Dust and Pollutants

Objectives

At the end of this chapter you should:

- be familiar with the types of dust and pollutants which can affect cultural heritage material;
- be familiar with the sources of these pollutants;
- have a basic understanding of how to minimise pollution in your collection's environment;
- have a basic understanding of how to deal with the problems caused by dust and pollution; and
- be familiar with the types of materials which are safe to use with cultural material.

Introduction

There are three main sources of damaging pollutants that can affect cultural material:

- the external environment, that can produce dust and atmospheric pollutants;
- the environment inside the museum or storage space that can produce dust and pollution through workshop, tearoom or conservation activities; and
- materials that are used to store or display objects which can contain harmful chemicals.

Sulphur dioxide, salt-laden winds, and carbonaceous material are good examples of pollutants produced in the external environment. Acetic acid or formaldehyde offgassing from display cases, cement dust from a new building, and dust generated from workshops are all good examples of pollutant material that may be produced in close proximity to the collections area.

Damaging pollutants are usually referred to as being either particulate or gaseous.

Particulate matter

Solid particles that are suspended in air are usually referred to as particulate matter or aerosols.

Materials that settle on surfaces in still air are usually referred to as dust or grit.

The size of the particles is measured in microns—µm. One micron is one-thousandth of a millimetre. Smaller particles remain suspended in the air until they are trapped on a surface. Materials which are porous or have heavily textured or sticky surfaces are particularly likely to attract these very fine particles. Larger particles tend to settle near their source.

Where does particulate matter come from?

Particulate matter from the outside environment comes from a variety of sources: burning fuel, motor vehicle exhaust, furnaces, metal from tram tracks, dust from building sites, chlorides from salt spray or dust and dirt from the natural environment.

Particulate matter can also be generated within a building. In new buildings, concrete and cement can give off very fine dust particles for up to two years after initial pouring. These particles are extremely alkaline and will damage objects they settle on, for example, they will discolour linseed oil, some dyes and pigments and attack alkaline-sensitive material such as silks and photographs.

In existing buildings, air-conditioning systems which are not cleaned regularly or do not have appropriate filters, as well as gas and oil heaters, kitchens and workrooms, have the potential to produce particulate pollution which can affect objects.

A lot of dust is made up of human skin and hair. These materials are very attractive to insects.

Chemically active particulate material can also be introduced as part of some pest control treatments. For example, certain large chemical dust particles placed on surfaces such as shelves can poison pests as they crawl over these areas. However, this type of pest control treatment is not advised where cultural materials may be present.

Particulate matter may also contain other adsorbed or absorbed material such as acids from atmospheric sulphur dioxide, or traces of metal from industrial processes.

Problems with particulate matter

Dust can build up to quite a large mass in areas that are not easily accessible, or which may easily trap airborne dust particles. Dust absorbs moisture readily, so that areas with a large build-up of dust can have quite high local humidity even when the environment surrounding the object is completely stable at 50%RH.

In recessed areas, such as between the lower stretcher bar and the canvas of a painting or in the interstices of basketwork, the build-up of dust creates problems for paint layers. This can lead to cracking and other physical damage as the dust creates physical distortion of the structural components of the object.

Dust on objects will absorb and adsorb pollutants. In conjunction with moisture, absorption of pollutants can lead to severe damage. For example, dust particles which contain chlorides can cause bronze disease on bronze objects.

Dust also attracts and harbours pests—enabling insects to hide and nest in secure environments.

Gritty dust causes physical damage, particularly if you clean the dust away by rubbing. It could lead to abrasion and scratching.

Sticky dust, for example, soot, will stain most surfaces. Dirt can be absorbed into extremely porous or intricate surfaces such as paper, basketwork and plaster casts which, once dirty, may be impossible to clean.

Carbonaceous material

Carbonaceous particulate matter is produced from several sources including cigarette smoke, car fumes, furnaces and industrial workplaces which burn material. It is often extremely sticky and tarry.

If a surface is not porous, carbonaceous particles are quite easy to remove when they first settle. However, if left on an object, their acidity will cause them to etch into the surface. Airborne carbonaceous material is also likely to contain sulphur compounds.

Chlorides

Salt air is a particular problem. While marine environments are the most likely source of salt, there are other sources of chloride contamination of cultural material. These include chlorinated water and areas with high saline concentrations—such as occur in some inland areas of Australia—and sweaty fingers.

Chlorides are gritty and will abrade surfaces, but they can also produce chemical reactions. An example of this is the reaction in copper which produces copper chlorides—a highly corrosive substance capable of causing considerable damage to cultural material. This type of damage to copper and bronze objects is commonly known as bronze disease.

For more information

For more information on chlorides and bronze disease, please see the chapter on Metals in *Caring for Cultural Material 2*.

Protection from dust

Protecting your collection from the harmful effects of dust is a combination of common sense and expertise. Good building design to keep dust out—together with good housekeeping practices to stop its distribution through to display and storage areas—will radically reduce damage from particulate matter.

It is worth developing a strategic plan to identify and deal with problems. The best place to start is to look at the building and its ability to keep out dust. In salty, dusty or dirty environments:

- use air-sealing strips around doors, windows and filter air vents;
- provide doormats for visitors;
- double doors will provide some protection against dust entering the building;
- keep windows closed if possible. This is not always advisable in a tropical climate, because good ventilation is vital to reduce the risk of mould growth; and
- place any objects which are particularly susceptible to abrasion—or are hard to clean—in dust jackets or boxes during storage, and in display cases for exhibition.

Even well-protected buildings can have large amounts of particulates in the atmosphere. New concrete should be sealed. But remember to check that the sealant is safe for use in areas which contain cultural objects, and make sure that there are no objects nearby when it is applied. It is important also to allow enough time for the sealant to dry and offgas before housing the objects in the area. Don't underestimate the time it takes a material to offgas. Plastic paints need to be aired for three to six weeks to allow for the acetic acid to dissipate fully.

Workshop areas and kitchens are known producers of particulate matter. If possible, these areas should be sealed well and sited away from storage and exhibition areas. Use good housekeeping practices in these areas—try to vacuum regularly.

Remember that air-conditioning systems will circulate harmful material from one outlet to another, so check that your ducting system is not pumping workroom dust or tearoom grease onto your objects. If possible, design your air-conditioning ducting so that dust-producing areas are at the end of the system.

Protect particularly susceptible surfaces. Plaster casts and natural history specimens should be housed in cases or provided with dust jackets. Works of art on paper should be stored in Solander boxes or sealed in frames. Objects with intricate surfaces, such as basketry or textiles, should be boxed for storage or displayed in display cases. And avoid spraying aerosols near objects. These usually contain hydrocarbons and other harmful pollutants. Hydrocarbons react in the presence of air, and become brown and sticky over time, causing irreversible staining.

Many materials are either electrostatic or sticky enough to attract dust. Perspex, Mylar and plastics are good examples of this. Some coatings which are recommended in conservation literature may also be sticky, for example waxes and dressings, or will build up an electrostatic charge, for example, synthetic resins. Seek the advice of a trained conservator before using coatings and resins on cultural objects.

Cases, boxes, slip covers and folders can all be used to protect objects from particulate matter. Cases can be fitted with dust filters; and silicon sealant can be used in loose-fitting cases. Slip covers can be made out of undyed, natural fabrics such as calico.

If you have an air-conditioning system, it needs to be kept in good condition, and filters checked and changed as necessary. An air-conditioning system which is not maintained properly can cause more damage to a collection than no air-conditioning at all.

Pollutant gases

Damage from pollutant gases may result from:

- the offgassing of chemically active materials in the museum, gallery or library; or
- from pollutants in the external environment.

Industrial pollution occurs in most major cities in the world. In Australia, Melbourne and Sydney are well known for their polluted environments; but even in small country towns air pollution can be a problem.

Sulphur dioxide, nitrogen oxides, carbon dioxide and ozone are all pollutant gases. Of these, sulphur dioxide, nitrogen dioxide and ozone cause the most damage. Sulphur dioxide and nitrous oxide are called acidic gases because they react with water to produce acids.

Sulphur dioxide and sulphuric acid

Sulphuric acid and sulphur dioxide are harmful substances produced from pollutants in the air. These substances are formed when sulphur reacts with oxygen in the atmosphere to produce sulphur dioxide, and ultimately sulphuric acid while in the presence of water.

Polluting sulphur in the environment reacts with oxygen to produce sulfur dioxide:

$$S + O_2 = SO_2$$

The sulphur dioxide further reacts with oxygen:

$$2SO_2 + O_2 = 2SO_3$$

and in the presence of water sulphuric acid is formed:

$$SO_3 + H_2O = H_2SO_4$$

Sulphuric acid is highly corrosive. It attacks outdoor sculpture and damages buildings as these contain calcium carbonate—a material present in limestone, marble and sandstone.

All three sulphur compounds—sulphur, sulphur dioxide and sulphuric acid—also have an affect on certain metals. For example, sulphur dioxide rusts iron. Whereas sulphur on its own can cause silver to tarnish. As for lead, this metal deteriorates rapidly in the presence of sulphur dioxide.

But not all metals are affected by the sulphur compounds. For example, bronzes which have a patina are generally not affected by sulphur dioxide.

Materials containing cellulose—as used in the production of paper—are susceptible to damage from sulphuric acid. The widespread phenomenon of brittle books is a direct consequence of this problem.

Sulphuric acid also affects protein-based materials. One example of this is red rot—a well-documented problem in libraries—caused by sulphuric acid attacking bookbinding leathers.

Silk and photographs are affected by sulphuric acid—whether in the gaseous or liquid state. Synthetic textiles are also affected by acid gases.

For more information
For information about red rot, please see the chapter on Books in *Caring for Cultural Material 1*.

Nitrogen oxides

Like sulphur dioxide, nitrogen dioxide is also a harmful substance in itself, which, when combined with water, forms nitric and nitrous acid.

$$2NO_2 + H_2O = \underset{\text{nitrous acid}}{HNO_2} + \underset{\text{nitric acid}}{HNO_3}$$

Nitrogen dioxide attacks cellulose and polyesters as well as some dyestuffs.

Nitrogen oxides also produce oxidising agents. These are very reactive and cause severe damage to most materials with which they come in contact.

Ozone

Ozone is an extremely reactive oxidising gas. It attacks organic materials at a molecular level. Because many objects in museums, galleries and libraries are organic, ozone in your environment could be disastrous.

Photographs, which are usually made up of a paper support with a gelatine emulsion, are extremely susceptible to damage from ozone.

Metal corrosion is also very common in the presence of ozone.

Fortunately, ozone has a short life. Even in a polluted environment, it is likely to have reacted with the external environment before it reaches the collection storage and display areas. Unfortunately, ozone can still be produced within a museum environment—for example, by photocopiers.

Factors which increase the effect of acidic gases

Strong visible light, continuous exposure to UV radiation, and high levels of humidity and temperature in the museum environment, all increase the effects of acidic gases on materials used in cultural objects.

For example, strong light levels can accelerate the chemical production of harmful acids in the environment as well as increase the rate of deterioration of various materials with these acids.

Some reactions are initiated by more energetic wavelengths of light and by UV radiation.

Furthermore, chemical reactions are more likely to take place and proceed faster in humid conditions and at higher temperatures. As a rough guide, a 10°C increase in temperature doubles the rate of chemical reactions.

For more information
For more information about adverse environmental effects, please see the chapters on Light and Ultraviolet Radiation and on Humidity and Temperature in this volume.

Display and packing materials

There are many reasons to place items in their own sealed environment when they are on display, in storage or being transported. A sealed and protected environment will:

- limit damage from dust and air pollution;
- impede insects;
- reduce accidental and physical damage such as scratches, knocks and breakages; and
- reduce the risk of theft.

But remember, objects that are placed within a sealed, secure environment are at risk if that environment contains active chemicals which can affect the object. Paper is affected by acidic materials such as wood-pulp, cardboard or wood, whereas ceramics will be unaffected by these materials. The following information is provided as a guide—so that you can avoid damage caused by display and packing materials.

Wood

Different woods produce different volatile substances. For example, plantation pine gives off phenolic acid; other woods produce acetic acid.

Paper, textiles and other items which are adversely affected by acids should not be in direct contact with wood.

Lead is extremely susceptible to acids from wood, particularly from oak. Solid, metallic lead will react with acids from the oak, to form a white powdery substance.

Woods are generally considered safe for packing, storing and displaying cultural material include Hoop, Kauri Pine and Ash.

Metals

Metals are generally considered to be safe, but if they are likely to corrode they should not be used.

Some problems have been noted with enamelled coatings on steel cabinets, where underfiring of the coating has resulted in the subsequent offgassing of formaldehyde (Applebaum, 1991).

Stainless steel and aluminium are generally considered safe.

Acrylics

Acrylics are generally considered safe. They include Perspex and resins which can be mixed to form emulsions and solutions.

Acrylics in emulsion and solution form can be used as varnishes or surface coatings. If you are using a commercially prepared emulsion or solution, make sure that it does not contain harmful additives such as excess catalysts, or materials like toxic plasticers.

Polyvinyl chlorides—PVC

Polyvinyl chlorides breakdown over time—with moisture from the air— to produce hydrochloric acid. Avoid using PVC and other chlorinated hydrocarbons.

Polyester, polyethylene and polypropylene

Polyester, polyethylene and polypropylene come in a variety of forms and grades. Whatever the type, these substances are safe to use.

Polyvinyl acetate and polyvinyl alcohol—PVA & PVOH

Polyvinyl alcohol is a derivative of polyvinyl acetate. Both of these materials are used as a base for paints, coating and adhesives. They are safe to use in some circumstances, but must be allowed to fully dry and cure. For advice on their use in specific applications, consult a conservator.

Fabrics

In general, pure cotton and linen which are unsized and undyed are safe to use near objects. Wool—sized or dyed fabrics—should not be used because they may contain reactive substances and may hold water, increasing the local relative humidity. Wool should not be used with metals and other sulphur-susceptible materials, because it usually contains sulphur.

Polyurethanes

Polyurethanes react with light and heat, and break down. As they always contain additives, a range of potentially harmful chemical compounds can be released into the environment. They should not be used as coatings.

Chipboard, compressed board and plywood

Chipboard, compressed board and plywood should be avoided. They are usually prepared with formaldehyde, which produces formic acid. It is possible to buy processed wood products which do not contain formaldehyde, but it is important to check that they do not contain other corrosive volatile organics.

Sealants

It is often suggested that sealing cases with varnish or an acrylic sealer will stop offgassing. This is not true. No sealant is truly impermeable and their use will slow down, but not reduce, the total amount of offgassing.

Nitrate film

CAUTION

Nitrate film is extremely dangerous. It is made from cellulose nitrate which is a very unstable material. As it degrades, it produces nitrogen oxide. Further degradation will result in spontaneous combustion of the film. And as nitrogen oxide reactions produce oxidising agents, this reaction can occur without the presence of oxygen in the air. This means that degraded cellulose nitrate can burn even under water or when smothered. Degraded cellulose nitrate becomes dark, sticky and smelly.

The National Film and Sound Archive has conducted a search for nitrate film in Australian collections. If you suspect you have cellulose nitrate in your collection, contact the National Film and Sound Archive, or a relevant State institution.

Cellulose nitrate was used as a coating, as a film emulsion and to make objects. It seems to be at its most unstable as film stock; however, if you suspect you have cellulose nitrate in any form seek the advice of a conservator.

Methods for detecting pollutant gases

Detecting the presence of pollutant gases is generally best left to the experts. But there are some simple methods that will detect pollutant gases which might affect your collection.

Oddy tests

Oddy tests are named after the person who devised them. They involve placing different types of metal strips in the areas where you think pollutant gases may be a problem. The effect of the gas is measured by the condition of the metal.

These tests are described in the literature (Oddy, 1975) and are a quick and easy way of checking for problems.

Draeger detector tubes

These tubes are available commercially and there are a wide variety of tubes—each specific for a certain gas.

You will need to contact a supplier to buy these tubes. Try chemical supply companies in your area, or ring your State or Territory Environmental Pollution Authority.

Various monitors

There are a wide range of specialist monitors and detectors on the market. Osborn (1989) provides a list of many of these. In most cases, you will need to commission an expert who is familiar with the use of the equipment to undertake an assessment and provide a report.

pH indicator strips

pH indicator strips are used to determine whether acidic gas is being produced in an area. When moistened with neutral pH distilled water, the strips absorb gases from the air and indicate whether acids are formed.

You will need distilled water and one or two pH indicator strips for each test you make. Test the pH of the distilled water with a pH strip. Compare the colour change on the strip with the reference chart on the case, and record the pH of the water. The water should be at pH 7: neutral. A small variation in pH—down to 6—is acceptable, because contact with carbon dioxide in air makes distilled water slightly acidic.

Leave the moist pH strip in the air for 15-30 minutes, and monitor any colour changes against the reference chart on the indicator strip case.

pH indicator strips are a guide only, so further testing should be done.

Check with experts

Your local municipal offices have information about environmental pollution in your area, and may be able to help you contact local experts.

The Environment Protection Authority or similar authority in your state should be able to give you the names of professionals who can help.

Outdoor objects

The protection of exposed objects from pollutant gases requires commonsense and expert knowledge.

Remember that reactions from pollutant chemicals are increased with high light levels, and changes in relative humidity and temperature. The possible impact of these factors can be reduced fairly easily. The following steps will help.

- Provide drainage channels around the base of statues and clean away accumulated organic debris.
- Reduce moisture levels in and around cultural objects. Moisture in tropical climates can be more difficult to control, but you may be able to provide shelter from rain, and shade to help keep the temperature down.
- Relocate an object to the least-exposed area of a building. For example, moving an object from the seaward side of a building to a more protected location will reduce, although not completely stop, the effect of salt-laden wind.
- Commonsense often dictates the use of protective coatings on objects. But commonsense can be wrong. If you want to provide a protective coating on an outdoor object, then you need to consult an expert. Surface coatings applied inappropriately can do more harm than good. If the coating is to be applied to a work of art and is likely to change the finish of the work, then you should consult the artist as well.
- Some metals provide their own protective layers against corrosion. These could be disturbed by cleaning.

Protecting from atmospheric pollution

To develop proper strategies for the care of your objects, you will need to do much more reading and familiarise yourself with a wider body of information than it is possible to provide in this manual. Talk to as many experts as possible, and get to know the problems which are particular to your area.

Air-conditioning

If you are thinking of installing an air-conditioning system, it is advisable to talk to small museums or institutions similar to your own. Cultural material has special requirements, and if you deal with experienced people you are likely to have fewer problems.

Pollutant gases are removed usually by water sprays or activated carbon filters. Air-conditioning systems which incorporate water sprays pass air through a sheet of water to trap pollutant gases. It is important that a system like this incorporates a dehumidifier, to maintain a stable humidity. It is important also to keep the water source clean because it could become acidic from a build-up of pollutants, and circulate humidified, acidic air onto objects.

Air-conditioning systems should be designed to correct specific temperature, relative humidity and pollution problems. They are expensive to build, install and maintain, and it's best to consult an expert who has experience with buildings of a similar scale to yours; rather than, for example, a firm with experience in domestic air-conditioning only.

Many new buildings are designed to incorporate passive environmental control techniques within the building. Air-conditioning may not be required if your building has been designed this way and is working effectively.

If you have an existing system in the building, have it checked regularly and keep a report on its condition which can be reviewed at each subsequent examination.

Activated carbon filters

Activated carbon filters control pollution emissions by adsorbing pollutants onto their surfaces. They need to be checked regularly. Once they are saturated, they will give out pollutants—and the problem will worsen rather than improve.

Potassium permanganate

Potassium permanganate is a good filtration system for museums (Appelbaum 1991). The system is similar to silica gel systems used for humidity control. You should seek advice from a conservator before considering this option.

Commonsense approaches

While some options for controlling pollution require expert advice and financial outlay, there are a number of options which offer protection with little cost and effort. For example:

- use display cases and layers of storage to provide a protective local environment for the object;
- frame and glaze artworks which are on display;
- provide dust jackets for books;
- place flat paper-based objects in Solander boxes;
- provide archival-quality boxes for fragile or susceptible objects; and
- cover large objects which will not fit in storage cases or boxes with appropriate sheeting, for example, unbleached and undyed cotton or linen, or Tyvek, when they are not on display.

For more information
For more information about Tyvek, please see the chapter on Textiles in *Caring for Cultural Material 2*.

These are some options only. As you familiarise yourself with more information in other sections of *reCollections*, you will find that other simple options are available. Even if you can't control the environment completely, you can make some difference with even small changes.

MORE ABOUT DUST AND POLLUTANTS

Particulate matter

Aerosols

The term aerosol is used in a number of different ways in the literature. Osborn (1989) provides a good definition. He defines aerosols as 'very small particles which are less than 1 micron and which act as a nucleus for the condensation of liquid'.

Smaller particles which tend to be trapped

Generally, smaller particles—from .01 microns to 15-20 microns—remain suspended in the air until they are trapped. They can be trapped by adhesion to sticky surfaces such as waxes; porous surfaces such as paper; textured surfaces such as feathers; or by a physical barrier. Being small, they are usually light and are extremely mobile.

Larger particles which tend to settle

Larger particles—particles greater than 15-20 microns—tend to settle near their source. This means that near the source there is likely to be a heavy deposit of these large particles. This kind of particulate matter is easier to collect than the smaller particles, but it will cause more damage because of its mass.

Concrete buildings

Studies have indicated that concrete dust can be given off for up to two years after the completion of the building. The only studies on this have been done by Toishi (Thompson, 1986). However, this phenomenon has been seen in buildings in Australia, and is easily checked in buildings—by placing a clean blotter on a shelf in a suspect area. If concrete dust is a problem, you will see dust settling on the paper.

Developing a strategic plan for examining the problems in your building

If you are concerned about your building, try to work systematically through a checklist of perceived problems, and determine strategies for dealing with these problems. In some cases you'll be able to deal with the problems simply and without expert help; in other cases you'll need expert help.

If you have a plan, you can budget in advance for times when specialist advice or expensive modifications to the building are needed. First determine your problem.

The external environment

The first step is to look at the external environment and determine any problems.

If one side of the building is near a busy freeway, you may need to completely seal this side of the building.

You may be surrounded by dusty parkland, and so may need to put good seals around doors and windows.

You may be in a very polluted environment and so need to have sealed cases with pollutant scavengers to protect your objects.

The internal environment

Look at areas which produce dust or pollutants, and work out how these move through your building.

Simple solutions—like providing doormats and keeping doors shut; or more complex solutions like adding a double entry door into a collection area—may reduce significantly the movement of dust or pollutants.

If the dust is being produced in a workshop, consider installing a localised extraction system.

If the air-conditioning system is pulling dust into collection areas, you may need to have the duct system redesigned.

Products used with cultural material

While you will probably be more concerned with offgassing, some materials with your cultural materials will cause dust problems.

For example, polystyrene packing material breaks down into small particles which are extremely electrostatic.

Call in experts

Think about whether you need to call in experts.

Do you understand the problems you are facing?

If you're not sure of the type of pollutants in the air, you may want to have an analysis undertaken.

Then take action

Once you have determined the problems you're facing, draw up an action plan.

Deal with the simple problems, and get expert advice and written reports if you need them. Plan for the long term.

It may be advisable to allocate a budget line—to ensure that you can afford to fund changes.

If necessary, locate larger grant programs which will enable you to undertake major works when required.

If you have a problem related to dust or pollutants and don't know how to deal with it, contact a conservator. Conservators can offer advice and practical solutions.

For further reading

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Self-evaluation quiz

Question 1.

Which of the following are sources of pollutants that may affect cultural material?

a) The external environment, a source of dust and atmospheric pollution.

b) The internal environment which produces dust and pollution from activities undertaken in the building.

c) Inappropriate materials which will offgas or contain chemicals which may damage cultural material.

d) All of the above.

Question 2.

Particulate matter includes:

a) sulphur dioxide;

b) aerosols;

c) dust and grit;

d) carbonaceous material.

Question 3.

Give examples of sources of particulate matter.

Question 4.

Which of the following statements are true?

a) Dust attracts and harbours pests.

b) Dust can cause mechanical damage.

c) Dust adsorbs and absorbs pollutants.

d) Dust deposits can create localised areas of high humidity.

e) Dust can impregnate porous surfaces, making them impossible to clean.

f) All of the above.

Question 5.

Chloride contamination can come from

a) sweaty fingers;

b) chlorinated waters;

c) cigarette smoke;

d) sea air;

e) car exhausts.

Question 6.

Collections can be protected from the effects of particulate matter by:

a) providing seals and filters on windows, doors and air vents;

b) locating workshops and kitchens away from collection display and storage areas ;

c) spraying regularly with aerosol polishes;

d) boxing, framing or providing covers for cultural objects.

Question 7.

Which of the following statements are false?

a) Sulphur dioxide, nitrogen dioxide and ozone are pollutant gases.

b) Photocopiers present no risk to valuable items.

c) Sulphur dioxide can convert to sulphuric acid in the presence of moisture.

d) Nitrogen dioxide is not a problem for collections.

Question 8.

Match the following materials with the damaging materials they can produce.

a)	wood	1.	sulphur
b)	metals	2.	acetic acid
c)	acrylics	3.	phenolic and acetic acids
d)	PVC	4.	formaldehyde
e)	PVA	5.	hydrochloric acid
f)	compressed wood pulp	6.	corrosion and some coatings are damaging
g)	wool	7.	some additives can be harmful

Question 9.

Which of the following methods can you use to detect pollutant gases?

a) Oddy tests using metal strips.

b) Activated carbon filters.

c) pH indicator strips for acidic offgassing.

d) Air-conditioning.

Question 10.

Activated carbon filters:

a) adsorb pollutant gases;

b) need to be checked regularly;

c) need to be used with caution because if saturated they will give out pollutants;

d) all of the above.

Question 11.

Give four examples of how you can protect items from the effects of pollutant gases.

Answers to self-evaluation quiz

Question 1.

Answer: d).

Question 2.

Answer: b), c) and d). a) is a pollutant gas.

Question 3.

Answers could include:

- burning fuel;
- exhaust fumes from cars;
- industrial furnaces;
- burning off;
- metal from train and tram tracks;
- dust from building sites or paddocks;
- salt spray;
- pesticide dust;
- old or poorly maintained air-conditioning systems;
- dust from new concrete.

Question 4.

Answer: f).

Question 5.

Answer: a), b) and d). c) and e) are sources of carbonaceous materials.

Question 6.

Answer: a), b) and d). You should not spray aerosols near valuable items.

Question 7.

Answer: b) and d) are false. Photocopiers produce ozone which is extremely reactive with carbon-based material, and it increases the corrosion of metals. Nitrogen dioxide can convert to nitric acid in the presence of moisture, and is very corrosive. It produces oxidising agents which are very reactive and easily break chemical bonds.

Question 8.

Answer:

a) 3

b) 6

c) 7

d) 5

e) 2

f) 4

g) 1

Question 9.

Answer: a) and c). b) and d) are methods to help protect against pollutant gases.

Question 10.

Answer: d).

Question 11.

Answer: Answers could include:

- frame and glaze artwork;
- provide dust covers for large objects;
- use display cases for smaller objects;
- ensure stable temperature and humidity—avoid high temperatures and high humidity;
- provide layers of storage;
- place items in boxes.