Rustin Science Olympiad Invitational – January 6, 2018

Optics: Division B

School Name:	Team Number:
Student Name(s):	

Written Test Score: / 64

1. What type of wave is light wave? (1pt)
    a. Mechanical, Traverse
    b. Electrical, Traverse
    c. Electromagnetic, Longitudinal
    d. Electromagnetic, Surface
    e. None of the above

2. The wavelength of an electromagnetic wave that has a frequency of 10Hz is (1pt)
    a. Greater than 0.1m
    b. Equal to 0.1m
    c. Less than 0.1m
    d. Not enough information to calculate

3. Frequency of a Blue light is near (1pt)
    a. 60.6 THz
    b. 6.06×10^{10} Hz
    c. 606 THz
    d. 6.06 MHz

4. When light travels from glass to water, (1pt)
    a. Frequency increases & Velocity remains the same
    b. Frequency decreases & Velocity remains the same
    c. Frequency remains the same & Velocity increases
    d. Frequency remains the same & Velocity decreases

5. The difference(s) between FM radio wave and light wave is(are) its (1pt)
    a. Speed
    b. Wavelength
    c. Frequency
    d. Both a and b
    e. Both b and c
    f. Both a and c
    g. All a, b and c

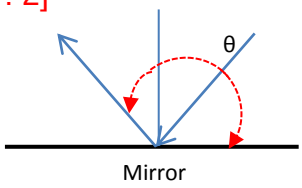
6. Wavelength of ultraviolet light is closer to (1pt)
    a. 300mm
    b. 900nm
    c. 390nm
    d. 700THz
    e. None of the above

7. As the angle of incidence is increased for a ray incident on a reflecting surface, the angle between the incident ray and normal ultimately approaches what value? (1pt)
    a. 45 degrees
    b. 90 degrees
    c. 180 degrees
    d. 360 degrees
    e. 0 degrees

8. If you stand 0.25m away from a plane mirror and your friend stands 0.75m away from the same mirror right behind you, how far is your friend's image you'll see from where you stand? (1pt) [Tie Breaker: 1]
    a. 0.5m
    b. 0.75m
    c. 1m
    d. 1.25m
    e. 1.5m

9. One of the examples for diffuse reflection is: (1pt)
    a. Reflection from a dresser mirror
    b. Reflection for a glossy laptop screen
    c. Reflection from a water falls
    d. Reflection from a window of a building

10. If the angle θ in the mirror, showing incident and reflected rays, is 105 degrees, what is the angle of incidence? (1pt) [Tie Breaker: 2]
    a. 75 degrees
    b. 15 degrees
    c. 52.5 degrees
    d. Not enough information



11. Refractive Index of Sapphire is 1.7. What is the speed at which light travels in Sapphire? (1pt)
    a. 1.8×10^8 m/s
    b. 5.1×10^8 m/s
    c. 3×10^8 m/s
    d. 1.8 m/s

12. Refraction results from differences in light's (1pt)
    a. Frequency
    b. Amplitude
    c. Velocity
    d. Both a and b
    e. Both a and c
    f. All of the above
    g. None of the above

13. Calculate the index of refraction for an object in which light travels at 1.97×10^8 m/s. (1pt)
    a. 1.97 m/s
    b. 0.66 m/s
    c. 1.52 m/s
    d. 1.95
    e. 1.52

14. Different wavelengths have different indices of refraction. This phenomenon is called (1pt)
    a. Deviation
    b. Dispersion
    c. Diffraction
    d. Polarization

15. Choose the answer with correct order of the angle of deviation of a prism (θ_{color}) for different colors. (1pt) [Tie Breaker: 3]
    a. $\theta_{red} < \theta_{blue} < \theta_{green}$
    b. $\theta_{green} < \theta_{blue} < \theta_{red}$
    c. $\theta_{blue} < \theta_{green} < \theta_{red}$
    d. $\theta_{red} < \theta_{green} < \theta_{blue}$

16. Mirage is an optical phenomena caused by (1pt)
    a. Diffused Reflection by non-uniform ground
    b. Scattering of light wave in hot weather
    c. Diffraction due to desert sand
    d. Refraction in a non-uniform medium

17. A spherical mirror that forms only virtual images has a radius of curvature of 0.5 meters. The focal length of this mirror is? (1pt)
    a. -0.125 m
    b. -25 cm
    c. 2.5 m
    d. 0.25 m

18. Magnification of a convex mirror is always (1pt)
    a. Less than or equal to 1
    b. Greater than 1
    c. Can be both a. and b. above.
    d. None of the above

19. A convex mirror has radius of curvature of 54cm. Find the distance of the image from the mirror, when object is placed 9cm away from the mirror. (1pt) [Tie Breaker: 4]
    a. -6.75cm
    b. 13.5cm
    c. -13.5cm
    d. -10.8cm

20. A spherical concave mirror is used in a flash light. Where would the bulb of the headlight be located to produce a parallel beam of reflected light? (1pt)

    a. Between the principal focus and the mirror
    b. Beyond the center of curvature of the mirror
    c. At the principal focus of the mirror
    d. At the center of the curvature of the mirror

21. The color of an object seen in observer's eyes depends on: (1pt)

    a. The frequency of light that is emitted from the object
    b. The color of light that is scattered from the object
    c. The wavelength of light that is reflected by the object
    d. The wavelength of light that is absorbed by the object
    e. B, C and D above
    f. C and D above
    g. All of the above

22. Three spheres under Cyan light are seen as Black, Green and Blue respectively. The real colors of the spheres in white light are (1pt)

    a. Red, Green and Magenta
    b. Black, Yellow and Blue
    c. Black, Yellow and Cyan
    d. Blue, Green and Blue
    e. Answer can be both A and B above
    f. Answer can be both A and D above
    g. Answer can be A, B and C above
    h. All A, B, C and D above
    i. None of the above

23. Illuminating with _____ color is least efficient for the growth of green leafed plant. (1pt) [Tie Breaker: 5]

    a. Red
    b. Blue
    c. Green
    d. All are equally bad
    e. None of the above

24. Choose the combination that gives the correct pair of complementary colors of light: (1pt)

    a. Red and Cyan; Green and Magenta; Blue and Yellow
    b. Red and Magenta; Green and Yellow; Blue and Cyan
    c. Red and Yellow; Green and Cyan; Blue and Magenta

25. An unpolarized light will be fully blocked when it passes through 2 polarizing lens whose axes are (1pt)

    a. Parallel to each other
    b. 45 degrees to each other
    c. Perpendicular to each other
    d. 180 degrees to each other
    e. Parallel or Perpendicular to each other

26. A polarized sunglasses help block the sun glare reflecting from a body of water because (1pt)
    a. the reflection in water surface polarizes the reflected sun light horizontally.
    b. the reflection in water surface polarizes the reflected sun light vertically.
    c. the reflection in water surface reduces the intensity of sun light.
    d. some of the sunlight get refracted in to water reducing the intensity of sun light.
    e. not enough information.

27. Which part of the eye can detect different wavelengths of the light? (1pt)

    a. Pupil
    b. Cornea
    c. Rods
    d. Cones
    e. Eyelid

28. The proper name for farsightedness is (1pt)

    a. Hyperopia
    b. Presbyopia
    c. Astigmatism
    d. Myopia
    e. Glaucoma

29. An object .050 meter high is placed .20 meter from a converging (convex) lens. If the distance from the image of the lens is .40 meter, the height of the image is? (1pt) [Tie Breaker: 6]

    a. 0.050 m
    b. 0.100 m
    c. 0.150 m
    d. 0.025 m

30. The focal length of a diverging lens is 18cm. If an object is placed 8cm away from the lens, the image will be (1pt)

    a. Smaller and Virtual
    b. Smaller and Real
    c. Larger and Real
    d. Larger and Virtual
    e. Same size and Real

31. A convex lens that is converging in air is made of a material with refractive index 1.25. If this lens is placed under water, (1pt)

    a. It will become diverging under water
    b. It will still be converging under water but with change in focal length
    c. It will still be converging under water without any change in focal length

32. Driving on a sunny day, when entering a tunnel there are bright lights installed at the entrance that slowly fades as you go deeper in to the tunnel. These bright lights help (1pt)

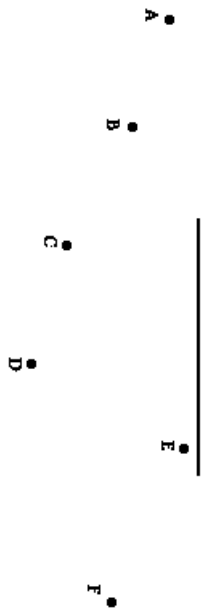
    a. Ciliary Muscle of the eye accommodate instantly
    b. Cornea of the eye shrink faster
    c. Retina of the eye move away slowly
    d. Pupil of the eye dilate gradually
    e. Pupil of the eye constrict relaxingly

33. A neon sign does not produce (1pt)
    a. Photons
    b. An emission spectrum
    c. An absorption spectrum
    d. A line spectrum

34. Shown is a car bumper sticker. What is it referring to? (1pt.)
    a. It's an optical illusion due to dispersion that changes color when driving very fast.
    b. It's Doppler shift of the color of light towards blue that is not possible at driving speeds.
    c. It's scattering caused by Xenon light bulbs of car headlights that make the sticker look blue at higher speeds at bad weather conditions.
    d. It is effect seen by NASCAR drivers when driving with polarized sunglasses on during evening sun at speeds faster than 200MPH.

35. Though water is colorless and transparent, why are you able to see a round water drop on a table? (1pt)
    a. Because table reflects the light
    b. Refraction of light through the water drop give away its location
    c. Due to Viscosity of water
    d. Water drop reflect lights
    e. Both A and B above
    f. Both B and C above
    g. Both B and D above
    h. All of the above

36. A, B, C, D, E and F are standing in front of the mirror as shown below. Using the line of sight constructions, draw the images and rays, then determine the following: (8pts)



a. A can see the images of _____
b. B can see the images of _____
c. C can see the images of _____
d. D can see the images of _____
e. E can see the images of _____
f. F can see the images of _____

37. A warehouse safety mirror, semi spherical in shape with 15cm radius, is shown here. 3.3m tall fork lift is standing 2m from the mirror surface.

a. Where is the image present relative to the surface of the mirror (3pts)

b. How large is the image of the fork lift. (3pts)

38. The width of a pop-up home projector screen that was setup during a pool party is 2.5m. Image from a DLP projector that uses a DMD chip (Digital Micro-mirror Device) is projected on to this screen. This 10mm wide DMD chip displays the movie on its flat surface acting like a digital film. The DMD chip surface is magnified and projected as image on the screen using the projector lens. Suppose the screen is placed 5m away from the projector lens, [Tie Breaker: 7]
    a. Find the magnification of the image (3pts)

    b. Find the focal length of the projector lens (3pts)

39. An upright image is reduced to 1/4th of the object's height when the object is placed 20cm from the lens.
    a. Find the type of the image and lens used here (2pt)

    b. Find the focal length of the lens. (3pts)

40. The security guards for a celebrity catch a reporter shooting pictures of her at home. The celebrity claims the reporter was trespassing by standing in her front yard while taking the pictures. Her front yard is 30m from the curb of a public street. She gives as evidence the film she seized filing charges against the reporter. Her 1.75m height is 8.25mm tall image on the film and the focal length of the camera lens used was 210mm. How close was the reporter standing to her? Where they able to find if he is guilty with trespassing using the evidence given? (4pt)