ATOM :-

According to Dalton, Atom is a smallest, undivisible and ultimate particle of matter.

SUB-ATOMIC PARTICLES :-

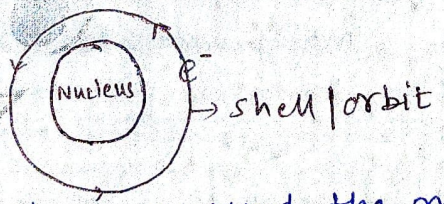
Particles which are smaller than Atom.
Ex :- Proton, Electron and Neutron.

Ques :- 1. Can you Explain, How Dalton Theory of Atom failed to Explain How electric charges are created when rod is rubbed with silk.

Ans :- 1. According to Dalton, Atom is the smallest particle of matter. When Rod is rubbed with silk, electrons get transfered from Rod to silk which creates charges and results in attraction. This experiment shows that Atom is divisible. It is not the smallest particle and there are many particles which are smaller than atom like electron.

ELECTRON :-

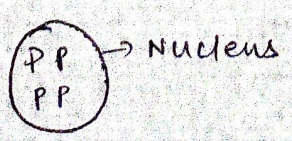
1.) Discovered by J.J Thomson, cathode ray experiment.
2.) Charge / Mass Ratio calculated by J.J Thomson.
3.) Electron is negatively charged particle present in all atom.
4.) location of Electron in Atom :- shells.



5.) Electron is Atom is moving around the nucleus.
6.) Fact :-
i) Charge :- -1.6×10^{-19} C (C = columb)
ii) Mass :- 9.1×10^{-31} kg
iii) Charge / Mass Ratio :- $\frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}} = 1.71 \times 10^{11}$ C / kg.

PROTON :-

1.) Discovered by GOLDSTEIN by Anode Ray Experiment.
2.) Proton is positively charged particle.
3.) Location in Atom :- Nucleus.



4) Facts :-

i) Charge :- $+1.6 \times 10^{-19} C$

ii) Mass :- $1.673 \times 10^{-27} kg$

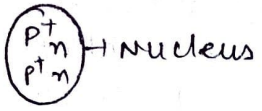
iii) Charge / Mass Ratio :- $\frac{1.6 \times 10^{-19} C}{1.673 \times 10^{-27}} = 9.58 \times 10^{7} C/kg$.

NEUTRON :-

1) Discovered by CHADWICK.

2) Neutral particle, NO charge.

3) Location in Atom :- Nucleus.



4) Facts :-

i) Charge :- 0

ii) Mass :- $1.675 \times 10^{-27} kg$

iii) Charge / Mass Ratio :- 0

ATOMIC NUMBER (Z)

1) No. of p^+ present in Nucleus.

2) No. of e^- present in NEUTRAL ATOM.

3)

H = 1	Na = 11	Scandium : Sc	= 21
He = 2	Mg = 12	Titanium : Ti	= 22
Li = 3	Al = 13	Vanadium : V	= 23
Be = 4	Si = 14	Chromium : Cr	= 24
B = 5	P = 15	Manganese : Mn	= 25
C = 6	S = 16	Iron : Fe	= 26
N = 7	Cl = 17	Cobalt : Co	= 27
O = 8	Ar = 18	Nickel : Ni	= 28
f = 9	K = 19	Copper : Cu	= 29
Ne = 10	Ca = 20	Zinc : Zn	= 30

MASS NUMBER (A)

1) Sum of Number of protons and Neutrons in Nucleus is called Mass Number.

2) It is whole Number.

AVERAGE ATOMIC MASS :-

Some Elements EXIST in Nature as Isotopes. In such cases, Average Atomic Mass is calculated as :-

$$\text{Average Atomic Mass} :- \frac{\text{Mass No. of I Isotope} \times \text{Abundance} + \text{Mass No. of II Isotope} \times \text{Abundance}}{\text{Total Abundance.}}$$

ATOMIC SPECIES	SIMILARITIES	DIFFERENCES	EXAMPLES
ISOTOPES	I) Atomic NO. (Z) II) NO. of p^+ III) NO. of e^- IV) Electronic configuration V) Chemical properties VI) Position in the periodic table.	I) Mass NO. (Z) II) NO. of Neutrons III) Physical properties	I) $_{1}^{1}H$, $_{1}^{2}H$, $_{1}^{3}H$ II) $_{8}^{16}O$, $_{8}^{17}O$, $_{8}^{18}O$ III) $_{17}^{35}Cl$, $_{17}^{37}Cl$
ISOBARS	I) Mass NO. (A) II) NO. of Nucleons.	I) Atomic NO. (Z) II) Electronic configuration III) Chemical properties IV) position in the periodic table	I) $_{18}^{40}Ar$, $_{19}^{40}K$, $_{20}^{40}Ca$
ISOTONES	I) NO. of Neutrons	I) Atomic NO. II) Mass NO. III) Electronic configuration IV) physical and chemical properties V) position in the periodic table.	I) $_{14}^{30}Si$, $_{15}^{31}P$, $_{16}^{32}S$ 2) $_{19}^{39}K$, $_{20}^{40}Ca$ 3) $_{1}^{3}H$, $_{2}^{4}He$ 4) $_{6}^{13}C$, $_{7}^{14}N$
ISOELECTRONIC SPECIES	I) NO. of Electrons 2) Electronic config.	I) Atomic NO. 2) Mass NO.	I) N_2O, CO_2, CNO^- 2) P^{3-}, S^{2-}, Cl^-, Ar, K^+ and Ca^{2+}.

Ques 2. Why Isotopes have same chemical properties but different physical properties?

Ans 2. • Chemical properties depends upon NO. of electrons which are same in Isotopes. Hence, They show similar chemical properties.

• physical properties depends upon mass but Isotopes have different mass. so, they have different physical properties.

Quantization of charge :-

Charge on any species is created by loss or gain of e^-. Hence, charge on any species is always integral multiple of charge of e^-.

$$\boxed{q = \pm ne}$$

ELECTROMAGNETIC WAVES / RADIATION :-

Maxwell in 1870 suggested that when any charge particle moves under acceleration, it produce alternating Electric and Magnetic field which are transmitted as Electromagnetic waves.

Features of EM waves :-

1) $\vec{E}$ and $\vec{B}$ are perpendicular to each other.
2) They do not require any medium to move.
3) They travel with speed of light (3×10^8 m/s).
4) There are many EMW, They can be arrange in increasing order of wavelength or decreasing order of frequency. This makes Electromagnetic spectrum,

⟶ Decreasing frequency.

γ-rays X-rays U.V Visible IR Micro waves Radio waves

⟶ Increasing wavelength.

Ques :- 3. What are Electromagnetic Radiation? What are their properties?

Ans :- 3. Light and other forms of Radiant Energy propogate without any medium in space in the form of waves are known as Electromagnetic Radiations. These waves can be produced by a charged body, moving in a magnetic field or a magnet in a electric field. Ex :- γ-rays, α-rays, etc.

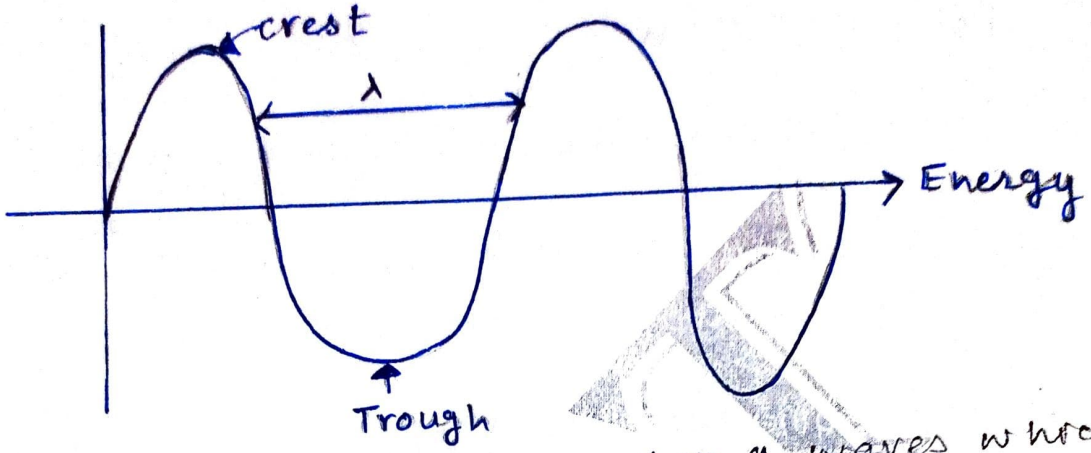
CHARACTERISTICS :-

1) All Electromagnetic Radiations travel with the velocity of light ($C = 3 \times 10^8$ m/s)
2) These consist of Electric and magnetic fields components that oscillate in directions perpendicular to each other and perpendicular to the direction in which the wave is travelling.

VARIOUS PARAMETERS OF ELECTROMAGNETIC WAVE :-

A wave is always characterized by the following five characteristics :-

1.) **Wavelength**:- The distance between two nearest crests or nearest troughs is called the wavelength. It is denoted by λ (Lambda) and is measured in terms of cm, A°, μ, nm.



2) **Frequency**:- It is defined as the number of waves which pass through a point in one second. It is denoted by the symbol ν (nu) and is expressed in terms of cycles (or waves) per second.

$$\nu = \frac{c}{\lambda}$$

3) **Velocity**:- It is defined as the distance covered in one second by the wave. It is denoted by letter 'c'.

$$c = \lambda\nu$$

4.) **Wave Number**:- This is reciprocal of wavelength i.e, the no. of wavelengths per centimetre. It is denoted by the symbol $\bar{\nu}$ (nu bar). It is expressed in cm^{-1} or m^{-1}.

$$\bar{\nu} = \frac{1}{\lambda}$$

5.) **Amplitude**:- It is defined as the height of the crest or depth of the trough of a wave. It is denoted by the letter 'A'. It determines the intensity of radiation.

Electromagnetic spectrum:-

The arrangement of various types of electromagnetic radiations in the order of their increasing or decreasing wavelengths or frequencies is known as Electromagnetic spectrum.

Ques:- 4. What is Black Body and Black body Radiation?

Ans:- 4. 1) The ideal body which emits and absorbs all radiation of all frequency is called black body.

2) Radiation emitted by black body is called Black Body Radiation.

Ques:- 5. Can you think why we should not wear Black cloth in summer.

Ans:- 5. It absorbs all radiations from sun including Infrared. Hence, Temperature Increases.

PLANCK'S QUANTUM THEORY :-

When Black body is heated, it emits thermal radiation's of different wavengths or frequency. To explain these radiations, max planck put forward a theory known as planck's Quantum theory :-

i) The radiant energy which is emitted or absorbed by the black body is not continuous but discontinuous in the form of small discrete packets of energy, each such packet of energy is called a 'quantum.' In case of light, the quant-um of energy is called a 'photon'.

ii) The energy of each quantum is directly proportional to the frequency (ν) of the radiation, i.e,

$$E \propto \nu$$

$$E = h\nu = \frac{hc}{\lambda}$$

where,

h = planck's constant

$= 6.626 \times 10^{-27}$ erg. sec. or 6.62×10^{-34} joules sec.

iii) The total amount of energy emitted or absorbed by a body will be some whole number quanta.

Hence, $\boxed{E = nh\nu}$

where, n is an integer.

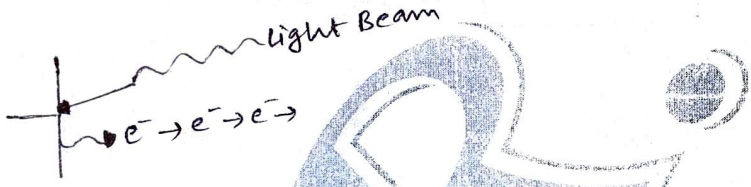
Ques:-5. What is the difference b/w Quantum and photon.?

Ans:-5. A Quantum is a packet of energy of definite magnitude ($E = h\nu$) of any wave. for Ex:- Red, X-Ray, etc

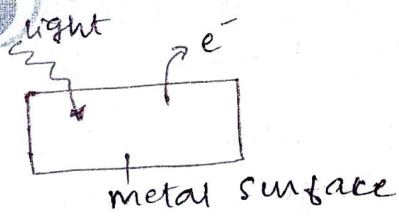
Photon is packet of energy associated with light only.

BASICS OF PHOTOELECTRIC EFFECT:-

In 1887, H. Hertz performed a very interesting experiment in which electrons (or electric current) were ejected when certain metals (for example:- potassium, Rubidium, caesium, etc) were exposed to a beam of light. The phenomenon is called photoelectric effect. The results observed in this experiment were:-



1) The electrons are ejected from the metals surface as soon as the beam of light strikes the surface, i.e., there is no time lag between the striking of light beam and the ejection of electrons from the metal surface.



2) The number of electrons ejected is proportional to the intensity or brightness of light.

Intensity (Energy)

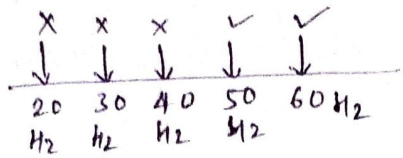
Blue light > Red light

$\lambda_B = 400\ nm$ $\quad\quad$ $\lambda_R = 750\ nm$

$E_B = \frac{hc}{\lambda_B}$ $\quad > \quad$ $E_B = \frac{hc}{\lambda_R}$

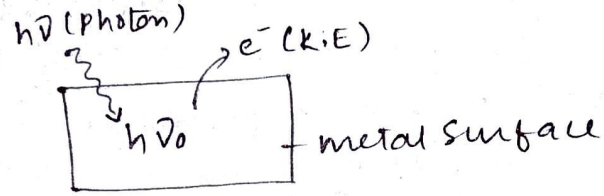
3) for each metal, there is a characteristic minimum frequency, (also known as threshold frequency) below which photoelectric effect is not observed.

for ex:- If threshold frequency of a metal is 50 Hz
Then, e^- will not be ejected if frequency of light is less than 50 Hz.



ν_0 = Threshold frequency.

4.) At a frequency more than threshold frequency, the ejected electrons come out with certain kinetic energy.



$E_{source} = W_0 + K.E$

$$h\nu = h\nu_0 + \frac{1}{2}mv^2$$

5) The kinetic energies of these electrons increase with the increase of frequency of the light used.

If ν of light increases,

→ Energy of light photon increases.
→ Hence e^- will come out with higher Energy (K.E)

★ **NOTE** :- The energy content of the beam of light depends upon the brightness of the light.

→ More bright light, more is the no. of photons.

OOOO
OOOO } 8 photons
less bright light

OOOOO
OOOOO } 10 photons
more bright light.

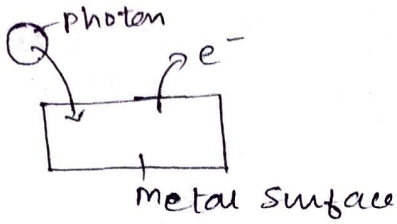
6) It has been observed that though the no. of electrons ejected does depend upon the brightness of light, the kinetic energy of the ejected electrons does not.

eg:- ○ photon = 100 J
(Ten photons)
more bright light

○ photon = 100 J
(5 photons)
less Bright light

EINSTEIN EXPLANATION OF PHOTOELECTRIC EFFECT:-

1.) Einstein (1905) was able to explain the photoelectric effect using planck's quantum theory of electromagnetic Radiation as a starting point, shining a beam of light on to a metal surface can, therefore, be viewed as shooting a beam of particles, the photons.



2.) When a photon of sufficient energy strikes an electron in the atom of the metal, it transfers its energy instantaneously to the electron during the collision and the electron is ejected without any time lag or delay.

$$E_{photon} = W_0 + K.E$$

Hence, If 100 J is energy of photons and if work function of metal is 90 J then, K.E of e^- = 10 J

100 J (photon) = 90 J (W_0) + 10 J (K.E)

3.) Greater the energy possessed by the photon, greater will be transfer of energy to the electron and greater the kinetic energy of the ejected electron. In other words, kinetic energy of the ejected electron is proportional to the frequency of electromagnetic radiation.

$$KE = E_p - W_0$$

If, E_p = 100 J, W_0 = 90 J

$$KE = 100 - 90 = 10 J$$

4.) A more intense beam of light consists of larger no. of photons, consequently the no. of electrons ejected is so larger as compared to that in an experiment in which a beam of weaker intensity of light is employed.

Intensity of light

Photon (10) → e^- (10) > Photons (5) → e^- (5)

THOMSON - ATOMIC MODEL (1898)

1.) Atom consist of two particles e^- and p^+
2.) p^+ are uniformly distributed.
3.) e's are embedded to give most stable electrostatic arrangement.
4.) Model also called :- PLUM PUDDING, WATERMELON.
5.) Ex:- He visualise atom as watermelon of positive charge with seeds (electron) embedded in it.

MERIT :-

Model was able to explain over all neutrality of atom as he seggested that $e^- = p^+$.

DEMERIT :-

This model fails to explain observations of Rutherford α- scattering Experiment.

RADIOACTIVITY :-

1.) It is a phenomenon of atom with unstable nucleus.
2) It is a nucleus phenomenon.
3.) Spontaneous emission of active radiation (α, β, γ) from nucleus is called Radioactivity.
4.) Three type of Emissions are emitted :-
   i) α ii) β iii) γ
5.) α - rays consist of He^{2+}
   a) mass of one He^{2+} = 4 a.m.u
   $= 4 \times 1.6 \times 10^{-27}$ kg
   $= 6.6 \times 10^{-27}$ kg
   b) charge on one He^{+2} is,
   $q = ne$
   $= 2 \times 1.6 \times 10^{-19}$ C
   $= 3.2 \times 10^{-19}$ C.
6.) β - rays are stream of electrons
   mass of β - particle $= 9.1 \times 10^{-31}$ kg
   charge of β - particle $= 1.6 \times 10^{-19}$ C
7.) γ- rays are high energy rays with no mass and no charge.

RUTHERFORD ATOMIC MODEL (1909)

EXPERIMENT :-

1) α-particles with very high speed were made to strike with gold foil
2) Angle of deviation (if any) were measured for α-particle after crossing gold foil.

OBSERVATIONS :-

1) most of α-particles passed through gold foil undeflected.
2) Small fraction of α-particles was deflected through small angle.
3) very few (1 in 20,000) bounce back at 180°.

RESULTS / CONCLUSION :-

1.) Most of the space in atom is empty as most α-particles donot get deflected. It fails Thomson model because according to thomson positive charge is distributed uniformly over atom. In that case α-particle should get deflected wherever it pass through atom.

2.) A few α-particles get deflected shows that +ve charge is not distributed uniformly in atom.

3.) one in 20,000 α-particle bounce back, this is the most unusual observation. α-particles were moving with very high speed. For them to bounce back, They need to be stopped and then very strongly repell. It can happen only when all positive charge is concentrated in Atom at single point. This leads to the concept of Nucleus.

4.) According to Rutherford, All positive charge is concentrated at the centre of atom called NUCLEUS.

5.) $r_{atom} \approx 10^{-10}$ m

$r_{nucleus} \approx 10^{-15}$ m.

Ques :- 6. If Instead of Au - foil, Al foil is used in Rutherford experiment, what would have been the result of passing α-particles.

Ans :- 6. Aluminium Atom has 13 protons while gold atom has 79 protons. ∴ If Al would have been used :-

1) No. of α-particles showing deflection would be less.
2) No α-particles will show rebound back phenomenon because 13 protons are not enough to stop fast moving α-particles.

Ques :- 7. What are drawbacks | limitations of Rutherford model?

Ans :- 7. 1) It fails to explain Maxwell EMW Theory. "According to maxwell, Any charged particle in Acceleration emit energy as electromagnetic waves".
Acc. to Rutherford, e^- are moving around nucleus in orbits. With each motion, e^- should lose energy acc. to maxwell and hence e^- should end up in nucleus. But it never happened Hence, Rutherford fails to explain stability of e^- in orbit.

2.) Rutherford fails to explain distribution of e^- in atom and energy of e^-s in orbit.

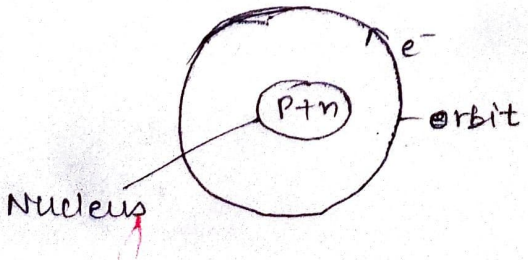
3.) Rutherford fails to explain line spectra of Hydrogen atom.

POSTULATES | KEY POINTS OF RUTHERFORD ATOMIC MODEL :-

1.) Positive charge and most of the mass of atom is concentrated in small region called NUCLEUS.

2) e^-s revolve around nucleus as planets around sun in fixed orbits called SOLAR SYSTEM MODEL.

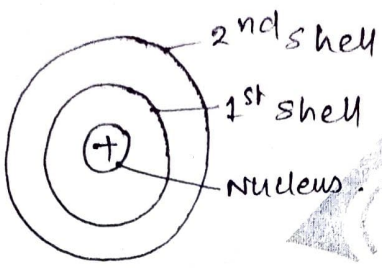
3.) e^-s are held by Electrostatic force of Attraction.



BOHR- MODEL (1913)

Ques:8. what are various postulates of Bohr atomic model?

Ans:8. 1) e^- revolve around nucleus only in selected circular orbitals called energy level or shells. Each shell has definite energy.



2.) Electron can revolve only in those orbits whose angular momentum is conserved, i.e, angular momentum is integral multiple of $h/2\pi$.

L = Angular Momentum = mvr

m = mass of e^-

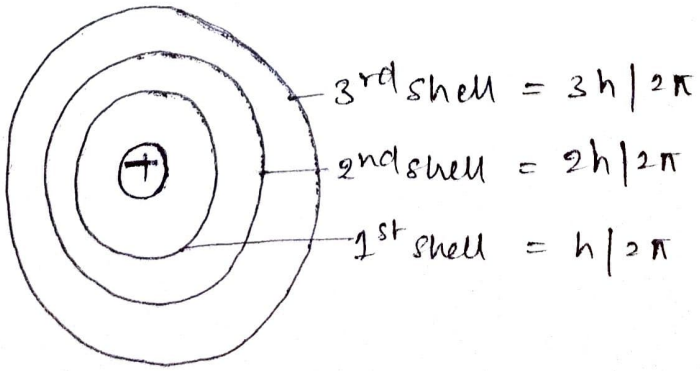
v = velocity of e^-

r = Radius of shell

$$mvr = \frac{nh}{2\pi}$$ Condition of conservation of angular momentum.

h = planck's constant = 6.626×10^{-34} J.s

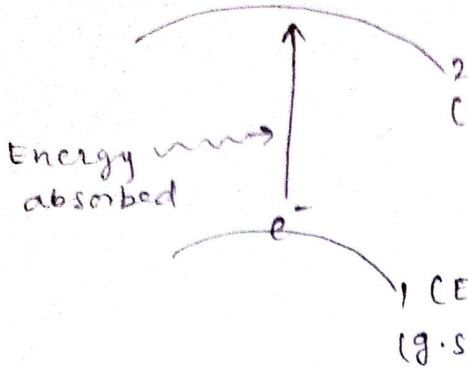
n = Shell Number = 1, 2, 3, ...



3.) As long as e^- revolve in orbit, it does not lose energy Hence energy of electron remain constant. These orbits are also called STATIONARY ORBITS.

4.) If energy is given to e^- in shell, it can jump to higher shell by absorbing definite amount of energy.

$$\Delta E_{abs} = E_2 - E_1$$



When e⁻ comes back to ground state it lose energy.

$$\Delta E = h\nu$$

$$\boxed{\nu = \frac{\Delta E}{h}}$$

$\nu \Rightarrow$ frequency emitted.

Ques:-9. What is the difference between ground state and Excited state?

Ans:-9. Ground state is the shell in which electrons should be present according to electronic configuration. It is minimum energy state and electron remain highly ~~stable~~ stable in ground state

Excited State is the high energy state which is achieved by electron when it absorb energy and goes to higher shell. electron remain unstable in excited state.

BOHR - RADIUS FORMULA FOR H- and H- like one ELECTRON SPECIES:-

$$r_n = \frac{n^2}{z} \times 0.529\ A^\circ$$

$$= \frac{n^2}{z} \times 52.9\ pm$$

$$= \frac{n^2}{z} \times 0.0529\ nm$$

n = shell No.

z = Atomic No.

Ques:-10. Calculate Radius of first five shells of Hydrogen atom.

Ans:-10.

$$r_1 = \frac{52.9}{(1)} \times (1)^2 = 52.9\ pm$$

$$r_2 = \frac{52.9}{1} \times (2)^2 = 211.6\ pm$$

$$r_3 = \frac{52.9}{1} \times (3)^2 = 476.1\ pm$$

$$r_4 = \frac{52.9}{1} \times (4)^2 = 846.9\ pm$$

$$r_5 = \frac{52.9}{1} \times (5)^2 = 1322.5\ pm$$