**Here is the complete test and answer key content for you to replicate in Python or any PDF generation tool.**

**Science Olympiad Division B Optics Test**

**Instructions:**

* **Time: 45 minutes**
* **Total points: 65**
* **Show all work for partial credit.**
* **Use appropriate SI units and round answers to three significant digits.**
* **Calculators and a single 8.5 x 11 reference sheet are allowed.**

**Part 1: Multiple Choice (20 points)**

**Each question is worth 2 points.**

1. **Which type of reflection occurs when light hits a rough surface?**
   * **a. Specular reflection**
   * **b. Diffuse reflection**
   * **c. Total internal reflection**
   * **d. Rayleigh scattering**
2. **The refractive index of a material is defined as:**
   * **a. The ratio of the speed of light in a vacuum to the speed of light in the material**
   * **b. The angle of incidence divided by the angle of refraction**
   * **c. The ratio of the wavelength in air to the wavelength in the material**
   * **d. The angle of refraction divided by the angle of incidence**
3. **A concave mirror produces a virtual image when the object is:**
   * **a. Beyond the center of curvature**
   * **b. At the focal point**
   * **c. Between the mirror and the focal point**
   * **d. At the center of curvature**
4. **Light passing through a prism separates into its constituent colors because of:**
   * **a. Diffraction**
   * **b. Reflection**
   * **c. Dispersion**
   * **d. Polarization**
5. **The primary additive colors of light are:**
   * **a. Red, Blue, Green**
   * **b. Cyan, Magenta, Yellow**
   * **c. Red, Yellow, Blue**
   * **d. Green, Orange, Purple**
6. **Which part of the human eye is responsible for adjusting the focus of light?**
   * **a. Retina**
   * **b. Lens**
   * **c. Iris**
   * **d. Cornea**
7. **The formula for magnification in an optical system is:**
   * **a. M=hiho=didoM = \frac{h\_i}{h\_o} = \frac{d\_i}{d\_o}**
   * **b. M=ho−hiM = h\_o - h\_i**
   * **c. M=1fM = \frac{1}{f}**
   * **d. M=di+doM = d\_i + d\_o**
8. **A yellow object illuminated with blue light appears:**
   * **a. Yellow**
   * **b. Blue**
   * **c. Black**
   * **d. Green**
9. **The focal length of a convex lens is:**
   * **a. Positive**
   * **b. Negative**
   * **c. Zero**
   * **d. Variable depending on the object distance**
10. **A plane mirror produces an image that is:**
    * **a. Real, inverted, and the same size as the object**
    * **b. Virtual, upright, and the same size as the object**
    * **c. Real, upright, and magnified**
    * **d. Virtual, inverted, and reduced**

**Part 2: Short Answer (15 points)**

**Each question is worth 3 points.**

1. **Define the difference between specular and diffuse reflection and provide one example of each.**

1. **A biconvex lens has a focal length of 10 cm. Calculate the image distance if an object is placed 15 cm from the lens. Indicate whether the image is real or virtual.**

1. **Explain why a blue sky is observed during the day but sunsets appear red.**

1. **Draw and label a ray diagram for a concave lens with an object placed beyond twice the focal length. Describe the type, orientation, and size of the image.**
2. **Describe the basic structure and function of a human eye, focusing on the roles of the cornea, lens, retina, and optic nerve.**

**Part 3: Problem-Solving (15 points)**

**Each question is worth 5 points.**

1. **A light ray traveling in air strikes a glass slab (n = 1.5) at an angle of incidence of 45°. Calculate the angle of refraction using Snell’s Law.**
2. **A double convex lens has a focal length of 20 cm. An object 5 cm tall is placed 30 cm from the lens. Calculate:**
   * **a. The image distance**
   * **b. The magnification**
   * **c. The height of the image**
3. **A beam of white light passes through a prism with a refractive index of 1.52 for red light and 1.55 for violet light. The prism is 10 cm thick. Calculate the angular dispersion between red and violet light.**

**Part 4: Color Theory and Pigments (15 points)**

**Each question is worth 3 points.**

1. **Mixing Primary Paint Colors: Indicate the result of mixing the following primary colors of paint in equal amounts:  
   a. Cyan + Magenta = \_\_\_\_\_\_\_  
   b. Cyan + Yellow = \_\_\_\_\_\_\_  
   c. Magenta + Yellow = \_\_\_\_\_\_\_  
   d. Cyan + Magenta + Yellow = \_\_\_\_\_\_\_**
2. **White Appearance: What primary pigments must be imparted to an object to give it the appearance of white?**
3. **Black Appearance: What primary pigments must be imparted to an object to give it the appearance of black?**
4. **Absorption by Pigments: A primary pigment selectively absorbs a specific primary color of light. Use your understanding of color addition and subtraction to indicate the primary colors of light absorbed by each primary pigment:  
   a. Cyan pigment absorbs the primary light color \_\_\_\_\_\_\_.  
   b. Magenta pigment absorbs the primary light color \_\_\_\_\_\_\_.  
   c. Yellow pigment absorbs the primary light color \_\_\_\_\_\_\_.**
5. **Color Equations and Pigments: Complete the equations and identify the pigment(s):  
   a. R+G+B−B=R+G=Yellow;R + G + B - B = R + G = Yellow; Yellow pigment is present.  
   b. R+G+B−G−B=R=Red;R + G + B - G - B = R = Red; Magenta and Yellow pigments are present.  
   c. R+G+B−R=G+B=Cyan;R + G + B - R = G + B = Cyan; Cyan pigment is present.  
   d. R+G+B−G=R+B=Magenta;R + G + B - G = R + B = Magenta; Magenta pigment is present.  
   e. R+G+B−R−G−B=Black;R + G + B - R - G - B = Black; Cyan, Magenta, and Yellow pigments are present.**