St John Baptist De La Salle Catholic School, Addis Ababa

Grade 10 Physics Final Examination

4^{th} Quarter

June, 2023

Notes, and use of other aids is **NOT** allowed. Read all directions carefully and **write your answers in the answer sheet**. To receive full credit, you must show all of your work. **USE OF CALCULATORS IS ALLOWED**.

Name:_____ Roll Number:_____ Section:___Time Allowed: **2 hours**

Multiple Choice Questions

1. Why are diverging mirrors often used for rear-view mirrors in vehicles? What is the main disadvantage of using such a mirror compared with a plane one?

   A. It gives a wide range of view. The image appears to be closer than the actual object.

   B. It gives a narrow range of view. The image appears to be farther than the actual object.

   C. It gives a narrow range of view. The image appears to be closer than the actual object.

   D. It gives a wide range of view. The image appears to be farther than the actual object.

   Answer: A

2. When you focus a camera, you adjust the distance of the lens from the film. If the camera lens acts like a thin lens, why can it not be kept at a fixed distance from the film for both near and distant objects?

   A. To focus on a distant object, you need to increase the image distance.

   B. To focus on a distant object, you need to increase the focal length of the lens.

   C. To focus on a distant object, you need to decrease the focal length of the lens.

   D. To focus on a distant object, you may need to increase or decrease the focal length of the lens.

   Answer: No answer
   To focus a distant object, we would need to decrease the distance between the film and the lens, i.e., the image distance.

3. A telephoto camera uses a mirror instead of a lens to capture an image. What radius is needed for a concave mirror to replace a 0.800 -m focal-length telephoto lens?
   A. 0.400 m B. 1.60 m C. 4.00 m D. 16.0 m
   Answer: B

4. An optical fiber uses flint glass (n = 1.66) clad with crown glass (n = 1.52) . What is the critical angle?
   A. 33.2° B. 23.7° C. 0.92 rad D. 1.16 rad
   Answer: D

5. A camera's zoom lens has an adjustable focal length ranging from 2.0cm to 5.0cm . What is its range of powers?
   A. 1 D to 10 D B. 2 D to 5 D C. 20 D to 50 D D. 10 D to 25 D
   Answer: C

6. What is the focal length of a makeup mirror that produces a magnification of 2.00 when a person's face is 8.00 cm away?
   A. –16 cm B. –5.3 cm C. 5.3 cm D. 16 cm
   Answer: D

7. According to concepts on which Maxwell's equations are based on, why is a compass needle is deflected when the compass is brought near a wire that is carrying an electric current?
   A. The charges in the compass needle and the charges in the electric current have interacting electric fields, causing the needle to deflect.
   B. The electric field from the moving charges in the current interacts with the magnetic field of the compass needle, causing the needle to deflect.
   C. The magnetic field from the moving charges in the current interacts with the electric field of the compass needle, causing the needle to deflect.
   D. The moving charges in the current produce a magnetic field that interacts with the compass needle's magnetic field, causing the needle to deflect.

   Answer: D

8. In which region of the electromagnetic spectrum would you find radiation that is invisible to the human eye and has low energy?
   A. Long-wavelength and high-frequency region B. Long-wavelength and low-frequency region
   C. Short-wavelength and high-frequency region D. Short-wavelength and low-frequency region
   Answer: B

9. Light travels at different speeds in different media. Put these media in order, from the slowest light speed to the fastest light speed: air, glass, vacuum, water.
   A. glass, water, air, vacuum B. vacuum, glass, air, water C. glass, air, water, vacuum
   D. air, glass, water, vacuum
   Answer: A

10. Standing in front of a fire, we can sense both its heat and its light. How are the light and heat radiated by the fire the same, and how are they different?
    A. Both travel as waves, but only light waves are a form of electromagnetic radiation.
    B. Heat and light are both forms of electromagnetic radiation, but light waves have higher frequencies.
    C. Heat and light are both forms of electromagnetic radiation, but heat waves have higher frequencies.
    D. Heat and light are both forms of electromagnetic radiation, but light waves have higher wavelengths.

    Answer: B

11. Light travels through the wall of a soap bubble that is 600 nm thick and is reflected from the inner surface back into the air. Assume the bubble wall is mostly water and that light travels in water at 75 percent of the speed of light in vacuum. How many seconds behind will the light reflected from the inner surface arrive compared to the light that was reflected from the outer surface?
A. $4.0 \times 10^{-8}s$ B. $5.3 \times 10^{-6}s$ C. $2.65 \times 10^{-15}s$ D. $5.3 \times 10^{-15}s$
Answer: C

12. An image of a 2.0 - cm object reflected from a mirror is 0.8 cm tall. What is the magnification of the mirror?
A. 0.4 B. 2.5 C. 3 D. 10
Answer: A

13. An object is placed 4.00cm in front of a mirror that has a magnification of 1.50. What is the radius of curvature of the mirror?
A. -24 cm B. -4.8cm C. 24 cm D. 4.8cm
Answer: C

14. If the lens-to-retina distance is 2.00cm, what is the power of the eye when viewing an object 50.0cm away?
A. 52.0 D B. 1.92 D C. -52.0 D D. 0.52 D
Answer: A

15. Which form of EM radiation has the most penetrating ability through an object?
A. blue light B. microwaves C. x rays D. infrared radiation
Answer: C

16. A pin stands erect 10cm from a converging mirror of focal length 20cm. How far apart are the pin and its image?
A. 10cm B. 7cm C. 20cm D. 30cm
Answer: A

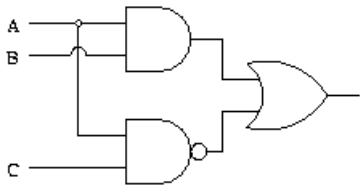
17. Which of the following is true about semiconductors?
    A. At a certain temperature, semiconductors have both a positive and negative charge carriers.
    B. Semiconductors have positive charge carriers
    C. The number of charge carriers in semiconductors decreases with temperature
    D. Conduction is in semiconductors is only due to free electrons.

    Answer: A, B

18. An input of alternating current to a device results in an output of a direct current. The device could be:
A. a diode with capacitor filter B. transistor C. capacitor D. resistor
Answer: A

19. A lens produces a real image that is four times as large as the object and is located 24 cm from the lens. What is the focal length of the lens?
A. 4 cm B. 8 cm C. 6 cm D. 4.8 cm
Answer: D

20. The diagram below represents a combination of logic gates. If a signal is present in all inputs but B, what is the output of the combination?



A. Signal B. No signal C. Indefinite
Answer: B

21. A lightyear is the distance light travels in one Earth year. What is 1 light year in kilometers?
A. $2.59 \times 10^{10} km$ B. $1.58 \times 10^{11} km$ C. $2.63 \times 10^{9} km$ D. $9.46 \times 10^{12} km$
Answer: D

22. Water floats on the liquid state of carbon tetrachloride. The two liquids do not mix. A light ray passing from water into carbon tetrachloride has an incident angle of 45.0 degrees and an angle of refraction of 40.1 degrees. If the index of refraction of water is 1.33, what is the index of refraction of carbon tetrachloride?
A. 1.60 B. 1.49 C. 1.21 D. 1.46
Answer: D

23. What is the magnification of a convex lens if it produces a virtual, 12-cm high image of a 4-cm high object?
A. -3 B. +3 C. $\frac{1}{3}$ D. $-\frac{1}{3}$
Answer: B

24. Which of the following is not the result of refraction?

A. A stick immersed in water appears to be broken.

B. Formation of images by mirrors.

C. The apparent depth of an object in water being smaller than the actual object.

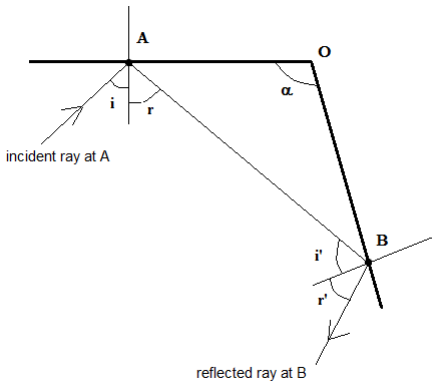
D. A star looking higher in the sky than it actually is.

Answer: B

25. The magnification of a book held 7.50 cm from a 10.0 cm focal length lens was found to be 4.00. What is the magnification for the book when it is held 8.50 cm from the magnifier?
A. +6.67 B. +3.33 C. -6.67 D. -3.33
Answer: A

26. Calculate the power of the mirror formed by the shiny back of a spoon that has a 3.00 cm radius of curvature.
A. +66.7 D B. +33.3 D C. -66.7 D D. -33.3 D
Answer: C

27. In the figure below, if $\mathbf{i} = 30^0$(the angle of incidence at A) and $\alpha = 95^0$, what is the value of $\mathbf{r'}$(the angle of reflection for the reflected ray at B)?



A. 25^0 B. 75^0 C. 65^0 D. 15^0
Answer: C

28. For eye surgery, we use a $193nm$ UV radiation. Assuming the accuracy with which this EM radiation can ablate the cornea is directly proportional to wavelength, how much more accurate can this UV be than the shortest visible wavelength of light($380nm$)?
A. 0.508 B. 1.97 C. 2 D. 1.508
Answer: B

29. If the moon suddenly exploded, how long after the incident will we find out here on Earth if the Moon is on average, $384,400km$ away from Earth?
A. 1.28 s B. 2.56 s C. 2.4 s D. 7 minutes & 46 seconds
Answer: A

30. Where does an object need to be placed relative to a microscope for its 0.500 cm focal length objective to produce a magnification of -400?
A. 0.510 cm B. 0.501 cm C. 0.610 cm D. 0.499 cm
Answer: B

Workout Problems

31. Combine thin lens equations to show that the magnification for a thin lens is determined by its focal length and the object distance and give a function that expresses the magnification as a function of the focal length and distance of object.

From the thin lens equation, we know the following:

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$$

$$\frac{1}{d_i} = \frac{d_o - f}{f d_o}$$

$$d_i = \frac{f d_o}{d_o - f}$$

We know that the magnification is given by:

$$M = \frac{-d_i}{d_o}$$

$$M = \frac{-\frac{fd_o}{d_o - f}}{d_o} \implies M = \frac{\frac{fd_o}{f - d_o}}{d_o}$$

$$M = \frac{f}{f - d_o}$$

32. What power of spectacle lens is needed to correct the vision of a nearsighted person whose far point is 25.0 cm? Assume the spectacle (corrective) lens is held 1.50 cm away from the eye by eyeglass frames.

    Since the person is nearsighted, when the correction is applied, they need to be able to observe far objects. For this, the distance of the image is the near point for with respect to the lens. To our eye, the near point is 25.0cm away, but for a spectacle lens that is between our eye and the near point, the distance shortens to (25.0cm-1.50cm). Thus, $d_i = -23.5cm$
    The distance of object, as we tried to see above, is very large, so we just use $d_o = \infty$.

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{1}{f} = \frac{1}{-23.5cm} + \frac{1}{\infty}$$

$$P = \frac{1}{f} = -4.26D + 0$$

$$P = -4.26D$$

33. A dentist uses a small mirror that gives a magnification of 5.0 when it is held 0.60cm from tooth.

    - What is the radius of curvature of the mirror?

      Here, the distance of the object(tooth) is 0.60cm. We have been given a magnification of 5.0, which indicates that it is a converging mirror because it is able to magnify. We first need to find the distance of the image and then the focal length.

$$M = \frac{-d_i}{d_o} \implies d_i = -Md_o \implies d_i = -5.0 \times 0.60cm = -3cm$$

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{1}{f} = \frac{1}{-3cm} + \frac{1}{0.60cm}$$

$$\frac{1}{f} = \frac{1 + (-5)}{-3cm}$$

$$\frac{1}{f} = \frac{4}{3cm}$$

$$f = \frac{3}{4}cm$$

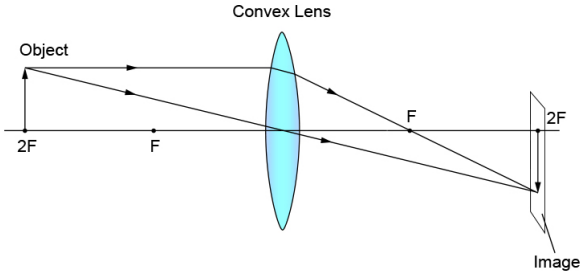
    - What about its power?

$$P = \frac{1}{f} = \frac{1}{\frac{0.03m}{4}}$$

$$P = \frac{400}{3}D$$

34. For an object placed in front of a convex lens such that $d_o = 2f$,

- trace the rays and draw the image.



- show that the image is as far away from the lens as the object is.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

We know that $d_i = 2f$

$$\frac{1}{f} = \frac{1}{2f} + \frac{1}{d_i}$$
$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{2f}$$
$$\frac{1}{d_i} = \frac{2-1}{2f}$$
$$\frac{1}{d_i} = \frac{1}{2f} \implies d_i = 2f$$

QED

35. If a pulsed laser may produce an electromagnetic wave with a maximum electric field strength of $2.05 \times 10^{11} V/m$ for a time span of 1.00 ns, determine

- the maximum magnetic field strength in the wave

$$E = cB \implies B = \frac{E}{c}$$
$$B = \frac{2.05 \times 10^{11} V/m}{3 \times 10^8}$$
$$B = 683T$$

- the potential difference if it was applied over a distance of 2μm

$$V = Ed$$
$$V = 2.05 \times 10^{11} V/m \times 2 \times 10^{-6} m$$
$$V = 4.10 \times 10^5 V$$

Extra Credit Problems

36. An EM radiation from a 6.00-W laser is concentrated on an area of $0.50mm^2$, if a static charge moves at a speed of $0.005c$, what is the maximum force it can feel?

The average intensity of this EM wave can be calculated as follows:

$$I = \frac{P}{A}$$
$$I = \frac{6.00W}{5 \times 10^{-10}m^2}$$
$$I = 1.2 \times 10^{11}W/m^2$$

From this, we can find the electric field.

$$E_0 = \left(\frac{2I_{ave}}{c\epsilon_0}\right)^{1/2}.$$
$$E_0 = \left(\frac{2 \times 2 \times 10^{11}W/m^2}{3 \times 10^8 m/s \times 8.85 \times 10^{-12}C^2/Nm^2}\right)^{1/2}$$
$$E_0 = \left(\frac{2 \times 2 \times 10^{11}W/m^2}{3 \times 10^8 m/s \times 8.85 \times 10^{-12}C^2/Nm^2}\right)^{1/2}$$
$$E_0 = \left(1.507 \times 10^{14}\right)^{1/2} V/m$$
$$E_0 = \left(1.23 \times 10^7\right) V/m$$

From this, we can calculate the magnetic field.

$$B_0 = \frac{E_0}{c}$$
$$B_0 = \frac{(1.23 \times 10^7)\, V/m}{3.00 \times 10^8 m/s}$$
$$B_0 = 4.09 \times 10^{-2}T$$

Now that we have calculated the electric and magnetic fields, we can calculate the force. The maximum force the charge can experience under this radiation is the Lorentz force.

$$F = qvB + qE$$
$$F = q(vB + E)$$
$$F = q(0.005 \times 3 \times 10^8 m/s(4.09 \times 10^{-2}T) + 1.23 \times 10^7 V/m)$$
$$F = q(6.14 \times 10^4 + 1.23 \times 10^7)N/C$$
$$F = q(1.24 \times 10^7)N/C$$

37. Find the power of a lens whose radii are 10cm and 12cm and if it is made of crown glass($n = 1.52$)?

$$\frac{1}{f} = (n-1)(\frac{1}{R_1} + \frac{1}{R_2})$$
$$\frac{1}{f} = (1.52-1)(\frac{1}{10cm} + \frac{1}{12cm})$$
$$P = (0.52)(\frac{1}{0.1m} + \frac{1}{0.12m})$$
$$P = 9.53D$$

a