Physics unit 2 pp notes!

- Diffraction :

  Diffraction is the spreading out of the wave

  As it passes through an aperture/around an obstacle
- Why do electrons go through substantial diffraction? :

  λ = spacing/gap between atoms OR the size of the atoms OR spacing/gap in the graphite
- Energy level:

  A statement which implies only certain energies are allowed e.g.

  Allowed/possible energy of atom/electron (in an atom)

  Discrete energy of an atom/electron

  One of the energies of the atom/electron

  Energy an atom/electron can have
- Photon:

  Photon is a (discrete) package/packet/quantum of (electromagnetic) energy/particle of light
- Standing wave due to a loud speaker and metal sheet:

  Interference (pattern) produced / superposition occurs/ standing wave formed

  Maxima related to constructive interference/antinode and/or minima related to destructive interference/node

  Maxima/antinode formed where the waves are in phase / path difference nλ

  Minima/node formed where the waves are in antiphase / path difference = (n+½)λ

  [out of phase is not sufficient]
- Why minima never has a o value? :

  (minima never zero) because there is not complete cancellation/overall displacement is not zero/ not total destructive interference

  Because the waves have different amplitudes/amplitude decreases with distance

  OR

  energy loss due to reflection or spreading out

  OR

  reflection off other surfaces
- as the microphone is moved towards the metal plate the amplitudes of the minima gradually decrase y ? :

  As the microphone moves towards the plate, the path difference decreases

  Amplitudes (of waves) get similar
- ohm law:

  Current (through a conductor) is (directly) proportional to the potential difference/voltage (across it)
  providing the temperature of conductor remains constant OR external conditions remain constant.
- The filament of a lamp is made of metal. Explain why the lamp does not demonstrate Ohm's law: Filament lamps work at high temperatures OR as temp of lamp increases OR as lamp heats up. Resistance of conductor changes OR the ions vibrate more

- Unpolarised light oscillates/vibrates in many planes/ directions while polarized oscillates/vibrates in one plane/direction only OR labelled diagram

- Explain how Polaroid sunglasses can enable the fish to be seen.:

1. Filters at 90 o to the (polarised) reflected light.
2. sunglasses cut out the reflected light/polarise light/glare
3. But not the light from the fish OR light from fish is unpolarised.

- Why cant sound waves be polarized?
  Sound is a longitudinal wave OR sound is not a transverse wave OR oscillations in one direction already OR only transverse waves can be polarised.
- HOW SOUND WAVES TRAVEL THROUGH AIR?

ANY THREE	
Sound waves are longitudinal waves	(1)
Air molecules vibrate	(1)
Parallel to the direction of travel of the wave	(1)
In a series of compressions and rarefactions	(1)

- Animals detect infrasound / lower frequencies than humans / vibrations through the ground. Infrasound travels faster than the tidal wave

- Particle theory

1. Reference to $E=hf$ or quanta of energy /packets of energy/photons (1)
2. Increased f means more energy of photon (1)
3. Release of electron requires minimum energy /work function (1)
4. One photon releases one electron (1)
5. Greater energy of photon means greater KE of electrons (1)
6. More intense light means more photons, therefore more electrons (1)

- Wave theory

1. Wave energy depends on intensity (1)
2. More intense light should give greater K.E of electrons (1)
3. Energy is spread over the whole wave (1)
4. If exposed for long enough photons eventually released, doesn't happen.

- State and explain what happens to the resistance of a sample of silicon as its temperature increases.:
  Its resistance decreases because (as temperature increases) n increases OR there are more electrons /charge carriers.

- Coherent: Waves of constant phase relationship
- Standing wave: no (net) transfer of energy OR pattern of nodes and antinodes OR points of maximum displacement and zero displacement
-

Resistivity is a constant for the material / metal
OR resistivity depends on / is a property of the material / metal

Resistance depends on (resistivity and) length / area /dimensions
OR $R = \rho l/A$ with terms defined (do not credit rearranged equation)

Identifies two rays of light

Two rays have same frequency/come from same source/are coherent

Path difference (between the two reflected rays)

They superpose (when they meet) /constructive and destructive interference occur

If they meet in phase/$n\lambda$ /λ path difference, constructive interference/ bright fringe

If they meet in antiphase / $(n+ ½)\lambda$ / ½ λ path difference, destructive interference/dark fringe

- Temp of a wire increases. Explain what happens to the drift velocity of the electrons if the pd is constant:

Increased lattice/ions/atoms vibrations
(causing) resistance to increase OR increased electron collisions with ions/atoms
(This leads to a) reduction in the drift velocity / v

Plot a graph of $v \rightarrow \sqrt{T}$, $v^2 \rightarrow T$, $f \rightarrow \sqrt{T}$, or $f^2 \rightarrow T$
Graph should be a straight line through the origin
Statement of what gradient equals (consistent with what has been plotted)

(For this experiment μ is a constant. A graph using a variable μ can score max 1 mark for the correct gradient)

-
- State why the ultrasound is transmitted in pulses.: The idea that one pulse must return before the next is sent (1)(ignore references to interference/stationary waves)
- Give one property of X-rays which makes them more hazardous to use than ultrasound.:
  X rays cause ionisation OR can damage DNA/cells/tissue OR cause mutation
- State two other differences between X-rays and ultrasound:

1. X rays transverse, US longitudinal OR X rays can be polarised, US can't (1)
2. X rays travel in vacuum, US doesn't (1)
3. X ray Electromagnetic, US mechanical (1)
4. X rays have (much) higher *f* /shorter *λ* / greater speed.

- What is unpolarised light

Oscillations/vibrations occur in any number of directions/every direction (
which are perpendicular to the direction of wave travel /wave
propagation/energy transfer (do not accept direction of wave) (

OR
Oscillations/vibrations may occur in more than one plane

- When a ray of light from the Sun is incident on a block of ice, most of the light is refracted into the ice. Some of it is reflected. The light that is reflected is partially plane polarised. Describe a test to confirm that the reflected ray is partially plane polarized::
  Use of polarising filter /Polaroid (not just filter) (1)
  Rotation/turning of the filter (1)
  After 90º rotation (block) intensity changes
- Some skiers wear sunglasses with polarising lenses. These sunglasses reduce the amount of reflected light entering their eyes. Suggest how these sunglasses work.:::
  Reflected light OR light from ice is (partially) polarised (1)
  (Polarising) filters/lenses/glasses are at right angles to (the plane of polarisation of) the light
  [1st mark must be about the reflected light being polarised]
  (Answers which say that the sunglasses are polarising the light score 0/2)
- (Work function) is the (minimum) amount of energy that a surface electron needs to break free/be released

Which one of the following graphs correctly shows the relationship between potential difference (*V*) and current (*I*) for a filament lamp?

-
- p.d. is electrical energy(/coulomb) transferred between two points/electrical energy transformed/converted to other forms
- e.m.f is the energy(/coulomb) supplied to a circuit/given to the charge/energy output of the cell
- e.m.f. as a source of electrical energy and p.d. as a sink of electrical energy
- A student looks at the sunlight reflected off a puddle of water. She puts a polarizing (Polaroid) filter in front of her eye. As she rotates the filter the puddle appears darker then lighter.Explain this observation.::

Reflected light is polarized, Polarised light vibrates/oscillates in one plane/direction, Polaroid filter only allows vibrations/oscillations in one direction/plane to pass through, When planes are parallel puddle appears light OR when perpendicular puddle appears dark

- n; number of charge carriers per unit volume OR number of charge carriers m -3 OR charge carrier density (1)
- *v*; drift velocity (of charge carriers) OR average velocity OR drift speed, (accept free electrons or charge carriers throughout)
- Compare the properties of the two sound waves necessary to produce complete cancellation of the two waves that reach the ear.::: Waves must have same frequency or wavelength (1) Waves must have same amplitude (1) Waves must be 180o, ½ wavelength, half a cycle, π radians apart or in antiphase
- In practice the incoming sound is reduced in volume rather than cancelled completely. Noise-cancelling headphones work well when the noise is from a jet engine. They are not very effective at cancelling speech or music. Explain why.::
  Noise of a vibrating object has a constant pitch/frequency (1) Speech/sound varies in pitch and/or amplitude (1) The idea of the difficult of matching a changing signal (1)

- Fluorescent lamp much more efficient OR filament lamp is less efficient(1) Sensible attempt to process the values given (1) Indicates that less than 25% of national power used for lighting (1) Reduction in wasted energy as thermal energy (1) Reduction in CO_2 emission or preserves fossil fuel resources (1)
- Why are ultra sounds transmitted in pulses? One pulse must return before the next one is sent OR So that time interval between transmitted and received pulses can be measured OR No overlap between pulses OR No interference between pulses
- The waves slow down in a denser medium like water or glass. Sometimes when a wave travels through a medium, different wavelengths travel at different speed this is called <u>dispersion</u> because the waves spread out
- Displacement is the distance from the centre of the oscillation to the rope. It is a vector so a trough is negative. The maximum displacement occurs at a peak or a trough of the wave. It is called the amplitude of the wave.
- Bigger amplitude waves carry more energy. The energy is directly propotional to [amplitude^2]
- A ray is a very narrow band of waves and is drawn as a straight line in the direction of movement of the wave
- Light is refracted because it slows down or speeds up
- One medium to another: relative refractive index, vaccum to a medium: absolute refractive index!
- A refractive index of less than1 means that the light is speeding up, so it is refracting away fro mthe normal
- Critical angel: the largest angle at which refraction out of a denser medium is just possible
- Everytime that a ray meet sa boundry between 2 mediums some light is reflected!
- Changes in density or concentration will change the refractive index
- USES OF DIODE OF LED:
  1. Rectification / AC to DC / DC supply [not DC appliances]
  2. Preventing earth leakage
  3. Stabilising power output
  4. To protect components
  5. A named use of LED if linked to LED as component in (a) (eg
  6. calculator display / torch)
  7. A voltage controlled switch
  8. (Allow current in only one direction)

- Ideal voltmeter

Ideal voltmeter has infinite resistance OR extremely high resistance OR highest possible R OR much larger resistance than that of component it is connected across OR quotes value > 1 M Ω (1)

Current through voltmeter is zero (negligible) OR doesn't reduce the resistance of the circuit OR doesn't reduce the p.d. it is meant to be measuring.

- Filament lamp:

<u>Graph</u>

+I,+V quadrant; curve through origin with decreasing gradient (1)

[do not give this mark if curve becomes flat and then starts going down i.e. it has a hook]

-I,-V quadrant reasonably accurate rotation of +I,+V quadrant (1)

<u>Shape of graph</u>

As current/voltage increases, temperature of the lamp increases / lamp heats up (1)
Leading to increase in resistance of lamp (1)
Rate of increase in current decreases OR equal increases in V lead to smaller increases in I (1)
Qowc (1)

- How nodes and antinodes are produced

  Superposition/combination/interference/overlapping/crossing of emitted/incident/initial and reflected waves

  Antinodes: waves (always) in phase OR reference to coincidence of two compressions/rarefactions/peaks/troughs /maxima/minima, hence constructive interference/reinforcement

  Nodes: waves (always) in antiphase/exactly out of phase OR compressions coincide with rarefactions etc, hence destructive interference / cancellation

Measuring the speed of sound

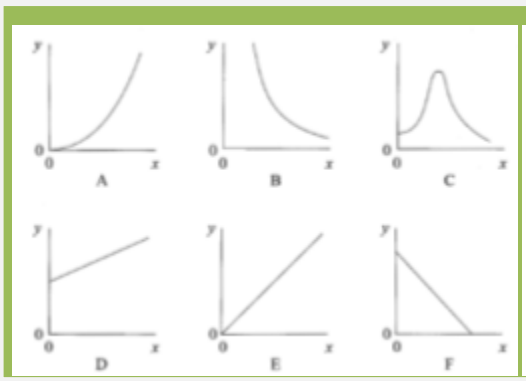
Measure separation between (adjacent) nodes / antinodes and double to get λ/this is ½λ [not between peaks and troughs]

Frequency known from/produced by signal generator OR measured on CRO / by digital frequency meter

Detail on measurement of wavelength OR frequency
e.g. measure several [if a number is specified then ≥3] node spacings and divide by the number [not one several times]
OR measure several (≥3) periods on CRO and divide by the number
OR adjust cro so only one full wave on screen

Use v (allow c) = $f\lambda$

Why sitting at node is not sucha big prob:
Reflected wave not as strong as incident wave OR walls are covered to reduce reflections OR waves arrive from elsewhere [reflections/different speakers] OR such positions depend on wavelength / frequency



Variable on y-axis	Variable on x-axis	Graph					
		A	B	C	D	E	F
Amplitude of a forced oscillation	Frequency of the driving force			○			
Intensity of radiation from a point source in a vacuum	Distance from the source		○				
Spacing of fringes in a double slit experiment	Wavelength of the radiation					○	
Observed wavelength of a spectral line	Recession speed of the galaxy emitting the light				○		

Resistance of ammeter is zero/0/0Ω
[do not accept negligible or a low numerical value]

Current passes through ammeter or ammeter in series in circuit. (1)
p.d. or power loss across ammeter needs to be zero, negligible or very small or it does not reduce the current it is measuring (1)

OR If A had resistance it would reduce the current it is meant to be measuring (1)

Resistance of voltmeter is infinite (symbol acceptable)
[do not accept very high or large numerical value]

Voltmeter in parallel or across component or it provides alternative path. (1)
Current in voltmeter needs to be zero, negligible or very small or it does not reduce the pd it is measuring(1)

OR If V had a lower resistance it would reduce the pd it is meant to be measuring (1)

- Two pieces of wire A and B are made of the same material but have different diameters. They are connected in series with each other and a power supply. (i) Which terms from the above equation will be the same for both wires?:::
  N I and q

- X-RAYS treatement::

- It was known that X penetrated (1)
- It was not known that X rays were harmful (1)
- Doctors died because of too much exposure (1)
- Lack of shielding (1)

- New treatments may have unknown side effects (1)
- Treatments need to be tested / time allowed for side effects to appear (1)

Q) how did considering light as a photon explain y electrons could be emitted instantly from a metal surface????

The energy of the wave is concentrated into a photon (1)
One photon gives all its energy to one electron (1)

Q) why this effect only happens when light is above a certain frequency??

Energy of photon increases as frequency increases OR reference to $E = hf$ (1)
Electrons require a certain amount of energy to break free and this corresponds to a minimum frequency

Q) Doppler and blood flow:: Doppler shift is the change in frequency of a wave when the source or the receiver is moving (1)
Requirement for a continuous set of waves (1)
Two transducers required (one to transmit and one to receive) (1)
Change in frequency is directly related to the speed of the blood (1)

Q] How nodes and antinodes are produced

Superposition/combination/interference/overlapping/crossing of emitted/incident/initial and reflected waves (1)

Antinodes: waves (always) in phase OR reference to coincidence of two compressions/rarefactions/peaks/troughs /maxima/minima, hence constructive interference/reinforcement (1)
Nodes: waves (always) in antiphase/exactly out of phase OR compressions coincide with rarefactions etc, hence destructive interference / cancellation (1)

<u>Critical angle:</u>
The angle beyond which total internal reflection (of the light) occurs [allow T.I.R] / r = 90°

<u>Superposition along PQ [central maxima in youngs double slit]</u>
Constructive interference / reinforcement / waves of larger amplitude / larger crests and troughs (1)
Crests from S_1 and S_2 coincide / waves are in phase / zero phase difference / zero path difference
Amplitude is the sum of the individual amplitudes (OR twice the amplitude of the separate wave)

<u>Explanation of refraction taking place</u>

change in speed / density / wavelength

<u>Explain what is meant by critical angle ::</u> Identify the angle as that in the denser medium (1)

Indicate that this is max angle for refraction OR total internal reflection occurs beyond this (1)

<u>Ultrasound</u>:
High frequency sound / sound above human hearing range / sound above 20 kHz / sound too high for humans to hear (1)

<u>Pulses used:</u>
to prevent interference between transmitted and reflected signals /allow time for reflection before next pulse transmitted / to allow for wave to travel to be determined (1)

High pulse rate: Greater accuracy in detection of prey's motion / position / continuous monitoring / more frequent monitoring

<u>polaroid Experiment</u>

Named light source plus polaroid (OR polariser OR polarising filter) / Laser / Named light source and suitable reflector (e.g. bench) (1)
2nd Polaroid plus means to detect the transmitted light (1)
(i.e. eye OR screen OR LDR OR light detector OR instruction to e.g. look through polaroids)
Rotate one Polaroid [Only award if expt would work] (1)
Detected intensity varies / No light when polaroids are at 90° (1)
Maxima and minima 90° apart / changes from dark to light every 90° (1)
[Use of microwaves, slits or “blockers”: 0/5
Use of filters or diffraction gratings: lose first two marks

Use of "sunglasses" to observe: lose mark 2]

Why sound can't be polarised

They are longitudinal / They are not transverse / Only transverse waves can be polarised / Longitudinal waves cannot be polarised / Because the (*) is parallel to the (**) (1)

(*) = vibration OR displacement OR oscillation OR motion of particles

(**) = direction of travel OR direction of propagation OR motion of the wave OR direction of energy transfer

Why nodes

String cannot move / no displacement / zero amplitude /no oscillation / phase change of π on reflection / two waves cancel out / two waves are exactly out of phase (1) (OR have phase difference of π OR half a cycle) /destructive interference

Explanation of absorption line

Light of this wavelength is absorbed by hydrogen (1) In the outer part of the Sun (OR Sun's atmosphere)

Absorbed radiation is reemitted in all directions (1) Transition from B to C (OR –3.4 to –1.5) (1)

Meaning of superposition:: When vibrations/disturbances/waves from 2 or more sources coincide at same position (1) resultant displacement = sum of displacements due to individual waves

Explanation of formation of standing wave ::

description of combination of incident and reflected waves/waves in opposite directions (1)

described as superposition or interference (1)

where in phase, constructive interference / antinodes OR where antiphase, destructive interference nodes OR causes points of constructive and destructive interference OR causes nodes and antinodes (1) 3

Plane polarised:
Vibrations / oscillations (1)
in one plane (1)

Why pulses are used:

- Allow time for pulse to return before next pulse sent
- To prevent interference/superposition
- A continuous signal cannot be used for timing
- Can't transmit / receive at the same time (2)

Why microwaves are reflected:: Wave is reflected when passing from one medium to another/ when density changes / when speed changes

Varying amplitude

Varying differences in density of the two mediums produce different intensities of signal (1)

Different distances travelled give different amplitudes (1)

Following a reflection there is less energy available

Varying time:different thicknesses of medium

Resistivity drop advv:
Less heating / less energy lost / greater efficiency / lower voltage needed / less power lost

Meaning of stopping potential
Minimum potential difference between C and A / across the photocell **(1)** Which reduces current to zero OR stops electrons reaching A /crossing the gap / crossing photocell **(1)**

Photocell when Vs is applied to it ::

Light (OR radiation OR photons) releases electrons from cathode

- Photon energy is greater than work function / frequency of light > threshold frequency / flight > f_0 / wavelength of light is shorter than threshold wavelength / $\lambda < \lambda_0$
- PD slows down the electrons (OR opposes their motion OR

creates a potential barrier OR means they need energy to cross the gap)

- Electrons have a range of energies / With the PD, fewer (OR not all) have enough (kinetic) energy (OR are fast enough) to cross gap
- Fewer electrons reach anode / cross the gap

Why the current is 0 at Vs??

(ii)
- (At or above V_S) no electrons reach the anode / cross the gap
- Electrons have a maximum kinetic energy / no electrons have enough energy (OR are fast enough) to cross

Explain how vapour emits light:: electrons excited to higher energy levels **(1)** as they fall they emit photons/electromagnetic radiation/waves/energy **(1)**

Meaning of spectral line (when the light is split up) each frequency/wavelength/photon energy is seen as a separate/discrete line (of a different colour) **(1)**

Explanation of different colours

different colours = different freq/wavelengths / photons of different energies **(1)**

photon energy/frequency/wavelength depends on difference between energy levels **(1)**

diff atoms have diff energy levels/diff differences in levels **(1)**

Meaning of energy level:Specific allowed energy/energies (of electron in an atom)

Meaning of photon: Quantum/packet/particle of energy/radiation/light/electromagnetic wave

Explanation of 'excited':: Electrons/atoms gain energy **(1)** and electrons move to higher (energy) levels **(1)**

Explanation of how radiation emitted by mercury atoms:: Electrons (lose energy as they) drop to lower levels **(1)** Emit photons / electromagnetic radiation

Explanation of why only certain wavelengths are emitted

1. Wavelength (of photon) depends one energy **(1)**
2. Photon energy depends on difference in energy levels **(1)**
3. Levels discrete / only certain differences / photon energies possible (and therefore certain wavelengths)

Why threshold frequency is needed

- Electron requires certain amount of energy to escape from surface **(1)**
- This energy comes from one photon of light **(1)**
- $E = hf$ **(1)** Max 2

What eV_S tells us

Maximum **(1)**

Kinetic energy of the electrons / ½ mv^2 of electrons **(1)**

19. Example of light behaving as a wave

- diffraction
- refraction
- interference
- polarisation **(1)**

❖ Initially the temperature is low so current is high
Resistance of filament increases as temperature increases
Current falls to steady value when temperature is constant
Maximum heating is when lamp is switched on / when current is highest
Filament breaks due to melting caused by temperature rise

❖ Reference to $I = nqvA$ **(1)**

For the lamp
Increased atomic vibrations reduce the movement of electrons **(1)**
Resistance of lamp increases with temperature **(1)**

For the thermistor

Increased atomic vibrations again reduce movement of electrons **(1)**
But increase in temperature leads to a large increase in n **(1)**
Overall the resistance of the thermistor decreased with increase in temperature. **(1)**

Uses of diode!! ::

Rectification / AC to DC / DC supply [not DC appliances]
Preventing earth leakage
Stabilising power output
To protect components
A named use of LED if linked to LED as component in (a)(eg calculator display / torch)
A voltage controlled switch

Definition of E.M.F.
Energy (conversion) or work done **(1)**
Per unit charge **(1)**
[work done/coulomb 1/2, energy given to a charge 1/2, energy given to a charge of a coulomb 2/2]

OR	**OR**
E = W/Q **(1)**	E = P/I
Symbols defined **(1)**	Symbols defined
(E = 1 J/C scores 1)	(E = 1 W/A scores 1)

((Terminal) potential difference when no current is drawn 1/2)

Filament lamp graph “::

<u>Shape of graph</u>
As current/voltage increases, temperature of the lamp increases / lamp heats up **(1)**
Leading to increase in resistance of lamp **(1)**
Rate of increase in current decreases OR equal increases in V lead to smaller increases in I **(1)**
Qowc **(1)**
Ecf if a straight line graph is drawn max 3

R constant **(1)**
V α I **(1)**
Qowc **(1)**

- (As temperature of thermistor increases) its resistance decreases [Do not credit the converse]
  (slight) decrease in *v* (symbol, velocity or drift velocity)
  Large increase in *n* increases [accept electrons/charge carriers for *n*]
  A, Q and (pd) remain constant