Linnemann,

James T

Keep this exam **CLOSED** until advised by the instructor.

Fill out the bubble sheet: last name, first initial, student number, section number. Leave the code area empty.

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50 minute long closed book exam.

One 8.5 by 11 handwritten help sheet is allowed.

When done, hand in your **bubble sheet**, and your **exam**.

Thank you and good luck!

Posssibly useful constants:

- $k_e = 8.99 \times 10^9$ Nm^2/C^2
- $\epsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2
- $\mu_0 = 1.26 \times 10^{-6}$ Tm/A
- e $= 1.60 \times 10^{-19}$ C
- c $= 3.00 \times 10^8$ m/s

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5 pt An object is placed 13.7 cm in front of a concave mirror that has a focal length of 22.9 cm. Determine the location of the image.
(in cm)

1.A◯ -1.12×10^1 **B**◯ -1.40×10^1 **C**◯ -1.75×10^1
D◯ -2.18×10^1 **E**◯ -2.73×10^1 **F**◯ -3.41×10^1
G◯ -4.26×10^1 **H**◯ -5.33×10^1

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5 pt What is the magnification of the object discussed above?

2.A◯ 1.33 **B**◯ 1.55 **C**◯ 1.82 **D**◯ 2.13
E◯ 2.49 **F**◯ 2.91 **G**◯ 3.41 **H**◯ 3.99

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5 pt In this example the image is ...

3. **A**◯ Real and upright.
B◯ Virtual and upright.
C◯ Real and inverted.
D◯ Virtual and inverted.

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5 pt A convex mirror has a radius of curvature whose magnitude is 51 cm. The mirror is positioned on a horizontal optical bench with its front surface at 0 cm. A 13.0 cm long fluorescent lamp oriented vertically is placed at +96 cm. What is the focal length of the mirror?
(in cm)

4.A◯ -9.9 **B**◯ -11.6 **C**◯ -13.6 **D**◯ -15.9
E◯ -18.6 **F**◯ -21.8 **G**◯ -25.5 **H**◯ -29.8

5 pt At what distance from the mirror can we find a sharp image of the lamp?
(in cm)

5.A◯ -20.1 **B**◯ -26.8 **C**◯ -35.6 **D**◯ -47.4
E◯ -63.0 **F**◯ -83.8 **G**◯ -111.5 **H**◯ -148.3

5 pt How tall is the image of the lamp?
(in cm)

6.A◯ 0.62 **B**◯ 0.89 **C**◯ 1.30 **D**◯ 1.88
E◯ 2.73 **F**◯ 3.96 **G**◯ 5.74 **H**◯ 8.32

5 pt If the convex mirror were replaced by a plane mirror and the lamp moved to 194 cm from the plane mirror, how tall would the image be?
(in cm)

7.A◯ 2.3 **B**◯ 3.1 **C**◯ 4.2 **D**◯ 5.5
E◯ 7.3 **F**◯ 9.8 **G**◯ 13.0 **H**◯ 17.3

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5 pt An object is placed at 13 cm in front of a thin lens. An image is observed on a screen at 26 cm behind the lens. What is the focal length of the lens?
(in cm)

8.A◯ 8.67 **B**◯ 1.08×10^1 **C**◯ 1.35×10^1
D◯ 1.69×10^1 **E**◯ 2.12×10^1 **F**◯ 2.64×10^1
G◯ 3.31×10^1 **H**◯ 4.13×10^1

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7 pt An object is placed between a diverging lens and the focal point of the lens. Which of the following is true?

9. **A**◯ The image is bigger than the object, virtual and upright.
B◯ The image is smaller than the object, real and inverted.
C◯ The image is bigger than the object, real and upright.
D◯ The image is bigger than the object, real and inverted.
E◯ The image is smaller than the object, real and upright.
F◯ The image is smaller than the object, virtual and inverted.
G◯ The image is bigger than the object, virtual and inverted.
H◯ The image is smaller than the object, virtual and upright.

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7 pt

A contact lens is made of plastic with an index of refraction of 1.57. The lens has a focal length of +26.7 cm, and its inner surface has a radius of curvature of +16.8 mm. What is the radius of curvature of the outer surface?
(in cm)

10.A◯ 8.55×10^{-1} **B**◯ 1.14 **C**◯ 1.51
D◯ 2.01 **E**◯ 2.68 **F**◯ 3.56
G◯ 4.73 **H**◯ 6.30

5 pt Two slits separated by a distance of d = 0.15 mm are located at a distance of D = 0.67 m from a screen. The screen is oriented parallel to the plane of the slits. The slits are illuminated by a coherent light source with a wavelength of $\lambda = 520$ nm. A wave from each slit propagates to the screen. The interference pattern shows a peak at the center of the screen (m=0) and then alternating minima and maxima. What is the pathlength difference between the waves at the first maximum (m=1) on the screen?

(in `mm`*)*

11.A◯ 2.21×10^{-4} **B**◯ 2.50×10^{-4} **C**◯ 2.82×10^{-4}
D◯ 3.19×10^{-4} **E**◯ 3.60×10^{-4} **F**◯ 4.07×10^{-4}
G◯ 4.60×10^{-4} **H**◯ 5.20×10^{-4}

5 pt What is the pathlength difference between the waves at the first **minimum** (m=0) on the screen?

(in `mm`*)*

12.A◯ 2.04×10^{-4} **B**◯ 2.30×10^{-4} **C**◯ 2.60×10^{-4}
D◯ 2.94×10^{-4} **E**◯ 3.32×10^{-4} **F**◯ 3.75×10^{-4}
G◯ 4.24×10^{-4} **H**◯ 4.79×10^{-4}

5 pt Calculate the distance on the screen between the central maximum (m=0) and the first maximum (m=1) (you can assume $\sin(\theta) = \tan(\theta) = \theta$ with θ expressed in radians).
(in `mm`*)*

13.A◯ 1.75 **B**◯ 2.32 **C**◯ 3.09
D◯ 4.11 **E**◯ 5.46 **F**◯ 7.27
G◯ 9.67 **H**◯ 1.29×10^{1}

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7 pt Light with a wavelength of $\lambda = 650$ nm is incident on a diffraction grating. A screen is placed at a distance of L = 2.67 m from the grating. The grating has 170 lines per millimeter. What is the distance between the m = 3 maximum and the central (i.e. zeroth order) maximum on the screen? Important note: You should not use the small angle approximation.
(in `m`*)*

14.A◯ 9.38×10^{-1} **B**◯ 1.25 **C**◯ 1.66
D◯ 2.21 **E**◯ 2.94 **F**◯ 3.90
G◯ 5.19 **H**◯ 6.91

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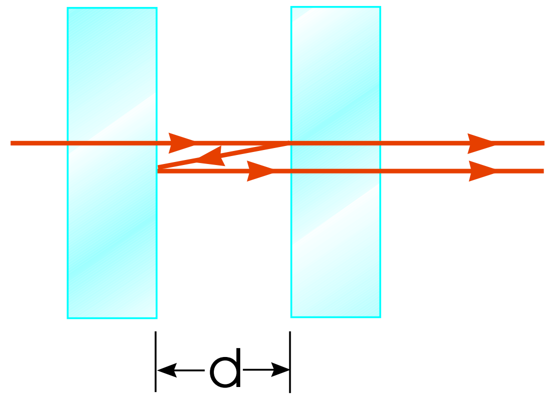
7 pt An unpolarized beam of light is sent through a stack of three ideal polarizing sheets, oriented so that the angle between the polarizing directions of adjacent sheets is 29.0^{o}. What fraction of the incident beam intensity is transmitted to the other side?

15.A◯ 1.65×10^{-1} **B**◯ 2.20×10^{-1} **C**◯ 2.93×10^{-1}
D◯ 3.89×10^{-1} **E**◯ 5.18×10^{-1} **F**◯ 6.88×10^{-1}
G◯ 9.15×10^{-1} **H**◯ 1.22



7 pt

A beam of light of wavelength 676 nm passes through two closely spaced glass plates, as shown in the figure.
For what minimum nonzero value of the plate separation d will the transmitted light be bright? (This arrangement is often used to measure the wavelength of light and is called a Fabry-Perot interferometer.)
(in `nm`*)*

16.A◯ 3.380×10^{2} **B**◯ 4.225×10^{2}
C◯ 5.281×10^{2} **D**◯ 6.602×10^{2}
E◯ 8.252×10^{2} **F**◯ 1.031×10^{3}
G◯ 1.289×10^{3} **H**◯ 1.612×10^{3}

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5 pt The near point of an eye is 105 cm. A corrective lens is to be used to allow this eye to focus clearly on objects 26.0 cm in front of it. What should be the focal length of this lens?
(in `cm`*)*

17.A◯ 1.13×10^{1} **B**◯ 1.64×10^{1} **C**◯ 2.38×10^{1}
D◯ 3.46×10^{1} **E**◯ 5.01×10^{1} **F**◯ 7.27×10^{1}
G◯ 1.05×10^{2} **H**◯ 1.53×10^{2}

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5 pt What is the power of the needed corrective lens (in diopters)? Do not enter units.

18.A◯ 2.89 **B**◯ 4.20 **C**◯ 6.08
D◯ 8.82 **E**◯ 1.28×10^{1} **F**◯ 1.85×10^{1}
G◯ 2.69×10^{1} **H**◯ 3.90×10^{1}