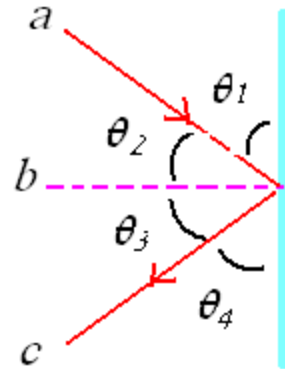


****Don't worry about significant figures on this test; we will grade calculations leniently! Point values are given in parentheses next to questions** Show your work for partial credit. Please do not write on this test.**

Diana was shopping on Rodeo Drive in Beverly Hills when she saw an attractive male off of a shop window. Diana was at position A and the attractive male, named Ian, was at position C. Assume $\theta_1 = 50.0$.

1. What type of reflection lets Diana see the attractive male? (1)
2. What is θ_3 (in degrees)? (1)
3. If both Ian and Diana are 5.00 meters away from the the window, how far is she from Ian (i.e. what is the distance $\vec{a}\vec{c}$)? (3)



As Diana approached Ian, she saw a pool of water on the floor, and because Beverly Hills is really hot, she was super super thirsty. When she approached closer, she saw an interesting colorful pattern on the surface of the puddle.

4. What type of phenomenon is this? (1)
5. What principle says that you can sum together the troughs and crests of two or more waves to produce a new wave? (1)
6. Give a short explanation for why the phenomenon in question 4 occurs. (2)

Then Diana fell in the puddle and made a fool of herself. :(

7. (Tiebreaker) Diana was trying to tell this story to her friends and wanted to recreate the colorful pattern. Unfortunately, she spent her time shopping instead of studying for physics so she tries to relearn the concepts. She set up a double slit experiment where the distance between the two slits is $2.6 \mu\text{m}$. The first-order bright fringe is found to be 12° from the central maximum. What is the wavelength of light used to created this pattern (in nm)? (3) Hint: the relevant equation here is $d \sin \theta = m\lambda$.

The next day, Diana and her boyfriend Harry Styles went spearfishing for rainbow trout in Alaska because Harry had a private jet to fly them with. However, after using their ice auger to carve out a 2 ft x 3 ft hole, all the spears they threw into the water overshot the fish. As it turns out, the fish were closer than they appeared.

8. What phenomenon caused this effect? (1)
 - a. Love at first sight - they were too distracted with each other
 - b. Reflection
 - c. Refraction
 - d. Diffraction

Out of the blue Harry proposed to her, with a sparkling diamond.

9. What phenomenon related to light makes the diamond sparkle? (1)

Diana was taken aback and said she would consider it, but she needed to consult her fortune teller first. The fortune teller peered into a prism made of crown glass with an apex angle of 55 degrees. Assume the medium outside the prism is air where $n_0=1$.

10. Calculate the angle of minimum deviation. Hint: the equation on the right may come in handy. (3)
- $$\frac{n_{prism}}{n_0} = \frac{\sin \frac{1}{2}(\sigma + \delta)}{\sin \frac{1}{2}\sigma}$$
11. When is the angle of deviation minimized? (1)
- When the angle of incidence is equal to the critical angle
 - When the angle of incidence is equal to 0
 - When the apex angle is equal to 45 degrees.
 - When the entrance and exit angles are equal
12. What is the name of the sum of the deflections of a ray of light in the prism? (1)
- Critical angle
 - Deviation angle
 - Dispersion angle
 - Refracted angle

With a gasp, the fortune teller told Diana that she has an ominous future with Harry. Ian would return to crash their wedding and ruin it. With this, Diana decided that it would no longer be worth it to try to marry Harry.

Harry searched his mind for anything to win over his soon-to-be fiance. He decided on taking them to the zoo, where they visited the penguin exhibit (Diana's favorite!). A 120 cm Rockhopper penguin stood a distance of 30 cm from a concave mirror with a focal length of 14.2 cm.

13. Determine the image distance and the image size (to the nearest hundredth for ease of grading plz). (2)

In the next exhibit they visited, the penguins were standing in front of lenses (as opposed to mirrors). Diana, who always brings around her sketchpad and a pencil, decided to depict the penguin standing at the lens. Diana sucks at drawing though so she just drew vertical lines to represent the penguins. Even though she sucks at drawing penguins, she still draws the ray tracings spot on.

14. Draw the correct ray tracing for a convex lens as Diana would for each of the following scenarios: (Make sure to label the resulting image with the correct height and the arrows on the rays pointing in the direction of light.) (3 per part)
- A 3 cm object between F and 2F
 - A 4 cm object at 1 focal length away from the lens.
15. (Tiebreaker) Draw the ray diagram for two convex lenses when the object is placed as shown below. You may disregard the image formed from the first lens alone. (2)
16. Select one of the statements from the following. Statements may be used more than once or not at all. (3).

- i. Convex mirror, inside 1 focal length
- ii. Convex lens, inside 1 focal length
- iii. Convex lens, outside 1 focal length

- a. Virtual and upright
- b. Virtual and inverted
- c. Real and upright
- d. Real and inverted

An angry ANGRY Rebecca was trying to spy on Diana and Harry's date at the zoo, so she used a telescope to try and observe them. The telescope had an objective lens focal length of 25000 mm and an eyepiece focal length of 10 mm.

17. What was the total magnification of the telescope? (2)

18. A compound microscope contains 2 lenses, called the _____ lens and the _____ lens. They are both _____ (concave/convex) lenses. (3)

After the penguin exhibit, Diana was feeling very thirsty again so the two of them stopped by an Icee stand. She only likes Icees that are the secondary colors of light.

19. What are the three colors of Icees she bought? (3)

Next, they entered a hedgehog light show. At a zoo! Built with bazillionaire Aarthi's money! Many different colored lights shone around the room.

20. Red light and green light combine to make what color light? (1)

21. In the normal daylight, Diana's socks appear red. This means they reflect light with a wavelength of about _____ nm. (1)

22. The longest visible wavelength is _____ and the shortest is _____. (2)

23. Diana's shirt is violet. This means her shirt absorbs which of the following colors? Select all that apply. (1)

- a. Red
- b. Yellow
- c. Green
- d. Violet

After the light show, Diana was convinced! She was gonna marry Harry! She loved the light show so much she even invited Aarthi to her wedding.

24. The lights really caught Diana's eye. How many rods are in the human eye? (1)

25. The photoreceptors in the human eye are approximately _____% rods and _____% cones. (2)

26. Which part of the eye contracts and relaxes to alter the size of the aperture in the center? (1)

27. What is the name of the white outer layer of the eyeball, composed of collagen and elastic fiber? (1)

It was finally Diana's wedding day! However, Ian brought out massive spotlights to attempt to blind the bride, groom, and guests. Aarthi saved the day though, with a pair of polarizing sunglasses for everyone! After she saved the day, Diana kicked out Rebecca as the maid of honor after learning of her snooping, and replaced her with Aarthi!

28. Which of the following is true regarding polarizers? (mark all that apply) (1)
- They can be used to adjust the intensity of a light source
 - They can be used to reduce glares or hot spots
 - Polarization is a phenomenon specific to waves that vibrate in a direction parallel to the direction of propagation.
 - Sound waves can be polarized.

At the wedding Diana made her own light show. This time with water though.

29. Light travels from (room temperature) water into an acrylic medium with index of refraction 1.498, at an angle of incidence of 48° . What is the angle of refraction of the light ray? (2)

30. Diana even had the light get projected into a weird new material she found. If the speed of light through the material is 2.0×10^9 m/s. What is the index of refraction for the material? (2)

Diana and Harry lived happily ever after - until 5 years later when Diana left Harry for Ian. Luckily, Harry was having an affair with Aarthi's friend David at the time, so they got hitched instead. Then Aarthi was left sad and alone. :(RIP AARTHI.

31-33. Identify these types of spectra (continuous, absorption, or emission):

