Environmental Studies
FACT SHEET
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The Properties Of Pollutants

Table 1 illustrates how the properties of a pollutant may affect its impact

Table 1. Properties of pollutants

Property	Description	Notes
Persistence	How long it takes for a pollutant to break down. The more persistent it is, the longer it takes	The older pesticides such as DDT, which are often incorrectly described as non-biodegradable, can be broken down but only very slowly; the half-life of DDT was 20 years. More modern pesticides have much shorter half-lives. However, non-persistent pesticides are often much more immediately toxic than their longer-lived predecessors, they are often applied in greater quantities and their well–advertised low persistence has sometimes led them to be used in locations where persistent ones would not have been e.g. close to rivers.
Mobility	How easily a pollutant moves in the environment.	Heavy metals trapped in rocks cannot move and do not therefore cause a pollution problem. Once they are mined, they may escape into air, water and soil where they may harm living organisms. The place where they cause harm may be a long way from the source rock.
Bio-accumulation	The build-up in a particular organism of a pollutant.	Organochlorine pesticides such ad DDT and heavy metals such as cadmium may accumulate in organisms. This may happen if the pollutant is soluble in fat (liposoluble), and the pollutant becomes stored in the fatty tissues of the organism. The organisms usually have no way of excreting the toxins.
Bio-magnification	The increasing concentration of a toxin along a food chain.	A toxin that has been accumulated in a plant may be eaten by a herbivore. That toxin is now in the tissues of the herbivore. Over the course of a year, the herbivore eats 100 such plants, ending up with 100x the amount of the toxin that was in the original plant. A carnivore now eats 10 of these toxin-filled herbivores. It now contains 1000x the amount of toxin that had accumulated in the original plant. The longer the carnivore lives and the more herbivores it eats, the more toxin it will concentrate. The concentration of the toxin may reach lethal levels. In the 1950s/1960s biomagnification of DDT and its breakdown product DDE threatened to wipe out the bald eagle and osprey in the US and the peregrine falcon in the UK
Synergistic action	When the combined effect of two pollutants is greater than the sum of their individual effects (see Box p2).	If cadmium solution is sprayed on bean shoots, their growth is slowed. A similar effect is seen if zinc solution is used. If a mixture of zinc and cadmium is applied the reduction in growth is much more than if the individual effects had been added together (see Box p2).
Mutagens	Substance that cause a mutation – an inheritable change in the structure of the DNA. This changes the functions of genes, possibly fatally.	Many organic compounds e.g. 1,1,1-trichloromethane, bromochloromethane are mutagenic
Teratogens	A teratogen affects the DNA of a developing foetus	Thalidomide was taken by thousands of pregnant women in the 1960s - resulted in shortage or absence of arms and legs in the newborn baby. Rubella virus (German measles) is also a teratogen during the last three months of pregnancy.
Carcinogens	Carcinogens stimulate uncontrolled cell growth i.e cancer	• Chemical – e.g. Disinfectants bi-products • Biological – e.g. Viruses • Physical – e.g. UV rays

Table 2 uses lead (Pb), mercury (Hg) and cadmium (Cd) to illustrate how the properties of compounds containing these elements influence their pollution significance.

Table 2 The sources, properties and effects of lead, mercury and cadmium

	Pb	Hg	Cd
Source	Manufacture of paint, pesticides, pottery, glazes and smelting of lead ores	Used in production of electrical equipment. Electrolysis of sodium chloride into Cl_2 and in fungicides in developing countries.	Used as an anti-friction and anti-rust agent, in semiconductors and in batteries, pigments, metal coatings and plastics. Cadmium enters the air from mining, industry, and from burning coal and household wastes. Cadmium usually enters the body in cigarette smoke, in foods such as shellfish or through the inhalation of air near the burning of fossil fuels or household waste.
General effects	Slows decomposition of organic matter in soil by toxic effects on bacteria. Lead prevents production of haemoglobin so anaemia is the first effect of chronic lead poisoning in humans. Lead displaces calcium in key metabolic reactions - damaging any processes in which calcium has a role.	Mercury can exist in different forms – as a metal, or as an inorganic compound or as an organic compound. The organic form is the most toxic because it is easily absorbed and is soluble in lipids. Thus it can accumulate to high concentrations in mammals. Mercury compounds can be changed from one form to the other by bacteria in the soil – so even relatively harmless forms can be quickly transformed into harmful ones.	It binds strongly to soil particles and some forms dissolve in H_2O. In the body cadmium can displace zinc - damaging any processes where zinc would normally have a role e.g. repair of DNA.
Bio-accumulation	Persistent - so accumulates	Persistent - so accumulates	Plants absorb it efficiently so it accumulates, and it also accumulates in the liver and kidneys of mammals
Bio-magnification	Persistent and can bio-magnify.	In 1953 a factory released methyl mercury into Minimata Bay, Japan. It accumulated in shellfish. 700 people were poisoned when they ate the shellfish.	Persistent and can bio-magnify. High concentrations can cause kidney disease and brain damage
Synergism	Mercury, cadmium and lead may act in pairs and in triplet, synergistically affecting transmission of synapses in the brain		Cd and Zn solutions have a negative synergistic effect on the growth of bean shoots (see Box).

Synergistic action of cadmium and zinc on bean plants

Grow seedlings in solution containing (i) cadmium only , (ii) zinc only (iii) distilled water.

Box

	2µM Cd	2µM Zn	2µM Cd + 2µM Zn	Distilled water
mean height of shoot (mm)	29	31	12	38
mean reduction in height compared to distilled water/ mm (%)	9 (23%)	7 (18%)	26 (68%)	

Conclusions

- Cd reduces shoot growth
- Zn reduces shoot growth
- Cd + Zn together hugely reduce shoot growth - the total reduction in growth is greater than the individual effects of Cd and Zn added together i.e. they have interacted.

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