trig2Bnk:Study

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mixed quiz 155136981835

Thursday 28$^{\text{th}}$ February, 2019

Though posted on Wikiversity, this document was created without wikitex using Python to write LaTeX markup. With a bit more development it will be possible for users to download and use software that will permit them to create, modify, and print their own versions of this document.

Contents

1 a16OscillationsWaves_amplitudes

1. A 0.156 kg mass is on a spring that causes the frequency of oscillation to be 95 cycles per second. The maximum velocity is 50.6 m/s. What is the maximum force on the mass?[1]

   A. 2.2 x 10^3 N

   B. 4.7 x 10^3 N

   C. 1 x 10^4 N

   D. 2.2 x 10^4 N

   E. 4.7 x 10^4 N

2. A spring with spring constant 5.5 kN/m is attached to a 9.8 gram mass. The maximum acelleration is 3.4 m/s^2. What is the maximum displacement?[2]

   A. 1.92 x 10^{-7} m

   B. 6.06 x 10^{-7} m

   C. 1.92 x 10^{-6} m

   D. 6.06 x 10^{-6} m

   E. 1.92 x 10^{-5} m

3. A spring of spring constant 9.1 kN/m causes a mass to move with a period of 6.5 ms. The maximum displacement is 8.1 mm. What is the maximum kinetic energy?[3]

The next page might contain more answer choices for this question

A. 9.44×10^{-3} J

B. 2.99×10^{-2} J

C. 9.44×10^{-2} J

D. 2.99×10^{-1} J

E. 9.44×10^{-1} J

4. A spring with spring constant 3.1 kN/m undergoes simple harmonic motion with a frequency of 2.9 kHz. The maximum force is 2.3 N. What is the total energy?[4]

A. 2.7×10^{-4} J

B. 8.53×10^{-4} J

C. 2.7×10^{-3} J

D. 8.53×10^{-3} J

E. 2.7×10^{-2} J

2 a17PhysHearing_echoString

1. The temperature is -2 degrees Celsius, and you are standing 0.88 km from a cliff. What is the echo time?[5]

A. 4.238×10^{0} seconds

B. 4.576×10^{0} seconds

C. 4.941×10^{0} seconds

D. 5.335×10^{0} seconds

E. 5.761×10^{0} seconds

2. While standing 0.88 km from a cliff, you measure the echo time to be 5.069 seconds. What is the temperature?[6]

A. 2.72×10^{1}Celsius

B. 3.15×10^{1}Celsius

C. 3.63×10^{1}Celsius

D. 4.19×10^{1}Celsius

E. 4.84×10^{1}Celsius

3. What is the speed of a transverse wave on a string if the string is 1.11 m long, clamped at both ends, and harmonic number 4 has a frequency of 611 Hz?[7]

A. 1.57×10^{2} unit

B. 1.91×10^{2} unit

C. 2.31×10^{2} unit

D. 2.8×10^{2} unit

E. 3.39×10^{2} unit

The next page might contain more answer choices for this question

3 b_waves_PC

1. People don't usually perceive an echo when[8]
   - **A. it arrives less than a tenth of a second after the original sound**
   - B. it arrives at exactly the same pitch
   - C. it arrives at a higher pitch
   - D. it arrives at a lower pitch
   - E. it takes more than a tenth of a second after the original sound to arrive

2. Why do rough walls give a concert hall a fuller sound, compared to smooth walls?[9]
   - A. Rough walls make for a louder sound.
   - **B. The difference in path lengths creates more reverberation.**
   - C. The difference in path lengths creates more echo.

3. Comparing a typical church to a professional baseball stadium, the church is likely to have[10]
   - **A. reverberation instead of echo**
   - B. echo instead of reverberation
   - C. both reverberation and echo
   - D. neither reverberation nor echo

4. A dense rope is connected to a rope with less density (i.e. fewer kilograms per meter). If the rope is stretched and a wave is sent along high density rope towards the low density rope,[11]
   - A. the low density rope supports a wave with a higher frequency
   - B. the low density rope supports a wave with a lower frequency
   - C. the low density rope supports a wave with a higher speed
   - **D. the low density rope supports a wave with a lower speed**

5. A low density rope is connected to a rope with higher density (i.e. more kilograms per meter). If the rope is stretched and a wave is sent along the low density rope towards the high density rope,[12]
   - A. the high density rope supports a wave with a higher frequency
   - B. the high density rope supports a wave with a lower frequency
   - **C. the high density rope supports a wave with a higher speed**
   - D. the high density rope supports a wave with a lower speed

6. What happens to the wavelength on a wave on a stretched string if the wave passes from lightweight (low density) region of the rope to a heavy (high density) rope?[13]
   - **A. the wavelength gets longer**
   - B. the wavelength stays the same
   - C. the wavelength gets shorter

7. When a wave is reflected off a stationary barrier, the reflected wave[14]
   - **A. has lower amplitude than the incident wave**
   - B. has higher frequency than the incident wave
   - C. both of these are true

The next page might contain more answer choices for this question

8.  These two pulses will collide and produce[15]

   A. constructive interference

   B. destructive interference

   C. constructive diffraction

   D. destructive diffraction

9.  These two pulses will collide and produce[16]

   A. constructive interference

   B. destructive interference

   C. constructive diffraction

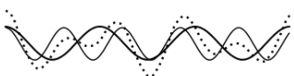
   D. destructive diffraction

10.  The two solid signals add to a (dashed)[17]

   A. octave

   B. fifth

   C. dissonance

11.  The two solid signals add to a (dashed)[18]

   A. octave

   B. fifth

   C. dissonance

12.  The two solid signals add to a (dashed)[19]

   A. octave

   B. fifth

   C. dissonance

13. Why don't we hear beats when two different notes on a piano are played at the same time?[20]

   A. The beats happen so many times per second you can't hear them.

   B. The note is over by the time the first beat is heard

   C. Reverberation usually stifles the beats

   D. Echo usually stifles the beats

14. A tuning fork with a frequency of 440 Hz is played simultaneously with a tuning fork of 442 Hz. How many beats are heard in 10 seconds?[21]

   A. 20

   B. 30

   C. 40

   D. 50

   E. 60

The next page might contain more answer choices for this question

15. If you start moving towards a source of sound, the pitch[22]
    A. becomes higher
    B. becomes lower
    C. remains unchanged

16. If a source of sound is moving towards you, the pitch [23]
    A. becomes higher
    B. becomes lower
    C. remains unchanged

4 a18ElectricChargeField_findE

1. What is the magnitude of the electric field at the origin if a 1.8 nC charge is placed at x = 7.9 m, and a 2.1 nC charge is placed at y = 7 m?[24]
    A. 2.61 x 10^{-1}N/C
    B. 3.02 x 10^{-1}N/C
    C. 3.48 x 10^{-1}N/C
    D. 4.02 x 10^{-1}N/C
    E. 4.64 x 10^{-1}N/C

2. What angle does the electric field at the origin make with the x-axis if a 1.1 nC charge is placed at x = -6.5 m, and a 1.4 nC charge is placed at y = -8.3 m?[25]
    A. 3.8 x 10^{1}degrees
    B. 4.39 x 10^{1}degrees
    C. 5.06 x 10^{1}degrees
    D. 5.85 x 10^{1}degrees
    E. 6.75 x 10^{1}degrees

3. A dipole at the origin consists of charge Q placed at x = 0.5a, and charge of -Q placed at x = -0.5a. The absolute value of the x component of the electric field at (x,y) =(6a, 4a) is β kQ/a^2, where β equals[26]
    A. 1.33 x 10^{-3}
    B. 1.61 x 10^{-3}
    C. 1.95 x 10^{-3}
    D. 2.37 x 10^{-3}
    E. 2.87 x 10^{-3}

4. A dipole at the origin consists of charge Q placed at x = 0.5a, and charge of -Q placed at x = -0.5a. The absolute value of the y component of the electric field at (x,y) =(1.1a, 1.2a) is β kQ/a^2, where β equals [27]
    A. 2.36 x 10^{-1}
    B. 2.86 x 10^{-1}
    C. 3.47 x 10^{-1}
    D. 4.2 x 10^{-1}
    E. 5.09 x 10^{-1}

The next page might contain more answer choices for this question

5 a19ElectricPotentialField_Capacitance

1. A parallel plate capacitor has both plates with an area of 1.05 m^2. The separation between the plates is 0.63mm. Applied to the plates is a potential difference of 2.85 kV. What is the capacitance?[28]

   A. 8.44 nF.

   B. 9.7 nF.

   C. 11.16 nF.

   D. 12.83 nF.

   E. 14.76 nF.

2. Consider a parallel plate capacitor with area 1.05 m^2, plate separation 0.63mm, and an applied voltage of 2.85 kV. How much charge is stored?[29]

   A. 24.05 µ C.

   B. 27.65 µ C.

   C. 31.8 µ C.

   D. 36.57 µ C.

   E. 42.06 µ C.

3. A 0.8 Farad capacitor is charged with 1.5 Coulombs. What is the value of the electric field if the plates are 0.7 mm apart?[30]

   A. 1.76 kV/m.

   B. 2.03 kV/m.

   C. 2.33 kV/m.

   D. 2.68 kV/m.

   E. 3.08 kV/m.

4. A 0.8 Farad capacitor is charged with 1.5 Coulombs. What is the energy stored in the capacitor if the plates are 0.7 mm apart?[31]

   A. 0.8 J.

   B. 0.92 J.

   C. 1.06 J.

   D. 1.22 J.

   E. 1.41 J.

5. A 0.8 Farad capacitor is charged with 1.5 Coulombs. What is the force between the plates if they are 0.7 mm apart?[32]

   A. 2009 N.

   B. 2310 N.

   C. 2657 N.

   D. 3055 N.

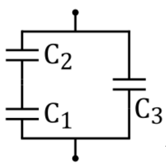
   E. 3514 N.

The next page might contain more answer choices for this question

6 d_cp2.8

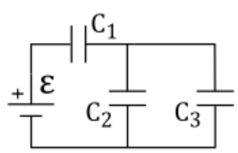
1. An empty parallel-plate capacitor with metal plates has an area of 1.0 m^2, separated by 1.0 mm. How much charge does it store if the voltage is 3.000E+03 V?[33]

   A. 2.195E+01 μ C
   B. 2.415E+01 μ C
   C. 2.656E+01 μ C
   D. 2.922E+01 μ C
   E. 3.214E+01 μ C

2. 

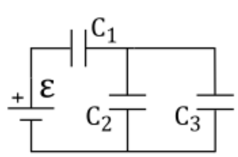
What is the net capacitance if C_1=1 μ F, C_2=5 μ F, and C_3=8 μ F in the configuration shown?[34]

   A. 8.030E+00 μ F
   B. 8.833E+00 μ F
   C. 9.717E+00 μ F
   D. 1.069E+01 μ F
   E. 1.176E+01 μ F

3. 

In the figure shown C_1=12 μ F, C_2=2 μ F, and C_3=4 μ F. The voltage source provides ε =12 V. What is the charge on C_1?[35]

   A. 3.606E+01 μ C
   B. 3.967E+01 μ C
   C. 4.364E+01 μ C
   D. 4.800E+01 μ C
   E. 5.280E+01 μ C

4. 

In the figure shown C_1=12 μ F, C_2=2 μ F, and C_3=4 μ F. The voltage source provides ε =12 V. What is the energy stored in C_2?[36]

   A. 1.600E+01 μ J
   B. 1.760E+01 μ J
   C. 1.936E+01 μ J
   D. 2.130E+01 μ J
   E. 2.343E+01 μ J

The next page might contain more answer choices for this question

7 a19ElectricPotentialField_KE_PE

1. How fast is a 2642 eV electron moving?[37]
   - **A. 3 x 10^7 m/s.**
   - B. 4.6 x 10^7 m/s.
   - C. 6.9 x 10^7 m/s.
   - D. 1 x 10^8 m/s.
   - E. 1.5 x 10^8 m/s.
2. A proton is accelerated (at rest) from a plate held at 45.3 volts to a plate at zero volts. What is the final speed?[38]
   - A. 2.8 x 10^4 m/s.
   - B. 4.1 x 10^4 m/s.
   - C. 6.2 x 10^4 m/s.
   - **D. 9.3 x 10^4 m/s.**
   - E. 1.4 x 10^5 m/s.
3. What voltage is required accelerate an electron at rest to a speed of 9.4 x 10^6 m/s?[39]
   - A. 7.4 x 10^1 volts
   - B. 1.1 x 10^2 volts
   - C. 1.7 x 10^2 volts
   - **D. 2.5 x 10^2 volts**
   - E. 3.8 x 10^2 volts
4. What voltage is required to stop a proton moving at a speed of 8.5 x 10^4 m/s?[40]
   - A. 7.4 x 10^0 volts
   - B. 1.1 x 10^1 volts
   - C. 1.7 x 10^1 volts
   - D. 2.5 x 10^1 volts
   - **E. 3.8 x 10^1 volts**

8 a20ElectricCurrentResistivityOhm_PowerDriftVel

1. A 4 volt battery moves 27 Coulombs of charge in 2.6 hours. What is the power?[41]
   - A. 7.86 x 10^{-3} W
   - B. 9.52 x 10^{-3} W
   - **C. 1.15 x 10^{-2} W**
   - D. 1.4 x 10^{-2} W
   - E. 1.69 x 10^{-2} W
2. The diameter of a copper wire is 5.5 mm, and it carries a current of 76 amps. What is the drift velocity if copper has a density of 8.8E3 kg/m^3 and an atomic mass of 63.54 g/mol? (1 mol = 6.02E23 atoms, and copper has one free electron per atom.)[42]
   - A. 1.35 x 10^{-4}m/s

The next page might contain more answer choices for this question

B. 1.63×10^{-4}m/s
C. 1.98×10^{-4}m/s
D. 2.39×10^{-4}m/s
E. 2.9×10^{-4}m/s

3. A 168 Watt DC motor draws 0.3 amps of current. What is effective resistance?[43]
   A. 1.87×10^{3} Ω
   B. 2.26×10^{3} Ω
   C. 2.74×10^{3} Ω
   D. 3.32×10^{3} Ω
   E. 4.02×10^{3} Ω

4. A power supply delivers 113 watts of power to a 104 ohm resistor. What was the applied voltage?[44]
   A. 5.03×10^{1} volts
   B. 6.1×10^{1} volts
   C. 7.39×10^{1} volts
   D. 8.95×10^{1} volts
   E. 1.08×10^{2} volts

9 a21CircuitsBioInstDC_circuits

1. An ideal 5.2 V voltage source is connected to two resistors in series. One is $1.2k\Omega$, and the other is 2.8 $k\Omega$. What is the current through the larger resistor?[45]
   A. 0.7 mA.
   B. 0.9 mA.
   C. 1.1 mA.
   D. 1.3 mA.
   E. 1.5 mA.

2. A 7.7 ohm resistor is connected in series to a pair of 5.8 ohm resistors that are in parallel. What is the net resistance?[46]
   A. 6.1 ohms.
   B. 7 ohms.
   C. 8 ohms.
   D. 9.2 ohms.
   E. 10.6 ohms.

3. Two 8 ohm resistors are connected in parallel. This combination is then connected in series to a 6.6 ohm resistor. What is the net resistance?[47]
   A. 9.2 ohms.
   B. 10.6 ohms.
   C. 12.2 ohms.
   D. 14 ohms.

The next page might contain more answer choices for this question

E. 16.1 ohms.

4. An ideal 7.9 volt battery is connected to a 0.09 ohm resistor. To measure the current an ammeter with a resistance of $20m\Omega$ is used. What current does the ammeter actually read?[48]

   A. 71.8 A.

   B. 82.6 A.

   C. 95 A.

   D. 109.2 A.

   E. 125.6 A.

5. A battery has an emf of 5.3 volts, and an internal resistance of 326 $k\Omega$. It is connected to a 3 $M\Omega$ resistor. What power is developed in the 3 $M\Omega$ resistor?[49]

   A. 5.01 μW.

   B. 5.76 μW.

   C. 6.62 μW.

   D. 7.62 μW.

   E. 8.76 μW.

10 a21CircuitsBioInstDC_RCdecaySimple

1. A 621 mF capacitor is connected in series to a 628 kΩ resistor. If the capacitor is discharged, how long does it take to fall by a factor of e^3? (where e =2.7...)[50]

   A. 1.17 x 10^5 s.

   B. 3.7 x 10^5 s.

   C. 1.17 x 10^6 s.

   D. 3.7 x 10^6 s.

   E. 1.17 x 10^7 s.

2. A 784 µ F capacitor is connected in series to a 543 kΩ resistor. If the capacitor is discharged, how long does it take to fall by a factor of e^3? (where e =2.7...)[51]

   A. 4.04 x 10^1 s.

   B. 1.28 x 10^2 s.

   C. 4.04 x 10^2 s.

   D. 1.28 x 10^3 s.

   E. 4.04 x 10^3 s.

3. A 354 mF capacitor is connected in series to a 407 MΩ resistor. If the capacitor is discharged, how long does it take to fall by a factor of e^3? (where e =2.7...)[52]

   A. 4.32 x 10^7 s.

   B. 1.37 x 10^8 s.

   C. 4.32 x 10^8 s.

   D. 1.37 x 10^9 s.

   E. 4.32 x 10^9 s.

The next page might contain more answer choices for this question

4. A 10 F capacitor is connected in series to a 9Ω resistor. If the capacitor is discharged, how long does it take to fall by a factor of e^4? (where e =2.7...)[53]

   A. 3.6 x 10^2 s.

   B. 1.14 x 10^3 s.

   C. 3.6 x 10^3 s.

   D. 1.14 x 10^4 s.

   E. 3.6 x 10^4 s.

11 d_cp2.10

1. A given battery has a 12 V emf and an internal resistance of 0.1 Ω . If it is connected to a 0.5 Ω resistor what is the power dissipated by that load?[54]

   A. 1.503E+02 W

   B. 1.653E+02 W

   C. 1.818E+02 W

   D. 2.000E+02 W

   E. 2.200E+02 W

2. A battery with a terminal voltage of 9 V is connected to a circuit consisting of 4 20 Ω resistors and one 10 Ω resistor. What is the voltage drop across the 10 Ω resistor?[55]

   A. 7.513E-01 V

   B. 8.264E-01 V

   C. 9.091E-01 V

   D. 1.000E+00 V

   E. 1.100E+00 V

3. Three resistors, $R_1 = 1\,\Omega$, and $R_2 = R_2 = 2\,\Omega$, are connected in parallel to a 3 V voltage source. Calculate the power dissipated by the smaller resistor (R_1.) [56]

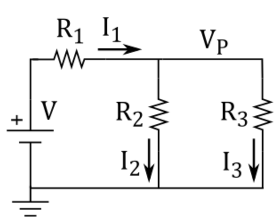
   A. 6.762E+00 W

   B. 7.438E+00 W

   C. 8.182E+00 W

   D. 9.000E+00 W

   E. 9.900E+00 W



4. In the circuit shown V=12 V, R_1=1 Ω , R_2=6 Ω , and R_3=13 Ω . What is the power dissipated by R_2?[57]

   A. 1.552E+01 W

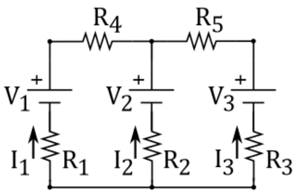
   B. 1.707E+01 W

   C. 1.878E+01 W

The next page might contain more answer choices for this question

D. 2.066E+01 W

E. 2.272E+01 W

5. 

The resistances in the figure shown are R_1= 2 Ω , R_2= 1 Ω , and R_2= 3 Ω . V_1 and V_3 are text 0.5 V and 2.3 V, respectively. But V_2 is opposite to that shown in the figure, or, equivalently, V_2=−0.6 V. What is the absolute value of the current through R_1?[58]

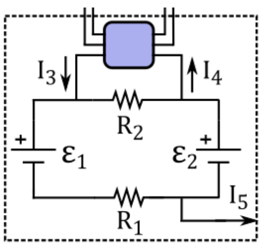
A. 1.653E-01 A

B. 1.818E-01 A

C. 2.000E-01 A

D. 2.200E-01 A

E. 2.420E-01 A

6. 

Two sources of emf ε_1=22.5 V, and ε_2=10 V are oriented as shown in the circuit. The resistances are R_1=2 kΩ and R_2=1 kΩ . Three other currents enter and exit or exit from portions of the circuit that lie outside the dotted rectangle and are not shown. I_3=5.0 mA and I_4=1.25 mA enter and leave near R_2, while the current I_5 exits near R_1.What is the magnitude (absolute value) of I_5?[59]

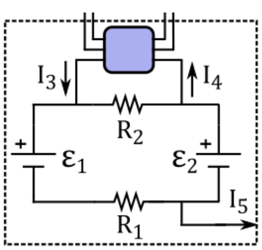
A. 3.099E+00 mA

B. 3.409E+00 mA

C. 3.750E+00 mA

D. 4.125E+00 mA

E. 4.538E+00 mA

7. 

Two sources of emf ε_1=22.5 V, and ε_2=10 V are oriented as shown in the circuit. The resistances are R_1=2 kΩ and R_2=1 kΩ . Three other currents enter and exit or exit from portions of the circuit that lie outside the dotted rectangle and are not shown. I_3=5.0 mA and I_4=1.25 mA enter and leave near R_2, while the current I_5 exits near R_1.What is the magnitude (absolute value) of voltage drop across R_1?[60]

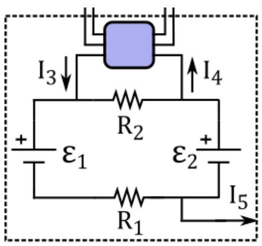
A. 5.000E+00 V

B. 5.500E+00 V

C. 6.050E+00 V

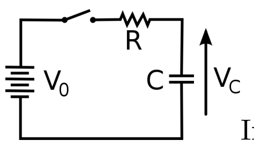
D. 6.655E+00 V

E. 7.321E+00 V

8. 

Two sources of emf ε_1=22.5 V, and ε_2=10 V are oriented as shown in the circuit. The resistances are R_1=2 kΩ and R_2=1 kΩ . Three other currents enter and exit or exit from portions of the circuit that lie outside the dotted rectangle and are not shown. I_3=5.0 mA and I_4=1.25 mA enter and leave near R_2, while the current I_5 exits near R_1.What is the magnitude (absolute value) of voltage drop across R_2?[61]

   A. 6.198E+00 V
   B. 6.818E+00 V
   C. 7.500E+00 V
   D. 8.250E+00 V
   E. 9.075E+00 V

9. 

In the circuit shown the voltage across the capacitor is zero at time t=0 when a switch is closed putting the capacitor into contact with a power supply of 100 V. If the combined external and internal resistance is 101 Ω and the capacitance is 50 mF, how long will it take for the capacitor's voltage to reach 80 V?[62]

   A. 8.128E+00 s
   B. 8.940E+00 s
   C. 9.834E+00 s
   D. 1.082E+01 s
   E. 1.190E+01 s

12 a21CircuitsBioInstDC_circAnalQuiz1

1. 3 amps flow through a 1 Ohm resistor. What is the voltage?[63]
   A. $3V$
   B. $1V$
   C. $\frac{1}{3}V$
   D. None these are correct.

2. A 1 ohm resistor has 5 volts DC across its terminals. What is the current (I) and the power consumed?[64]
   A. I = 5A & P = 3W.
   B. I = 5A & P = 5W.
   C. I = 5A & P = 25W.
   D. I = 5A & P = 9W

3. The voltage across two resistors in series is 10 volts. One resistor is twice as large as the other. What is the voltage across the larger resistor? What is the voltage across the smaller one? [65]
   A. $V_{Big-Resistor} = 3.33V$ and$V_{small-Resistor} = 6.67V$.

The next page might contain more answer choices for this question

B. $V_{small-Resistor} = 5V$ and $V_{Big-Resistor} = 5V$.

C. $V_{Big-Resistor} = 6.67V$ and $V_{small-Resistor} = 3.33V$.

D. None of these are true.

4. A 1 ohm, 2 ohm, and 3 ohm resistor are connected in series. What is the total resistance?[66]

A. $R_{Total} = 0.5454\Omega$.

B. $R_{Total} = 3\Omega$.

C. $R_{Total} = 6\Omega$.

D. None of these are true.

5. Two identical resistors are connected in series. The voltage across both of them is 250 volts. What is the voltage across each one?[67]

A. $R_1 = 150V$ and $R_2 = 100V$.

B. None of these are true.

C. $R_1 = 125V$ and $R_2 = 125V$.

D. $R_1 = 250V$ and $R_2 = 0V$.

6. A 1 ohm, 2 ohm, and 3 ohm resistor are connected in "parallel". What is the total resistance?[68]

A. $\frac{11}{6}\Omega$.

B. $\frac{3}{6}\Omega$.

C. $\frac{6}{11}\Omega$.

D. $\frac{6}{3}\Omega$.

7. A 5 ohm and a 2 ohm resistor are connected in parallel. What is the total resistance?[69]

A. $\frac{6}{10}\Omega$.

B. $\frac{7}{10}\Omega$.

C. $\frac{10}{6}\Omega$.

D. $\frac{10}{7}\Omega$.

8. A 7 ohm and a 3 ohm resistor are connected in parallel. What is the total resistance?[70]

A. $\frac{21}{10}\Omega$.

B. $\frac{11}{7}\Omega$.

C. $\frac{7}{11}\Omega$.

D. $\frac{10}{21}\Omega$.

9. Three 1 ohm resistors are connected in parallel. What is the total resistance?[71]

A. 3Ω.

B. $\frac{1}{3}\Omega$.

C. $\frac{3}{2}\Omega$.

D. $\frac{2}{3}\Omega$.

10. If you put an infinite number of resistors in parallel, what would the total resistance be?[72]

A. R_{total} would approach Zero as The No. of Resistors In parallel Approaches Infinity.

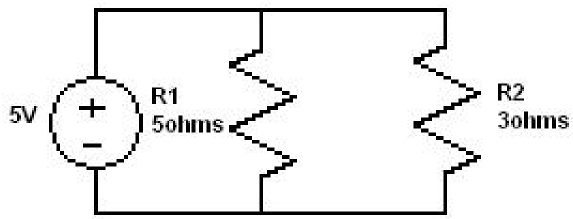
B. None of these are true.

The next page might contain more answer choices for this question

C. R_{total} would approach 1 as The No. of Resistors In parallel Approaches Infinity

D. It is not possible to connect that Number of Resistors in parallel.

11. What is the current through R1 and R2 in the figure shown?



[73]

A. $I_1 = 0.1A$ and $I_2 = 0.1667A$.

B. $I_1 = 10A$ and $I_2 = 16.67A$.

C. $I_1 = 1A$ and $I_2 = 25A$.

D. $I_1 = 1A$ and $I_2 = 1.667A$.

12. Why do we say the "voltage across" or "the voltage with respect to?" Why can't we just say voltage?[74]

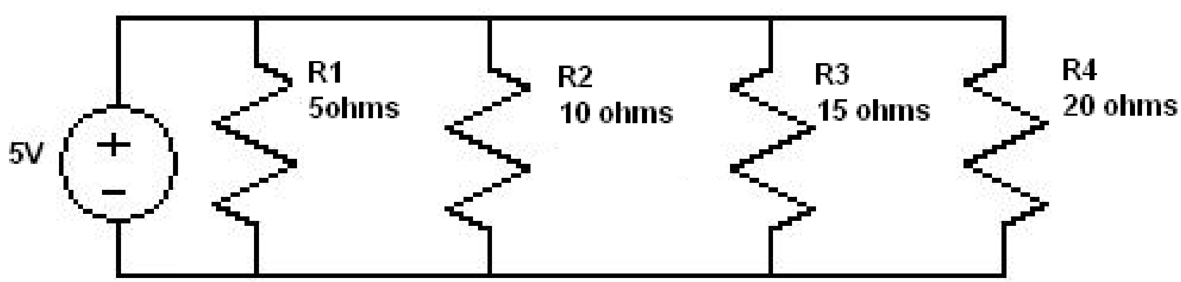
A. It's an Electrical "Cliche".

B. The other point could be Negative or positive.

C. None these are correct

D. Voltage is a measure of Electric Potential difference between two electrical points.

13. What is the current through R1, R2, R3, and R4 in the figure shown?



[75]

A. $I_1 = 10A$; $I_2 = 50A$; $I_3 = 33A$; $I_4 = 25A$..

B. $I_1 = 1A$; $I_2 = 5A$; $I_3 = 3.3A$; $I_4 = 2.5A$.

C. $I_1 = 1A$; $I_2 = 0.5A$; $I_3 = 0.33A$; $I_4 = 0.25A$.

D. $I_1 = 0.25A$; $I_2 = 0.33A$; $I_3 = 0.5A$; $I_4 = 0.1A$.

14. Two resistors are in parallel with a voltage source. How do their voltages compare?[76]

A. The voltage across both resistors is the same as the source.

B. None of these are true.

C. One has full voltage, the other has none.

D. The voltage across both resistors is half the voltage of the source.

15. A resistor consumes 5 watts, and its current is 10 amps. What is its voltage?[77]

A. 2V.

The next page might contain more answer choices for this question

B. 10V.

C. 0.5V.

D. 15V.

16. A resistor has 10 volts across it and 4 amps going through it. What is its resistance?[78]

A. None of these are true.

B. 3.5Ω.

C. 4.5Ω.

D. 2.5Ω.

17. If you plot voltage vs. current in a circuit, and you get a linear line, what is the significance of the slope? [79]

A. Power.

B. Resistance.

C. Discriminant.

D. None of these are true.

18. A resistor has 3 volts across it. Its resistance is 1.5 ohms. What is the current?[80]

A. 12A

B. 3A

C. 2A

D. 1.5A

19. A resistor has 8 volts across it and 3 Amps going through it. What is the power consumed?[81]

A. 2.2W

B. 24W

C. 8W

D. 3W

20. A resistor has a voltage of 5 volts and a resistance of 15 ohms. What is the power consumed? [82]

A. None of these are ture.

B. 11.67 Joules

C. 1.67 Watts

D. 2.5 Watts

21. A resistor is on for 5 seconds. It consumes power at a rate of 5 watts. How many joules are used?[83]

A. 25 Joules

B. 3 Joules

C. 5 Joules

D. None of these are true

The next page might contain more answer choices for this question

13 a22Magnetism_forces

1. A cosmic ray alpha particle encounters Earth's magnetic field at right angles to a field of 5.7 µ T. The kinetic energy is 361 keV. What is the radius of particle's orbit?[84]

   A. 1.5 x 10^{2} m.

   B. 4.8 x 10^{2} m.

   C. 1.5 x 10^{3} m.

   D. 4.8 x 10^{3} m.

   E. 1.5 x 10^{4} m.

2. Two parallel wires are 7.2 meters long, and are separated by 6.9 mm. What is the force if both wires carry a current of 13.7 amps?[85]

   A. 1.24 x 10^{-2} newtons

   B. 3.92 x 10^{-2} newtons

   C. 1.24 x 10^{-1} newtons

   D. 3.92 x 10^{-1} newtons

   E. 1.24 x 10^{0} newtons

3. Blood is flowing at an average rate of 21.5 cm/s in an artery that has an inner diameter of 3.5 mm. What is the voltage across a hall probe placed across the inner diameter of the artery if the perpendicular magnetic field is 0.11 Tesla?[86]

   A. 8.28 x 10^{-6} Volts

   B. 2.62 x 10^{-5} Volts

   C. 8.28 x 10^{-5} Volts

   D. 2.62 x 10^{-4} Volts

   E. 8.28 x 10^{-4} Volts

4. An electron tube on Earth's surface is oriented horizontally towards magnetic north. The electron is traveling at 0.07c, and Earth's magnetic field makes an angle of 22.5 degrees with respect to the horizontal. To counter the magnetic force, a voltage is applied between two large parallel plates that are 54 mm apart. What must be the applied voltage if the magnetic field is 45µ T?[87]

   A. 2 x 10^{-1} volts

   B. 6.2 x 10^{-1} volts

   C. 2 x 10^{0} volts

   D. 6.2 x 10^{0} volts

   E. 2 x 10^{1} volts

14 d_cp2.11

1. An alpha-particle (q=3.2x10^{-19}C) moves through a uniform magnetic field that is parallel to the positive z-axis with magnitude 1.5 T. What is the x-component of the force on the alpha-particle if it is moving with a velocity $(2.2\,\mathbf{i} + 3.3\,\mathbf{j}\ + 1.1\,\mathbf{k})\,\mathrm{x}\,10^4$ m/s?[88]

   A. 1.440E-14 N

   B. 1.584E-14 N

The next page might contain more answer choices for this question

C. 1.742E-14 N

D. 1.917E-14 N

E. 2.108E-14 N

2. A charged particle in a magnetic field of 1.000E-04 T is moving perpendicular to the magnetic field with a speed of 5.000E+05 m/s. What is the period of orbit if orbital radius is 0.5 m?[89]

A. 4.721E-06 s

B. 5.193E-06 s

C. 5.712E-06 s

D. 6.283E-06 s

E. 6.912E-06 s

3. An alpha-particle (m=6.64x10^{-27}kg, q=3.2x10^{-19}C) briefly enters a uniform magnetic field of magnitude 0.05 T . It emerges after being deflected by 45° from its original direction. How much time did it spend in that magnetic field?[90]

A. 3.259E-07 s

B. 3.585E-07 s

C. 3.944E-07 s

D. 4.338E-07 s

E. 4.772E-07 s

4. A 50 cm-long horizontal wire is maintained in static equilibrium by a horizontally directed magnetic field that is perpendicular to the wire (and to Earth's gravity). The mass of the wire is 10 g, and the magnitude of the magnetic field is 0.5 T. What current is required to maintain this balance?[91]

A. 3.920E-01 A

B. 4.312E-01 A

C. 4.743E-01 A

D. 5.218E-01 A

E. 5.739E-01 A

5. A long rigid wire carries a 5 A current. What is the magnetic force per unit length on the wire if a 0.3 T magnetic field is directed 60° away from the wire?[92]

A. 1.074E+00 N/m

B. 1.181E+00 N/m

C. 1.299E+00 N/m

D. 1.429E+00 N/m

E. 1.572E+00 N/m

6. A circular current loop of radius 2 cm carries a current of 2 mA. What is the magnitude of the torque if the dipole is oriented at 30 ° to a uniform magnetic fied of 0.5 T? [93]

A. 4.292E-07 N m

B. 4.721E-07 N m

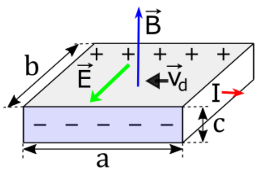
C. 5.193E-07 N m

D. 5.712E-07 N m

The next page might contain more answer choices for this question

E. 6.283E-07 N m

7. An electron beam (m=9.1×10^{-31}kg, q=1.6×10^{-19}C) enters a crossed-field velocity selector with magnetic and electric fields of 2 mT and 6.000E+03 N/C, respectively. What must the velocity of the electron beam be to transverse the crossed fields undeflected ?[94]
   - A. 2.254E+06 m/s
   - B. 2.479E+06 m/s
   - C. 2.727E+06 m/s
   - **D. 3.000E+06 m/s**
   - E. 3.300E+06 m/s

8. 

The silver ribbon shown are a=3.5 cm, b=2 cm, and c= 0.2 cm. The current carries a current of 100 A and it lies in a uniform magnetic field of 1.5 T. Using the density of 5.900E+28 electrons per cubic meter for silver, find the Hall potential between the edges of the ribbon.[95]
   - A. 5.419E-06 V
   - B. 5.961E-06 V
   - C. 6.557E-06 V
   - D. 7.213E-06 V
   - **E. 7.934E-06 V**

9. A cyclotron used to accelerate alpha particlesm=6.64×10^{-27}kg, q=3.2×10^{-19}C) has a radius of 0.5 m and a magneticfield of 1.8 T. What is their maximum kinetic energy?[96]
   - **A. 3.904E+01 MeV**
   - B. 4.294E+01 MeV
   - C. 4.723E+01 MeV
   - D. 5.196E+01 MeV
   - E. 5.715E+01 MeV

15 a23InductionACcircuits_Q1

1. Two orbiting satellites are orbiting at a speed of 85 km/s perpendicular to a magnetic field of 56 µ T. They are connected by a cable that is 29 km long. A voltmeter is attached between a satellite and one end of the cable. The voltmeter's internal impedance far exceeds the net resistance through the ionosphere that completes the circuit. What is the measured voltage?[97]
   - A. 7.76 x 10^4 volts.
   - B. 9.4 x 10^4 volts.
   - C. 1.14 x 10^5 volts.
   - **D. 1.38 x 10^5 volts.**
   - E. 1.67 x 10^5 volts.

2. An loop of wire with 25 turns has a radius of 0.85 meters, and is oriented with its axis parallel to a magetic field of 0.58 Tesla. What is the induced voltage if this field is reduced to 49

The next page might contain more answer choices for this question

A. 9.24×10^0 volts

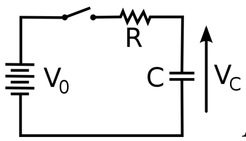
B. 1.12×10^1 volts

C. 1.36×10^1 volts

D. 1.64×10^1 volts

E. 1.99×10^1 volts

16 d_cp2.16

1. 

A parallel plate capacitor with a capicatnce C=1.00E-06 F whose plates have an area A=225.9 m^2 and separation d=2.00E-03 m is connected via a swith to a 2 Ω resistor and a battery of voltage V_0=2 V as shown in the figure. The current starts to flow at time t=0 when the switch is closed. What is the voltage at time t=4.00E-06?[98]

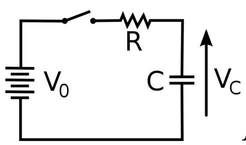
A. 1.729E+00 V

B. 1.902E+00 V

C. 2.092E+00 V

D. 2.302E+00 V

E. 2.532E+00 V

2. 

A parallel plate capacitor with a capicatnce C=1.00E-06 F whose plates have an area A=225.9 m^2 and separation d=2.00E-03 m is connected via a swith to a 2 Ω resistor and a battery of voltage V_0=2 V as shown in the figure. The current starts to flow at time t=0 when the switch is closed. What is the magnitude of the electric field at time t=4.00E-06?[99]

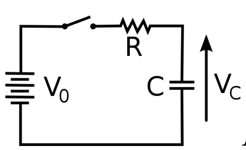
A. 8.647E+02 V/m

B. 9.511E+02 V/m

C. 1.046E+03 V/m

D. 1.151E+03 V/m

E. 1.266E+03 V/m

3. 

A parallel plate capacitor with a capicatnce C=1.00E-06 F whose plates have an area A=225.9 m^2 and separation d=2.00E-03 m is connected via a swith to a 2 Ω resistor and a battery of voltage V_0=2 V as shown in the figure. The current starts to flow at time t=0 when the switch is closed. What is the magnitude of the displacement current at time t=4.00E-06?[100]

A. 1.230E-01 A

B. 1.353E-01 A

C. 1.489E-01 A

D. 1.638E-01 A

The next page might contain more answer choices for this question

E. 1.801E-01 A

4. A 60 kW radio transmitter on Earth sends it signal to a satellite 100 km away. At what distance in the same direction would the signal have the same maximum field strength if the transmitter's output power were increased to 90 kW?[101]

   A. 9.202E+01 km

   B. 1.012E+02 km

   C. 1.113E+02 km

   D. 1.225E+02 km

   E. 1.347E+02 km

5. What is the radiation pressure on an object that is 9.00E+10 m away from the sun and has cross-sectional area of 0.04 m^2? The average power output of the Sun is 3.80E+26 W.[102]

   A. 1.701E-05 N/m^2

   B. 1.871E-05 N/m^2

   C. 2.058E-05 N/m^2

   D. 2.264E-05 N/m^2

   E. 2.491E-05 N/m^2

6. What is the radiation force on an object that is 9.00E+10 m away from the sun and has cross-sectional area of 0.04 m^2? The average power output of the Sun is 3.80E+26 W.[103]

   A. 8.233E-07 N

   B. 9.056E-07 N

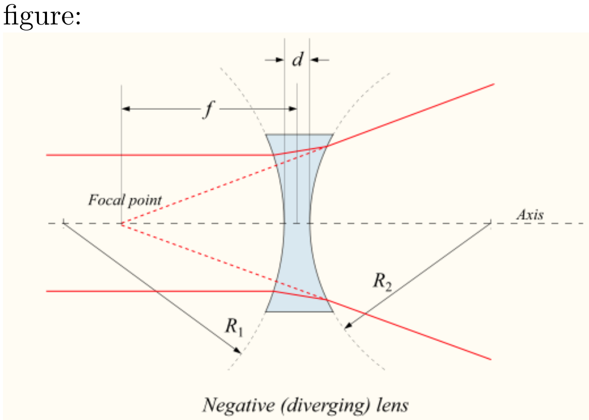
   C. 9.962E-07 N

   D. 1.096E-06 N

   E. 1.205E-06 N

17 a25GeometricOptics_image

1. figure:



Shown is a corrective lens by a person who needs glasses. This ray diagram illustrates[104]

   A. how a nearsighted person might see a distant object

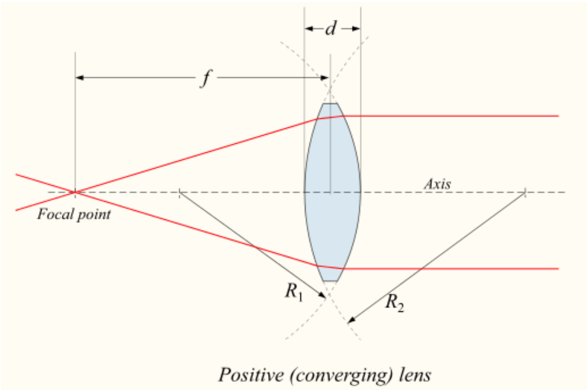
   B. how a nearsighted person might see an object that is too close for comfort

   C. how a farsighted person might see an object that is too close for comfort

The next page might contain more answer choices for this question

D. how a farsighted person might see a distant object

2. figure:



Shown is a corrective lens by a person who needs glasses. This ray diagram illustrates[105]

A. how a nearsighted person might see a distant object

B. how a farsighted person might see a distant object

C. how a farsighted person might see an object that is too close for comfort

D. how a nearsighted person might see an object that is too close for comfort

3. In optics, "'normal"' means[106]

A. to the left of the optical axis

B. parallel to the surface

C. perpendicular to the surface

D. to the right of the optical axis

4. The law of reflection applies to[107]

A. only light in a vacuum

B. telescopes but not microscopes

C. curved surfaces

D. both flat and curved surfaces

E. flat surfaces

5. When light passes from air to glass[108]

A. the frequency decreases

B. the frequency increases

C. it bends away from the normal

D. it bends towards the normal

E. it does not bend

6. When light passes from glass to air[109]

A. it does not bend

B. the frequency decreases

C. the frequency increases

D. it bends towards the normal

The next page might contain more answer choices for this question

E. it bends away from the normal

7. An important principle that allows fiber optics to work is[110]

   A. the invariance of the speed of light

   B. total internal reflection

   C. total external refraction

   D. partial internal absorption

   E. the Doppler shift

8. The focal point is where[111]

   A. rays meet whenever they pass through a lens

   B. rays meet if they were parallel to the optical axis before striking a lens

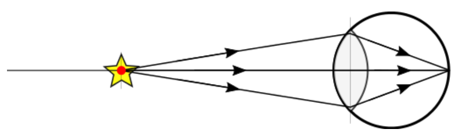
   C. rays meet whenever they are forming an image

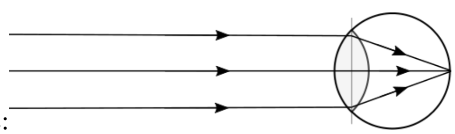
   D. rays meet if they are parallel to each other

   E. the center of the lens

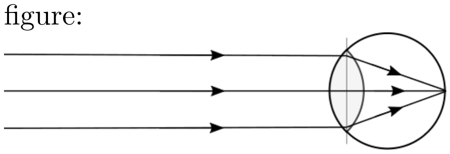
18 a25GeometricOptics_vision

1. Which lens has the shorter focal length?[112]

   A. This lens:
   

   B. This lens:
   

   C. Both lenses have the same the same focal length

2. figure:
   

   If this represents the eye looking at an object, where is this object?[113]

   A. One focal length in front of the eye

   B. Very far away

   C. One focal length behind the eye

   D. at the eye's cornea

   E. at eye's retina

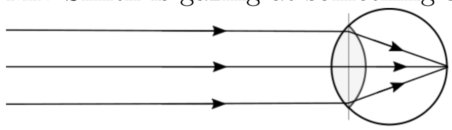
3. The focal point is where the rays from an object meet after they have passed through a lens.[114]

   A. False

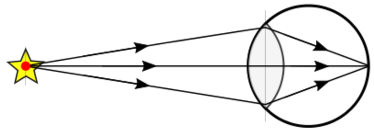
   B. True

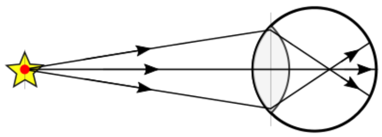
The next page might contain more answer choices for this question

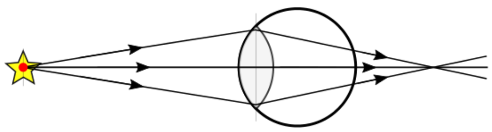
4. Mr. Smith is gazing at something as shown in the figure:



Suppose the object is suddenly moved closer, but for some reason Mr. Smith does not refocus his eyes. which drawing below best depicts the rays' paths.[115]

A. This drawing: 

B. This drawing: 

C. This drawing: 

19 a25GeometricOptics_thinLenses

1. An object is placed 5.8 cm to the left of a diverging lens with a focal length of 4.9 cm. How far is the image from the lens?[116]

   A. 4.72 x 10^{-1} cm
   B. 8.4 x 10^{-1} cm
   C. 1.49 x 10^{0} cm
   D. 2.66 x 10^{0} cm
   E. 4.72 x 10^{0} cm

2. An object is placed 6.05 cm to the left of a converging lens with a focal length of 5.4 cm. How far is the image from the lens?[117]

   A. 5.03 x 10^{1} cm
   B. 8.94 x 10^{1} cm
   C. 1.59 x 10^{2} cm
   D. 2.83 x 10^{2} cm
   E. 5.03 x 10^{2} cm

3. An object of height 0.59 cm is placed 149 cm behind a diverging lens with a focal length of 57 cm. What is the height of the image?[118]

   A. 1.63 x 10^{-1} cm
   B. 1.96 x 10^{-1} cm
   C. 2.35 x 10^{-1} cm
   D. 2.82 x 10^{-1} cm
   E. 3.39 x 10^{-1} cm

The next page might contain more answer choices for this question

4. An object is placed 12.1 cm to the left of a diverging lens with a focal length of 15.4 cm. On the side, at a distance of 6.5 cm from the diverging lens is a converging lens with focal length equal to 4 cm. How far is the final image from the converging lens?16.65[119]

   A. 5.72 x 10^{0} cm

   B. 1.81 x 10^{1} cm

   C. 5.72 x 10^{1} cm

   D. 1.81 x 10^{2} cm

   E. 5.72 x 10^{2} cm

20 a20ElectricCurrentResistivityOhm_PowerDriftVel

1. A 4 volt battery moves 27 Coulombs of charge in 2.6 hours. What is the power?[120]

   A. 7.86 x 10^{-3} W

   B. 9.52 x 10^{-3} W

   C. 1.15 x 10^{-2} W

   D. 1.4 x 10^{-2} W

   E. 1.69 x 10^{-2} W

2. The diameter of a copper wire is 5.5 mm, and it carries a current of 76 amps. What is the drift velocity if copper has a density of 8.8E3 kg/m^3 and an atomic mass of 63.54 g/mol? (1 mol = 6.02E23 atoms, and copper has one free electron per atom.)[121]

   A. 1.35 x 10^{-4}m/s

   B. 1.63 x 10^{-4}m/s

   C. 1.98 x 10^{-4}m/s

   D. 2.39 x 10^{-4}m/s

   E. 2.9 x 10^{-4}m/s

3. A 168 Watt DC motor draws 0.3 amps of current. What is effective resistance?[122]

   A. 1.87 x 10^{3} Ω

   B. 2.26 x 10^{3} Ω

   C. 2.74 x 10^{3} Ω

   D. 3.32 x 10^{3} Ω

   E. 4.02 x 10^{3} Ω

4. A power supply delivers 113 watts of power to a 104 ohm resistor. What was the applied voltage?[123]

   A. 5.03 x 10^{1} volts

   B. 6.1 x 10^{1} volts

   C. 7.39 x 10^{1} volts

   D. 8.95 x 10^{1} volts

   E. 1.08 x 10^{2} volts

The next page might contain more answer choices for this question

21 b_QuantumTimeline

1. Excepting cases where where quantum jumps in energy are induced in another object (i.e., using only the uncertainty principle), which would NOT put a classical particle into the quantum regime?[124]

   A. high speed

   B. confinement to a small space

   C. low speed

   D. low mass

2. How does the Bohr atom differ from Newton's theory of planetary orbits?[125]

   A. The force between proton and electron is not attractive for the atom, but it is for planets and the sun.

   B. The force between planets and the sun is not attractive for the atom, but it is for proton and electron.

   C. planets make elliptical orbits while the electron makes circular orbits

   D. electrons make elliptical orbits while planets make circular orbits

3. What are the units of Plank's constant?[126]

   A. mass x velocity x distance

   B. energy x time

   C. momentum x distance

   D. all of the above

   E. none of the above

4. What are the units of Plank's constant?[127]

   A. mass x energy

   B. energy x distance

   C. momentum x time x mass

   D. all of the above

   E. none of the above

5. How would you describe Old Quantum Theory[128]

   A. complete and self-consistent

   B. complete but not self-consistent

   C. self-consistent but not complete

   D. neither complete nor self-consistent

6. The first paper that introduced quantum mechanics was Plank's study of [129]

   A. light

   B. electrons

   C. protons

   D. energy

7. What are examples of energy?[130]

   A. $\frac{1}{2}mv^2$

   B. mgh where m is mass, g is gravity, and h is height

The next page might contain more answer choices for this question

C. heat

D. all of the above

E. none of the above

8. What are examples of energy?[131]

A. $\frac{1}{2}mv$

B. momentum

C. heat

D. all of the above

E. none of the above

9. What was Plank's understanding of the significance of his work on blackbody radiation?[132]

A. he was afraid to publish it for fear of losing his reputation

B. he eventually convinced his dissertation committee that the theory was correct

C. the thought it was some sort of mathematical trick

D. he knew it would someday win him a Nobel prize

10. What was "spooky" about Taylor's 1909 experiment with wave interference?[133]

A. The light was so dim that the photoelectric effect couldn't occur

B. The light was dim, but it didn't matter because he was blind.

C. The light was so dim that only one photon at a time was near the slits.

D. The interference pattern mysteriously disappeared.

11. The pilot wave hypothesis was that the Schroedinger wave described the electron's charge density.[134]

A. True

B. False

12. The pilot wave hypothesis was that the Schroedinger wave described the electron's probability density.[135]

A. True

B. False

13. The pilot wave hypothesis was that the Schroedinger wave described a force on the electron.[136]

A. True

B. False

22 d_Bell.solitaire

1. Your solitaire deck uses ♡ ♠ ♣ and your answer cards are 4 and 5. You select 4♠, 4♣, and 5♡. If the questions were Q♠ and Q♣, you would___[137]

A. lose 3 points

B. lose 1 point

C. win 1 point

D. win 3 points

E. be disqualified for cheating

The next page might contain more answer choices for this question

2. Your solitaire deck uses ♡ ♠ ♣ and your answer cards are 4 and 5. You select 4♠, 5♣, and 5♡. If the questions were Q♠ and Q♣, you would___[138]
   A. lose 3 points
   B. lose 1 point
   C. win 1 point
   D. win 3 points
   E. be disqualified for cheating

3. You solitaire deck uses ♡ ♠ ♣ and your answer cards are 4 and 5. You select 4♠, 5♣, and 5♡. If the questions were Q♠ and Q♣. Which of the following wins?[139]
   A. K♡ and K♠
   B. K♠ and K♣
   C. K♡ and K♣
   D. two of these are true
   E. none of these are true

4. You solitaire deck uses ♡ ♠ ♣ and your answer cards are 4 and 5. You select 4♠, 5♣, and 5♡. If the questions were Q♠ and Q♣. Which of the following loses?[140]
   A. K♡ and K♠
   B. K♠ and K♣
   C. K♡ and K♣
   D. two of these are true
   E. none of these are true

5. If you play the solitaire game 6 times, you will on average win ____ times.[141]
   A. 4
   B. 2
   C. 3
   D. 6
   E. 5

6. If you play the solitaire game 3 times, you will on average lose ____ times.[142]
   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

7. If you play the solitaire game 6 times, you will on average lose ____ times.[143]
   A. 4
   B. 2
   C. 3
   D. 6

The next page might contain more answer choices for this question

E. 5

8. If you play the solitaire game 3 times, you will on average win ____ times.[144]

A. 1

B. 2

C. 3

D. 4

E. 5

23 d_Bell.binomial

1. The normal distribution (often called a "bell curve") is never skewed[145]

A. True

B. False

2. The normal distribution (often called a "bell curve") is usually skewed[146]

A. True

B. False

3. By definition, a skewed distribution[147]

A. is broader than an unskewed distribution

B. includes negative values of the observed variable

C. is a "normal" distribution

D. is asymmetric about its peak value

E. contains no outliers

4. The binomial distribution results from observing n outcomes, each having a probability p of "success"[148]

A. True

B. False

5. What is the probability of success, p, for a binary distribution using a six-sided die, with success defined as "two"?[149]

A. 3/6

B. 2/6

C. 1/6

D. 5/6

E. 4/6

6. What is the probability of success, p, for a binary distribution using a six-sided die, with success defined as anything but "two"?[150]

A. 3/6

B. 2/6

C. 1/6

D. 5/6

The next page might contain more answer choices for this question

E. 4/6

7. What is the probability of success, p, for a binary distribution using a six-sided die, with success defined as either a "two" or a "three"?[151]

   A. 3/6

   B. 2/6

   C. 1/6

   D. 5/6

   E. 4/6

8. How would you describe the "skew" of a binary distribution?[152]

   A. The binary distribution is always skewed, but has little skew for a large number of trials n.

   B. The binary distribution is always skewed, but has little skew for a small number of trials n.

   C. The binary distribution is never skewed if it is a true binary distribution.

   D. Distributions are never skewed. Only experimental measurements of them are skewed.

   E. None of these are true.

9. For a binomial distribution with n trials, the variance is σ^2=np(1-p). If 90 trials are observed, then 68% of the time the observed number of positive outcomes will fall within ±___ of the expected value if p=.11 is the probability of a positive outcome. Make the approximation that this binomial distribution is approximately a Gaussian (normal) distribution).[153]

   A. 6

   B. 18

   C. 3

   D. 9

   E. 1

10. For a binomial distribution with n trials, the variance is σ^2=np(1-p). If 40 trials are observed, then 68% of the time the observed number of positive outcomes will fall within ±___ of the expected value if p=.11 is the probability of a positive outcome. Make the approximation that this binomial distribution is approximately a Gaussian (normal) distribution).[154]

    A. 6

    B. 18

    C. 3

    D. 9

    E. 2

11. For a binomial distribution with n trials, the variance is σ^2=np(1-p). If 40 trials are made and p=.11, the expected number of positive outcomes is__. Make the approximation that this binomial distribution is approximately a Gaussian (normal) distribution.[155]

    A. 4.4

    B. 2.2

    C. 9.9

    D. 3.3

The next page might contain more answer choices for this question

E. 1.1

12. For a binomial distribution with n trials, the variance is σ^2=np(1-p). If 90 trials are made and p=.11, the expected number of positive outcomes is__. Make the approximation that this binomial distribution is approximately a Gaussian (normal) distribution.[156]

A. 2.2

B. 9.9

C. 3.3

D. 1.1

13. Recall that only 4.6% of the outcomes for a normal distribution lie outside of two standard deviations from the mean, and approximate the binomial distribution as normal for large numbers. If the variance is σ^2=np(1-p) where n is the number of trials and p=.11 is the probability of a positive outcome for 40 trials, roughly 98% of the outcomes will be smaller than approximately __[157]

A. 6

B. 8

C. 12

D. 16

E. 22

14. Recall that only 4.6% of the outcomes for a normal distribution lie outside of two standard deviations from the mean, and approximate the binomial distribution as normal for large numbers. If the variance is σ^2=np(1-p) where n is the number of trials and p=.11 is the probability of a positive outcome for 90 trials, roughly 98% of the outcomes will be smaller than approximately __[158]

A. 6

B. 8

C. 12

D. 16

E. 22

15. A local college averages 2500 new incoming students each year. Suppose the pool of potential high school graduates in the local area is so large that the probability of a given student selecting this college is small, and assume a variance of σ^2 equal to p(1-p). What standard deviation would you expect in the yearly total of new enrollees, assuming nothing changes in this population from year to year? [159]

A. 50

B. 150

C. 500

D. 200

E. 250

16. A local college averages 1600 new incoming students each year. Suppose the pool of potential high school graduates in the local area is so large that the probability of a given student selecting this college is small, and assume a variance of σ^2 equal to p(1-p). What standard deviation would you expect in the yearly total of new enrollees, assuming nothing changes in this population from year to year? [160]

A. 16

B. 160

The next page might contain more answer choices for this question

C. 40
D. 10
E. 32

24 d_Bell.polarization

1. The light is linearly polarized, the electric field is oriented ______ to the direction of motion[161]
   A. parallel
   B. perpendicular
   C. at 45 degrees
   D. all of these are possible

2. Hold a pendulum a moderate distance from equilibrium and release it by tossing it in a direction perpendicular to the displacement of the mass from equilibrium. The resulting polarization will be ____ (pick the best answer)[162]
   A. linear
   B. circular
   C. circular or linear
   D. circular or elliptical
   E. linear or elliptical

3. A mathematically pure (monochromatic) _________ wave or oscillation that is unpolarized cannot be created if it is[163]
   A. electromagnetic
   B. a pendulum
   C. either electromagnetic or a pendulum
   D. both oscillations can be created as pure (monochromatic) oscillations

4. To create an unpolarized pendulum oscillation[164]
   A. create an elliptically polarized wave with an ε¿0.2
   B. create an elliptically polarized wave with an ε¡0.8
   C. create an elliptically polarized wave with an 0.2¡ε¡0.8
   D. start with a linear, circular, or elliptical wave and evolve it randomly to different polarizations

5. If the hypotenuse of a 45°-45° right triangle has a length of $\sqrt{2}$ what is the length of each side?[165]
   A. $\frac{1}{2}$
   B. $\frac{1}{\sqrt{2}}$
   C. 1
   D. $\sqrt{2}$
   E. $2\sqrt{2}$

6. If the hypotenuse of a 45°-45° right triangle has a length of 1 what is the length of each side?[166]
   A. $\frac{1}{2}$
   B. $\frac{1}{\sqrt{2}}$

The next page might contain more answer choices for this question

C. 1
D. $\sqrt{2}$
E. $2\sqrt{2}$

7. If the hypotenuse of a 60°-30° right triangle has a length of 1 what is the length of the shorter side?[167]
   A. $\frac{1}{4}$
   B. $\frac{1}{\sqrt{2}}$
   C. $\frac{1}{2}$
   D. $\frac{\sqrt{3}}{2}$
   E. $\frac{3}{4}$

8. If the hypotenuse of a 60°-30° right triangle has a length of 1 what is the length of the longer side?[168]
   A. $\frac{1}{4}$
   B. $\frac{1}{\sqrt{2}}$
   C. $\frac{1}{2}$
   D. $\frac{\sqrt{3}}{2}$
   E. $\frac{3}{4}$

9. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. By what factor does a filter reduce the electric field if it is oriented 30° to that field?[169]
   A. $\frac{1}{4}$
   B. $\frac{1}{\sqrt{2}}$
   C. $\frac{1}{2}$
   D. $\frac{\sqrt{3}}{2}$
   E. $\frac{3}{4}$

10. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. By what factor does a filter reduce the electric field if it is oriented 60° to that field?[170]
   A. $\frac{1}{4}$
   B. $\frac{1}{\sqrt{2}}$
   C. $\frac{1}{2}$
   D. $\frac{\sqrt{3}}{2}$
   E. $\frac{3}{4}$

11. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. A 12 mW laser strikes a polarizing filter oriented 30° to the incoming axis of polarization. How much power passes the filter?[171]
   A. 3mW
   B. 4mW
   C. 6mW

The next page might contain more answer choices for this question

D. 8mW
E. 9mW

12. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. A 12 mW laser strikes a polarizing filter oriented 30° to the incoming axis of polarization. How much power is blocked by the filter?[172]

A. 3mW
B. 4mW
C. 6mW
D. 8mW
E. 9mW

13. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. A 12 mW laser strikes a polarizing filter oriented 60° to the incoming axis of polarization. How much power is blocked by the filter?[173]

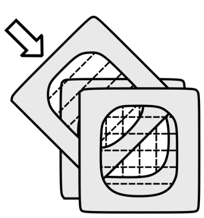
A. 3mW
B. 4mW
C. 6mW
D. 8mW
E. 9mW

14. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. A 12 mW laser strikes a polarizing filter oriented 60° to the incoming axis of polarization. How much power is passed by the filter?[174]

A. 3mW
B. 4mW
C. 6mW
D. 8mW
E. 9mW

15. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. A 12 mW laser strikes a polarizing filter oriented 45° to the incoming axis of polarization. How much power is passed by the filter?[175]

A. 3mW
B. 4mW
C. 6mW
D. 8mW
E. 9mW

16.  A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. Unpolarized light impinges on three linear filters, each oriented 45° to the previous, as shown. What fraction of the power incident on the first filter emerges from the last?[176]

The next page might contain more answer choices for this question

A. 1/32
B. 1/16
C. 3/32
D. 1/8
E. 3/16

17. Hold a pendulum a moderate distance from equilibrium and release it by tossing it in a direction parallel to the displacement of the mass from equilibrium. The resulting polarization will be _____ (pick the best answer)[177]

A. linearly
B. circular
C. circular or linear
D. circular or elliptical
E. linear or elliptical

18. A linear polarizer selects a component of the electric field. Also, the energy density of light is proportional to the square of the electric field. Unpolarized light impinges on three linear filters. The second is oriented 30° from the first, and the third is rotated by an additional 60°, making it at right angles from the first filter. What fraction of the power incident on the first filter emerges from the last?[178]

A. 1/32
B. 1/16
C. 3/32
D. 1/8
E. 3/16

25 d_Bell.partners

1. When is the referee allowed to observe Alice and Bob?[179]

A. never
B. While they are discussing strategy (phase 1), but not while their backs are turned to each other.
C. While their backs are turned, but not while they are discussing strategy (phase 1)
D. The referee should carefully observe Alice and Bob all the time

2. Is it cheating for one of the partners to change their mind in after communication ceases?[180]

A. It is cheating and the game should be terminated if the partners are caught doing this
B. It is cheating, but fortunately the penalty allows partners to do it
C. It is not cheating, but allowing to partners to do so violates the spirit of the game as a Bell's test experiment simulation.
D. It is not cheating, and allowing to partners to do this is in the spirit of the game as a Bell's test experiment simulation.

3. The β -strategy is a new strategy introduced in the couples version of the card game that calls for[181]

A. Alice and Bob to sometimes give different answers (one "even" while the other "odd")
B. Alice and Bob to always give different answers (one "even" while the other "odd")
C. Alice and Bob to always answer "even"

The next page might contain more answer choices for this question

D. Alice and Bob to always answer "odd"

E. None of these describes the β -strategy

4. The α -strategy in the couples version of the card game is similar to the strategy introduced in the solitaire version, and calls for[182]

A. Alice and Bob to sometimes give different answers (one "even" while the other "odd")

B. Alice and Bob to always give different answers (one "even" while the other "odd")

C. Alice and Bob to always answer "even"

D. Alice and Bob to always answer "odd"

E. None of these describes the α -strategy

5. Suppose the referee gives Alice and Bob receive question cards of the different suit (different questions). What are the best and worst possible outcomes for the partners? (Assume for this question that $Q > 3$)[183]

A. Best for partners: +1 ... Worst: $-Q$

B. Best for partners: +1 ... Worst: -3

C. Best for partners: 0 ... Worst: $-Q$

D. Best for partners: 0 ... Worst: -3

E. None of these is correct

6. Suppose the referee gives Alice and Bob receive question cards of the same suit (same questions). What are the best and worst possible outcomes for the partners? (Assume for this question that $Q > 3$)[184]

A. Best for partners: +1 ... Worst: $-Q$

B. Best for partners: +1 ... Worst: -3

C. Best for partners: 0 ... Worst: $-Q$

D. Best for partners: 0 ... Worst: -3

E. None of these is correct

7. Suppose the partners choose the β strategy (which was not available in the solitaire version). What are the best and worst possible outcomes for the partners? (Assume for this question that $Q > 3$)[185]

A. Best for partners: +1 ... Worst: $-Q$

B. Best for partners: +1 ... Worst: -3

C. Best for partners: 0 ... Worst: $-Q$

D. Best for partners: 0 ... Worst: -3

E. None of these is correct

8. Suppose both partners choose to answer "even" to any question that is asked. What are the best and worst possible outcomes for the partners? (Assume for this question that $Q > 3$)[186]

A. Best for partners: +1 ... Worst: $-Q$

B. Best for partners: +1 ... Worst: -3

C. Best for partners: 0 ... Worst: $-Q$

D. Best for partners: 0 ... Worst: -3

E. None of these is correct

9. Suppose both partners choose to answer "even" to any question that is asked. Why would such a strategy ever be adopted? (Assume for this question that $Q > 3$)[187]

The next page might contain more answer choices for this question

A. The partners might have cheated so much in the past that they need to lose a round.

B. One partner might announce that all answers will be "even", while the other is certain that the both question cards will have the same suit.

C. Both partners agree that there is a 90

D. Two of these reasons for this strategy might be valid

E. There is no reason for the partners to ever adopt this strategy

10. How much do the partners win or lose if Alice answers 4♠ to K♠ while Bob answers 4♡ to A♡?[188]

A. win 1 point

B. lose Q points

C. no points awarded or lost

D. lose 3 points

11. How much do the partners win or lose if Alice answers 4♠ to K♠ while Bob answers 5♡ to A♡?[189]

A. win 1 point

B. lose Q points

C. no points awarded or lost

D. lose 3 points

12. How much do the partners win or lose if Alice answers 4♠ to K♠ while Bob answers 4♠ to A♠? [190]

A. win 1 point

B. lose Q points

C. no points awarded or lost

D. lose 3 points

13. How much do the partners win or lose if Alice answers 4♠ to K♠ while Bob answers 5♠ to A♠? [191]

A. win 1 point

B. lose Q points

C. no points awarded or lost

D. lose 3 points

14. Suppose referee adopts neutral scoring with Q=4 and asks the same question with a probability P_S=0.25. This reduces the average loss rate for their partners for the following reason: Consider a probability space with[192]

A. 3 equally probable events: On two they are given different questions, winning twice. On the third event they are given the same answer and lose a point.

B. 3 equally probable events: On two they are given different questions, winning once and losing once. On the third event they are given the same answer and lose a point.

C. 3 equally probable events: On two they are given different questions, winning once and losing once. On the third event they are given the same answer and neither gain nor lose a point.

D. 4 equally probable events: On three they are given different questions, winning once but losing twice. On the fourth event they are given the same answer and lose a point.

E. 4 equally probable events: On three they are given different questions, winning twice but losing once. On the fourth event they are given the same answer and neither gain nor lose a point.

The next page might contain more answer choices for this question

15. Although it decreases the rate at which the partners lose point, increasing the probability of asking the same question is more effective at persuading students to act as particles by relying on the α -strategy because relying on a larger penalty for giving different answers to the same question will tempt students to use the β -strategy only briefly (hoping never to be caught) and then requesting a break to "re-establish" quantum entanglement.[193]

   A. True

   B. False

16. Suppose the referee selects neutral scoring with $Q = \frac{4}{3}\left(\frac{1-P_S}{P_S}\right)$. What number does the penalty approach as the probability of asking the same question goes to 1?[194]

   A. 0

   B. ∞

   C. 3

   D. 4

   E. 4/3

17. Suppose the referee selects neutral scoring with $Q = \frac{4}{3}\left(\frac{1-P_S}{P_S}\right)$. What number does the penalty approach as the probability of asking the same question goes to 0?[195]

   A. 0

   B. ∞

   C. 3

   D. 4

   E. 4/3

18. Suppose the referee selects neutral scoring with $Q = \frac{4}{3}\left(\frac{1-P_S}{P_S}\right)$. What is the penalty if the probability of asking the same question is 0.25?[196]

   A. 0

   B. ∞

   C. 3

   D. 4

   E. 4/3

19. Suppose the referee selects neutral scoring with $Q = \frac{4}{3}\left(\frac{1-P_S}{P_S}\right)$. What is the penalty if the probability of asking the same question is 0.5?[197]

   A. 0

   B. ∞

   C. 3

   D. 4

   E. 4/3

The next page might contain more answer choices for this question

26 d_Bell.photon

1. If the wavelength "λ " associated with a photon is cut in half, the photon's energy "E"[198]
   - A. is cut in half
   - B. is reduced by a factor of 4
   - C. stays the same
   - **D. becomes twice as big**
   - E. becomes 4 times as big
2. If the wavelength "λ " associated with a photon doubles, the photon's frequency "f"[199]
   - **A. is cut in half**
   - B. is reduced by a factor of 4
   - C. stays the same
   - D. becomes twice as big
   - E. becomes 4 times as big
3. If the frequency "f" associated with a photon increases by a factor of 4, the photon's wavelength "λ "[200]
   - A. is cut in half
   - **B. is reduced by a factor of 4**
   - C. stays the same
   - D. becomes twice as big
   - E. becomes 4 times as big
4. If the frequency "f" associated with a photon increases by a factor of 4, the photon's energy "E"[201]
   - A. is cut in half
   - B. is reduced by a factor of 4
   - C. stays the same
   - D. becomes twice as big
   - **E. becomes 4 times as big**
5. If an atom emits two photons in a cascade emission and both photons have 2 eV of energy, the atom's energy[202]
   - A. stays the same
   - B. increases by 2 eV
   - C. increases by 4 eV
   - D. decreases by 2 eV
   - **E. decreases by 4 eV**
6. If an atom absorbs a photon with 2 eV energy, the atom's energy[203]
   - A. stays the same
   - **B. increases by 2 eV**
   - C. increases by 4 eV
   - D. decreases by 2 eV
   - E. decreases by 4 eV

The next page might contain more answer choices for this question

7. If a 3 eV photon strikes a metal plate and causes an electron to escape, that electron will have a kinetic energy that is[204]

   A. zero

   B. less than 3 eV

   C. equal to 3 eV

   D. greater than 3 eV

   E. equal to 6 eV

8. In the PhET Interactive Simulation for photoelectric effect, how was the electron's kinetic energy measured?[205]

   A. measuring spin

   B. measuring polarization

   C. measuring both spin and polarization

   D. deflecting the electron with a magnetic field

   E. stopping the electron with an applied voltage

9. If an atom absorbs a photon with 4 eV energy, the atom's energy[206]

   A. stays the same

   B. increases by 2 eV

   C. increases by 4 eV

   D. decreases by 2 eV

   E. decreases by 4 eV

10. If 10^{18} photons pass through a small hole in your roof every second, how many photons would pass through it if you doubled the diameter?[207]

    A. 10^{18}

    B. $2\text{x}10^{18}$

    C. $4\text{x}10^{18}$

    D. $6\text{x}10^{18}$

    E. $8\text{x}10^{18}$

11. Two black bodies of are created by cutting identical small holes in two large containers. The holes are oriented so that all the photons leaving one will enter the other. The objects have different temperature and different volume. Which object has the greater electromagnetic ("photon") energy density (energy per unit volume)?[208]

    A. The hotter object has a greater energy density.

    B. The larger object has a greater energy density.

    C. They have the same energy density (since the holes are identical).

    D. No unique answer exists because two variables are involved (temperature and volume).

12. Two black bodies of are created by cutting identical small holes two large containers. The holes are oriented so that all the photons leaving one will enter the other. The objects have different temperature and different volume. Which object emits more photons per second (above a given threshold energy)?[209]

    A. The object with the greater temperature emits more.

    B. The object with the greater volume.

    C. They both emit the same number of photons (since the holes are identical).

The next page might contain more answer choices for this question

D. No unique answer exists because two variables are involved (temperature and volume).

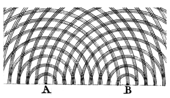
13. Two black bodies of are created by cutting identical small holes in two large containers. The holes are oriented so that all the photons leaving one will enter the other. The objects have different temperature and different volume. Which object has the greater electromagnetic (”photon”) energy?[210]

A. The hotter object has a greater energy.

B. The larger object has a greater energy.

C. They have the same energy (since the holes are identical).

D. No unique answer exists because two variables are involved (temperature and volume).

14.  This figure is associated with [211]

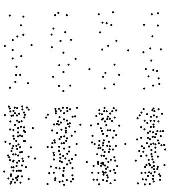
A. Photons striking metal and ejecting electrons (photo-electric effect explained in 1905)

B. Diffraction observed in light so faint that photons seemed to have no mechanism to interact with each other

C. A system similar to the one that led to the 1901 proposal that light energy is quantized as integral multiples of hf (except that Plank assumed that the walls were conductive.)

D. Evidence presented in 1800 that light is a wave.

E. The transfer of energy and momentum of a high energy photon of a nearly free electron.

15.  This figure is associated with [212]

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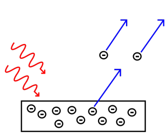
16.  This figure is associated with [213]

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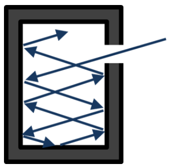
The next page might contain more answer choices for this question

17.  This figure is associated with [214]

A. Photons striking metal and ejecting electrons (photo-electric effect explained in 1905)

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E. The transfer of energy and momentum of a high energy photon of a nearly free electron.

18. A photon is polarized at 5° when it encounters a filter oriented at 35°. What is the probability that it passes?[215]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

19. A photon is polarized at 10° when it encounters a filter oriented at 55°. What is the probability that it passes?[216]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

20. A photon is polarized at 10° when it encounters a filter oriented at 70°. What is the probability that it passes?[217]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

21. A photon is polarized at 10° when it encounters a filter oriented at 40°. What is the probability that it is blocked?[218]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

22. A photon is polarized at 5° when it encounters a filter oriented at 50°. What is the probability that it is blocked?[219]

A. 0

The next page might contain more answer choices for this question

B. 1/4

C. 1/2

D. 3/4

E. 1

23. A photon is polarized at 5° when it encounters a filter oriented at 65°. What is the probability that it is blocked?[220]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

24. A photon is polarized at 10° when it encounters a filter oriented at 100°. What is the probability that it passes?[221]

A. 0

B. 1/4

C. 1/2

D. 3/4

E. 1

25. A photon is polarized at 10° when it encounters a filter oriented at 100°. What is the probability that it is blocked?[222]

A. 0

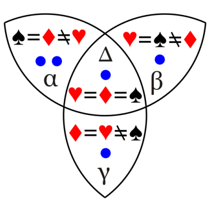
B. 1/4

C. 1/2

D. 3/4

E. 1

27 d_Bell.Venn

1. 

Calculate the measured probability: P(♠,♢) = ? Assume the dots represent five observations.[223]

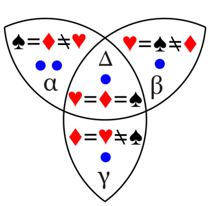
A. 2/4=1/2

B. 2/5

C. 3/5

D. 3/4

E. 5/6

2. 

Calculate the measured probability: P(♠,♡) = ? Assume the dots represent five observations.[224]

The next page might contain more answer choices for this question

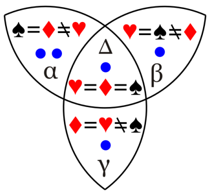
A. 2/4=1/2

B. 2/5

C. 3/5

D. 3/4

E. 5/6

3. 

Calculate the probability P(♠,♢)+P(♠,♡)+P(♡,♢) = ? Assume the dots represent five observations.[225]

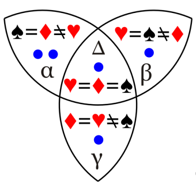
A. 4/5

B. 5/6

C. 5/4

D. 6/5

E. 7/5

4. 

Calculate the quantum correlation: C(♠,♢) = ? Assume the dots represent five observations.[226]

A. −2/5

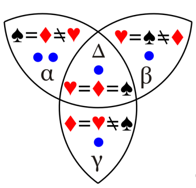
B. −1/5

C. 0

D. +1/5

E. +2/5

F. +1

5. 

Calculate the measured quantum correlation: C(♠,♡) = ? Assume the dots represent five observations.[227]

A. −2/5

B. −1/5

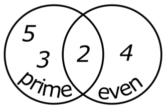
C. 0

D. +1/5

E. +2/5

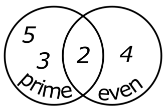
F. +1

The next page might contain more answer choices for this question

6. 

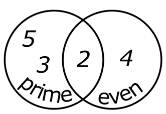
If a number is randomly selected from the set 2,3,4,5, what is P(even), or the probability that the number is even?[228]

A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1
F. 5/4

7. 

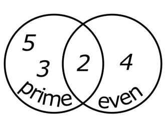
If a number is randomly selected from the set 2,3,4,5, what is P(prime), or the probability that the number is prime?[229]

A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1
F. 5/4

8. 

If a number is randomly selected from the set 2,3,4,5, what is P(prime)+P(even), or the sum of the probability that it is even, plus the probability that it is prime?[230]

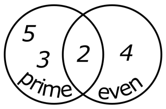
A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1
F. 5/4

9. 

If a number is randomly selected from the set 2,3,4,5, what is the probability that it is both even and prime?[231]

A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1
F. 5/4

The next page might contain more answer choices for this question

10. 

If a number is randomly selected from the set 2,3,4,5, what is the probability that it is either even or prime?[232]

A. 0
B. 1/4
C. 1/2
D. 3/4
E. 1
F. 5/4

28 b_WhyIsSkyDarkAtNight

1. Approximately how often does a supernovae occur in a typical galaxy?[233]
   A. once a 5 months
   B. once every 5 years
   C. once every 50 years

2. If a star were rushing towards Earth at a high speed[234]
   A. there would be a blue shift in the spectral lines
   B. there would be a red shift in the spectral lines
   C. there would be no shift in the spectral lines

3. An example of a standard candle is[235]
   A. any part of the nighttime sky that is giving off light
   B. any part of the nighttime sky that is dark
   C. a supernova in a distant galaxy
   D. all of these are standard candles

4. If a galaxy that is 10 Mpc away is receding at 700km/s, how far would a galaxy be receding if it were 20 Mpc away?[236]
   A. 350km/s
   B. 700km/s
   C. 1400km/s

5. The "apparent" magnitude of a star is[237]
   A. How bright it would be if you were exactly one light year away
   B. How bright it would be if it were not receding due to Hubble expansion
   C. How bright it is as viewed from Earth

6. In the essay "Why the sky is dark at night", a graph of velocity versus distance is shown. What is odd about those galaxies in the Virgo cluster (circled in the graph)?[238]
   A. they all have nearly the same speed
   B. they have a wide variety of speeds

The next page might contain more answer choices for this question

C. they are not receding away from us

D. the cluster is close to us

7. Why was it important to observe supernovae in galaxies that are close to us?[239]

A. we have other ways of knowing the distances to the nearby galaxies; this gives us the opportunity to study supernovae of known distance and ascertain their absolute magnitude.

B. they have less of a red-shift, and interstellar gas absorbs red light

C. it is easier to measure the doppler shift, and that is not always easy to measure.

D. because supernovea are impossible to see in distant galaxies

8. What if clouds of dust blocked the light from distant stars? Could that allow for an infinite and static universe?[240]

A. No, the clouds would get hot

B. No, if there were clouds, we wouldn't see the distant galaxies

C. No, there are clouds, but they remain too cold to resolve the paradox

D. Yes, that is an actively pursued hypothesis

29 Attribution

Notes

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