Part 1.

Please read each question carefully. Each question worth's 1 point.
For the following questions, please circle ◯ the correct answer.

1. Which one of the following statements concerning the index of refraction for a given material is ***true***?

A) It may be less than 1.
B) It may be measured in nanometers.
C) It does not depend on the frequency of the incident light.
D) For a given frequency, it is inversely proportional to the wavelength of light in vacuum.
E) For a given frequency, it is inversely proportional to the wavelength of light in the material.

2. Which one of the following statements ***best describes*** the equipotential surfaces surrounding a point charge?

A) The equipotential surfaces are planes extending radially outward from the charge.
B) The equipotential surfaces are curved planes surrounding the charge, but only one passes through the charge.
C) The equipotential surfaces are concentric cubes with the charge at the center.
D) The equipotential surfaces are concentric spheres with the charge at the center.
E) The equipotential surfaces are concentric cylinders with the charge on the axis at the center.

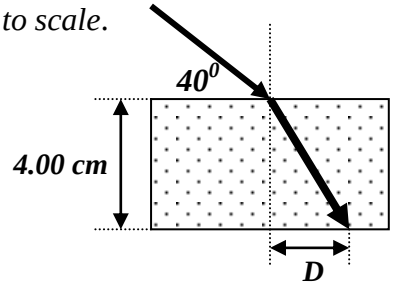
3. When two capacitors are connected in series, the equivalent capacitance of the combination is **100 μF**. When the two are connected in parallel, however, the equivalent capacitance of is **450 μF**. What are the capacitances of the individual capacitors?

A) 200 μF and 250 μF
B) 125 μF and 325 μF
C) 175 μF and 275 μF
D) 150 μF and 300 μF
E) 80 μF and 370 μF

4. The bending of light as it moves from one medium to another with differing indices of refraction is due to a change in what property of the light?

A) amplitude
B) period
C) frequency
D) speed
E) color

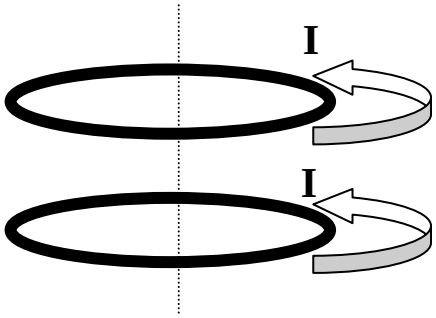
5. A ray of light passes from air into a block of glass with a refractive index of ***1.50*** as shown in the figure. Note: *The drawing is not to scale*.



What is the value of the distance ***D***?

A) 1.42 cm B) 1.66 cm
C) 1.90 cm D) 2.14 cm
E) 2.38 cm

6. Two conducting loops carry equal currents **I** in the same direction as shown in the figure. If the current in the upper loop suddenly drops to zero, what will happen to the current in the bottom loop?



A) The current will decrease.
B) The current will increase.
C) The current will not change.
D) The current will also drop to zero.
E) The current will reverse its direction

7. Two point charges of magnitude **+ 7.00 μC** and **– 9.00 μC** are placed along the ***x*–axis** at ***x* = 0 cm** and ***x* = 40.0 cm**, respectively. Where a third charge, **q** , must be placed along the ***x*–axis** so that it **does not** experience any net force because of the other two charges?

A) 0.200 m B) 2.99 m C) – 0.187 m D) – 2.99 m E) 0.187 m

8. A particle with a charge of **4.0 μC** has a mass of **5.0×10^{-3} kg**. What electric field directed upward will exactly balance the weight of the particle?

A) 4.1×10^2 N/C B) 8.2×10^2 N/C C) 4.4×10^4 N/C
D) 1.2×10^4 N/C E) 5.1×10^6 N/C

9. When a dielectric material is introduced between the plates of a parallel plate capacitor the capacitance increases by a factor of 4. What is the dielectric constant of the material introduced between the plates?

A) 0.4 B) ¼ C) 4 D) 2 E) none of the above

10. What is the frequency of light that has a wavelength in water of **600 nm** if the refractive index for this light is **1.33**?

A) 3.76×10^{14} Hz B) 5.00×10^{14} Hz C) 6.65×10^{14} Hz
D) 7.25×10^{14} Hz E) 9.52×10^{14} Hz

11. Resonance in a series RLC circuit occurs when

A) X_L is greater than X_C.
B) X_C is greater than X_L.
C) $(X_L - X_C)$ is equal to R^2.
D) $(X_L - X_C)^2$ is equal to R^2.
E) X_C equals X_L.

12. Blue light with a wavelength of **425 nm** passes from a vacuum into a glass lens; and the index of refraction is found to be **1.65**. The glass lens is replaced with a plastic lens. The index of refraction for the plastic lens is **1.54**. In which one of the two lenses does the light have the greatest speed and what is that speed?

A) glass, 2.28×10^8 m/s
B) plastic, 2.13×10^8 m/s
C) glass, 1.82×10^8 m/s
D) plastic, 1.95×10^8 m/s
E) The speed of the blue light is the same in the vacuum and both lenses; and it is 3.00×10^8 m/s.

13. A lamp uses an average power of **55 W** when it is connected to an **rms** voltage of **120.0 V**. Which entry in the following table is correct for this circuit?

	lamp resistance R (Ω)	***I_{rms} (A)***
A)	262	0.46
B)	22	3.8
C)	132	0.65
D)	175	0.57
E)	38	1.2

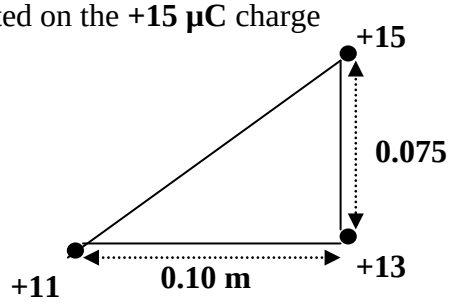
14. When an object is placed **15 cm** from a lens, a virtual image is formed. Which one of the following conclusions is ***incorrect***?

A) The lens may be a convex or concave.
B) If the image is upright the lens must be a diverging lens.
C) If the image is reduced, the lens must be a diverging lens.
D) If the lens is a diverging lens, the image distance must be less than 15 cm.
E) If the lens is a converging lens, the focal length must be greater than 15 cm.

15. A physics student desires to create a beam of light that consists of parallel rays. Which one of the following arrangements would allow her to accomplish this task?

A) A light bulb is placed at the focal point of a convex mirror.
B) A light bulb is placed at the focal point of a diverging lens.
C) A light bulb is placed at the focal point of a converging lens.
D) A light bulb is located at twice the focal length from a concave mirror.
E) A light bulb is located at twice the focal length from a converging lens.

16. Three charges are positioned as indicated in the figure. What are the horizontal and vertical components of the net force exerted on the **+15 μC** charge by the **+11 μC** and **+13 μC** charges?

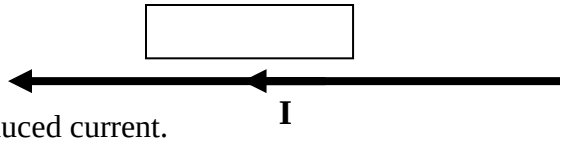


	horizontal	**vertical**
A)	95 N	310 N
B)	-76 N	310 N
C)	250 N	130 N
D)	-95 N	130 N
E)	76 N	370 N

17. When a dielectric with constant ***k*** is inserted between the plates of a charged isolated capacitor

A) the capacitance is reduced by a factor k.
B) the charge on the plates is reduced by a factor of k.
C) the charge on the plates is increased by a factor of k.
D) the electric field between the plates is reduced by a factor of k.
E) the potential difference between the plates is increased by a factor of k.

18. A long, straight wire is in the same plane as a rectangular, conducting loop. The wire carries a constant current I as shown in the figure. Which one of the following statements is true if the wire is suddenly moved **toward** the loop?



A) There will be no induced emf.
B) There will be an induced emf, but no induced current.
C) There will be an induced current which is clockwise around the loop.
D) There will be an induced current which is counterclockwise around the loop.
E) There will be an induced electric field which is clockwise around the loop.

19. A concave mirror is found to focus parallel rays at a distance of **9.0 cm**. Where is the image formed when an object is placed **6.0 cm** in front of the mirror?

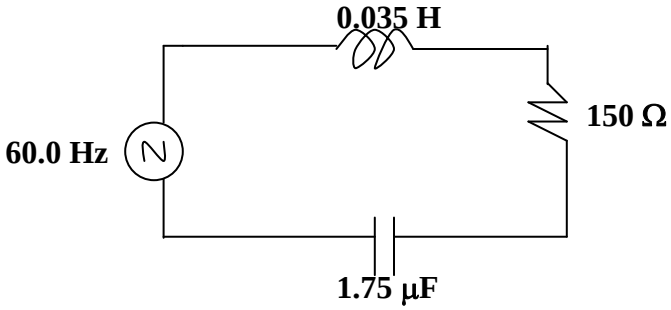
A) 11 cm in front of the mirror
B) 18 cm behind the mirror
C) 11 cm behind the mirror
D) 18 cm in front of the mirror
E) 9.2 cm in front of the mirror

20. Which one of the following statements is ***true*** concerning the strength of the electric field between two oppositely charged parallel plates?

A) It is zero midway between the plates.
B) It is a maximum midway between the plates.
C) It is a maximum near the positively charged plate.
D) It is a maximum near the negatively charged plate.
E) It is constant between the plates except near the edges

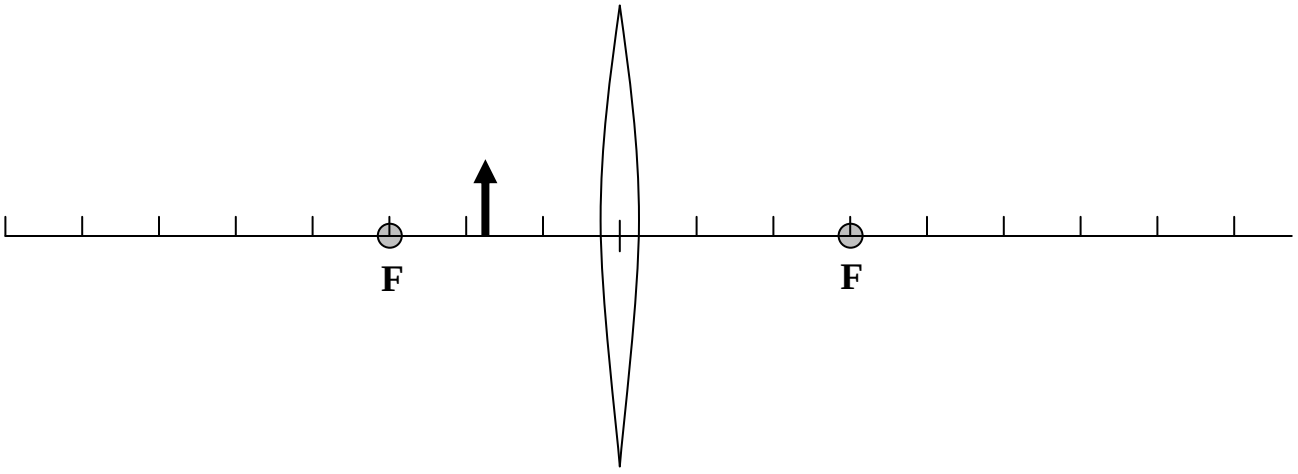
Part 2.

P.1. Use the information given in the figure for the **RCL** series circuit to determine the **phase angle** between the **current** and the **voltage**. ***(2 points)***



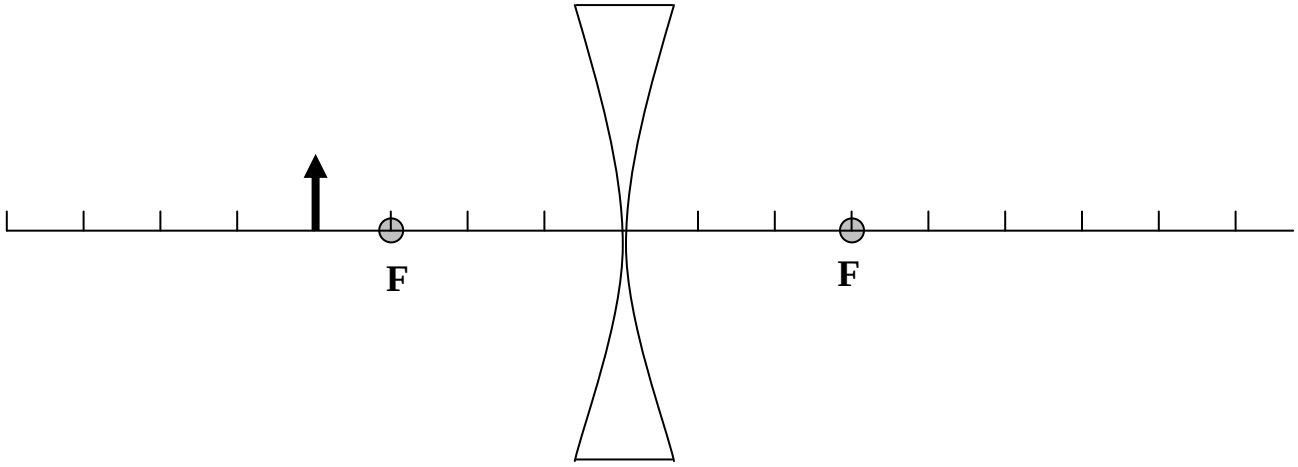
***Answer*_____**

P.2. An object is placed in front of a converging lens focal point as shown. Use the ***Ray Diagram*** to **find the location of the image and describe the image**. ***Each division represents 1cm.*** ***(4 points)***



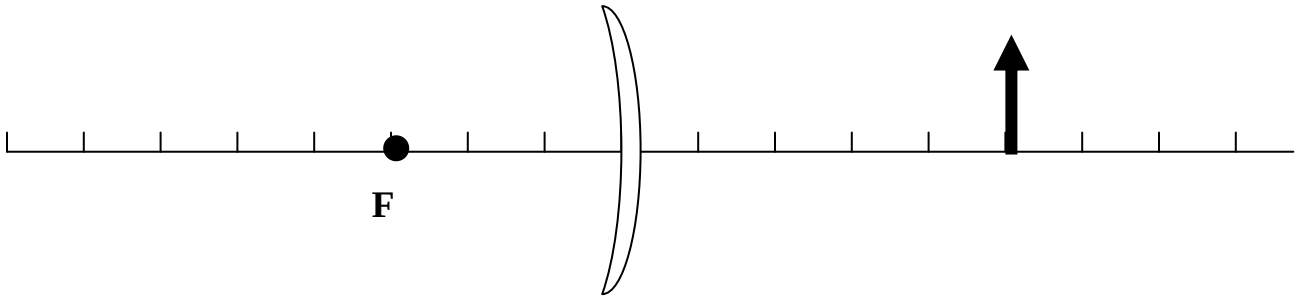
Answer (Image description) _____

P.3. An object is placed between the focal and the center of curvature of a diverging lens as shown. Use the ***Ray Diagram*** to **find** the **location of the image and describe the image**. ***Each division represents 1cm***. ***(4 points)***



Answer (Image description) _____

P.4. Show the **location of the image** by using a ***Ray Diagram*** for an object placed in front of a convex mirror as shown. **Describe the image**. ***Each division represents 1cm***. ***(4 points)***



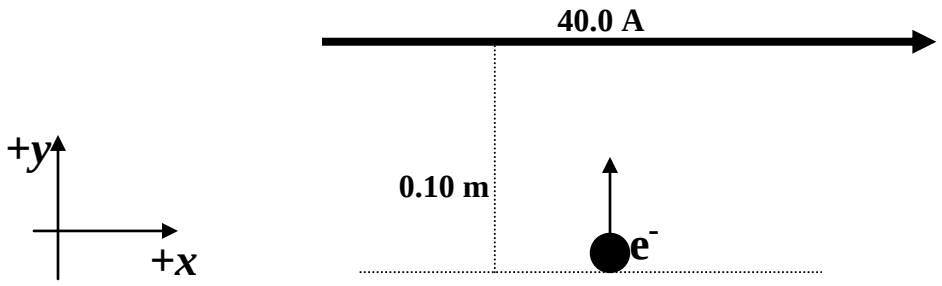
Answer (Image description) _____

P.5. The potential energy at $x = 8$ **m** is **–2000 V** and at $x = 2$ **m** is **+400 V**. What is the ***magnitude*** and ***direction*** of the ***electric field***? ***(3 points)***

***Answer*_____**

P.6. A long, straight wire carries a **40.0-A** current in the **+x** direction. At a particular instant, an electron moving at **1.0×10^{7} m/s** in the **+y** direction is **0.10 m** from the wire. The charge on the electron is **-1.6×10^{-19} C**. ***(3 points)***

What is the force on the electron at this instant?



***Answer*_____**

Some useful constants:

$e^{--} = 1.60 \times 10^{-19}$ C., $\mu_0 = 4\pi \times 10^{-7}$ T.m/A, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N.m^2)$,

$k = (1/4\pi\varepsilon_o) = 8.99 \times 10^9\ N.m^2/C^2$, $m_e = 9.1093897 \times 10^{-31}$ kg,

$m_p = 1.6726231 \times 10^{-27}$ kg, $m_n = 1.6749286 \times 10^{-27}$ kg,

$g = 9.80\ m/s^2$, $G = 6.67 \times 10^{-11}\ N.m^2/kg^2$, $c = 3.0 \times 10^8$ m/s,