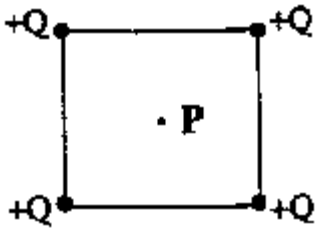
Test 4 Preparation Questions

A1. One joule of work is required to move a one-coulomb point charge from point A to point B in a uniform electric field. This indicates that
(A) the resistance between points A and B is 1.00 ohms.
(B) the potential difference between points A and B is 1.00 volt.
(C) the power dissipated while moving the charge is 1.00 watt.
(D) the current that flows between points A and B is 1.00 ampere.
(E) The kinetic energy of the charge increases by 1.00 joule.

A2. Four point charges, each with charge $+Q$, are placed at the corners of a square as shown. The length of the diagonal of the square is $2a$. What is the absolute electric potential at point P, at the centre of the square?



(A) $\frac{kQ}{a}$ (B) $2\frac{kQ}{a}$ (C) $4\frac{kQ}{a}$ (D) $\frac{kQ}{4a}$ (E) 0

A3. The resistance of a certain heater wire is found to be independent of its temperature. If the current through the heater wire is doubled, the rate at which heat is given out by the heater will
(A) increase by a factor of two.
(B) decrease by a factor of two.
(C) increase by a factor of four.
(D) decrease by a factor of four.
(E) increase by a factor of eight.

A4. Two wires *A* and *B* are made of the same material and have the same diameter. Wire *A* is twice as long as wire *B*. If each wire has the same potential difference across its ends, which of the following statements is true concerning the current in wire *A*?
(A) It is one-fourth that in wire *B*.
(B) It is four times that in wire *B*.
(C) It is equal to the current in wire *B*.
(D) It is half that in wire *B*.
(E) It is twice that in wire *B*.

Physics 111.6 Test 4 Preparation Questions

A5. Two equal-magnitude, positive charges are located at points A and B as shown in Figure 1 below. Suppose that the charges are now rearranged as shown in Figure 2. Which of the following statements is correct for the electric field and electric potential at P for the **new** (Fig. 2) arrangement as compared to their values for the **original** (Fig. 1) arrangement?

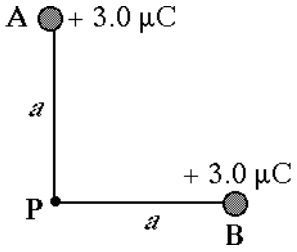


Figure 1

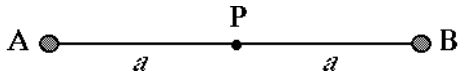
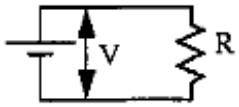


Figure 2

(A) Both the electric field and the electric potential are zero.
(B) The electric field is zero and the electric potential is unchanged.
(C) The electric field is unchanged and the electric potential is zero.
(D) The electric field is unchanged and the electric potential is decreased.
(E) Both the electric field and the electric potential are changed and non-zero.

A6. In the simple ideal battery circuit shown, the voltage V is kept the same while the resistance R is doubled. The power dissipated in the circuit will



(A) remain the same
(B) increase by a factor of two.
(C) increase by a factor of four.
(D) decrease by a factor of two.
(E) decrease by a factor of four.

A7. The electron volt is a unit of
(A) energy. (B) electric field strength. (C) electric charge.
(D) electric potential difference. (E) electric power.

A8. A positive point charge Q is placed at the origin. If the electric potential at $x = 2$ m is V, what is the electric potential at $x = 1$ m?
(A) $2\,V$ (B) V (C) $4\,V$ (D) $\frac{1}{2}\,V$ (E) $\frac{1}{4}\,V$

A9. Which one of the following situations results in a westward conventional electric current?
(A) a beam of protons moving eastward.
(B) a hydrogen atom moving westward.
(C) a beam of electrons moving eastward.
(D) a beam of neutral atoms moving westward.
(E) a plastic (ebonite) rod, charged by rubbing with fur, moving westward.

A10. Which of the following statements is true concerning the magnetic force on a charged particle in a magnetic field?
(A) It is a maximum if the particle is stationary.
(B) It is zero if the particle moves perpendicular to the field.
(C) It is a maximum if the particle moves parallel to the field.
(D) It acts in the direction of motion for a positively charged particle.
(E) It depends on the component of the particle's velocity that is perpendicular to the field.

Physics 111.6 Test 4 Preparation Questions

A11. A proton travelling due east in a region containing only a magnetic field experiences a force which is directed vertically upwards. What is the direction of the magnetic field?
(A) east (B) west (C) north (D) south (E) down

A12. When electromagnetic waves travel through a vacuum, the various colours of visible light differ in
(A) frequency only. (B) wavelength only. (C) speed only.
(D) frequency and wavelength. (E) frequency and speed.

A13. Consider a ray of light that passes from air into water. Which of the following statements is correct?
(A) On entering the water the speed of the light decreases, with a corresponding decrease in frequency.
(B) On entering the water the speed of the light increases, with a corresponding increase in frequency.
(C) On entering the water the speed of the light decreases, with a corresponding decrease in wavelength.
(D) On entering the water the speed of the light increases, with a corresponding increase in wavelength.
(E) There is no change in speed when the light enters the water.

A14. When a coin is viewed through a single lens, the image is seen to be upright and enlarged. Which of the following statements is correct?
(A) The coin is located within the focal point of a converging lens ($d_o < |f|$).
(B) The coin is located outside the focal point of a converging lens such that $|f| < d_o < |2f|$.
(C) The coin is located outside the focal point of a converging lens such that $d_o > |2f|$.
(D) The coin is located within the focal point of a diverging lens ($d_o < |f|$).
(E) The coin is located outside the focal point of a diverging lens ($d_o > |f|$).

A15. If you look carefully at an image formed in sunlight by a lens, you will observe chromatic aberration. This lens defect occurs because
(A) rays that are farther from the optical axis are focused at a different position than those which are closer to the optical axis.
(B) different wavelengths of light travel at different speeds through glass.
(C) some wavelengths interfere constructively and others interfere destructively when they pass through the lens.
(D) the lens creates a diffraction pattern similar to that produced by a circular aperture.
(E) light is a transverse wave, rather than a longitudinal wave, like sound.

A16. When two identical resistors, each of resistance R, are wired in series and connected to an ideal voltage source, the current drawn from the source is I_{ser}. When the two resistors are wired in parallel and connected to the same ideal voltage source the current drawn from the source is I_{par}. Which of the following statements is correct?
(A) $I_{par} = \frac{1}{4} I_{ser}$ (B) $I_{par} = \frac{1}{2} I_{ser}$ (C) $I_{par} = I_{ser}$ (D) $I_{par} = 2I_{ser}$ (E) $I_{par} = 4I_{ser}$

Physics 111.6 Test 4 Preparation Questions

A17. Two particles move through a uniform magnetic field that is directed out of the plane of the page. The figure at the right shows the paths taken by the two particles as they move through the field. The particles are not subject to any other forces or fields. Which of the following statements concerning these particles is true?

(A) The particles may both be neutral.
(B) Particle 1 is positively charged, particle 2 is negatively charged.
(C) Both particles are positively charged.
(D) Particle 1 is negatively charged, particle 2 is positively charged.
(E) Both particles are negatively charged.

A18. All electromagnetic waves travel through vacuum at
(A) the same speed.
(B) speeds that are proportional to their wavelengths.
(C) speeds that are inversely proportional to their wavelengths.
(D) speeds that are proportional to the square of their wavelengths.
(E) speeds that are proportional to the inverse square of their wavelengths.

A19. Medium 1 has index of refraction n_1, medium 2 has index of refraction n_2, and $n_1 > n_2$. Which of the following statements is correct?
(A) When light travels from medium 1 to medium 2, total internal reflection occurs for all angles of incidence less than the critical angle.
(B) When light travels from medium 1 to medium 2, total internal reflection occurs for all angles of incidence greater than the critical angle.
(C) When light travels from medium 2 to medium 1, total internal reflection occurs for all angles of incidence less than the critical angle.
(D) When light travels from medium 2 to medium 1, total internal reflection occurs for all angles of incidence greater than the critical angle.
(E) Total internal reflection occurs for all angles of incidence, regardless of the refractive indices of the media through which the light is travelling.

A20. A light ray travelling parallel to the principal axis of a converging lens strikes the lens a small distance away from the midpoint of the lens. After emerging from the lens the light ray travels so that
(A) it never crosses the principal axis of the lens.
(B) it crosses the principal axis of the lens at a point that is twice the focal length from the lens.
(C) it crosses the principal axis of the lens at a point that is between the focal point and the lens.
(D) it crosses the principal axis of the lens at a point that is the focal length from the lens.
(E) it is parallel to the principal axis.

A21. In a scene from a movie, a nearsighted character removes his glasses and uses them to focus the nearly parallel rays of the sun to start a fire. What is physically wrong with this scene?
(A) Parallel rays cannot be focused.
(B) The glasses have diverging lenses and cannot be used to focus parallel rays.
(C) The glasses have converging lenses and cannot be used to focus parallel rays.
(D) Sunlight cannot be used to start a fire.
(E) A fire can only be started if the image is virtual.

Physics 111.6 Test 4 Preparation Questions

A22. In a double slit experiment it is observed that the distance between adjacent maxima on a remote screen is 1.0 cm. What happens to the distance between adjacent maxima when the frequency of the light used is doubled?

(A) It remains the same.
(B) It reduces to 0.5 cm.
(C) It reduces to 0.25 cm.
(D) It increases to 2.0 cm.
(E) It increases to 4.0 cm.

A23. Which one of the following statements concerning electric resistance is true?

(A) The resistance is the same for all samples of the same size (regardless of material).
(B) Resistance is a property of resistors, but not of conductors.
(C) The resistance of a metal wire increases with an increase in temperature.
(D) The resistance is the same for all samples of the same material.
(E) The resistance of a wire is inversely proportional to its length.

A24. The resistance of a particular heating element is constant. If the current through the heating element is doubled, the power dissipated in the element will

(A) increase by a factor of two.
(B) decrease by a factor of two.
(C) increase by a factor of four.
(D) decrease by a factor of four.
(E) increase by a factor of eight.

A25. A proton, initially moving with a horizontal, north-directed velocity, passes into a region where there is a magnetic field **B** that is perpendicular to the proton's velocity. The proton's trajectory is observed to curve toward the east as a result of the magnetic field. The direction of **B** is

(A) to the east. (B) to the west. (C) downward. (D) upward. (E) to the south.

A26. The electrons in a wire are oscillating due to an applied alternating voltage. Which one of the following statements is true?

(A) Only an electric field will be produced.
(B) Only a magnetic field will be produced.
(C) Electromagnetic waves will be produced.
(D) Longitudinal waves will be produced.
(E) Neither electric nor magnetic fields will be produced.

A27. Which one of the following statements concerning the wavelength of an electromagnetic wave in a vacuum is true?

(A) The wavelength is independent of the speed of the wave.
(B) The wavelength is inversely proportional to the speed of the wave.
(C) The wavelength is the same for all types of electromagnetic waves.
(D) The wavelength is directly proportional to the frequency of the wave.
(E) The wavelength is inversely proportional to the frequency of the wave.

Physics 111.6 Test 4 Preparation Questions

A28. You are given two opaque disks. The diameter of disk 1 is twice that of disk 2 ($D_1 = 2D_2$). Disk 1 is placed 80 cm from your eye. By holding disk 2 at an appropriate location, you are able to just obscure your view of disk 1. The distance of disk 2 from your eye is

(A) 10 cm. (B) 20 cm. (C) 30 cm. (D) 40 cm. (E) 50 cm.

A29. Which one of the following statements correctly describes the second-order maximum in a double-slit experiment?

(A) Light from each slit travels the same distance.
(B) Light from one slit travels twice as far as light from the other slit.
(C) Light from one slit travels half as far as light from the other slit.
(D) Light from one slit travels one wavelength further than light from the other slit.
(E) Light from one slit travels two wavelengths further than light from the other slit.

B1. Calculate the diameter of a 2.00-cm length of tungsten filament in a small light bulb if its resistance is 0.0510 ohms. The resistivity of tungsten is 5.65×10^{-8} ohms·m.

B2. A 192 Ω resistor is connected across the terminals of an ideal 24.0 V battery. Calculate the current that flows through the resistor.

B3. You wish to replace a copper wire with an aluminum wire of the same length and same resistance. Calculate the ratio of the required diameter of the aluminum wire to that of the copper wire. i.e. Calculate $d_{\text{aluminum}}/d_{\text{copper}}$. The resistivity of aluminum is 2.82×10^{-8} Ω·m and the resistivity of copper is 1.72×10^{-8} Ω·m.

B4. A particle of charge -8.00×10^{-3} C is in a region where the only force acting on the particle is an electric force. The particle is released from rest at point A. At point B, the kinetic energy of the particle is 4.80 J. Calculate the magnitude of the electric potential difference between points B and A.

B5. A 9.00 V battery is connected to a light bulb of resistance 1.60 Ω. Calculate the number of electrons that leave the battery per second.

B6. A beam of protons, moving horizontally with speed 6.19×10^5 m/s, is directed from north to south in the northern hemisphere. The Earth's magnetic field at this point has a magnitude of 8.00×10^{-5} T and is at an angle of 58° below the horizontal. Calculate the magnitude of the magnetic force which acts on each proton.

B7. The critical angle for a particular type of glass is measured to be 58.7° when a piece of this glass is immersed in water ($n_{\text{water}} = 1.33$). Calculate the index of refraction of this glass.

B8. Calculate the separation of two slits that cause the second order maximum for light of wavelength 546 nm to occur at an angle of 0.600°.

B9. The internal resistance of a 9.00 V battery is 3.75 Ω. Calculate the terminal potential difference (*TPD*) when a 15.0 Ω load resistor is connected across the terminals of the battery.

Physics 111.6 Test 4 Preparation Questions

B10. Light of wavelength 450 nm is incident perpendicularly to the surface of a diffraction grating. It is observed that the second order maximum occurs at an angle of 30.0º to the incident beam direction. Calculate the spacing between the lines on the grating.

B11. Without his corrective contact lenses, Mr. Liu has an uncorrected nearpoint of 0.800 m. Calculate the refractive power of the contact lenses required to correct Mr. Liu's vision to the normal nearpoint of 0.250 m.

B12. A 13.8 Ω resistor is connected across an ideal alternating current power supply. The average electric power dissipated in the resistor is 342 W. Calculate the peak voltage generated by the power supply.

B13. The critical angle for a carbon tetrachloride/air interface is 43.2°. Calculate the index of refraction of carbon tetrachloride. (The index of refraction of air is 1.00.)

B14. An object is placed 37.5 cm to the left of a thin lens of focal length 25.0 cm. Calculate the distance of the image from the lens.

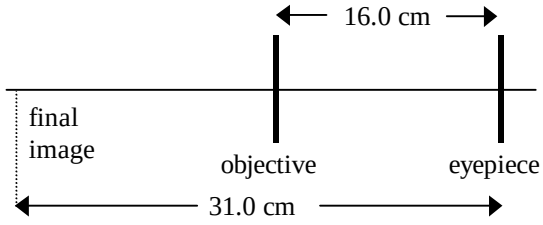
B15. Monochromatic light, with a wavelength of 450 nm, strikes a diffraction grating which has 8500 lines/cm. Calculate the angle of the second-order maximum.

C1. A point charge, $Q = +2.50 \times 10^{-12}$ C, is fixed in space. Point A is 10.0 cm from Q and point B is 1.00 cm from Q.
   (a) Calculate the magnitude of the potential difference between points A and B.
   (b) If an electron is released from rest at point A, calculate the speed of the electron when it reaches point B.

C2. Near the surface of the Earth there is a uniform electric field of 1.50×10^{2} V/m, pointing downward. Two identical balls, with mass 0.540 kg, are dropped from a height of 2.00 m above the ground. Ball 1 is electrically neutral while ball 2 has a charge of $+5.50 \times 10^{-4}$ C. Using conservation of energy, calculate the speeds of the two balls just before they hit the ground. (Neglect air resistance.)

C3. When a 25.0-Ω resistor is connected across the terminals of a real battery, the current in the circuit is 0.477 A. If this resistor is then replaced by a 100-Ω resistor, the current in the circuit changes to 0.120 A. Calculate the internal resistance and the emf of the battery.

C4. A compound microscope consists of an objective lens of focal length 0.450 cm and an eyepiece lens of focal length 4.00 cm, separated by a distance of 16.0 cm.

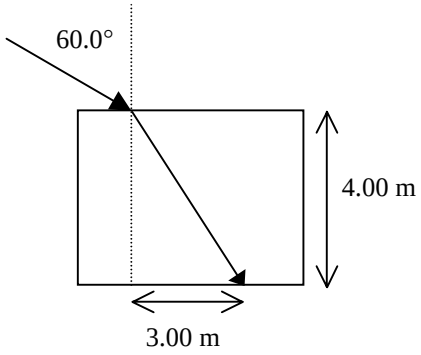


   (a) Calculate the distance from the objective lens at which an object must be placed so that the image formed by the eyepiece lens is at –31.0 cm. (Note: do not use the approximate formula given in the textbook.)
   (b) For the microscope adjusted as in (a), calculate the magnification obtained when a person with a nearpoint of 25.0 cm uses the microscope.

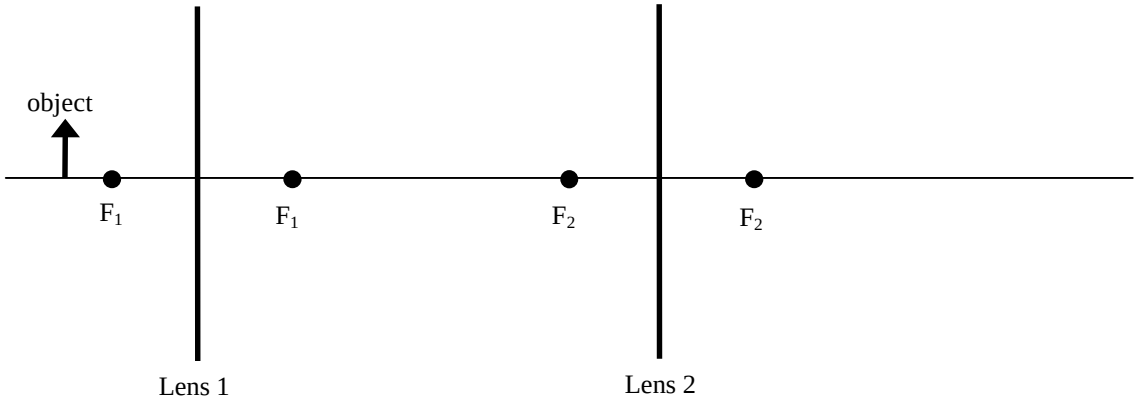
Physics 111.6 Test 4 Preparation Questions

C5. In a high-energy physics experiment, a subnuclear particle moves in a circular arc of 0.270 m radius, perpendicular to an externally applied magnetic field of magnitude 0.0270 T. The kinetic energy of the particle is 4.07×10^{-16} J and it has a positive electric charge equal to the elementary charge. Calculate the mass of the particle.

C6. A 4.00-m-high tank, open to the air, is filled to the brim with an unknown liquid. A ray of light is incident on the liquid at an angle of 60.0° and strikes a point on the floor of the tank that is horizontally displaced a distance of 3.00 m from the point where the light ray entered the liquid. Calculate the time for the ray of light to follow its path through the liquid from its point of incidence to the floor of the tank.



C7. Two converging lenses, each having a focal length of 12.0 cm, are placed 60.0 cm apart. An object is placed 18.0 cm to the left of the leftmost lens.
(a) Draw rays on the diagram below to find the location of the final image.



(b) **<u>Calculate</u>** the location of the final image relative to the rightmost lens.

C8. A singly-charged positive ion of mass 2.50×10^{-26} kg, initially at rest, is accelerated through a potential difference of magnitude 2.50×10^{2} V.

(a) Calculate the speed of the ion after passing through this potential difference.

(b) The ion then enters a region of uniform magnetic field of magnitude 0.500 T. The direction of the magnetic field is perpendicular to the ion's velocity. Calculate the radius of the path of the ion in the field.

Physics 111.6 Test 4 Preparation Questions

C9. The refractive power of the lenses in a pair of eyeglasses is –2.35 diopters. The eyeglasses are designed to be worn at a distance of 2.00 cm in front of the eyes. When wearing these glasses, a person has the normal range of vision of 25.0 cm to infinity, measured from the eye.

(a) This person is (circle one): myopic hyperopic

(b) Calculate the location of this person's uncorrected near point, measured from the eye.

Physics 111.6 Test 4 Preparation Questions

ANSWERS:

A1.	B	A18.	A	B1.	1.68×10^{-4} m	C1. (a)	2.03 V
A2.	C	A19.	B	B2.	0.125 A	(b)	8.44×10^{5} m/s
A3.	C	A20.	D	B3.	1.28	C2. (1)	6.26 m/s
A4.	D	A21.	B	B4.	600 V	(2)	6.31 m/s
A5.	B	A22.	B	B5.	3.52×10^{19} e^{-}/s		
A6.	D	A23.	C	B6.	6.72×10^{-18} N	C3. (a)	0.210 Ω
A7.	A	A24.	C	B7.	1.56	(b)	12.0 V
A8.	A	A25.	D	B8.	1.04×10^{5} nm	C4. (a)	0.467 cm
A9.	C	A26.	C	B9.	7.20 V	(b)	–188
A10.	E	A27.	E	B10.	1.80×10^{3} nm	C5.	1.67×10^{-27} kg
A11.	C	A28.	D	B11.	+2.75 diopters	C6.	2.40×10^{-8} s
A12.	D	A29.	E	B12.	97.2 V		
A13.	C			B13.	1.46	C7.	24.0 cm to right
A14.	A			B14.	75.0 cm	C8. (a)	5.66×10^{4} m/s
A15.	B			B15.	49.9°	(b)	0.0177 m
A16.	E					C9. (a)	myopic
A17.	E					(b)	16.9 cm