

Week 20

AP Environmental Science

Homework bundle for this week

本周作业合集

exercises.lol

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AP Environmental Science

Name: _____ Score: _____

1. **Air pollution** is...

- ☐ harmful substances added to the air
- ☐ clean air with no chemicals
- ☐ water in rivers
- ☐ soil erosion

2. Photochemical smog needs which one to form?

- ☐ sunlight
- ☐ darkness
- ☐ snow
- ☐ deep water

3. In a **thermal inversion**, the unusual thing is that...

- ☐ warm air sits above cooler air
- ☐ the ground is colder than space
- ☐ there is no air at all
- ☐ it always rains

4. The main problem with rising atmospheric CO₂ is that it...

- ☐ traps heat and warms the planet
- ☐ blocks all sunlight
- ☐ is poisonous to breathe
- ☐ makes water acidic to drink

5. **Carbon monoxide** is especially dangerous indoors because it...

- ☐ is invisible and odourless but deadly
- ☐ smells very strong
- ☐ is bright red
- ☐ is harmless to breathe

6. A _____ pollutant forms in the air when primary pollutants react, like ozone in smog.

7. The main harmful gas in photochemical smog is ground-level _____.

8. The warm air layer acts like a _____ that traps pollution below it.

9. The tiny solid and liquid bits floating in polluted air are called _____ matter.

10. Good _____ (fresh air flow) is the simplest way to lower indoor pollution.

1. **harmful substances added to the air**

Air pollution is any harmful substance added to the air — gases, particles, or droplets.

2. **sunlight**

“Photochemical” means light-driven — strong **sunlight** powers the reactions that make smog.

3. **warm air sits above cooler air**

Normally air cools with height. In an **inversion**, a warm layer sits on top of cooler air — upside down.

4. **traps heat and warms the planet**

CO₂ is the main greenhouse gas — it traps heat and drives global warming.

5. **is invisible and odourless but deadly**

Carbon monoxide cannot be seen or smelled, so it can build up and kill without warning.

6. **secondary**

A **secondary** pollutant is not emitted directly — it forms in the atmosphere, like ground-level ozone.

7. **ozone**

Ground-level **ozone** is the key ingredient of smog and irritates the lungs.

8. **lid**

The warm layer is a **lid** — cooler polluted air cannot rise through it and escape.

9. **particulate**

Particulate matter (PM) is the mix of tiny particles — soot, dust, droplets — in the air.

10. **ventilation**

Good **ventilation** flushes pollutants out and brings fresh air in.

7.1 Introduction to Air Pollution

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS primary 一次 • air pollution 空气污染 • secondary 二次
• secondary pollutants 二次污染物 • primary pollutants 一次污染物

Objective

Build the skills to answer exam questions on **air pollution**.

You must be able to:

- distinguish **primary** 一次 and **secondary** 二次 pollutants
- name major pollutants and their sources
- link combustion to air pollution

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Primary vs secondary pollutants

- **Primary pollutants** are emitted **directly** (e.g. CO, SO₂, NO_x, particulates from burning fuel).
- **Secondary pollutants** form **in the air** from reactions of primary ones (e.g. ozone in smog, sulfuric acid in acid rain).

■ Major pollutants and sources

- **CO** — incomplete combustion (cars).
- **SO₂** — burning coal (sulfur) → acid rain.
- **NO_x** — high-temperature combustion → smog, acid rain.
- **Particulate matter (PM)** — soot, dust → lung damage.

■ A worked classification

SO₂ from a coal plant is a **primary** pollutant; the sulfuric acid it forms in the atmosphere is a **secondary** pollutant.

■ The main cause

Most air pollution comes from **burning fossil fuels** in vehicles, power plants, and industry.

2 Practice

Now apply the methods above.

2.1 Distinguish a primary from a secondary pollutant. [2]

2.2 Name one pollutant from burning coal. [1]

2.3 What is the main human source of air pollution? [1]

3 Exam-style questions

3.1 A secondary pollutant is one that [1]

- **A** is emitted directly
- **B** forms in the air from other pollutants
- **C** is always harmless
- **D** comes only from volcanoes

3.2 A coal power plant emits SO_2 , which later forms sulfuric acid in the atmosphere.

(a) Classify SO_2 and sulfuric acid. [2]

(b) State one environmental effect of this. [1]

3.3 Explain why reducing fossil-fuel combustion reduces most air pollution. [2]

Solutions

2.1 Primary pollutants are emitted directly; secondary pollutants form in the air from primary ones.

2.2 SO_2 (or particulates).

2.3 Burning fossil fuels.

3.1 B — forms in the air from other pollutants.

3.2 (a) SO_2 = primary; sulfuric acid = secondary. (b) Acid rain.

3.3 Most primary and secondary pollutants come from burning fossil fuels, so cutting combustion cuts emissions of CO, SO_2 , NO_x , and particulates at the source.

3. Respond to parts A, B, C, D, E, F, and G.

- A.** One major environmental problem is air pollution. Air pollution can come from natural or anthropogenic sources. Motor vehicles can be a source of particulate matter (PM) and other pollutants.

Identify an anthropogenic source of particulate matter, other than from motor vehicles.

- B.** One way to reduce pollutants associated with motor vehicles is to use a vapor recovery nozzle. **Describe** one way a vapor recovery nozzle is used to reduce atmospheric pollution.
- C.** Acid rain is another air pollutant linked to motor vehicles. Over the past few years, there has been an increase in the number of people working from home, so fewer people are commuting to work in their personal vehicles.

Explain how a decrease in the number of people commuting to work in their personal vehicles could lead to a reduction in acid rain.

- D.** The average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city. One commuter sells their gasoline-powered SUV and replaces it with a hybrid SUV.

Calculate the percent change in gas mileage between the gasoline-powered SUV and the hybrid SUV based on the data provided. **Show** your work.

- E.** Both the gasoline-powered SUV and the hybrid SUV have 14-gallon gas tanks. As stated in part D, the average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city.

Calculate how many more miles the owner can drive in the hybrid SUV in the city than they could have driven in the gasoline-powered SUV. **Show** your work.

- F.** In addition to vehicles, buildings such as schools often have high energy consumption. The primary sources of energy use in many buildings are heating, cooling, and lighting.

Propose a realistic solution that schools could implement to decrease energy use for heating and cooling, other than a reduction in the amount of time the school building is occupied.

- G.** The school plans to upgrade its lighting to save money and reduce both its electricity use and its ecological footprint. The sustainability committee proposes that the school reduce its electricity use by switching to energy-efficient light-emitting diode (LED) bulbs. The school building uses 2.8×10^4 bulbs. The LED bulbs would each use 0.0085 kilowatts per hour. Each bulb would be used for an average of 2,340 hours per year.

Calculate the energy use in the school building in kilowatts per year using LED light bulbs. **Show** your work.

STOP

END OF EXAM

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

3. Respond to parts A, B, C, D, E, F, and G.

A. **Identify** a type of surface mining the company could use to access the coal.

B. **Describe** an environmental problem associated with surface mining.

C. The town is located downwind of the new coal-burning power plant.

Describe an environmental problem the town could experience as a result of the electricity generation at the coal-burning power plant.

D. The local government is concerned about the environmental consequences of using coal to generate electricity for the town.

Propose a realistic solution the local government could enact that would reduce the negative environmental consequences of using coal to generate electricity.

E. Burning one pound of coal produces an average of 0.88 kilowatt-hours (kWh) of electricity. An average household in the United States uses 1.064×10^4 kWh of electricity each year.

Calculate how many pounds of coal would need to be burned to generate enough electricity to power a town with 11,000 houses for a year. **Show** your work.

F. Researchers are concerned about the impact of noise pollution on songbirds in a forest near the power plant. Since the power plant was installed, bird species richness has declined from 7.5 species per hectare to 6.0 species per hectare.

Calculate the percent change in bird species per hectare since the power plant was installed. **Show** your work.

G. The town has been growing since it was built and had a growth rate of 5.38% in 2022, with a population of 26,250.

Assuming that the growth rate remains constant, **calculate** the year in which the population will reach 52,500. **Show** your work.

STOP

END OF EXAM

3. Crude oil is extracted, transported, and refined for various uses by humans.

- (a) **Describe** one environmental impact on marine ecosystems associated with extraction or transportation of crude oil.
- (b) **Identify** an atmospheric pollutant released during the combustion of refined oil products.
- (c) **Propose** a solution an individual can use to reduce their reliance on refined oil products for transportation.
- (d) **Justify** the solution proposed in part (c) by providing a benefit to human health.

Other natural resources, such as gold and silver, are also extracted. These resources can be used to make components for the electronics humans use. One metric ton of gold ore contains 5.0 grams of gold.

- (e) A deposit is estimated to contain 260 million metric tons of gold ore. **Calculate** the number of grams of gold that could be extracted from the deposit. **Show** your work.
- (f) Assuming the price of gold is \$62.56 per gram, **calculate** the value of the gold that could be recovered from 1,000 metric tons of gold ore in the deposit. **Show** your work.
- (g) A typical cell phone contains 0.034 grams of gold. **Calculate** how many metric tons of gold ore would need to be mined to extract enough gold to manufacture 100,000 cell phones. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

3. North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

- (a) **Identify** one negative human health effect linked to the exposure to pollutants resulting from the combustion of coal.
- (b) Coal ash, the powdery, solid substance that remains after coal combustion, presents a variety of potential environmental issues. Disposal of toxic coal ash is a growing concern in the state. Coal ash can be mixed with water and disposed of in large, unlined pits or as dry ash in landfills.
- (i) **Describe** an environmental problem associated with coal ash waste disposal.
- (ii) A proposed solution is to dispose of North Carolina's coal ash in clay-lined pits. **Justify** this solution by providing one advantage of using clay soil.
- (c) The population of Charlotte, North Carolina, has grown over the last few decades. The table shows the increase in the population size of Charlotte from 2013 to 2019.

Population of Charlotte, North Carolina, 2013–2019

Year	Population
2013	757,278
2014	774,807
2015	792,137
2016	808,834
2017	826,060
2018	841,611
2019	857,425

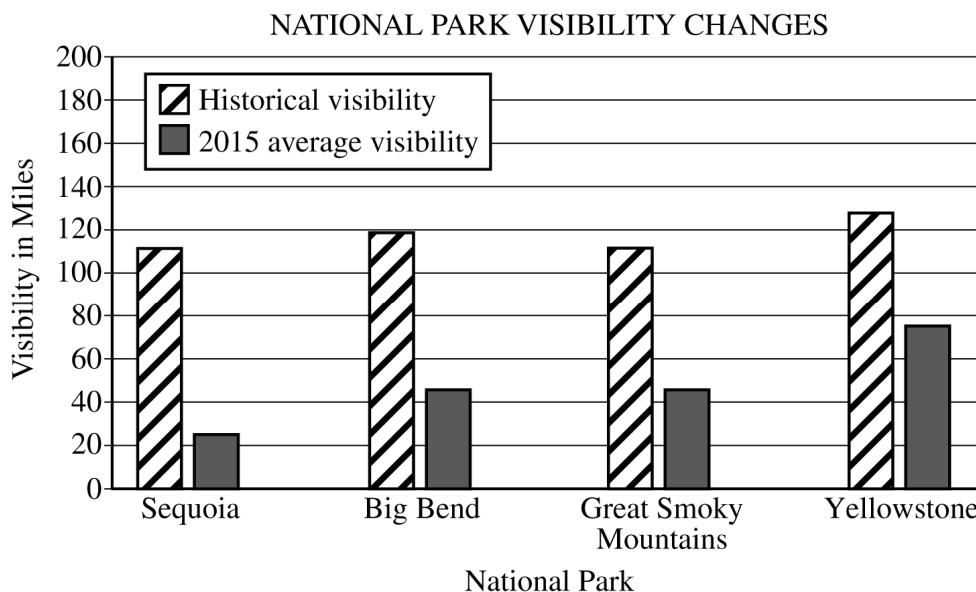
- (i) **Calculate** the percent change in Charlotte's population from 2013 to 2019. **Show** your work.
- (ii) Based on Charlotte's 2019 growth rate of 1.88%, **calculate** the year when the population of Charlotte will double, assuming the growth rate stays the same. **Show** your work.
- (iii) The average Charlotte resident uses 90 gallons of water per day. **Calculate** the gallons of water used by the population of Charlotte in the year 2018. **Show** your work.
- (d) Drought periods are becoming more frequent in North Carolina, causing water resources to become more scarce. **Describe** one realistic action that citizens could take to reduce domestic outdoor water use.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

4. One reason that people visit national parks is to view the scenery. Visibility at the four parks in the graph has been reduced over time so that by 2015 the visibility was an average of 70 miles less than the historical visibility. Regional air pollutant sources are commonly located over 100 miles away from national parks.



- (a) Based on the data provided in the graph, **identify** the national park that had the greatest loss of visibility as of 2015 when compared with the historical natural visibility.
- (b) Visibility in national parks can be affected by many different air pollutants.
- (i) **Identify** a primary air pollutant.
 - (ii) **Describe** how a primary air pollutant becomes part of the atmosphere.
 - (iii) **Identify** a secondary air pollutant.
 - (iv) **Describe** how a secondary air pollutant is formed within the atmosphere.
- (c) In 1990 Great Smoky Mountains National Park had a visibility of 25 miles. Visibility data for 2015 can be determined from the graph above.
- (i) **Calculate** the percentage increase in visibility from 1990 to 2015.
 - (ii) **Discuss** TWO specific actions that the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park.
- (d) Excluding air pollution, **discuss** TWO additional ways national park ecosystems are being degraded by high levels of visitor use.

STOP

END OF EXAM

7.2 Photochemical Smog

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS photochemical smog 光化学烟雾 • ozone 臭氧

Objective

Build the skills to answer exam questions on **photochemical smog**.

You must be able to:

- explain how **photochemical smog** 光化学烟雾 forms
- identify the role of **NO_x**, **VOCs**, and **sunlight**
- link smog to traffic and health

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ How smog forms

Photochemical smog forms when **NO_x** and **VOCs** (volatile organic compounds) from vehicle exhaust react in **sunlight**, producing ground-level **ozone** (O₃) and other irritants.

■ The key ingredients

- **NO_x** — from vehicle/industry combustion.
- **VOCs** — from fuels, solvents.
- **Sunlight** — drives the reaction (so smog is worst on **sunny, warm** days).

■ Where and when

Smog is worst in **sunny cities with heavy traffic** (e.g. Los Angeles), peaking in the afternoon when sunlight is strongest.

■ Health effects

Ground-level ozone irritates the lungs and eyes, worsening asthma and breathing problems.

■ A worked link

Morning traffic emits NO_x and VOCs; midday sun drives reactions that build up ozone, so smog peaks in the afternoon.

2 Practice

Now apply the methods above.

2.1 What two pollutants react to form photochemical smog? [2]

2.2 What drives the smog-forming reaction? [1]

2.3 What harmful gas is a main component of smog? [1]

3 Exam-style questions

3.1 Photochemical smog is worst on days that are [1]

- **A** cold and dark
- **B** sunny and warm with heavy traffic
- **C** rainy
- **D** windy at night

3.2 A sunny city has heavy morning traffic.

(a) Explain why smog peaks in the afternoon. [2]

(b) State one health effect of the ozone in smog. [1]

3.3 Explain how reducing vehicle emissions would reduce photochemical smog. [2]

Solutions

2.1 NO_x and VOCs.

2.2 Sunlight.

2.3 Ground-level ozone (O_3).

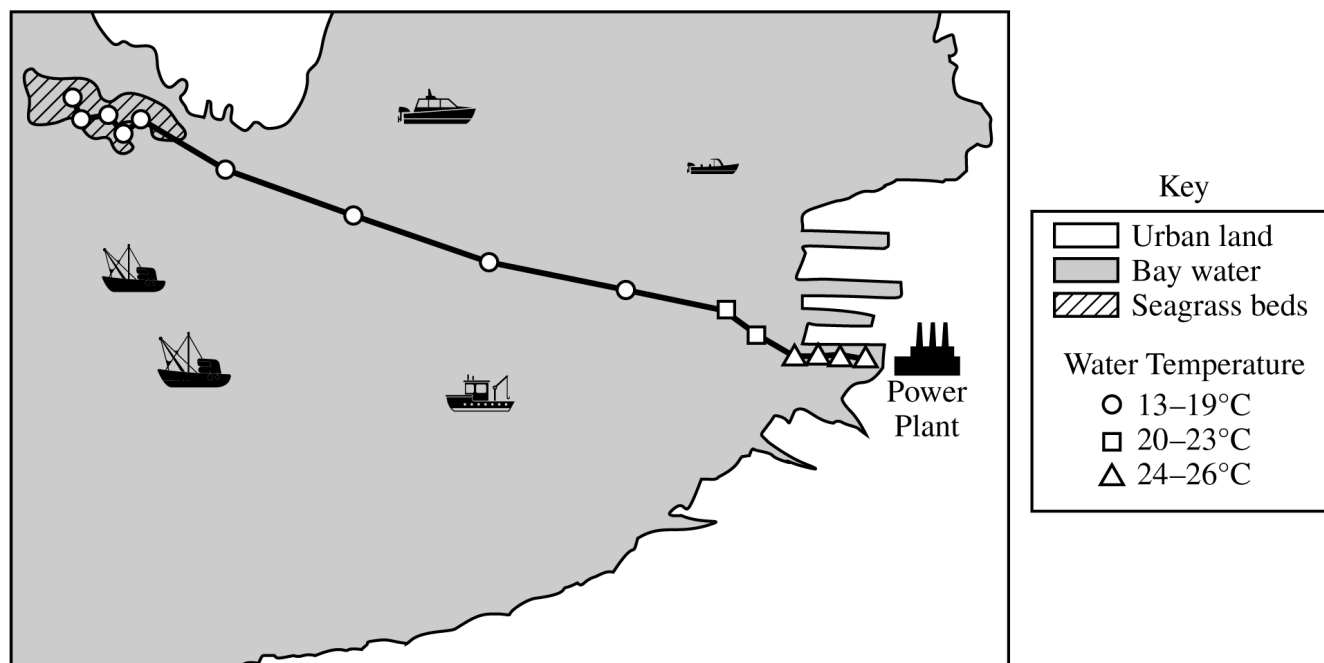
3.1 B — sunny and warm with heavy traffic.

3.2 (a) Morning traffic emits NO_x and VOCs; the midday sun drives reactions that build up ozone, so smog peaks in the afternoon. (b) It irritates the lungs/eyes and worsens asthma.

3.3 Fewer vehicle emissions mean less NO_x and VOCs available to react in sunlight, so less ozone/smog forms.

2. The diagram shows the movement of one adult manatee over a 12-hour period across an active shipping channel during the winter. Manatees are large, aquatic, herbivorous mammals that primarily eat seagrass. Manatees can travel several miles to graze. Manatees mature slowly, have low biotic potential, and inhabit warm coastal waters. They cannot survive in water below 20°C for extended periods of time.

Satellite Track and Water Temperature Log of the Movement of One Adult Manatee Over a 12-Hour Period



- (a) Based on the information in the diagram, **identify** the temperature range of the water through which the majority of the adult manatee's daily movement occurs.
- (b) Large groups of manatees are often observed in shallow waters near the waste water released by the electrical power plant during the winter. Based on the information in the diagram, **identify** a characteristic of the power plant waste water that would attract the manatees.
- (c) Based on the information in the diagram, **describe** a potential negative impact of the waste water released by the power plant on other aquatic species.
- (d) Seagrass beds have declined significantly over the last several years. In 2021 manatee mortality was three times higher than the previous five-year average.
- Describe** a characteristic of the manatees that increases their vulnerability to the recent decline of seagrasses.
 - Describe** the change in energy flow through the trophic levels that occurs when there is a significant loss of seagrasses.

(e) Research has shown increased nutrient and sediment runoff can cause seagrass beds to decline.

(i) **Propose** a solution to reduce nutrient or sediment pollution in an estuary that is surrounded by urban development.

(ii) **Justify** the solution proposed in part (e)(i) by providing an additional advantage of reduced nutrients in an estuary, other than one related to manatees.

Urban areas have a heavy dependence on automobiles and often experience photochemical smog.

(f) **Describe** how summertime weather conditions can increase the frequency of photochemical smog.

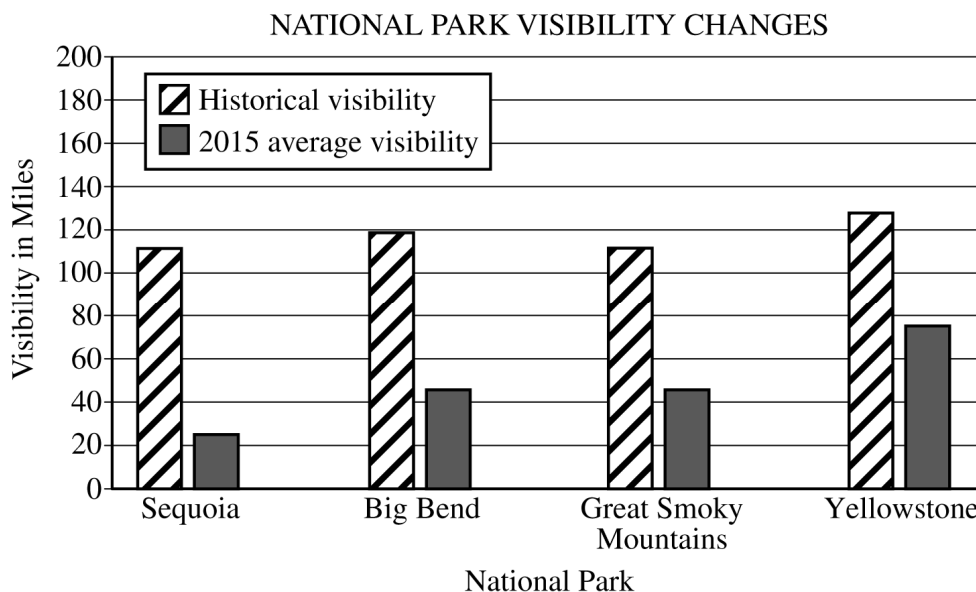
(g) **Identify** one ecological problem that results from exposure to photochemical smog.

A potential solution to reduce photochemical smog in urban areas with high automobile traffic is to replace gasoline-powered cars with cars powered by hydrogen fuel cells.

(h) **Describe** a potential disadvantage of using hydrogen fuel cells to power automobiles.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

4. One reason that people visit national parks is to view the scenery. Visibility at the four parks in the graph has been reduced over time so that by 2015 the visibility was an average of 70 miles less than the historical visibility. Regional air pollutant sources are commonly located over 100 miles away from national parks.



- (a) Based on the data provided in the graph, **identify** the national park that had the greatest loss of visibility as of 2015 when compared with the historical natural visibility.
- (b) Visibility in national parks can be affected by many different air pollutants.
- Identify** a primary air pollutant.
 - Describe** how a primary air pollutant becomes part of the atmosphere.
 - Identify** a secondary air pollutant.
 - Describe** how a secondary air pollutant is formed within the atmosphere.
- (c) In 1990 Great Smoky Mountains National Park had a visibility of 25 miles. Visibility data for 2015 can be determined from the graph above.
- Calculate** the percentage increase in visibility from 1990 to 2015.
 - Discuss** TWO specific actions that the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park.
- (d) Excluding air pollution, **discuss** TWO additional ways national park ecosystems are being degraded by high levels of visitor use.

STOP

END OF EXAM

7.3 Thermal Inversion

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS thermal inversion 逆温

Objective

Build the skills to answer exam questions on **thermal inversion**.

You must be able to:

- describe a **thermal inversion** 逆温
- explain how it traps pollutants
- link inversions to smog events

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Normal conditions

Usually air is **warmest near the ground** and cools with height, so warm polluted air **rises** and disperses.

■ A thermal inversion

In a **thermal inversion**, a layer of **warm air sits above cooler air** near the ground. The cool surface air cannot rise through the warm layer, so it — and the pollutants in it — are **trapped** near the ground.

■ Effect on pollution

Pollutants accumulate under the inversion, causing severe **smog** and health hazards until the inversion breaks (e.g. wind or heating).

■ Where it happens

Inversions are common in **valleys** (cool air pools) and cities surrounded by mountains, especially on calm, clear nights.

2 Practice

Now apply the methods above.

2.1 In normal air, how does temperature change with height near the ground? [1]

2.2 What is the arrangement of air in a thermal inversion? [1]

2.3 Why does an inversion worsen pollution? [1]

3 Exam-style questions

3.1 A thermal inversion traps pollutants because warm air [1]

- **A** below cool air lets pollution rise
 - **B** above cool air stops the surface air from rising
 - **C** removes all pollution
 - **D** cools the ground
-

3.2 A city in a valley experiences a thermal inversion.

(a) Explain why pollution builds up near the ground. [2]

(b) State one condition that could break the inversion. [1]

3.3 Explain why thermal inversions are common in valleys. [2]

Solutions

2.1 It gets cooler with height (warmest near the ground).

2.2 Warm air sits above cooler air near the ground.

2.3 The trapped surface air cannot rise, so pollutants accumulate near the ground.

3.1 B — above cool air stops the surface air from rising.

3.2 (a) The warm layer above traps the cool surface air, which cannot rise, so pollutants accumulate near the ground. (b) Wind (or the ground heating to break the inversion).

3.3 Cool, dense air sinks and pools at the valley floor while warmer air sits above it, creating the inversion layer, especially on calm clear nights.

7.4 Atmospheric CO₂ and Particulates

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS particulate matter 颗粒物

Objective

Build the skills to answer exam questions on **atmospheric CO₂ and particulates**.

You must be able to:

- explain rising CO₂ and its climate link
- describe **particulate matter (PM)** 颗粒物 and its health effects
- distinguish their different impacts

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Rising CO₂

Burning fossil fuels raises atmospheric CO₂, a **greenhouse gas** that traps heat and drives climate change. CO₂ is not directly toxic to breathe at these levels but is a major climate concern.

■ Particulate matter

Particulate matter (PM) is tiny solid/liquid particles (soot, dust). **PM2.5** (very fine) is most dangerous — it lodges deep in the lungs, causing respiratory and heart disease.

■ Different impacts

- CO₂ → mainly a **climate** problem (global).
- PM → mainly a **health** problem (local air quality).

■ A worked distinction

A diesel truck emits both CO₂ (adding to climate change) and PM (harming the lungs of nearby people) — two different kinds of impact.

2 Practice

Now apply the methods above.

2.1 Why is rising CO₂ a concern? [1]

2.2 What is particulate matter? [1]

2.3 Which is mainly a health problem: CO₂ or PM? [1]

3 Exam-style questions

3.1 The most dangerous particulate matter for health is [1]

- **A** large dust only
 - **B** fine PM_{2.5} that lodges deep in the lungs
 - **C** carbon dioxide
 - **D** oxygen
-

3.2 A city has high levels of both CO₂ and PM_{2.5}.

(a) State the main impact of each. [2]

(b) Explain why PM_{2.5} is especially harmful to health. [2]

3.3 Explain why CO₂ is described as a global problem while PM is more local. [2]

Solutions

2.1 It is a greenhouse gas that traps heat and drives climate change.

2.2 Tiny solid or liquid particles (soot, dust) in the air.

2.3 PM.

3.1 B — fine PM_{2.5} that lodges deep in the lungs.

3.2 (a) CO₂ → climate change; PM_{2.5} → respiratory/heart disease. (b) It is fine enough to lodge deep in the lungs and enter the bloodstream, causing serious respiratory and heart problems.

3.3 CO₂ mixes throughout the atmosphere and warms the whole planet (global), while PM settles out near its source, so its worst effects are on local air quality.

There is a natural climate phenomenon that occurs in the equatorial Pacific Ocean because of periodic fluctuations in sea surface conditions and atmospheric circulation. This phenomenon happens every few years, resulting in shifts in temperature and precipitation in many parts of the world.

Figure 1 shows temperature and precipitation patterns associated with one phase of this phenomenon in the equatorial Pacific Ocean. Figure 2 shows the associated temperature and precipitation patterns that occur over North America.

Figure 1. Effects of Changes in Sea Surface Conditions in Equatorial Pacific Ocean

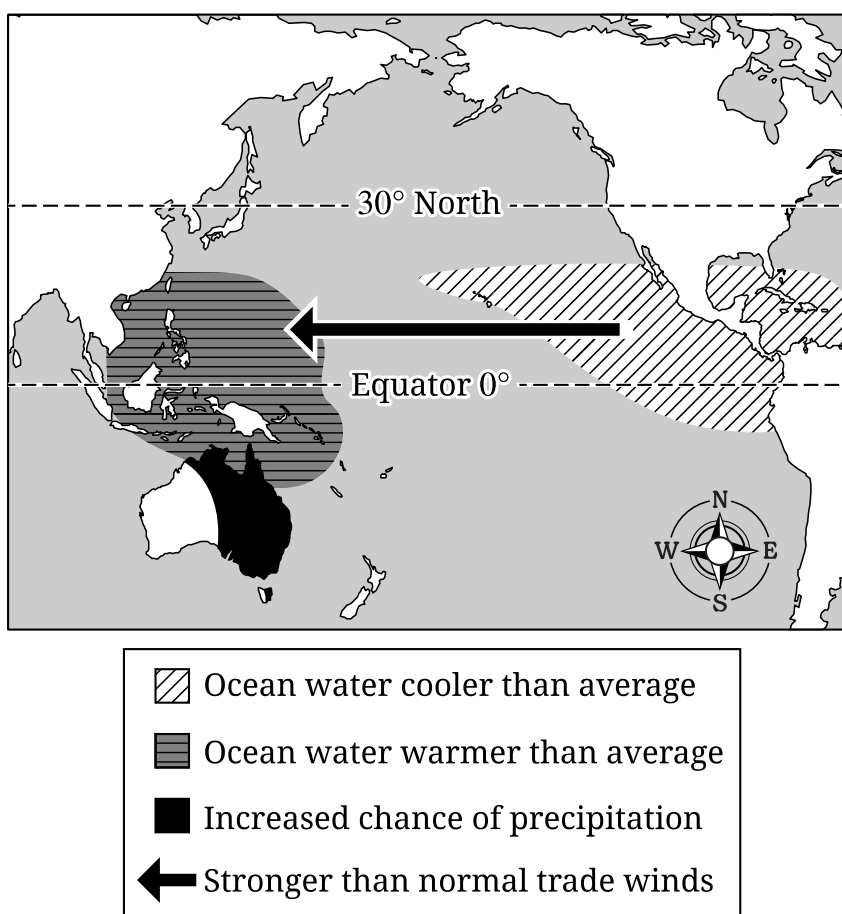
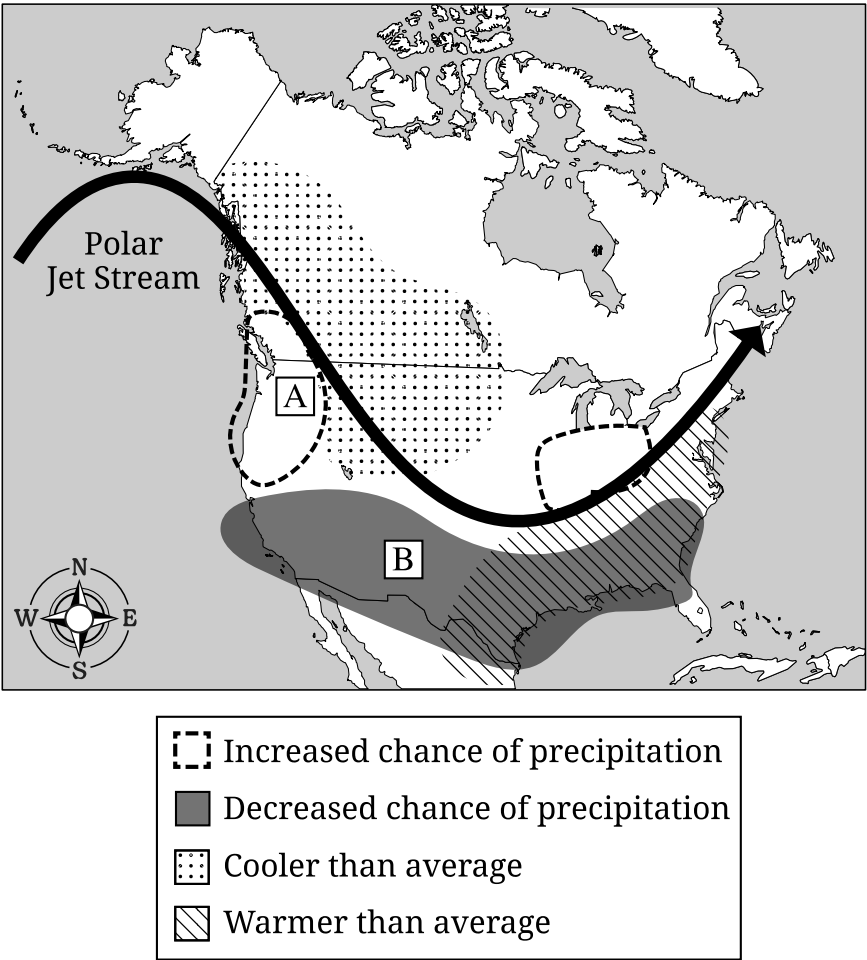


Figure 2. Polar Jet Stream and Climate Conditions in North America



2. Respond to parts A, B, C, D, E, F, G, H, I, and J.

- A. Identify** the sea surface condition for the eastern equatorial area of the Pacific Ocean illustrated in Figure 1.
- B.** Based on the information in Figure 1, **identify** the climate phenomenon associated with the sea surface conditions shown in the equatorial area of the Pacific Ocean.
- C.** Based on the information in Figure 2, **describe** a difference in climate patterns between the regions A and B.
- D.** Increases in regional precipitation can lead to increased flooding in certain locations. **Describe** one reason why there is an increased risk of flooding in urban areas during extended periods of precipitation.
- E. Propose** a realistic solution a city could implement to decrease the risk of flooding in urban areas.
- F. Justify** the solution proposed in part E by providing an additional advantage other than a reduction in the risk of flooding.
- G.** Terrestrial biomes are primarily determined by temperature and precipitation patterns. **Describe** one difference between the climate of a temperate seasonal forest and that of a savanna.
- H.** Droughts are one environmental problem that can affect the frequency and severity of forest fires. **Identify** the ecological process that occurs following a forest fire that leaves the soil intact.
- I. Describe** one way burning forests contribute to atmospheric pollution.
- J. Describe** one sustainable forestry practice that could be used to reduce the occurrence or severity of forest fires.

3. Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

- (a) **Describe** why coal is considered a nonrenewable energy source.
- (b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.
- (c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity.
- (d) When natural gas is used to heat homes, it can produce carbon monoxide gas, which can lead to carbon monoxide poisoning in humans. **Propose** a solution to reduce the incidence of carbon monoxide poisoning in humans.

Particulate matter is another common pollutant in emissions from vehicles, coal-fired power plants, and various other sources. One size of particulates, $\text{PM}_{2.5}$, presents a particular risk to human health.

ATMOSPHERIC CONCENTRATION OF PARTICULATE MATTER IN 1990 AND 2016

Year	Average Annual Atmospheric Concentration of $\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$)
1990	85
2016	188

- (e) **Calculate** the percent change in the average annual $\text{PM}_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work.
- (f) Trees can remove $\text{PM}_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $\text{PM}_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $\text{PM}_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work.
- (g) Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $\text{PM}_{2.5}$ concentration. A city experienced a 23% increase in $\text{PM}_{2.5}$ concentration and had 7,390 hospital admissions for cardiovascular issues over a one-year period. **Calculate** the anticipated increase in the number of hospital admissions for cardiovascular issues during the next year if the $\text{PM}_{2.5}$ concentration continues to rise at an identical rate. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

7.5 Indoor Air Pollutants

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS radon 氡 • asbestos 石棉 • air pollution 空气污染 • ozone 臭氧

Objective

Build the skills to answer exam questions on **indoor air pollutants**.

You must be able to:

- name common indoor pollutants (**radon** 氡, **CO**, **VOCs**, **asbestos** 石棉)
- state their sources and health effects
- explain why indoor air can be worse than outdoor

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Common indoor pollutants

- **Radon** — radioactive gas from soil/rock seeping into basements; causes lung cancer.
- **Carbon monoxide (CO)** — from faulty heaters/stoves; deadly (blocks oxygen in blood).
- **VOCs** — from paints, furniture, cleaners.
- **Asbestos** — old insulation; fibers cause lung disease.
- **Tobacco smoke** and mold.

■ Why indoor air can be worse

Homes are often **sealed** for energy efficiency, so pollutants **build up** without fresh air. People also spend most time indoors.

■ Prevention

Ventilation, radon testing, CO detectors, and avoiding smoking indoors reduce exposure.

■ A worked link

A tightly sealed home with a gas stove and no ventilation can accumulate CO and VOCs to unhealthy levels — worse than outside.

2 Practice

Now apply the methods above.

2.1 Name one radioactive indoor pollutant. [1]

2.2 What is a source of indoor carbon monoxide? [1]

2.3 Why can indoor air be worse than outdoor air? [1]

3 Exam-style questions

3.1 Radon gas enters homes mainly from [1]

- **A** vehicle exhaust
 - **B** soil and rock beneath the building
 - **C** the ozone layer
 - **D** ocean water
-

3.2 A well-sealed home uses a gas heater with poor ventilation.

(a) Name one dangerous pollutant that could build up. [1]

(b) Explain why sealing a home can worsen indoor air. [2]

3.3 Explain two ways to reduce indoor air pollution. [2]

Solutions

2.1 Radon.

2.2 A faulty heater/stove or burning fuel indoors.

2.3 Sealed homes trap pollutants so they build up without fresh air.

3.1 B — soil and rock beneath the building.

3.2 (a) Carbon monoxide (or VOCs). (b) Sealing reduces fresh-air exchange, so pollutants accumulate indoors instead of dispersing.

3.3 Any two: improve ventilation, install CO detectors, test for radon, avoid smoking/VOC sources indoors.

3. Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.

- (a) **Describe** why coal is considered a nonrenewable energy source.
- (b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.
- (c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity.
- (d) When natural gas is used to heat homes, it can produce carbon monoxide gas, which can lead to carbon monoxide poisoning in humans. **Propose** a solution to reduce the incidence of carbon monoxide poisoning in humans.

Particulate matter is another common pollutant in emissions from vehicles, coal-fired power plants, and various other sources. One size of particulates, $\text{PM}_{2.5}$, presents a particular risk to human health.

ATMOSPHERIC CONCENTRATION OF PARTICULATE MATTER IN 1990 AND 2016

Year	Average Annual Atmospheric Concentration of $\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$)
1990	85
2016	188

- (e) **Calculate** the percent change in the average annual $\text{PM}_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work.
- (f) Trees can remove $\text{PM}_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $\text{PM}_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $\text{PM}_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work.
- (g) Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $\text{PM}_{2.5}$ concentration. A city experienced a 23% increase in $\text{PM}_{2.5}$ concentration and had 7,390 hospital admissions for cardiovascular issues over a one-year period. **Calculate** the anticipated increase in the number of hospital admissions for cardiovascular issues during the next year if the $\text{PM}_{2.5}$ concentration continues to rise at an identical rate. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

Name:

STOP

END OF EXAM



4. In many parts of the world, biomass like peat, wood, and animal waste is burned indoors for cooking and home heating. Combustion of these fuels releases harmful household air pollutants that pose a health threat to billions of people, mostly in less developed countries.

- (a) Air pollutants are released during the burning of biomass indoors for cooking and heating.
- (i) **Identify** TWO air pollutants released during the burning of biomass indoors for cooking and heating.
- (ii) **Identify** a specific human respiratory illness that one of the pollutants you identified may cause.
- (b) **Identify** one realistic approach, other than banning the practice of burning biomass indoors, that could be used to reduce the impact of biomass combustion indoors on human respiratory health. **Describe** how this approach could reduce the incidence of respiratory illness.

In 2016 approximately four million people died from illnesses attributed to household air pollutants from burning biomass indoors. More than 10 percent of these deaths occurred in children under the age of five in less developed countries.

- (c) **Discuss** one reason children under the age of five are at a greater risk than adults for illnesses linked to household air pollutants.

In more developed countries, indoor air pollution is also a problem. Common indoor air pollutants in developed countries include:

- asbestos
- radon
- mold

- (d) Choose TWO of the three common indoor air pollutants (asbestos, radon, mold) listed above and complete the following table.

- (i) **Identify** a source for each indoor air pollutant.
- (ii) **Describe** a method for reducing exposure to each of the two pollutants you chose.

Indoor Air Pollutant	Source	Method for Reducing Exposure

STOP

END OF EXAM

7.6 Reduction of Air Pollutants

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS scrubbers 洗涤器 • catalytic converters 催化转化器
 • electrostatic precipitators 静电除尘器

Objective

Build the skills to answer exam questions on **reducing air pollutants**.

You must be able to:

- describe control technologies (**catalytic converters** 催化转化器, **scrubbers** 洗涤器, filters)
- explain regulation (**Clean Air Act**, emission standards)
- link each method to the pollutant it targets

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Control technologies

- **Catalytic converters** (cars) — convert CO, NO_x, and unburned fuel into less harmful gases.
- **Scrubbers** (smokestacks) — spray a liquid to remove SO₂.
- **Electrostatic precipitators / filters** — remove **particulates** from exhaust.

■ Regulation

Laws like the **Clean Air Act** set **emission standards** limiting how much pollution sources may release, forcing cleaner technology.

■ Prevention vs cleanup

Reducing the source (efficiency, renewables, less driving) prevents pollution; control devices clean it up after it forms. Prevention is often better.

■ A worked match

A coal plant uses **scrubbers** for SO₂ and **precipitators** for particulates; a car uses a **catalytic converter** for CO/NO_x.

2 Practice

Now apply the methods above.

2.1 What does a catalytic converter reduce? [1]

2.2 What does a scrubber remove from smokestack gases? [1]

2.3 What is the purpose of emission standards? [1]

3 Exam-style questions

3.1 A device that removes SO_2 from a smokestack is a [1]

- **A** catalytic converter
 - **B** scrubber
 - **C** wind turbine
 - **D** solar panel
-

3.2 A coal power plant must reduce its emissions.

(a) Name one technology to remove particulates and one to remove SO_2 . [2]

(b) Explain how emission standards force cleaner operation. [2]

3.3 Explain why preventing pollution at the source is often better than cleaning it up afterward. [2]

Solutions

2.1 CO, NO_x, and unburned hydrocarbons from car exhaust.

2.2 SO₂ (sulfur dioxide).

2.3 To limit how much pollution sources may release.

3.1 B — a scrubber.

3.2 (a) Particulates: electrostatic precipitator/filter; SO₂: scrubber. (b) They set legal limits, so plants must install control technology or reduce output to comply.

3.3 Prevention avoids creating the pollutant at all (saving cleanup costs and avoiding leaks), while control devices only capture some of it after it forms.

3. Respond to parts A, B, C, D, E, F, and G.

- A.** One major environmental problem is air pollution. Air pollution can come from natural or anthropogenic sources. Motor vehicles can be a source of particulate matter (PM) and other pollutants.

Identify an anthropogenic source of particulate matter, other than from motor vehicles.

- B.** One way to reduce pollutants associated with motor vehicles is to use a vapor recovery nozzle. **Describe** one way a vapor recovery nozzle is used to reduce atmospheric pollution.
- C.** Acid rain is another air pollutant linked to motor vehicles. Over the past few years, there has been an increase in the number of people working from home, so fewer people are commuting to work in their personal vehicles.

Explain how a decrease in the number of people commuting to work in their personal vehicles could lead to a reduction in acid rain.

- D.** The average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city. One commuter sells their gasoline-powered SUV and replaces it with a hybrid SUV.

Calculate the percent change in gas mileage between the gasoline-powered SUV and the hybrid SUV based on the data provided. **Show** your work.

- E.** Both the gasoline-powered SUV and the hybrid SUV have 14-gallon gas tanks. As stated in part D, the average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city.

Calculate how many more miles the owner can drive in the hybrid SUV in the city than they could have driven in the gasoline-powered SUV. **Show** your work.

- F.** In addition to vehicles, buildings such as schools often have high energy consumption. The primary sources of energy use in many buildings are heating, cooling, and lighting.

Propose a realistic solution that schools could implement to decrease energy use for heating and cooling, other than a reduction in the amount of time the school building is occupied.

- G.** The school plans to upgrade its lighting to save money and reduce both its electricity use and its ecological footprint. The sustainability committee proposes that the school reduce its electricity use by switching to energy-efficient light-emitting diode (LED) bulbs. The school building uses 2.8×10^4 bulbs. The LED bulbs would each use 0.0085 kilowatts per hour. Each bulb would be used for an average of 2,340 hours per year.

Calculate the energy use in the school building in kilowatts per year using LED light bulbs. **Show** your work.

STOP

END OF EXAM

3. Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

- (a) **Identify** a fuel used in a nuclear power plant.
- (b) **Describe** a negative environmental impact on nearby bodies of water that is caused by using water for cooling in nuclear power plants.
- (c) In 2021, 4.1×10^{12} kilowatt hours (kWh) of commercial electricity was generated in the United States. Nuclear power accounted for 18.9% of the total commercial electricity. **Calculate** the amount of electricity in kWh generated by nuclear power in the United States in 2021. **Show** your work.

Another approach to reduce greenhouse gas emissions is to switch from coal-burning power plants to natural gas power plants.

- (d) In addition to reducing greenhouse gas emissions, **describe** how switching from coal-burning power plants to natural gas power plants will improve air quality.

Researchers have proposed large-scale tree planting as a solution to reduce the effects of fossil fuel combustion on global climate change.

- (e) **Justify** the proposed solution by explaining an additional advantage, other than the reduction of atmospheric greenhouse gases.
- (f) 7.4×10^7 cubic meters of natural gas were extracted from a large deposit in 2020. An average of 4.76 kWh of electricity can be generated from each cubic meter of natural gas combusted. In 2020, an average home consumed 10,715 kWh of electricity. **Calculate** how many homes could have been provided with electricity by natural gas extracted from the large deposit in 2020. **Show** your work.
- (g) In 2021, 8.99×10^{11} kWh of electricity was generated through the combustion of coal. One kilogram of carbon dioxide is produced per kWh of electricity generated by combusting coal, while 0.42 kilograms of carbon dioxide is produced by combusting natural gas. **Calculate** how much less carbon dioxide would have been produced in 2021 if all coal-burning power plants were replaced with natural gas-burning power plants. **Show** your work.

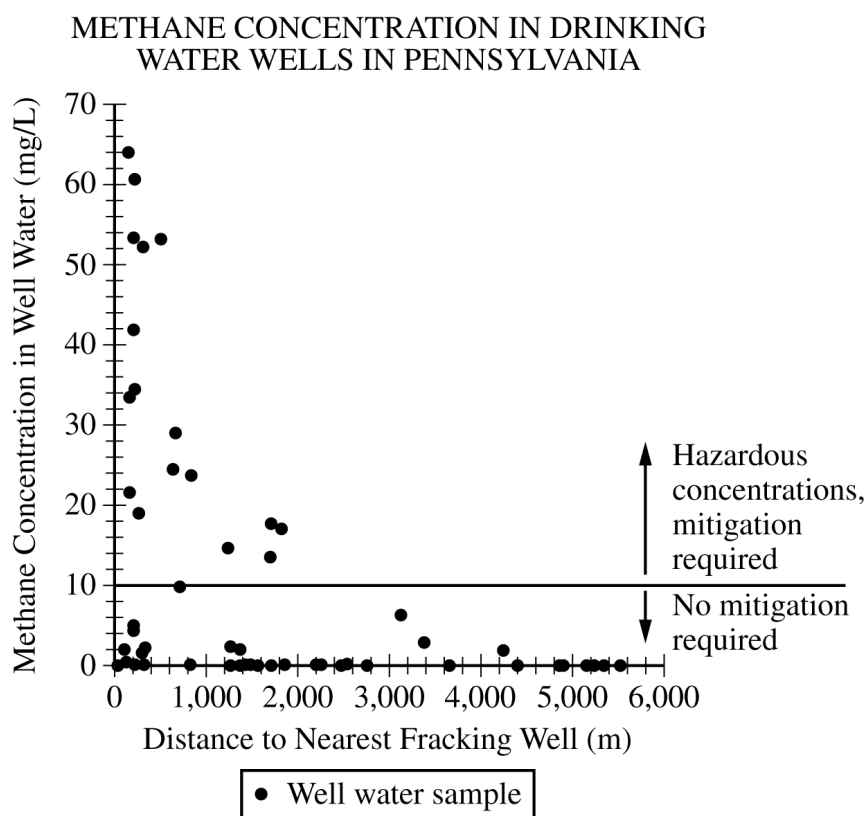
Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM



2. Developments in advanced hydraulic fracturing (fracking) technologies have allowed the total oil and gas production in the United States to increase rapidly.

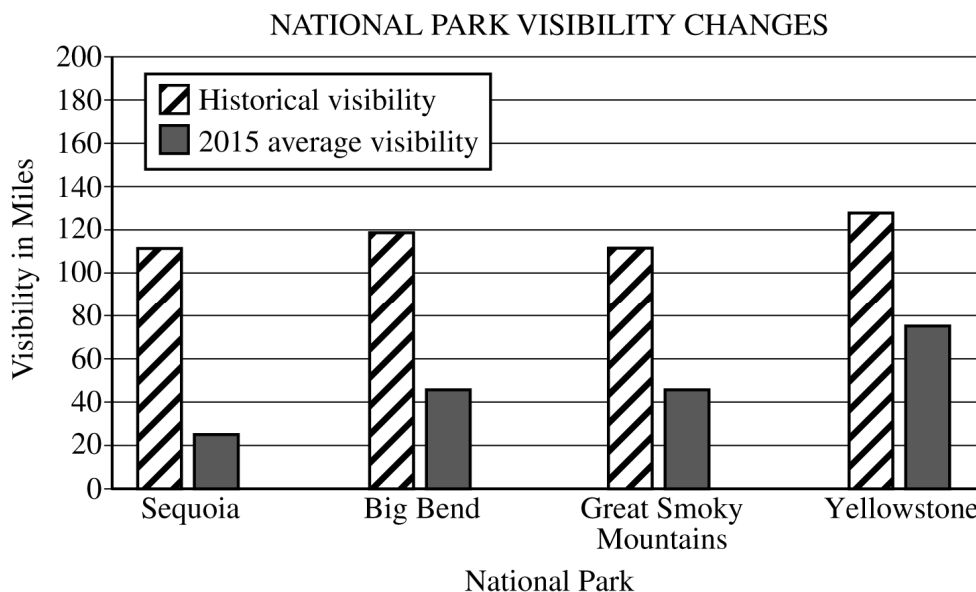


- (a) The graph shows the methane concentration in drinking water from home wells and the distance to the nearest fracking well in Pennsylvania.
- Based on the data in the graph, **identify** the highest methane concentration found in well water in Pennsylvania.
 - Based on the data in the graph, **describe** the relationship between the concentration of methane in well water and the distance to a fracking well.
 - Based on the data in the graph, **identify** the minimum safe distance that a new water well should be located from an existing fracking well.
 - Explain** how fracking fluid is used to access oil and natural gas in sedimentary rock, such as shale, during the fracking process.
 - Identify** one negative geologic effect in an area where hydraulic fracturing (fracking) occurs.
- (b) The volume of water used for oil and gas extraction is 28 times greater than it was fifteen years ago. Much of the water used for oil and gas extraction comes from groundwater sources in arid or semiarid regions. This increased use of water for fracking may mean that less water is available for local use.
- The use of groundwater for fracking is an example of individuals using a shared resource for their own self-interest. **Identify** the environmental concept illustrated by this example of overuse of a shared resource.
 - Describe** one environmental problem that may result from increased use of groundwater for fracking in arid or semiarid regions.
 - Describe** how overuse of coastal groundwater supplies can result in water that is unsuitable for human consumption.

- (c) In addition to water quality issues caused by fossil fuel extraction, air quality can also be negatively affected by combustion of oil and natural gas.
- (i) **Make a claim** for a realistic governmental action to improve air quality by reducing consumption of oil.
 - (ii) **Justify** the action proposed in part (c)(i) by stating a potential environmental advantage of that action, other than slowing global climate change.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

4. One reason that people visit national parks is to view the scenery. Visibility at the four parks in the graph has been reduced over time so that by 2015 the visibility was an average of 70 miles less than the historical visibility. Regional air pollutant sources are commonly located over 100 miles away from national parks.



- (a) Based on the data provided in the graph, **identify** the national park that had the greatest loss of visibility as of 2015 when compared with the historical natural visibility.
- (b) Visibility in national parks can be affected by many different air pollutants.
- Identify** a primary air pollutant.
 - Describe** how a primary air pollutant becomes part of the atmosphere.
 - Identify** a secondary air pollutant.
 - Describe** how a secondary air pollutant is formed within the atmosphere.
- (c) In 1990 Great Smoky Mountains National Park had a visibility of 25 miles. Visibility data for 2015 can be determined from the graph above.
- Calculate** the percentage increase in visibility from 1990 to 2015.
 - Discuss** TWO specific actions that the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park.
- (d) Excluding air pollution, **discuss** TWO additional ways national park ecosystems are being degraded by high levels of visitor use.

STOP

END OF EXAM

4. In many parts of the world, biomass like peat, wood, and animal waste is burned indoors for cooking and home heating. Combustion of these fuels releases harmful household air pollutants that pose a health threat to billions of people, mostly in less developed countries.

- (a) Air pollutants are released during the burning of biomass indoors for cooking and heating.
- (i) **Identify** TWO air pollutants released during the burning of biomass indoors for cooking and heating.
- (ii) **Identify** a specific human respiratory illness that one of the pollutants you identified may cause.
- (b) **Identify** one realistic approach, other than banning the practice of burning biomass indoors, that could be used to reduce the impact of biomass combustion indoors on human respiratory health. **Describe** how this approach could reduce the incidence of respiratory illness.

In 2016 approximately four million people died from illnesses attributed to household air pollutants from burning biomass indoors. More than 10 percent of these deaths occurred in children under the age of five in less developed countries.

- (c) **Discuss** one reason children under the age of five are at a greater risk than adults for illnesses linked to household air pollutants.

In more developed countries, indoor air pollution is also a problem. Common indoor air pollutants in developed countries include:

- asbestos
- radon
- mold

- (d) Choose TWO of the three common indoor air pollutants (asbestos, radon, mold) listed above and complete the following table.

- (i) **Identify** a source for each indoor air pollutant.
- (ii) **Describe** a method for reducing exposure to each of the two pollutants you chose.

Indoor Air Pollutant	Source	Method for Reducing Exposure

STOP

END OF EXAM

7.7 Acid Rain

Name: _____ Class: _____ Date: _____

Total: 11 marks**KEY WORDS** acid rain 酸雨 • scrubbers 洗涤器 • catalytic converters 催化转化器 • ozone 臭氧

Objective

Build the skills to answer exam questions on **acid rain**.

You must be able to:

- explain how **acid rain** 酸雨 forms from SO_2 and NO_x
- describe effects on water, soil, forests, and buildings
- suggest solutions

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ How acid rain forms

Burning fossil fuels releases **SO_2** and **NO_x** , which react with water in the atmosphere to form **sulfuric** and **nitric acids**. These fall as **acid rain** (pH below normal ~ 5.6).

■ Effects

- **Lakes/streams** become acidic, killing fish and aquatic life.
- **Soil** loses nutrients and releases toxic aluminum.
- **Forests** are damaged (leaf/needle loss).
- **Buildings/statues** (limestone, marble) are eroded.

■ It travels

Acid rain often falls **far from** the source (carried by wind), so pollution in one country can harm another — a transboundary problem.

■ Solutions

Reduce SO_2/NO_x using **scrubbers**, low-sulfur fuels, and catalytic converters; adding **lime** can temporarily neutralize acidified lakes.

2 Practice

Now apply the methods above.

2.1 Which two pollutants cause acid rain? [2]

2.2 State one effect of acid rain on aquatic life. [1]

2.3 State one way to reduce acid rain. [1]

3 Exam-style questions

3.1 Acid rain forms when SO_2 and NO_x react in the atmosphere with [1]

- **A** oxygen only
- **B** water to form acids
- **C** nitrogen gas
- **D** ozone

3.2 A coal-burning region downwind has acidified lakes.

(a) Explain how the coal plants cause the acidified lakes. [3]

(b) State one solution to reduce the emissions. [1]

3.3 Explain why acid rain is considered a transboundary (cross-border) problem. [2]

Solutions

2.1 SO_2 and NO_x .

2.2 It acidifies the water, killing fish/aquatic life.

2.3 Any one: scrubbers, low-sulfur fuel, catalytic converters, less fossil-fuel use.

3.1 B — water to form acids.

3.2 (a) The plants emit SO_2 and NO_x ; these react with water in the air to form sulfuric and nitric acids; the acid rain falls into the lakes and acidifies them. (b) Any one: scrubbers, low-sulfur fuel, reduce coal use.

3.3 The pollutants are carried by wind and fall as acid rain far from where they were emitted, so one country's emissions can damage another's ecosystems.

3. Respond to parts A, B, C, D, E, F, and G.

- A.** One major environmental problem is air pollution. Air pollution can come from natural or anthropogenic sources. Motor vehicles can be a source of particulate matter (PM) and other pollutants.

Identify an anthropogenic source of particulate matter, other than from motor vehicles.

- B.** One way to reduce pollutants associated with motor vehicles is to use a vapor recovery nozzle. **Describe** one way a vapor recovery nozzle is used to reduce atmospheric pollution.
- C.** Acid rain is another air pollutant linked to motor vehicles. Over the past few years, there has been an increase in the number of people working from home, so fewer people are commuting to work in their personal vehicles.

Explain how a decrease in the number of people commuting to work in their personal vehicles could lead to a reduction in acid rain.

- D.** The average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city. One commuter sells their gasoline-powered SUV and replaces it with a hybrid SUV.

Calculate the percent change in gas mileage between the gasoline-powered SUV and the hybrid SUV based on the data provided. **Show** your work.

- E.** Both the gasoline-powered SUV and the hybrid SUV have 14-gallon gas tanks. As stated in part D, the average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city.

Calculate how many more miles the owner can drive in the hybrid SUV in the city than they could have driven in the gasoline-powered SUV. **Show** your work.

- F.** In addition to vehicles, buildings such as schools often have high energy consumption. The primary sources of energy use in many buildings are heating, cooling, and lighting.

Propose a realistic solution that schools could implement to decrease energy use for heating and cooling, other than a reduction in the amount of time the school building is occupied.

- G.** The school plans to upgrade its lighting to save money and reduce both its electricity use and its ecological footprint. The sustainability committee proposes that the school reduce its electricity use by switching to energy-efficient light-emitting diode (LED) bulbs. The school building uses 2.8×10^4 bulbs. The LED bulbs would each use 0.0085 kilowatts per hour. Each bulb would be used for an average of 2,340 hours per year.

Calculate the energy use in the school building in kilowatts per year using LED light bulbs. **Show** your work.

STOP

END OF EXAM

4. Soil is a complex mixture of living organisms and organic material, along with minerals and other abiotic components. Soils help sustain life and support ecosystem functions.
- (a) **Describe** how TWO climate factors affect the rate of soil formation.
 - (b) As soils form, distinct layers known as horizons develop over time. One of these is the A horizon.
 - (i) **Identify** one specific biotic component of the A horizon.
 - (ii) **Identify** one abiotic component of the A horizon.

Resources such as soil and water can be degraded by human activities.

- (c) Nitrate levels exceeding the United States Environmental Protection Agency's primary drinking water standard have been found in the groundwater of areas with intensive agriculture.
 - (i) **Identify** one agricultural practice that can lead to elevated nitrate levels in groundwater.
 - (ii) **Describe** how the practice you identified in (c)(i) leads to elevated nitrate levels in groundwater.
- (d) Acid deposition has affected soil quality in many parts of the northeastern United States.
 - (i) **Explain** one way acid deposition onto soil can affect plant health.
 - (ii) **Describe** one method for remediating soil affected by acid deposition.
- (e) Climate change is causing far-reaching ecosystem changes, including soil degradation in many of the world's biomes. **Describe** TWO ways that climate change can degrade soil.

STOP

END OF EXAM

7.8 Noise Pollution

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS noise pollution 噪声污染 • stress 压力 • hearing loss 听力损失 • wildlife 野生动物

Objective

Build the skills to answer exam questions on **noise pollution**.

You must be able to:

- define **noise pollution** 噪声污染 and its sources
- describe effects on humans and wildlife
- suggest ways to reduce it

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ What it is

Noise pollution is unwanted or harmful sound, mostly from **traffic, industry, construction, and aircraft**, measured in **decibels (dB)**.

■ Effects on humans

Chronic noise causes **stress, sleep disruption, hearing loss** (at high levels), and raised blood pressure.

■ Effects on wildlife

Noise (especially **underwater sonar/ship noise**) interferes with animal **communication, navigation, and mating** — for example, disorienting whales and dolphins.

■ Reducing noise

- **Barriers** (sound walls along highways).
- **Quieter technology** and mufflers.
- **Zoning** (separating noisy areas from homes) and limits on hours.

■ A worked link

A highway sound wall reflects/absorbs traffic noise, lowering the decibel level reaching nearby homes.

2 Practice

Now apply the methods above.

2.1 Give one source of noise pollution. [1]

2.2 State one effect of chronic noise on humans. [1]

2.3 State one way to reduce noise pollution. [1]

3 Exam-style questions

3.1 Underwater noise pollution most harms marine animals by disrupting their [1]

- **A** communication and navigation
 - **B** photosynthesis
 - **C** digestion
 - **D** skeletons
-

3.2 A new highway is built near a residential area.

(a) State one human health effect of the added noise. [1]

(b) Suggest two ways to reduce the noise reaching homes. [2]

3.3 Explain how ship noise can affect whales. [2]

Solutions

2.1 Any one: traffic, industry, construction, aircraft.

2.2 Any one: stress, sleep disruption, hearing loss, high blood pressure.

2.3 Any one: sound barriers, quieter technology, zoning, hour limits.

3.1 A — communication and navigation.

3.2 (a) Any one: stress, sleep disruption, hearing effects. (b) Any two: sound walls, quieter road surfaces/vehicles, zoning/hour limits, tree buffers.

3.3 Ship noise masks the sounds whales use to communicate and navigate, disorienting them and interfering with finding mates or food.

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

3. Respond to parts A, B, C, D, E, F, and G.

A. **Identify** a type of surface mining the company could use to access the coal.

B. **Describe** an environmental problem associated with surface mining.

C. The town is located downwind of the new coal-burning power plant.

Describe an environmental problem the town could experience as a result of the electricity generation at the coal-burning power plant.

D. The local government is concerned about the environmental consequences of using coal to generate electricity for the town.

Propose a realistic solution the local government could enact that would reduce the negative environmental consequences of using coal to generate electricity.

E. Burning one pound of coal produces an average of 0.88 kilowatt-hours (kWh) of electricity. An average household in the United States uses 1.064×10^4 kWh of electricity each year.

Calculate how many pounds of coal would need to be burned to generate enough electricity to power a town with 11,000 houses for a year. **Show** your work.

F. Researchers are concerned about the impact of noise pollution on songbirds in a forest near the power plant. Since the power plant was installed, bird species richness has declined from 7.5 species per hectare to 6.0 species per hectare.

Calculate the percent change in bird species per hectare since the power plant was installed. **Show** your work.

G. The town has been growing since it was built and had a growth rate of 5.38% in 2022, with a population of 26,250.

Assuming that the growth rate remains constant, **calculate** the year in which the population will reach 52,500. **Show** your work.

STOP

END OF EXAM