1. Suppose a digital camera captures an RGB bit image that is 1000 x 2000 pixels. How many sensor elements does the camera have?

   - 2,000,000 **(answer)**
   - 6,000,000
   - 8,000,000
   - 12,000,000
   - 24,000,000

2. The white balance setting in the camera directly affects the RGB values in:

   - the RAW image but not the sRGB image
   - the sRGB image but not the RAW image **(answer)**
   - neither the RAW nor sRGB image
   - both the RAW and sRGB image

   Explanation: the white balance setting refers to what the camera user chooses to compensate for the lighting in the scene. This setting does not affect the RAW image, but rather the setting determines how the values in the RAW image are transformed to make the sRGB image.

3. Consider the filter $f(x) = \delta(x) - \delta(x+1)$. What is $f(x) * f(x)$?

   - $\delta(x) + \delta(x+1)$
   - $\delta(x) - \delta(x+2)$
   - $\delta(x) - 2\delta(x+1) + \delta(x+2)$ **(answer)**
   - $\delta(x+1) + 2\delta(x) + \delta(x-1)$
   - none of the others

   Explanation: You just need to perform a calculation similar to what was in the slides and exercises. You can treat it as $I(x) * f(x)$ where $I(x) = f(x)$ and sum up shifted $f()$'s according to definition.

4. In Matlab notation, the coefficients on the Prewitt filter are `[1 1 1; 0 0 0; -1 -1 -1]`. If this filter is designed to estimate a first derivative, then what value should all the coefficients by multiplied by ?

   - 1
   - $\frac{1}{2}$
   - $\frac{1}{3}$
   - $\frac{1}{4}$
   - $\frac{1}{6}$ **(answer)**
   - $\frac{1}{12}$

   Explanation: In the 1D case, the filter D that approximated $\frac{dI}{dx}$ was $[\frac{1}{2}, 0, -\frac{1}{2}]$ and the reason for the $\frac{1}{2}$ factor was that the local difference is applied on two pixels separated by a disance of 2, i.e. $(I(x+1) - I(x-1))/2$. In the 2D case with the Prewitt filter, we would need to divide by 2 for the same reason, but we would need to also divide the coefficients by 3 in order to compute an average of the three 1D derivatives in the three columns. So we divide by 6 in total. For example, if the actual y (column) derivative of the function is is 1 intensity value per pixel ($\frac{\partial I}{\partial y} = 1$), then Prewitt filter response would be 6, so we would need to divide that response by 6 to get the value 1. Alternatively, if we divide the coefficients by 6, then the filter estimates the first derivative.

5. Suppose we have a special camera that can give us a set of n points in 3D space, and we wish to fit a plane through these points using total least squares, namely we minimize the orthogonal distances between the points and the plane.

   What would be the dimension of our data matrix **A** in this case?

   - $n \times n$
   - $n \times 2$
   - $n \times 3$ **(answer)**
   - $n \times 4$

   Explanation: We want to find (a, b, c) of unit length that minimizes

   $$\sum_i (ax_i + by_i + cz_i)^2.$$

   The n rows of A are (x_i, y_i, z_i), so $n \times 3$. We minimize $\mathbf{u^T A^T A u}$ subject to u being of length 1.

