- ○ $(10, 6, 1)$
- ○ $(-10, -6, 34)$
- ○ $(-10, -6)$
- ◉ $(-10, -6, 1)$

Correct

A surface normal is defined as $(-\frac{\partial z}{\partial x}, -\frac{\partial z}{\partial y}, 1)$, which in this case works out to $(-2x, -2y, 1)$.

3. If the surface gradient at a scene point in pq-space is $(2, -2)$, then the unit surface normal n of the point is: **2 / 2 points**

- $n = (2, -2, 1)$
- $n = (\frac{2}{3}, -\frac{2}{3}, \frac{1}{3})$
- $n = (\frac{1}{3}, \frac{4}{3}, \frac{2}{3})$
- $n = (0.5, 0.5, 1)$

Correct

See relationship between surface gradient and surface normal: $n = \frac{N}{||N||} = \frac{(p,q,1)}{\sqrt{p^2+q^2+1}}$.

4. When do isobrightness contours occur along a conic section around the source direction? **1 / 1 point**

- Always
- Never
- Only for Lambertian surfaces
- Only for opaque surfaces

Correct

The reason isobrightness contours occur along a conic section around the source direction in Lambertian surfaces is specifically due to the property of Lambertian surfaces that image intensity is independent of viewing direction. If this were not true, then isobrightness contours would not be bound to a conic section of possible normal directions.

5. The surface gradient of the brightest point on a Lambertian surface illuminated by a source in the direction (p_s, q_s) is: **1 / 1 point**

- ○ $(p, q) = (1, 1)$
- ◉ $(p, q) = (p_s, q_s)$
- ○ $(p, q) = (0, 0)$
- ○ $(p, q) = (\frac{p_s}{2}, \frac{q_s}{2})$

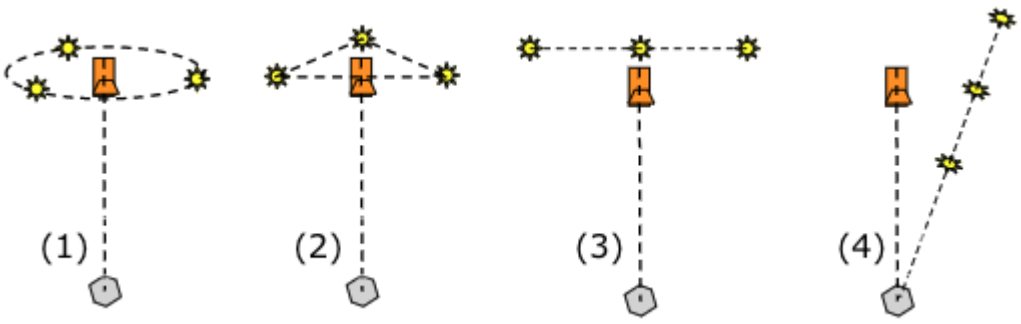
✓ **Correct**
A Lambertian surface is brightest when the angle of incidence is zero (when it is lit head-on). This corresponds to the surface normal being aligned with the source direction.

6. What is the minimum number of light sources needed to estimate the albedo and normal at all points of a Lambertian surface (assuming all light sources are visible to all points on the surface)? **1 / 1 point**

- ○ 1
- ○ 2
- ◉ 3
- ○ 4

✓ **Correct**
Photometric stereo needs three sources to work for a Lambertian surface.

7. **2 / 2 points**



Which of the following configurations of three light sources can NOT be used to perform photometric stereo?

- ○ (1) and (3)
- ○ (2) and (4)
- ◉ (3) and (4)
- ○ (1) and (2)

✓ **Correct**

For photometric stereo to work, the source matrix has to be invertible. When the sources are collinear (lie on the same line), the source matrix is singular. So, while (1) and (2) will work, (3) and (4) will not.

8. **0 / 1 point**

l_1	l_2	l_3	l_4	p	q
0.45	0.15	0.09	0.78	1.35	2.1
0.42	0.18	0.89	0.86	1.45	1.8
0.53	0.09	0.76	0.63	1.6	1.5
0.50	0.15	0.97	0.70	1.25	2.0
0.20	0.50	0.45	0.23	-1.6	1.9
0.50	0.15	0.90	0.70	1.3	1.9
0.75	0.18	0.94	0.77	1.5	-0.9

For 4 images, the captured image intensities of a point is the 4-tuple (0.5, 0.15, 0.9, 0.7). Using the following lookup table, give the estimated normal for that point:

- ◉ (1.35, 2.1)
- ○ (1.45, 1.8)
- ○ (1.6, 1.5)
- ○ (1.25, 2.0)
- ○ (-1.6, 1.9)
- ○ (1.3, 1.9)

- ◯ (1.5, -0.9)

⊗ **Incorrect**

9. A single distant light source illuminates a scene. The direction of the source can be found by taking a single image of a: **0 / 1 point**

- ◯ Lambertian sphere
- ◯ Specular sphere
- ◯ Either A or B
- ◉ Neither A nor B

⊗ **Incorrect**

10. Which of the following objects would be most affected by interreflection when performing photometric stereo? **1 / 1 point**

- ◯ A soccer ball
- ◯ A garden gnome
- ◉ An opaque glass
- ◯ A book

✓ **Correct**
Of the four objects, only the glass has significant concave surfaces, which would result in light from one point on the object's surface reflecting onto another point and resulting in a brighter image intensity.