

# E-WASTE MANAGEMENT

## E-waste

→ discarded materials of electrical & electronic gadgets

→ many materials that runs on potential

## How is e-waste generated?

- generated during production of electronics & electrical devices
- end of life of house-hold appliances

If e-waste not disposed properly,

- i) it contaminates / pollutes the environment as e-waste is non-environment friendly
- ii) it threatens human health

## Causes of e-waste

- i) fast growing technology
- ii) change in style & fashion
- iii) improper handling of electronic & electrical devices

## Types of E-waste

### [Sources of E-waste]

- 1) Large household appliances
- 2) Small household appliances
- 3) IT & telecommunication equipment
- 4) Lighting devices
- 5) Medical devices
- 6) Toys and sports equipments

### 1) Large household appliances

eg:- refrigerator, washing machine, AC, etc.

2) Small  
hair dry  
iron  
vacuum  
kettle  
coffee m

### 3) IT & Telecommunication equipment

eg:- TV, laptop, scanner, printer, series, robot, loud speaker

### 4) Lighting

eg:- fluorescent

### 5) Medical

eg:- use of

### 6) Toys & equipments

eg:-

## 2) Small household

eg:- hair dryer  
iron box  
vacuum cleaner  
kettle  
coffee makers

## 3) IT & Telecom equipments

eg:- TV, phone  
laptop, cellular phones  
Xbox machine  
scanner  
printer  
semiconductor devices  
solar panels  
loud speakers

in thin  
cord

## 4) Lighting devices

eg:- fluorescent lights/  
fluorescent bulbs/  
lamps

## 5) Medical devices

eg:- used in treatment  
of injury

## 6) Toys & sports equipment

eg:- battery

{ also ↑  
conductivity

## Composition of E-waste materials

- alloys
  - glass
  - organic polymers
  - ferrous metals / non-ferrous
  - valuable materials like gold, palladium, platinum, etc.
- (these do not pollute environment)
- even Cu & Ni don't pollute environment

- toxic metals - Pb (lead), tin, antimony, mercury, cadmium, beryllium, arsenic, chromium, barium, they pollute environment

→ used in integrated circuits

PCB → has Cu, Ni & Au  
Why Au?? → to avoid corrosion as they are noble metals

Silica, Sodium Oxide {  
Calcium → glass → toxic?

→ this harms trees  
the ground water {  
causes water pollution

### Organic pollutants

- PVC → poly vinyl chloride
- poly aromatic hydrocarbon
- on burning produces large amt of HCl gas { causes chronic respiratory & skin problems
- can't burn completely

2) Incineration  
→ indirect burning  
→ produces a lot of toxic metal gases when we burn directly

→ an incinerator is used to burn the e-waste materials at  $900 - 1200^{\circ}\text{C}$   
~~as~~ melting point of metal is very high)

→ we burn it in order to reduce some volume of e-waste.

i.e. reduce <sup>small amount of</sup> emission of toxic gases

→ thus better than hand filling

→ also a traditional method

3) Landfill  
→ demantling electrical & devices { end process using many  
→ It is better  
① & ②  
→ can reduce e-waste but even when dismantling, elements are

### Methods of disposal of E-waste

1) Land filling

2) Incineration

3) Recycling

4) Re-use

#### 1) Land-filling

- burying the materials in empty sites
- traditional methods (non-scientific) but not very effective
- As this method, pollutes soil { causes soil pollution

4) Re-use  
→ the best present  
→ minimize problems  
→ without degrading certain materials we use them  
• life span of electronic goods are very less  
∴ we need to extend their life span so, we need them

### 3) Recycling

- dismantling the electrical & electronic devices & then end processing them using many techniques
- It is better than ① & ②
- can reduce volume of e-waste  
but even while dismantling, toxic elements are released

### 4) Re-use

- the best method present
- minimize e-waste problems
- without disposing certain materials, we use them again
- life span of EEG Electronic goods are very low  
∴ we need to ↑ life span  
So, we need to re-use them

e.g.: - cartridge from printers can be re-filled & re-used instead of disposing it.

Thus, life span of cartridge is increased

- we can also give it back to the manufacturers

EPR

Extended Producer Responsibility

Some policy

- manufacturers should take back materials from people & re-use it

Thus, Re-use, best method.

Key factors for success of e-waste management

→ at end of chapter



## i) Effect of e-waste on environment

3 components: soil, water, air

- Burning e-waste produces lots of toxic gases & pollute air (In Incineration)  
Thus causing air pollution

- toxic materials penetrate soil & causes soil pollution (In land-fills recycling)

- that further penetrates ground water & thus causes water pollution

## ii) Human health

Substance	Applied in E-waste	Health impact
1) Pb - metal	<ul style="list-style-type: none"> <li>solder</li> <li>lead-acid battery</li> <li>CRT (cathode-ray tube)</li> <li>PCB (printed circuit board)</li> <li>fluorescent tubes</li> </ul>	<ul style="list-style-type: none"> <li>brain damage</li> <li>nervous system, kidney &amp; causes respiratory problems</li> </ul>
2) Hg	<ul style="list-style-type: none"> <li>battery</li> <li>backlight lamps / bulbs</li> <li>flat panel displays</li> <li>switches</li> </ul>	<ul style="list-style-type: none"> <li>damages brain &amp; kidney</li> </ul>

carcinogen  
solvent → benzene

formic acid → strong  
pKa (3.7) weak acid

acetic acid  
(4.7)

pKa ↑ less strength

(at least 4 metals  
& health impact)

3) Cd  
(Cadmium)

4) As  
(Arsenic)  
• carcinogenic material

5) Sb  
(Antimony)  
(carcinogenic)

6) Organic pollutants  
• PVC  
(polyvinyl chloride)

7) Beryllium  
- Be  
(carcinogenic)

8) Barium  
9) Chromium

benzene  
→ benzene  
(→ strong  
weak  
acid)

less strength

metals  
impact)

h impact

damage  
system,  
& causes  
problems

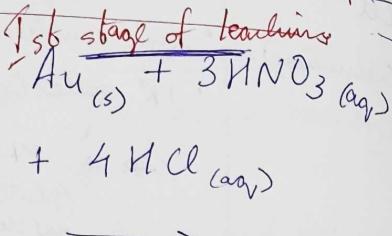
brain {

3) Cd (cadmium)	<ul style="list-style-type: none"><li>• Ni-Cd battery</li><li>• semi conductor chips</li><li>• IR detector<ul style="list-style-type: none"><li>eg:- PMT (photomultiplier tubes)</li><li>converts optical radiation signals to electrical signals</li></ul></li></ul>	<ul style="list-style-type: none"><li>• damages kidney</li></ul>
4) As (arsenic)  • <u>carcinogenic</u> material	<del>LED</del> • GaAs is (Gallium Arsenide) used in LED	<ul style="list-style-type: none"><li>• skin diseases &amp; lung cancer</li></ul>
5) Sb (Antimony)  <u>carcinogenic</u>	<ul style="list-style-type: none"><li>• melting agent in CRT (cathode ray tube) glass</li><li>• plastic computer house</li></ul>	<ul style="list-style-type: none"><li>• stomach pain, vomiting &amp; diarrhea, stomach ulcer.</li></ul>
6) Organic pollutants  • PVC (polyvinyl chloride)	<ul style="list-style-type: none"><li>• monitors, keyboards, cables &amp; plastic computer house</li></ul>	<ul style="list-style-type: none"><li>• respiratory problem &amp; skin diseases (Chlorine effect)</li></ul>
7) Beryllium - Be  <u>carcinogenic</u>	<ul style="list-style-type: none"><li>• power supply boxes</li><li>• mother boards</li></ul>	<ul style="list-style-type: none"><li>• lung cancer</li><li>• skin diseases</li></ul>
8) Barium		
9) Chromium		

## Extraction of Gold from e-waste material

- used in PCB to increase conductivity
- high corrosion resistance

PCB has 3 layers of :-  
- Cu, Ni, Au



Incinerate (at 900-1200°C)

~~Crush ing~~

Crushing

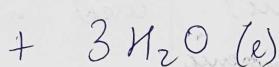
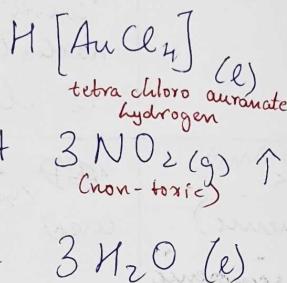
Aqua Regia

- acts as leachant (method of making it soluble in gold with suitable solvent & the solvent is leachant)

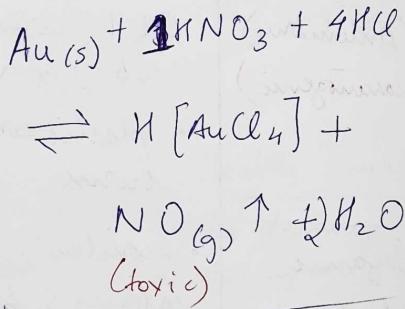
( $\text{HNO}_3 \& \text{HCl}$ )  
↓  
strongest oxidising acid

$\text{HCl} \rightarrow$  dissolves  $\text{Cu} \& \text{Ni}$  present in PCB  
→ slow process

$\text{HNO}_3 \rightarrow$  dissolves gold  
→ high conc. of  $\text{HNO}_3$   
→ fasten process



## II stage leaching of Gold



- 3) environmental decision making tool
- 4) EPR
- environmental policy
  - responsibility of producer to take back products used by people (user)

Adv → cheap method  
→ no side effect

Disadv →  
toxic gas i.e. NO released  
→ slower method

when  $\text{Au} + \text{HNO}_3 \rightarrow \text{Au}^{3+}$

$\text{Au}^{3+} + \text{HCl} \rightarrow \text{Au}^{+}$

## Confirming

(not in syllabus)

% purity of gold

Characterisation Techniques:

i) X-ray diffraction → ~~for~~ ~~to~~ ~~do~~

ii) EDAX method  
(Energy Dispersive) → to find composition

## Strategies

1) LCA (Life Cycle Assessment)

2) MFA (Material Flow Analysis)

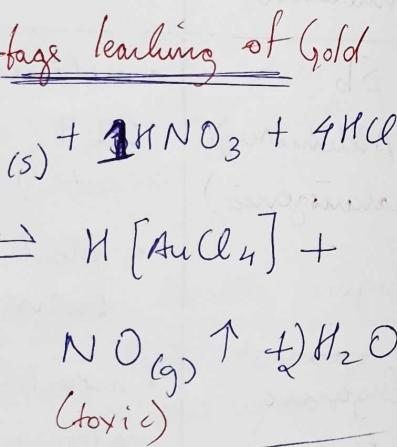
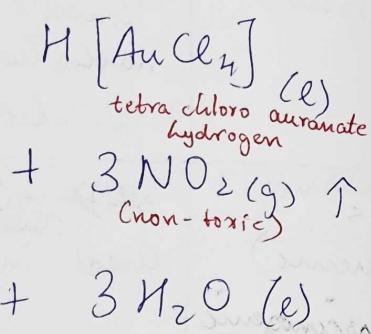
3) MCA (Multi Criteria Analysis)

4) EPR (Extended Producer Responsibility)

- 1) - to design ew friendly  
2) - study route of flow of e-waste  
Investigate flow of e-waste

waste material  
stage of leaching

$$\text{Au}_{(s)} + 3\text{HNO}_3 \text{ (aq)}$$

$$4\text{HCl} \text{ (aq)}$$


environmental decision  
 making tool

EPR  
 environmental policy  
 responsibility of producer to  
 take back products used by  
 people (user)

Adv → cheap method  
 → no side effect

Discadv →  
 → toxic gas i.e. NO released  
 → slower method

when  $\text{Au} + \text{HNO}_3 \rightarrow \text{Au}^{3+}$  ions

$\text{Au}^{3+} + \text{HCl} \rightarrow \text{H[AuCl}_4\text{]}$

Other methods

- Hydro metallurgy
- Pyro metallurgy
- Aqua regia

Confirming (not in syllabus)

→ % purity of gold

Characterisation Techniques:

- i) X-ray diffraction → to confirm if gold,  
 for % & morphology
- ii) EDAX method  
 (Energy Dispersive X-ray analysis)  
 → to find composition of element

### Strategies

- 1) LCA (Life Cycle Assessment)
- 2) MFA (Material Flow Analysis)
- 3) MCA (Multi Criteria Analysis)
- 4) EPR (Extended Producer Responsibility)

- 1) - to design eco friendly electronic devices
- 2) - study route of flow of e-waste material into disposal site  
 (investigate flow of e-waste)

## Key factors for success of e-waste management (in syllabus)

- i) design & produce eco friendly devices
- ii) proper collection of e-waste & proper recovery of noble metals
- iii) recycling by suitable & safe methods
- iv) disposals by different techniques
- iii) to create awareness among user & consumer abt effects of e-waste on environment