Team Number: _____

OPTICS **Team Members: _____**

WRIGHT STATE INVITATIONAL **School: _____**

28 February 2012

Circle your answer on each question or write your answer in the space provided. All questions are worth one point unless otherwise indicated.

Tiebreaker for this event will be based on the accuracy of laser shoot.

Part One: Geometric Optics (Total 30 pts)

1. A material transmits light at 120,000 km/sec. What is the index of refraction of this material?

A) 1.2
B) 0.9
C) 0.4
D) 2.5
E) Cannot be determined from information given

2. The shortest plane mirror in which you can see your entire image

A) is half your height.
B) is twice your height.
C) is equal to your height.
D) depends on how far the mirror is from you.
E) Cannot be determined from information given

3. An image formed by a single diverging lens

A) is upside down.
B) can be projected on a wall.
C) is virtual.
D) is larger than the object.
E) all of the above

4. Refraction is caused by

A) different wave speeds.
B) more than one reflection.
C) displaced images.
D) bending.

5. For visible light, refraction indices *n* of most transparent materials (*e.g.*, air, glasses) _____ with decreasing wavelength λ

A) increases
B) decreases
C) doesn't change

6. A concave shaving mirror has a radius of curvature of 42 cm. It is positioned so that the upright image of a child's face is 3.0 times the actual size. How far is the child's face from the mirror? **(2 pts)**
ANSWER: 14.0 cm

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Questions 7-9: The image of an object placed 24 cm away from a thin lens forms at a distance of 51 cm on the other side of the lens.

7. What is the focal length of the lens? **(2 pts)**

ANSWER: 16.3 cm

8. What type of lens is it? ***ANSWER: Bi-Convex or Convex or Converging***

9. What is the magnification? **(2 pts)**

ANSWER: 2.125

Questions 10-13: Below is a table that lists the various properties of lens. For each type of lens identify the location, relative size, type, and orientation of the image formed by an object at the listed locations. **(0.25 pt per block)**

	Lens Type	Object Location	Image Location (same side or other side)	Image Size relative to object size (smaller, larger, or same)	Type of Image (real or virtual)	Orientation of Image (upright or inverted)
10.	Converging	beyond "2f" from the lens	***Other***	***Smaller***	***Real***	***Inverted***
11.	Converging	between "2f" and "f"	***Other***	***Larger***	***Real***	***Inverted***
12.	Converging	between "f" & the lens	***Same***	***Larger***	***Virtual***	***Upright***
13.	Diverging	Anywhere	***Same***	***Smaller***	***Virtual***	***Upright***

Questions 14-20: Below is a table that lists the various properties of mirrors. For each type of mirror identify the location, relative size, type and orientation of the image formed by an object at the listed locations. **(0.25 pt per block)**

	Mirror Type	Object Location	Image Location (same side or other side)	Image Size relative to object size (smaller, larger, or same)	Type of Image (real or virtual)	Orientation of Image (upright or inverted)
14.	Concave	beyond "C" from the mirror	***Same***	***Smaller***	***Real***	***Inverted***
15.	Concave	between "C" and "f"	***Same***	***Larger***	***Real***	***Inverted***
16.	Concave	between "f" & the mirror	***Other***	***Larger***	***Virtual***	***Upright***
17.	Plane	Anywhere	***Other***	***Same***	***Virtual***	***Upright***
18.	Convex	Anywhere	***Other***	***Smaller***	***Virtual***	***Upright***

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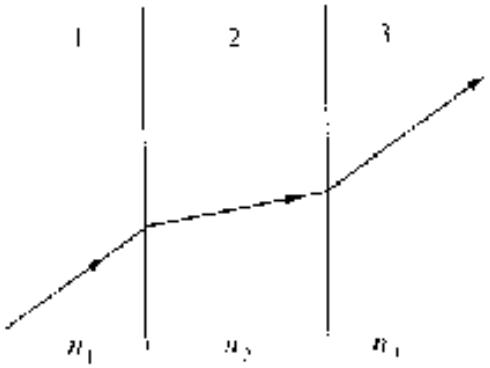
19. A concave mirror with a radius of curvature of 1 meter is used to collect light from a distant star. The distance between the mirror and the image of the star is most nearly

A) 0.5 m
B) 1 m
C) 2 m
D) unable to determine

20. The phenomenon in which phase velocity of a wave depends on its frequency is called

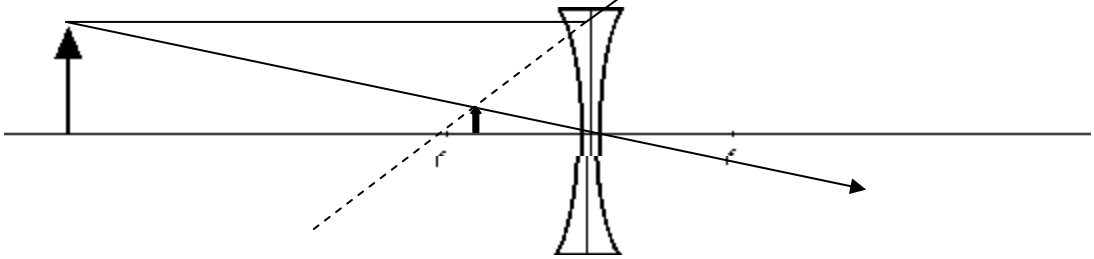
A) reflection
B) dispersion
C) diffusion
D) absorption

21. A light ray passes through substances 1, 2, and 3. The indices of refraction are n_1, n_2, and n_3, respectively. Ray segments in 1 and in 3 are parallel. From the directions of the ray, one can conclude that

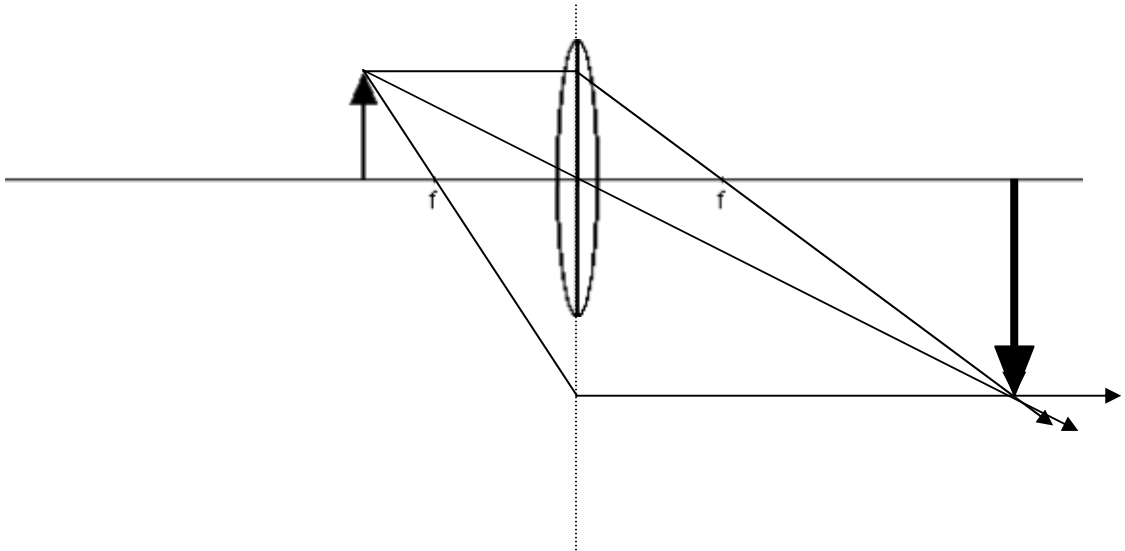


A) all three indices must be the same
B) n_2 must be less than n_1
C) n_1 must be equal to 1
D) n_3 must be the same as n_1

22. Draw the image of the "up arrow" object. **(3 pts)**



23. Draw the image of the "up arrow" object. **(3 pts)**



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Part Two: Physical Optics

24. According to the superposition principle, aligning two waves with identical frequency, wavelength, and amplitude will result in a wave with twice the ***amplitude*** of the original wave.

25. Which of the following statements regarding X-rays is **false**?

A) X-rays have a higher energy and shorter wavelength than visible light.
B) X-rays have a longer wavelength than gamma rays.
C) X-rays have a shorter wavelength and lower energy than ultraviolet rays.
D) X-rays pass easily through skin and muscles, but are absorbed by bone.

26. Compared to the other forms of electromagnetic radiation, radio waves

A) have the lowest energy and lowest frequency.
B) have the lowest energy and highest frequency.
C) have the highest energy and highest frequency.
D) have the highest energy and lowest frequency.

27. There are two types of photoreceptor cells, ***rods*** and ***cones***, which are sensitive to different aspects of light. ***Cone*** cells are less sensitive to the overall intensity of light, but come in three varieties that are sensitive to different frequency-ranges and thus are used in the perception of color. ***Rod*** cells are sensitive to the intensity of light over a wide frequency range, thus are responsible for black-and-white vision.

28. The generally-accepted normal near point of the human eye is _____; while the normal far point is _____.

A) 20 mm, 20 m
B) 25 cm, 100 m
C) 20 cm, 1000 m
D) 25 cm, infinity

29. Individuals with a near point beyond the normal near point are called _____.

A) far-sighted
B) glaucomatous
C) near-sighted
D) legally blind

30. The process of accommodation—changing the curvature (and, thus, optic power) of the human eye lens in order to maintain focus on an object—is primarily the function of:

A) vitreous humor
B) cilliary body
C) aqueous humor
D) iris

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31. An Nd:YAG laser, which has a fundamental frequency of 532 nm, is frequency-doubled before emitting out of the laser aperture. What type of EM wave is emitted? **(2 pts)**

A) Near Infrared
B) Green light
C) Near Ultraviolet
D) Gamma rays

32. Reflective mirrors used in modern astronomy telescopes are typically _____ in shape.

A) flat
B) spherical
C) hyperbolic
D) parabolic

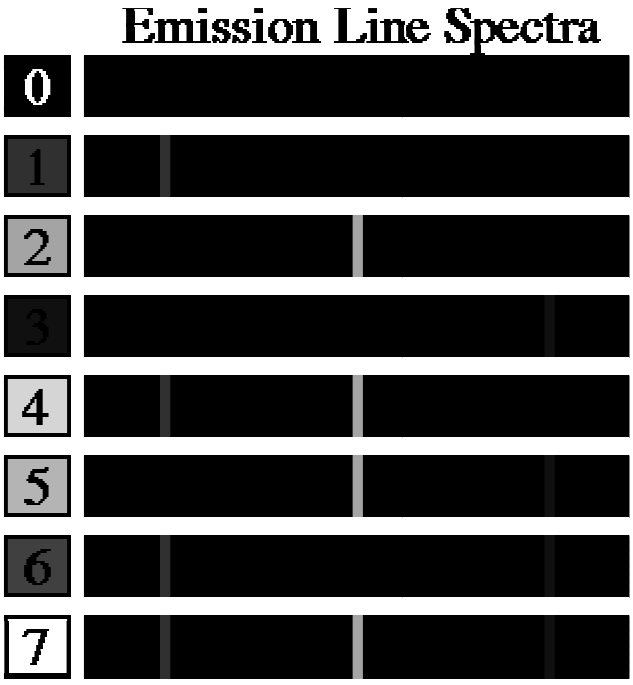
33. In telescope construction, mirrors are preferred over lenses to eliminate:

A) barrel distortion
B) shephical aberration
C) chromatic aberration
D) comatic aberration

34. What wavelength of light has the brightest response from the human eye?

A) 380 nm
B) 440 nm
C) 550 nm
D) 632 nm

Questions 35-42. Variation of laser gains can result in different color light emissions from plasma lasers. The emission line spectra below have been purposely printed in grayscale. Given that the lines decrease in wavelength from left to right (i.e., longer wavelengths are on left), fill in the blank with the number in the block that corresponds to that color's emission line.



35. Black __0_
36. Blue __3__
37. Cyan __5__
38. Green __2__
39. Magenta __6__
40. Red __1__
41. Yellow __4__
42. White __7__

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43. A 100-mW (average output power) continuous wave, diode laser emits a bright red (700 nm) spot on the wall with a diameter of 2 mm. The average irradiance of this beam is: **(2 pts)**

A) 100 mW
B) 700 nm
C) 8.0 x 10^3 W/m^2
D) 3.2 x 10^4 W/m^2

Questions 44-47. If the divergence in the laser beam in Question 43 is increased, will the following parameter increase (I), decrease (D), or remain the same (R)?

44. Average Output Power __***R***____

45. Wavelength __***R***____

46. Beam Diameter (on wall) __***I***___

47. Average Irradiance __***D***___

48. Analysis of spectral lines of hydrogen from a distant star where measured to have a wavelength of 21.107 cm. In a vacuum, hydrogen emission lines are known to be 21.106 cm. In terms of the speed of light (c), how fast is the star traveling? **(2 pts)**

ANSWER: v = 4.7380 x 10^{-5} * c

49. Which direction is it traveling (towards or away from us)? ***Away from us***

50. This is an example of red shift or blue shift? ***Red Shift***