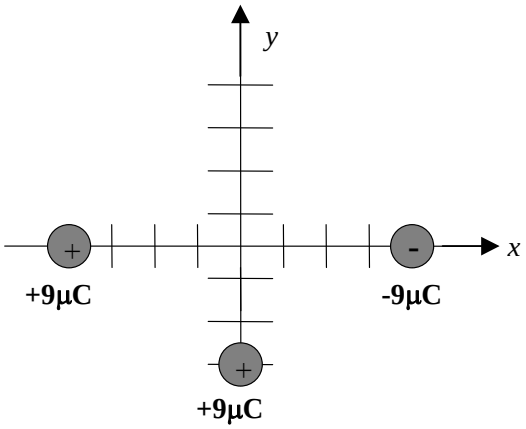
spring01 exam 1

The next two questions pertain to the following situation:

Three charges are placed located as shown in the figure to the right. The grid spacing is in **meters.**.



1. Calculate the ***x*-component of the net force** on the bottom charge at (0,-3) due to the two charges on the *x*-axis.

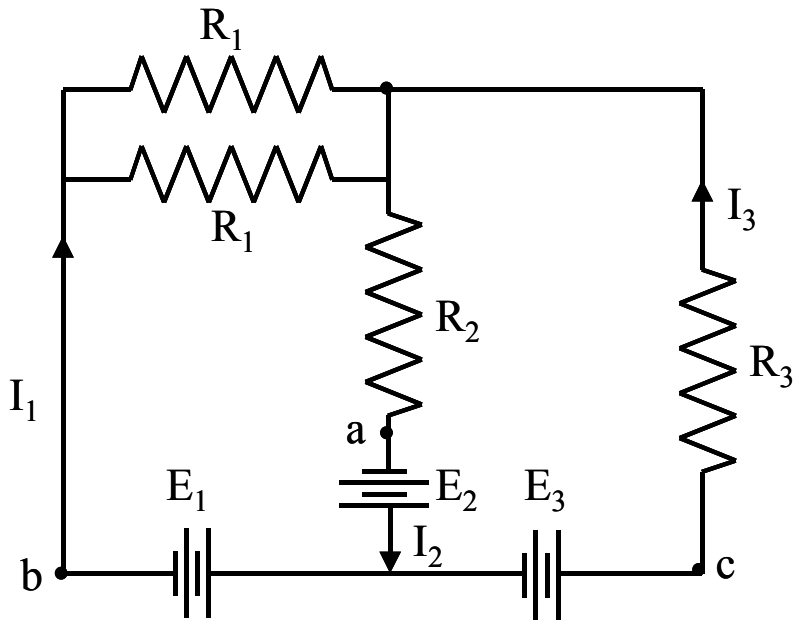
(A) $F_x = -4.66 \times 10^{-2}$ N
(B) $F_x = --3.50 \times 10^{-2}$ N
(C) $F_x = 0$
(D) $F_x = +3.50 \times 10^{-2}$ N
(E) $F_x = +4.66 \times 10^{-2}$ N

2. Calculate the ***y*-component of the net force** on the bottom charge due to the two other charges.

(A) $F_y = -4.66 \times 10^{-2}$ N
(B) $F_y = -3.50 \times 10^{-2}$ N
(C) $F_y = 0$
(D) $F_y = +3.50 \times 10^{-2}$ N
(E) $F_y = +4.66 \times 10^{-2}$ N

spring02 exam 1

The next three questions pertain to the following situation.



3. Which of the following equations is **not** valid?

a. $+E_1+R_1I_1+I_2R_2-E_2=0$
b. $+E_1+(R_1/2)I_1-R_3I_3+E_3=0$
c. $+E_2-R_2I_2-R_3I_3+E_3=0$

4. Which of the following is a valid Kirchhoff current equation for the above circuit?

a. $I_1+I_2+I_3=0$
b. $I_1-I_2+I_3=0$
c. $I_1+I_2-I_3=0$

5. Let $E_1 = 9$ volts, $E_2 = 3$ volts and $E_3 = 5$ volts. Which of the three points (a, b or c) has the lowest electric potential?

a. point a
b. point b
c. point c

spring04 exam 1

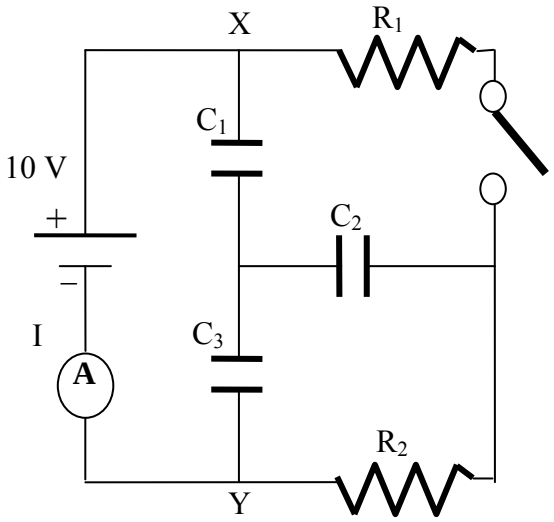
The next five questions pertain to the following situation:
The resistors R_1 and R_2 each have resistance 10 Ω, the capacitors C_1, C_2, and C_3 all have capacitance 1 μF. The battery supplies a potential difference of 10 V. A perfect ammeter (without resistance) is connected in the lower left of the circuit, as shown in the figure. The switch on the top right is initially in the open position, and the capacitors are fully charged.

6. What is the current I through the ammeter with the switch open?

a. 0.0 A
b. 1.0 A

7. What is the effective capacitance between points X and Y with the switch open?

a. 0.33 μF
b. 0.5 μF
c. 0.67 μF
d. 2 μF
e. 3 μF



8. What is the charge on capacitor C_2 with the switch open?

a. 1.11 μC
b. 2.22 μC
c. 3.33 μC
d. 4.44 μC
e. 6.67 μC

9. You close the switch and wait until the ammeter settles down. What current I is shown on the ammeter?

a. 0.5 A
b. 1.0 A
c. 2.0 A

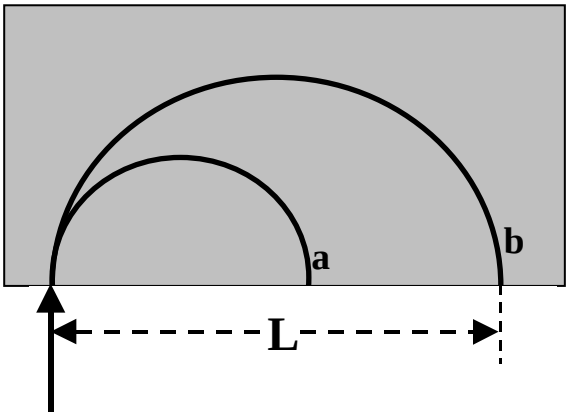
10. What is the charge on capacitor C_2 now that the switch is closed?

a. 0 μC.
b. 2.5 μC
c. 5.0 μC

spring01 exam 2

The next three questions pertain to the following situation:

Two **positively** charged particles enter a region of uniform magnetic field B. The B field is oriented perpendicular to the page. The paths of the two charged particles are shown.



11. Which direction is the B field pointing?

(A) Into the page
(B) Out of the page

12. If the two particles have the same mass and initial velocity which one has the greater charge?

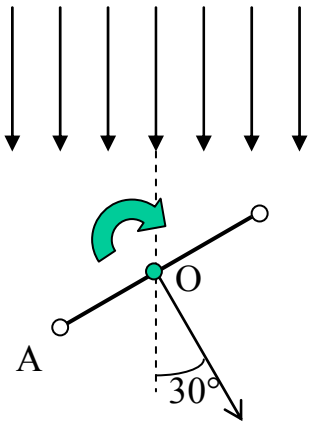
(A) Particle **a**
(B) Particle **b**

13. Let B =1.5 T, $m_b = 3.0 \times 10^{-27}$ kg, $v_b = 2 \times 10^7$ m/s and $q_b = 1.6 \times 10^{-19}$ C. What is the length L?

(A) L = 0.33 m
(B) L = 0.50 m
(C) L = 1.50 m
(D) L = 2.67 m
(E) L = 7.50 m

spring02 exam2
The next two questions pertain to the following situation:

In the figure is shown a square loop (L=2 cm) of wire in edge view, which is free to rotate around an axis O (perpendicular to the page). The loop consists of 8 loops of wire and the normal to the loops forms an angle of 30^o degrees. An external battery (not shown) causes a current I=3.0 amps to flow around the loop. The external magnetic field directed down (B=0.7 T) creates a clockwise torque on the current loop.



14. What is the direction of the current in wire A?

a. into the page
b. out of the page

15. What is the magnitude of the torque?

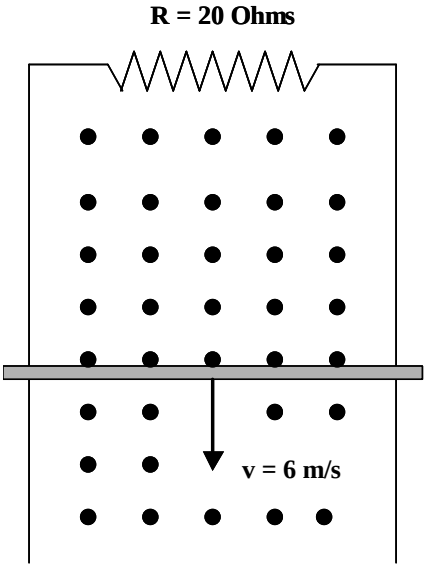
a. 3.4×10^{-3} N m
b. 8.4×10^{-3} N m
c. 12.6×10^{-3} N m

sp02 exam 2
The next three questions pertain to the following situation:

Two fixed conductors are connected by a resistor R=20 Ω. The two fixed conductors are separated by L=1.5 m. A moving conductor is pushed along them (without friction) **at a constant speed** v=6m/s. A 3 T magnetic field (shown by the black dots in the figure) points out of the page.

16. In which direction does the current flow through the resistor?

a. to the right
b. to the left



17. What force must be applied to the bar to keep it moving at 6 m/s?

a. 4 N
b. 6 N
c. 7.5 N

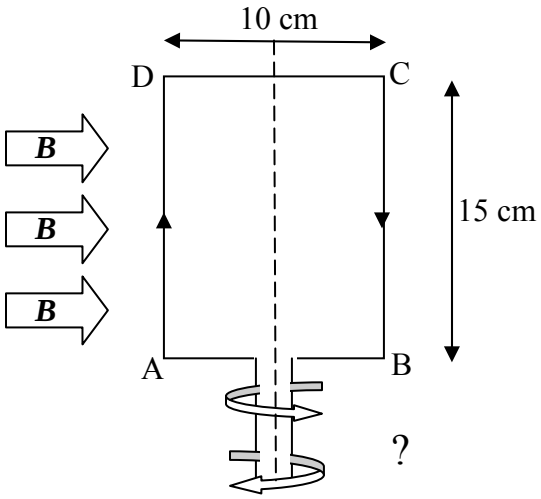
18. If the 20 ohm resistor was replaced by a 100 ohm resistor, the net force needed to keep the bar moving at 6 m/s would

a. Increase
b. Remain the same
c. Decrease

sp04 exam2

The next two questions refer to the same situation:

This loop has 200 turns of wire with resistance 0.3 Ω/m. It is turned at a steady rate and dissipates energy with a peak power of 100 W. The external magnetic field is constant and the current flows around the loop in the direction indicated in the figure at the instant shown.



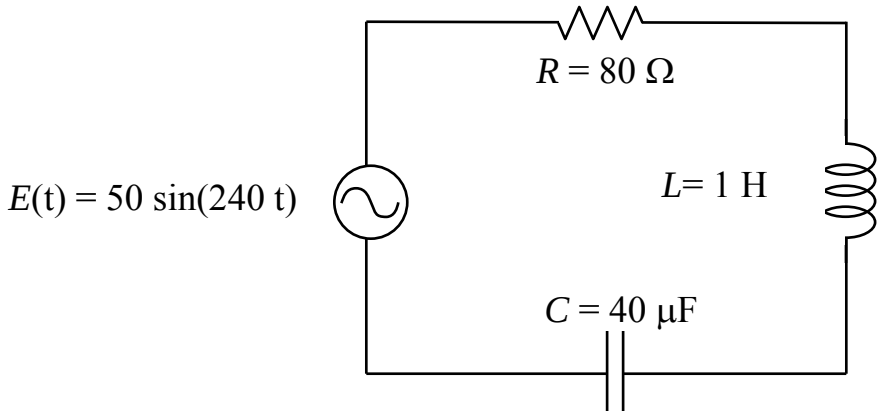
19. What is the peak emf generated in the loop?

a. 23 V
b. 55 V
c. 100 V
d. 173 V
e. 284 V

20. As viewed from below, the direction of rotation of the loop is

a. clockwise (that is, AD comes out of the page at the instant shown)
b. counter-clockwise (that is, AD goes into the page at the instant shown)

sp04 exam2
The next four questions pertain to the following series RLC circuit:



21. In an RLC circuit, the current is always in phase with

a. the resistor voltage
b. the inductor voltage
c. the capacitor voltage

22. What is the phase angle ϕ for the circuit above?

a. $\phi = +78.2°$
b. $\phi = +59.5°$
c. $\phi = -26.2°$
d. $\phi = -39.8°$
e. $\phi = -62.4°$

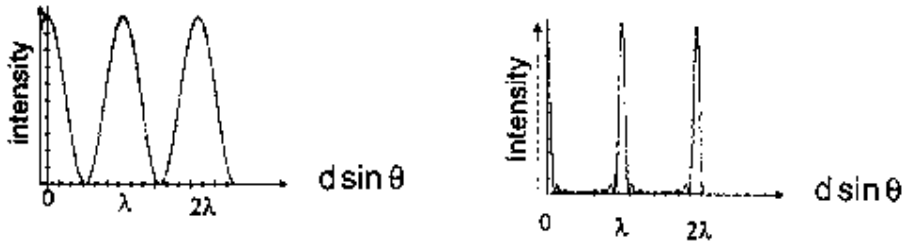
23. What is the maximum current in the circuit?

a. $I_{max} = 0.317$ A
b. $I_{max} = 0.724$ A
c. $I_{max} = 1.65$ A
d. $I_{max} = 2.12$ A
e. $I_{max} = 2.97$ A

24. To bring the circuit closer to resonance, the frequency of the oscillating voltage supply should be:

a. increased
b. decreased

sp04 exam3



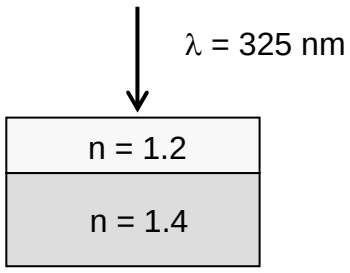
25. Consider a diffraction pattern produced by passing light of wavelength λ through a screen containing a series of equally spaced slits.

True or false: The total number of slits is greater in the pattern on the right than in the pattern on the left.

a. true
b. false

The next two questions pertain to the following series thin film:

26. Light with a wavelength $\lambda = 325$ nm in air constructively-interferes from a thin plastic coating (n = 1.2) on a thick glass plate (n = 1.4). Find the minimum (non-zero) thickness of the coating.



a. 135 nm
b. 206 nm
c. 315 nm
d. 443 nm
e. 586 nm

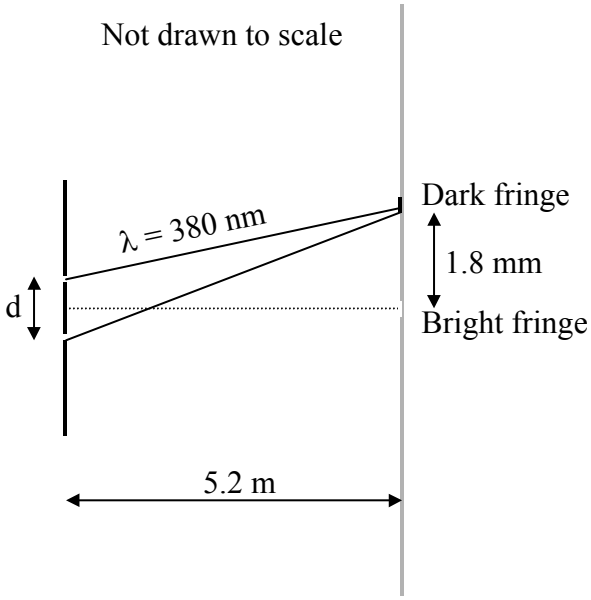
27. If the thick glass plate and thin plastic coating were submerged in water (n = 1.33), the answer to the previous problem (still assuming $\lambda = 325$ nm in air) would

a. change
b. not change

The next three questions pertain to the following situation:

28. Blue light with wavelength $\lambda = 380$ nm is incident upon two narrow slits separated by a distance *d* before striking a screen 5.2 meters away. The distance between the central bright fringe and first dark fringe is 1.8×10^{-3} m. Calculate *d* the spacing between the slits. (You may approximate $\sin(\theta) \approx \tan(\theta) \approx \theta$)

a. $d = 0.15$ mm
b. $d = 0.21$ mm
c. $d = 0.36$ mm
d. $d = 0.41$ mm
e. $d = 0.55$ mm

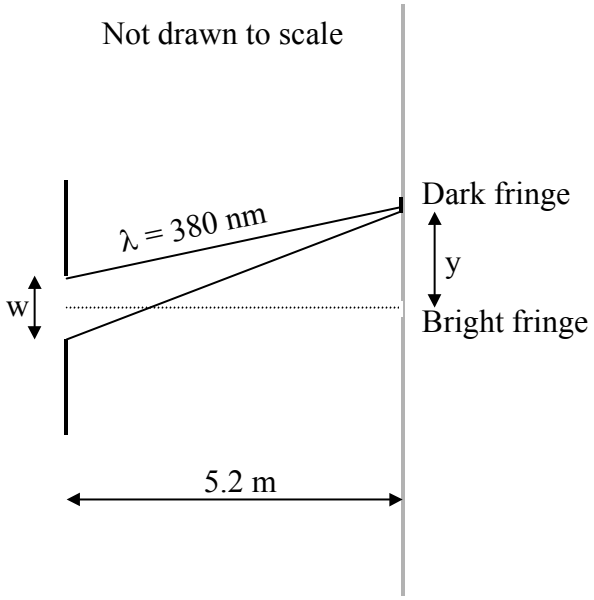


29. Now red light ($\lambda = 650$ nm) is incident on the same two slits, the distance *y* between the central bright fringe and the first dark fringe is

a. $y < 1.8$ mm
b. $y = 1.8$ mm
c. $y > 1.8$ mm

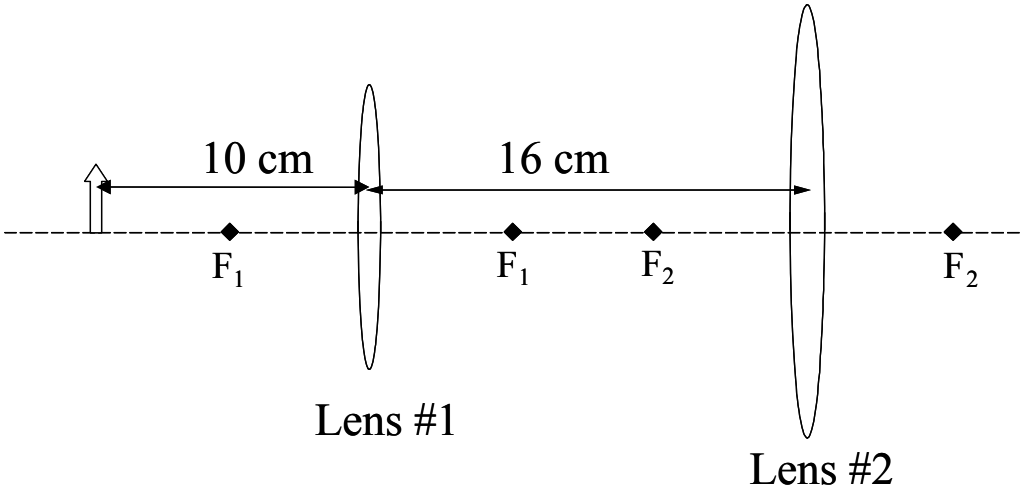
30. Now the two slits are replaced by a **single slit with width *w= d***, and illuminated with the original blue light. What is the distance y to the first dark fringe?

a. $y < 1.8$ mm
b. $y = 1.8$ mm
c. $y > 1.8$ mm



fa03 exam3
The next three questions pertain to the following situation.

Two lenses are separated by 16 cm. Both Lens #1 and Lens #2 are converging lenses and have a focal length of 5 cm. An object (arrow) is located 10 cm to the left of Lens #1.



31. **If lens #2 were not present,** the image formed by lens #1 would be

a. 5 cm to the right of lens #1.
b. 10 cm to the right of lens #1.
c. 15 cm to the right of lens #1.
d. 20 cm to the right of lens #1.
e. 25 cm to the right of lens #1.

32. Where is the final image of the **pair of lenses**?

a. 25 cm to the left of lens #2
b. 15 cm to the left of lens #2
c. 10 cm to the left of lens #2
d. 20 cm to the right of lens #2
e. 30 cm to the right of lens #2

33. The final image formed by the **pair of lenses** is

a. inverted relative to the object.
b. upright relative to the object.

fall04 exam 3

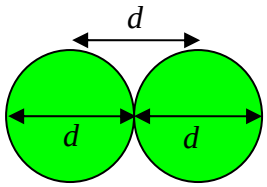
The next three questions refer to the following situation:

If you go to the Art Institute of Chicago, you can admire paintings by the French painter Georges Seurat. For his work, Seurat uses small dots of color to produce an image. At a distance of a few meters, the eye cannot resolve these dots. You thus see a "smooth" picture.

34. If each dot is the same size, which color dots are the easiest to resolve?

a. Red (λ=660 nm)
b. Green (λ=550 nm)
c. Blue (λ= 470 nm)

35. The diameter of the green (λ=550 nm) dots in the painting is d = 2.0 mm and the dots are touching each other, as shown in the figure below. What is the maximum distance, L, a person with normal, unaided vision (near point 25 cm, far point infinity, pupil diameter 2.0 mm) can stand from the painting to resolve the individual green dots?



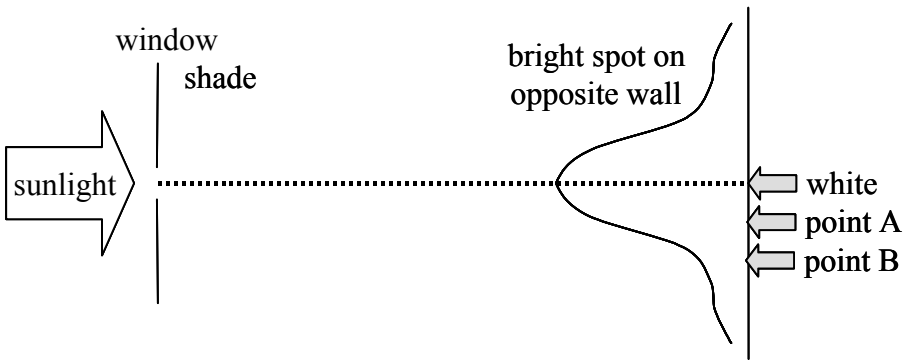
a. L = 1.44 m
b. L = 2.31 m
c. L = 3.27 m
d. L = 4.89 m
e. L = 5.96 m

36. Let L be the answer to the previous question. If the diameter of the green dots were 1.0 mm instead of 2.0 mm, the maximum distance a person with normal, unaided vision (near point 25 cm, far point infinity, pupil diameter 2.0 mm) can stand from the painting to resolve the individual green dots would be

a. smaller than L.
b. equal to L.
c. larger than L.

fall 05 exam 3

37. Sunlight shines through a pinhole in an otherwise opaque window shade, creating a bright spot on a wall on the opposite side of the room. Because of diffraction effects, the ***color*** of the bright spot (as well as its intensity) varies with distance from the center of the spot. Assume that the range of wavelengths in sunlight extends from 400 nm (blue) to 700 nm (red).



Which one of the following statements can be correct?

Relative to the center of the bright spot, which is white,

a. point A contains equal intensities of all colors of light while point B consists only of red light.
b. point A contains only blue light while point B contains only red light.
c. points A and B only contain green light.
d. point A is deficient in blue light while point B is deficient in red light.
e. point A is deficient in red light while point B is deficient in blue light.

Fall 98

38. A spaceship is constructed at the factory to be 75 meters long. After it is launched into space, it travels past the earth with a speed that is 0.6 of the speed of light. How long does the spaceship appear to be according to the crew of the spaceship and according to people on earth?

	crew	people on earth
a.	75m	75m
b.	75m	94m
c.	75m	60m
d.	60m	75m
e.	60m	60m

39. Of the hypothetical nuclear reactions below, which is possible? β^+ and β^- represent the positron and electron, with charges +1e, and –1e, respectively and ν and $\bar{\nu}$ represent (neutral) neutrinos

a. none are possible

b. ${}^{16}_{8}O + n \rightarrow {}^{17}_{8}O + \beta^- + \bar{\nu}$

c. ${}^{14}_{7}N + {}^{1}_{1}H \rightarrow {}^{14}_{6}C + \beta^+ + \nu$

d. ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow \alpha + n$

e. ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + \gamma$

40. If an electron has a spin of 3/2, its spin quantum number m_S could have the following four values: m_S = +3/2, +1/2, -1/2, and -3/2. If this were true, the first element with a filled shell would be the first of the noble gasses and it would be

a. He with 2 electrons
b. Li with 3 electrons
c. Be with 4 electrons
d. C with 6 electrons
e. 0 with 8 electrons

41. What is the maximum number of electrons that can be found in the n = 3 shell of an atom?

a. 14
b. 18
c. 24

42. Consider a singly ionized He atom. What is the wavelength of a photon that is emitted as the atom makes a transition between the n = 5 and n = 3 states?

a. 151 nm
b. 321 nm
c. 570 nm
d. 821 nm
e. 1282 nm

Textbook 29.4

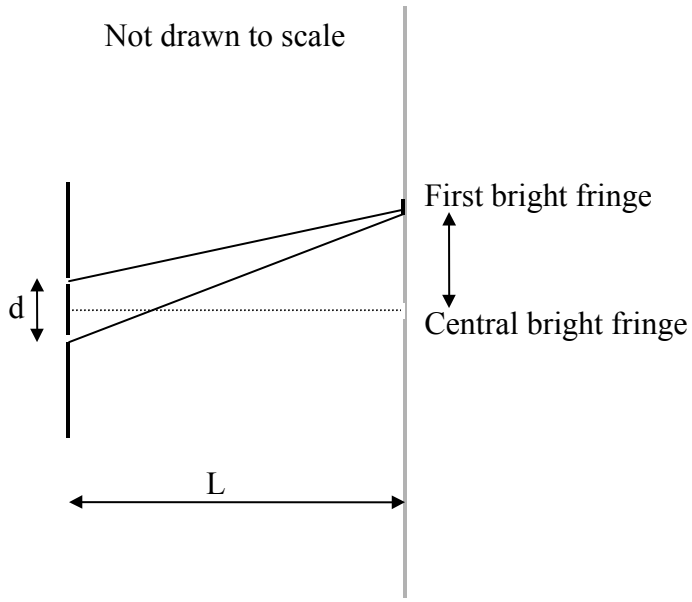
43. The nucleus of nitrogen $^{14}_{7}\mathrm{N}$ has a mass of 13,040 MeV/c^2. What is the binding energy of this nucleus? (The mass of the proton is 938.3 MeV/c^2, and that of the neutron is 939.5 MeV/c^2)

a. 2.2 MeV
b. 15.4 MeV
c. 47.9 MeV
d. 80.7 MeV
e. 104.6 MeV

44. A radioactive isotope has a half-life of 8 months. What fraction of a sample of the isotope will still remain after 2 years?

a. 1/32
b. 1/16
c. 1/8
d. 1/4
e. 1/2

The next two questions refer to the following situation:



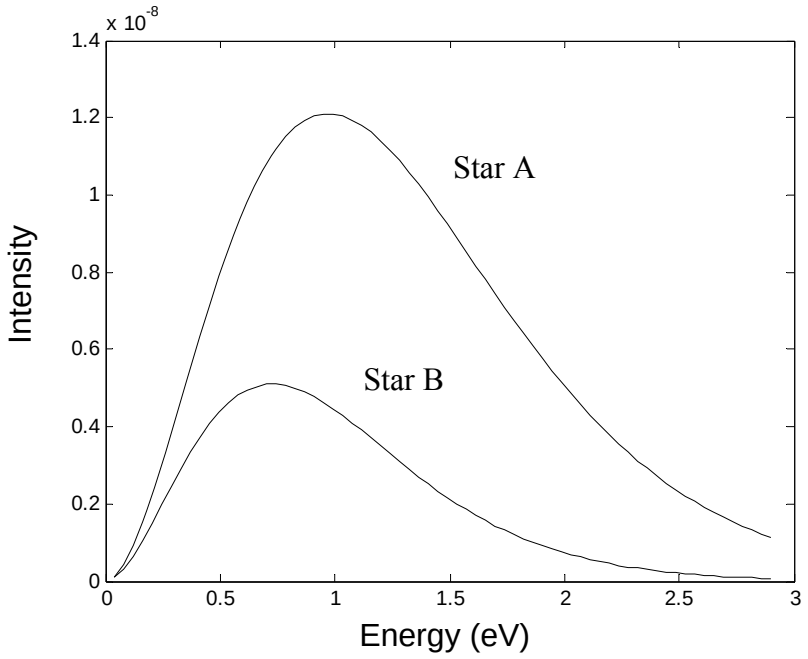
45. An electron beam of energy 2 eV is incident on two slits separated by a distance d=100 nm. A screen is placed L=2 m away from the slits. What is the separation between the first interference maximum and the center line? (The mass of the electron is 511 keV/c^2.)

a. 6.5 mm
b. 17.3 mm
c. 36.2 mm

46. The electron beam is replaced by a beam of light. What energy of photons will recreate the exact same pattern on the screen?

a. 2 eV
b. 350 eV
c. 1.4 keV

47. An astronomer observes two stars A and B, and obtains the following radiation spectrum for each (plotted as intensity vs. energy of the emitted light).



Which star is hotter? Assume that the stars behave as ideal blackbodies.

a. Star A
b. Star B

48. You decide to build your own burglar alarm system using your knowledge of the photoelectric effect from Phys. 102. Your idea is to shine a laser onto a metal, generating a current from the release of photoelectrons. If the beam is blocked (by a burglar), the current stops, and the alarm goes off.

To ensure that the burglar does not see the beam of light, you use an infrared laser (with wavelength 1064 nm). Now you need to select a metal with the right work function W_0 to complete your alarm; you have the following choices:

Metal A – W_0 = 1 eV
Metal B – W_0 = 1.5 eV
Metal C – W_0 = 2 eV

Which metal(s) will work for this application?

a. All of them
b. A and B
c. B and C
d. A only
e. C only

49. Which of the following quantities will two observers always measure to be the *same*, regardless of the relative velocity between the observers:

(i) the time interval between two events
(ii) the length of an object
(iii) the speed of light in a vacuum
(iv) the relative speed between them

a. All of them
b. (i) and (ii)
c. (iii) and (iv)
d. (iii) only
e. (iv) only

50. A muon is an unstable elementary particle. At rest, a muon has a lifetime of 2.2 μs. What is the lifetime of a muon traveling at a speed $v = 0.999c$?

a. 0.1 μs
b. 2.2 μs
c. 18 μs
d. 31 μs
e. 49 μs

ANSWER KEY

1. E
2. C
3. A
4. B
5. B
6. A
7. C
8. C
9. A
10. A
11. B
12. A
13. B
14. A
15. A
16. A
17. B
18. C
19. B
20. A
21. A
22. B
23. A
24. B
25. A
26. A
27. A
28. E
29. C
30. C
31. B
32. E
33. B
34. C
35. E
36. A
37. D
38. C
39. D
40. C
41. B
42. B
43. E
44. C
45. B
46. C
47. A
48. D
49. C
50. E