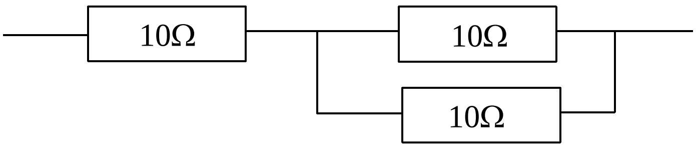
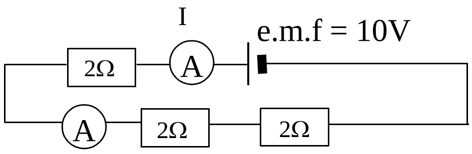
37) Kirchoff's second law states that in any closed loop the _____ of the _______ is equal to the e.m.f of the source. This law is a consequence of the conservation of ________

38) For resistors in series R_t = ... In parallel $1/R_t$ = ...

39) What is the resistance of this network



40) Use kirchoff's second law to calculate the current I in the circuit below



41) In a circuit with more than one cell e.m.f's are ___________

42) In practise all sources of e.m.f have an _________ resistance

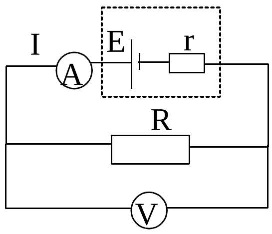
43) The voltmeter reads the voltage,V across the load resistance and is called the ________ p.d. It is less than the e.m.f. of the source because there is a potential difference across the _____ _____ of the source.

From Kirchoff's second law E = IR + ____

E = V + Ir

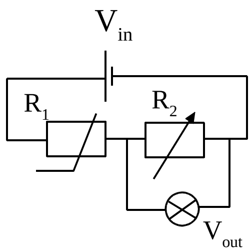
If this is rearranged so V = -Ir + E

a graph of ____ against _____ would give a _____ line with a gradient equal to the _______ and the y intercept equal to the ___________



44) This is a _________ _________ circuit containing a _________ and a ___________ resistor.

V_{out} = _________. If the temperature increases the thermistor resistance _______ and the p.d.across R_1 will drop and the V_{out} will increase making the lamp ____



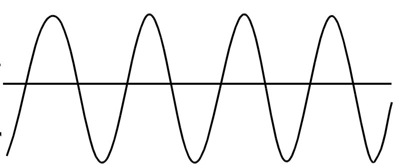
45) In the potential divider circuit what is V_{out} if V_{in}= 20V, R_1 = 500Ω and R_2 = 25Ω?

46) What will happen to the lamp if R_2 is increased and why?

47) Wave frequency is defined as the number of waves per _______.

48) Two wave are in phase if they are in ______ with each other. Phase difference is a measure of how out of _____ two waves could be. It can be described as a fraction of a _______ eg λ/2 or as an angle 180^0 for example.

49) On this wave indicate the amplitude, wavelength and two points with zero displacement



50) The period, T of a wave is the time for one _____ and T = ________

51) The speed of a wave v = ______

52) Refraction of a wave occurs because of a change in ______ when it enters a different medium. Diffraction is the _____ out of waves through a ______. Diffraction is greatest when the gap width is equal to____

37) sum p.d.'s energy

38) R_1+R_2 $1/R_1 + 1/R_2$

39) For parallel components

1/R = 1/10 + 1/10

1/R = 2/10 so R = 5Ω

total resistance = 10 + 5 = 15Ω

40) 10 = Ix2 + Ix2 +Ix2 = 6I

so I = 10/6 = 1.67A

41) Combined

42) Internal

43) terminal internal resistance

Ir

V I straight internal resistance

e.m.f

44) potential divider

thermistor variable resistor

$V_{out} = \frac{V_{in} R_2}{(R_1+R_2)}$ drops brighter

45) $V_{out} = \frac{V_{in} R_2}{(R_1+R_2)}$ =20x25/(500+25)=0.95V

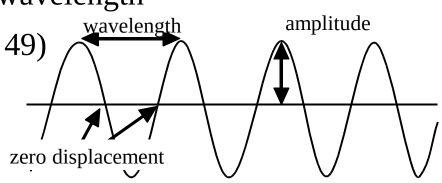
46) Gets brighter because V_{out} increases

47) second

48) step step

wavelength

49)



50) cycle or wave, T = 1/f

51) v = fλ λ – wavelength

52) speed

spreading gap wavelength

53) Two properties that all electromagnetic waves share is that they all travel at the speed of ________ and they are all ______

54) The order of the electromagnetic spectrum in increasing wavelength is gamma (10^{-15}m)..

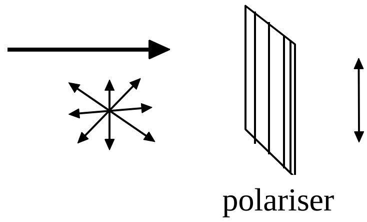
55) What is the frequency of gamma radiation with a wavelength of 10^{-15} m? $c = 3\times10^{8}\text{ms}^{-1}$

56) Electromagnetic waves with the largest _______ have the most energy. Ultra-violet frequencies and above can ______ atoms to make ions. This changes their chemistry and may lead to______. Infra-red, microwave and ________ have a ______ effect on objects. Microwaves of the right frequency can cause water molecules to resonate causing rapid heating.

57) UV part of the spectrum is split into UV-A,UV-B, UV-C, UV-A causes skin to _______, UV-B causes _____ UV-C is mostly absorbed by _________ in the atmosphere

58) Light is a _________ wave of different _______. In unpolarised light vibrations are in ______ planes

Polarised light is light where vibrations are in a single _____ (typically vertical or ______). Light can be polarised using a _________.



58b) Light emerging from this polariser is ________ polarised

59) When light reflects from a surface it is _______ polarised. Sunglasses contain a polariser which eliminates this polarised light.

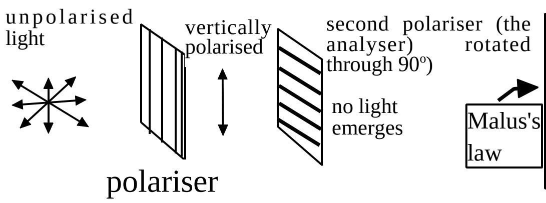
60) The intensity of a wave is the power per _____ metre. Its units are _______. As an equation Intensity I = _____

61) The intensity of a wave is proportional to _________^{2}, $I \propto A^2$

62) If the amplitude of a wave doubles its intensity ________. If the amplitude of a wave halves its intensity reduces by ________

63) If a wave has amplitude A_1 and intensity I_1 and its amplitude is changed to A_2 then we can write I_1/I_2 = _________

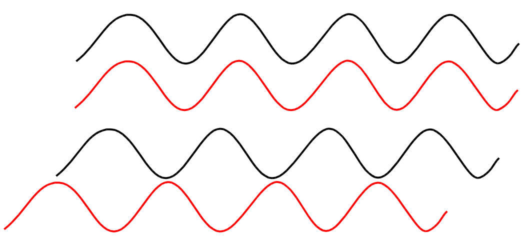
64)



For rotations of the analyser between 0 and 90° the transmitted intensity $I = I_0\cos^2\theta$ where I_0 is the ________ intensity and θ is the angle between the axis of the polariser and the plane of polarisation of the incident light

65) The principal of superposition states that when two or more waves meet.......................................

66)



These waves are in ______. If combined there would be _______ interference

67)

These waves are _____ of phase by _____. If combined there would be _______ interference

68) For observable interference wave sources must be ___________

69) Coherent waves are waves with the same __________

70) The path difference between two waves is the difference in ______ the two waves have travelled.

71) If the path difference between coherent waves is equal to a whole number of __________ (nλ) constructive ________ occurs

72) If the path difference between two coherent waves is equal to nλ/2 _________ interference occurs

53) light transverse

54) x ray(10^{-10}m), uv(10^{-8}m), visible (5×10^{-7}m) infrared (10^{-5}m), microwave (10^{-2}m), radio(10^{-1+}m)

55) $f = c/\lambda = 3\times10^{8}/10^{-15} = 3\times10^{23}$Hz

56) frequency ionise cancers heating

57) wrinkle, cancer, ozone

58) transverse frequencies all

plane horizontal polariser

58b) vertically

59) partially

60) square Wm^{-2}, I = P/A

61) amplitude

62) quadruples a quarter

63) $I_1/I_2 = A_1^2/A_2^2$

64) incident

65) the resulting displacement is the algebraic sum of the individual displacements

66) phase constructive

67) out 180° destructive

68) coherent

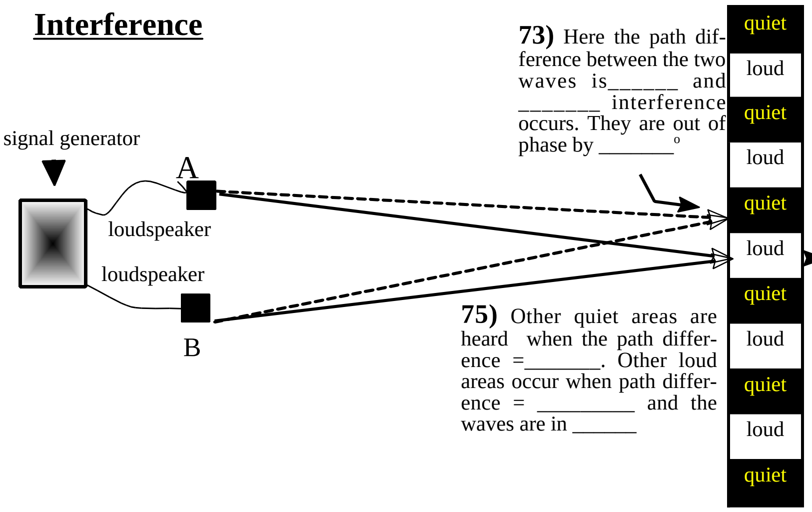
69) wavelength

70) distance

71) wavelengths interference

72) destructive

Interference



73) Here the path difference between the two waves is______ and _______ interference occurs. They are out of phase by _______°

74) Here there is _____ path difference between the waves. They are in _______

75) Other quiet areas are heard when the path difference =_______. Other loud areas occur when path difference = _________ and the waves are in ______

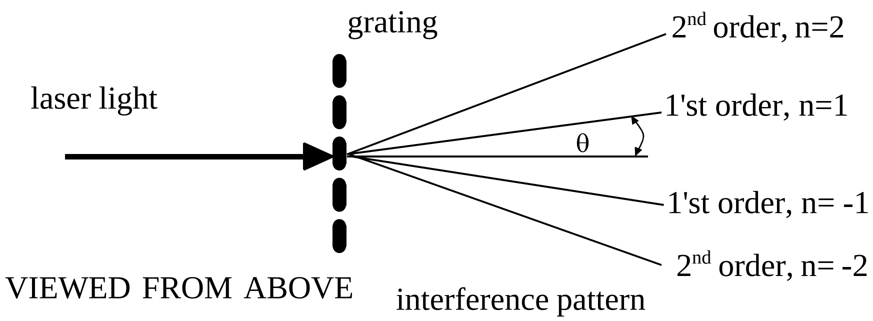
76) To observe interference of microwaves the same setup is used except a microwave __________ emits the signal. A barrier with two slits creates two __________ waves. These interfere and the interference pattern detected with a _________ detector.

77) In youngs slit experiment a laser is strikes a black slide with two parallel slits. This creates two ________ waves which interfere. The youngs slit equation is λ = _________, where a is __________, x is _______________ and D is ____________

78) In youngs slit experiment if slit separation decreases fringe separation ____________. If the slit screen distance increases the fringe separation ___________

79) Youngs slit experiment is confirmation of the wave like nature of light because it is explained by the principle of ________ of waves.

80) A diffraction grating is a material with many slits. At each slit __________ occurs. Diffracted waves then interfere to produce an interference pattern



81) The diffraction equation is dsinθ = __________. Where d is ....in metres, n is ...., and θ is the angle between the zeroth order (straight through) and the order number

82) If a diffraction grating has 3000 lines per cm the separation of each line = ___________cm = ______________m. If the first order maximum is detected at an angle of 10° as shown on the diagram what is the wavelength of the light?

83) Using a diffraction grating to measure the wavelength of light is better than youngs slit experiment because maxima are very _______ and __________. The maxima are widely separated and the angle can be measured very ___________. In yougs slit experiment the separation of two slits needs to be measured - a big % inaccuracy. In a grating their are many slits and their separation d can be worked out accurately

73) λ/2 destructive 180

74) zero phase

75) nλ/2 nλ phase

76) transmitter coherent microwave

77) coherent $\lambda = ax/D$
slit separation, fringe separation
slit to screen distance

78) increases, increases

79) superposition

80) diffraction

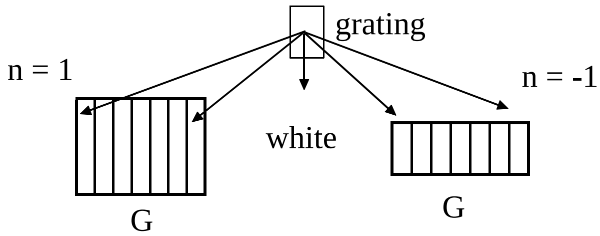
81) nλ
slit separation, the order number

82) $1/3000 = 3.33 \times 10^{-4}$cm $=3.33\times10^{-6}$m

$$\lambda = d\sin\theta/n = \frac{3.36\times10^{-6} \times \sin 10}{1} = 5.8\times10^{-7}\text{m}$$

83) bright sharp accurately

84) White light shone through a diffraction grating will produce maxima of all the colours of the __________
This happens because different colours have different ______ and from $d\sin\theta = n\lambda$ if the wavelength is bigger i.e. red light, the angle for maxima will be bigger



85) White light is shone into this grating and an interference pattern observed. The zeroth order remains ________.

86) Label the position of red R for the first order

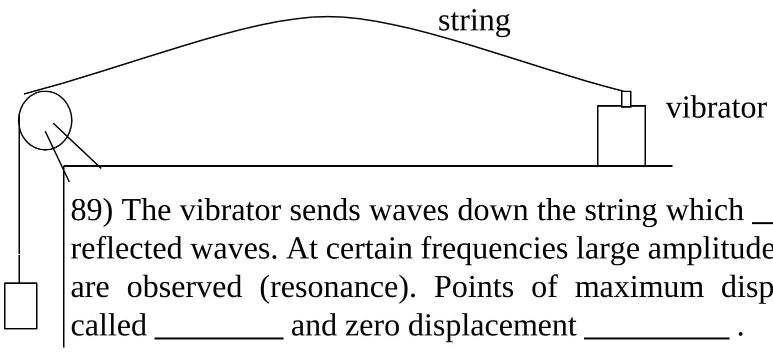
87) Transverse and longitudinal are classed as ____________ waves. They transfer ____________ and seem to move

Only ____________ can be polarised. Sound cannot be polarised because it is a ______________ wave.

88) Two properties of stationary waves are

(a) ____

(b) ____



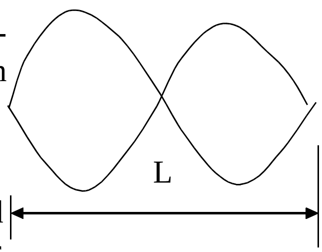
89) The vibrator sends waves down the string which _________ with reflected waves. At certain frequencies large amplitudes of vibration are observed (resonance). Points of maximum displacement are called _________ and zero displacement __________ .

The lowest frequency resonance occurs is called the ___________. The next frequency for resonance is call the __________ harmonic

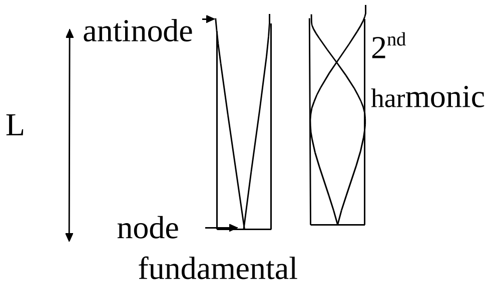
90) The distance between successive nodes is =..........................

91) The distance between successive anti-nodes is =..................

92) In a vibrating string this frequency is the ________ harmonic. In terms of wavelength L =

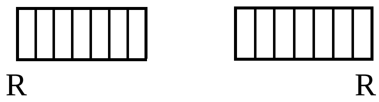


93) In an open ended pipe the closed end is fixed and air cannot vibrate this is a ________. If frequency is gradually increased a resonance occurs, (the fundamental). In terms of wavelength L = _________. Increasing the frequency produces the second harmonic and L = __________



84) rainbow wavelengths

85) white



87) progressive energy
transverse longitudinal

88) no energy is transferred
they do not progress

89) interfere
anti-nodes nodes

fundamental
second

90) $\lambda/2$

91) $\lambda/2$

92) second
$L = \lambda$

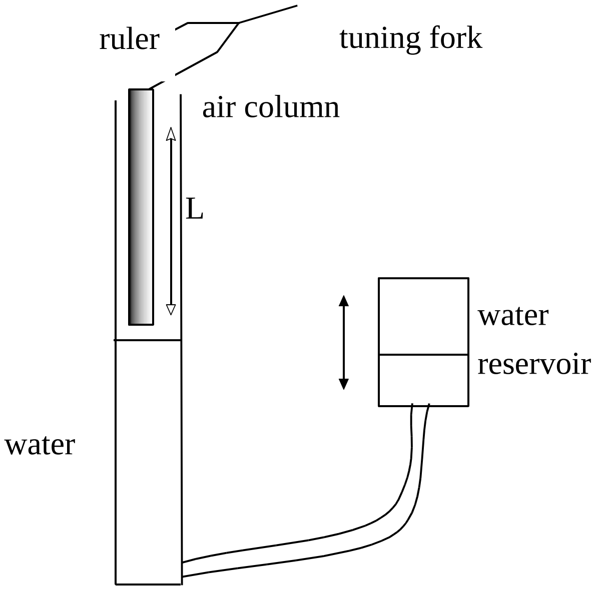
93) node

$L = \lambda/4$

$L = 3\lambda/4$

94a) To measure the speed of sound an experimenter changed the length of an air column by dropping or raising a water reservoir. The experimenter started with the air column very short then gradually increased it until maximum volume was heard

(a) sketch the stationary wave obtained label the node and anti-node)



(b) use these results to work out the speed of sound

frequency f = 512Hz	Length L = 0.16m

95) Electromagnetic radiation has a wave nature and a ________ nature.

96) Electromagnetic radiation travels as packets of energy called _______. Each photon has an energy E = ____ or E = ____

97) What is the energy of a gamma ray photon with wavelength 10^{-15}m?

98) The electron volt is a much smaller unit of _____ than the joule

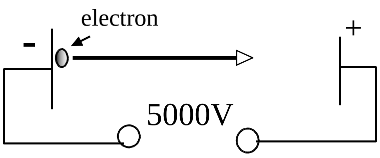
99) The electron volt is defined as the energy gained by an _______ when accelerated through a p.d. of 1 volt

from W = QV, W = eV, = 1.6×10^{-19}x1 = 1.6×10^{-19}J

100) How many joules is 10eV?

101) How many eV's is 2×10^{-18}J?

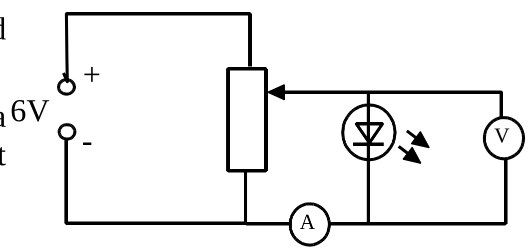
102) Near the negative plate the electron has an electric potential energy, W. W = QV = eV. This electric potential energy is converted to _______ energy as it accelerates towards the positive plate. So $eV = \frac{mv^2}{2}$



102b) What will be the velocity of the electron just before hitting if V = 5000V ($m_e = 9.11\times10^{-31}$Kg)

103) This apparatus can be used to calculate plancks constant,h.

The voltage is increased until a ______ just starts to flow. At this threshold voltage



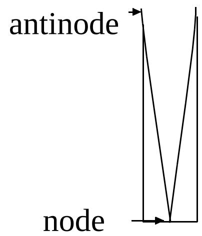
energy lost by electron = energy of emitted __________

so $eV = hf = hc/\lambda$

so $V = \frac{hc}{e}(1/\lambda)$

If different diodes are used of known wavelength a graph of V against $1/\lambda$ will give a _________ line with a gradient = ________. Plancks constant h = _______________

94)(a)



94b) $v = f\lambda$. From results at the fundamental $L = \lambda/4$

so $\lambda = 4L = 4\times0.16 = 0.64$m

so $v = f\lambda = 512\times0.64 = 328ms^{-1}$

95) particle

96) photons hf hc/λ

97) $E = hc/\lambda = (6.63\times10^{-34} \times 3\times10^{8})/10^{-15}$
$= 1.99\times10^{-11}$J

98) energy

99) electron

100) $10\times1.6\times10^{-19} = 1.6\times10^{-18}$J

101) $2\times10^{-18}/1.6\times10^{-19} = 12.5$eV

102) kinetic

102b) $v = \sqrt{(2eV/m)}$
$= \sqrt{(2\times1.6\times10^{-19}\times5000/9.1\times10^{-31})}$
$= 4.2\times10^{7}ms^{-1}$

103) current

photon

straight hc/e

h = (gradient x e)/c

104) In the **photoelectric effect** electrons are emitted from a metal surface using electromagnetic waves above a __________ frequency. Below this frequency no electrons are emitted no matter how intense.

A wave model of electromagnetic waves cannot explain this because more intensity with a wave model implies more energy.

If the intensity of electromagnetic waves above the threshold frequency is increased _______ electrons are emitted but the maximum kinetic energy of the ejected electrons remains __________. ***This is evidence of the particle nature of electromagnetic waves which we call _______ with energy = _______***

105) The Einstein photo-electric equation is ____

where hf is the _____________, ϕ is _____________

and $1/2mv^2$ is the maximum ________ of an ejected electron

106) At the threshold frequency hf_o = ___

107) The work function is defined as...................................

108) (a) What are the energy of a photons in an electromagnetic wave with wavelength 2.4×10^{-7}m?

(b) If these electromagnetic waves are incident on the surface of a metal whose work function is $2.8\text{x}10^{-19}$J calculate the maximum kinetic energy of electrons emitted.

(c) Determine the maximum speed of the emitted photons ($m_e = 9.11\text{x}10^{-31}$Kg)

109) **De Broglie** suggested if electromagnetic waves could behave like particles could particles behave as___________?

110) Evidence that particles can behave like waves is the ___________ of electrons through a thin layer of graphite.

111) The De Broglie equation is ______________

112) λ is a wave property, mass is a ______ property (the product mv is momentum also a particle property)

113) Calculate the de Broglie wavelength of an electron travelling at 10^7ms^{-1}. ($m_e = 9.11\text{x}10^{-31}$kg)

114) Will the electrons in the previous question be diffracted by solid materials (inter atomic spacing in solid materials is approx 10^{-10}m)

Emmision Spectra

115) White light has a _________ spectrum (all visible wavelengths are present). A hot gas like neon or sodium will produce a _______ spectrum where only certain wavelengths are emitted.

Absorption Spectra

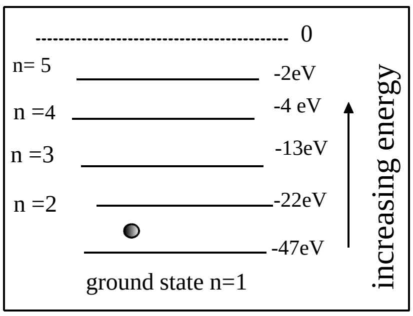
116) If white light shines through a gaseous element certain frequencies are absorbed and appear as _____ lines against the continuous spectrum of the white light.

117) When a photon is absorbed an electron is promoted to a higher ______ level in the atom. When an electron falls back to a lower level it emits a ________

118) The energy of the emitted photon is equal to the difference in ______ level i.e. $hf = E_2 - E_1$

119) If the electron at n=1, the ground state, absorbed a photon of energy 47ev it would be ....

120) What would the energy of an emitted photon if it fell from n = 3 to n = 2?



121) What would the frequency be of the emitted photon?

104) threshold

more the same

photons hf

105) $hf = \phi + 0.5mv^2$

photon energy work function

kinetic energy

106) ϕ

107) The minimum photon energy to just eject an electron

108) $E = hc/\lambda = (6.63\text{x}10^{-34}\text{x } 3\text{x}10^8)/2.4\text{x}10^{-7}$

$= 8.3\text{x}10^{-19}$J

(b) $0.5mv^2 = hf - \phi = 8.3\text{x}10^{-19} - 2.8\text{x}10^{-19}$

$= 5.5\text{x}10^{-19}$J

(c) $v = \sqrt{}(2KE/m) = \sqrt{}(2\text{x}5.5\text{x}10^{-19}/9.1\text{x}10^{-31})$

$= 1.1\text{x}10^6\text{ms}^{-1}$

109) waves

110) diffraction

111) $\lambda = h/mv$

112) particle

113) $\lambda = h/mv = 6.63\text{x}^{-34}/(9.1\text{x}10^{-31}\text{x}10^7)$

$= 7.3\text{x}10^{-11}$m

114) yes - wavelength and gaps similar

115) continuous line

116) dark

117) energy

photon

118) energy

119) just removed from the atom

120) $hf = E_2 - E_1 = -13-(-22) = 9$eV

121) $E=hf$, $f = E/h = 9\text{x}1.6\text{x}10^{-19}/6.63\text{x}^{-34}$

$= 2.2\text{x}10^{15}$Hz