Question 2: Analyze an Environmental Problem and Propose a Solution — 10 points

A — **Point 01**

Identify the sea surface condition for the eastern equatorial area of the Pacific Ocean illustrated in Figure 1.

Acceptable identification point:

- (Ocean water) cooler than average

B — **Point 02**

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.

Acceptable identification point:

- La Niña

C — **Point 03**

Based on the information in Figure 2, **describe** a difference in climate patterns between the regions A and B.

Examples of acceptable responses may include the following:

- Region A has an increased chance of precipitation, while Region B has a decreased chance of precipitation.
- Region A will be wetter, while Region B will be drier.

D — **Point 04**

Describe one reason why there is an increased risk of flooding in urban areas during extended periods of precipitation.

Examples of acceptable responses may include the following:

- Impervious/paved surfaces increase runoff/reduce infiltration/reduce absorption.
- Parking lots/roads/buildings/sidewalks increase runoff/reduce infiltration/reduce absorption.
- There is less vegetation and, therefore, less infiltration/absorption.

E — **Point 05**

Propose a realistic solution a city could implement to decrease the risk of flooding in urban areas.

Examples of acceptable responses may include the following:

- Use permeable pavement
- Plant vegetation/establish parks/create rain gardens/build green roofs
- Install retention ponds/stormwater basins

F **Justify** the solution proposed in part E by providing an additional advantage other than a reduction in the risk of flooding. **Point 06**

Examples of acceptable responses may include the following:

Solution from part E	Justification of solution with additional advantages
Use permeable pavement	• Increased recharge of nearby aquifers/groundwater • Decreased pollution in runoff
Plant vegetation/establish parks/create rain gardens/build green roofs	• Vegetation absorbs pollutants • Vegetation stores carbon dioxide/produces oxygen • Decreased erosion • Increased/restored habitat for wildlife • Increased biodiversity • Helps reduce urban heat island effect • Aesthetic enjoyment/improved quality of life • Creates jobs (in landscaping/park maintenance)
Install retention ponds/stormwater basins	• Decreased pollution in runoff • Increased habitat/biodiversity

G **Describe** one difference between the climate of a temperate seasonal forest and that of a savanna. **Point 07**

Examples of acceptable responses may include the following:

- Temperate seasonal forests have a cooler climate than a savanna.
- Temperate seasonal forests have a stronger/colder winter than a savanna.
- Temperate seasonal forests have four distinct seasons while savannas do not.
- Temperate seasonal forests receive more annual precipitation than savannas.
- Temperate forests receive precipitation throughout the year while savannas have a rainy season/dry season.

H **Identify** the ecological process that occurs following a forest fire that leaves the soil intact. **Point 08**

Acceptable identification point:

- Secondary succession

I	**Describe** one way burning forests contribute to atmospheric pollution. Acceptable description point: • Burning of trees releases CO_2/CO/NO_X/particulate matter/VOCs.	**Point 09**
J	**Describe** one sustainable forestry practice that could be used to reduce the occurrence or severity of forest fires. Examples of acceptable responses may include the following: • Prescribed burns can remove excess fuel/dead leaves/underbrush. • Brush removal can remove excess fuel/dead leaves/underbrush. • Selective cutting can create a fire break. • In agroforestry, ground crops that might otherwise be fuel can be harvested/removed.	**Point 10**

Question 3: Analyze an Environmental Problem and Propose a Solution

Doing Calculations — 10 points

(a) **Describe** why coal is considered a nonrenewable energy source. **1 point**

Accept one of the following:

- Nonrenewable energy sources like coal exist in a fixed/finite/limited amount.
- The formation rate of coal is less than the consumption/combustion rate of coal.

(b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant. **1 point**

Accept one of the following:

- Natural gas combustion emits fewer greenhouse gases/less CO_2.
- Natural gas combustion does not emit mercury/lead/cadmium/uranium.
- Natural gas combustion emits less NO_x/SO_x/reduces acid precipitation.
- Natural gas combustion produces less/no particulate matter/soot/smog.
- Transport of natural gas destroys/fragments less habitat or requires less fossil fuel use than transport of coal.
- Habitat destruction due to the impoundment of coal ash or coal slurry is negated.
- Coal extraction destroys habitat by strip mining or mountaintop removal.

(c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity. **1 point**

Accept one of the following:

- Transport of natural gas (in pipelines) costs less than transport of coal (by rail).
- Natural gas (methane) harvested from a decomposition reaction (landfills, wastewater treatment plants, biodigesters) costs less than coal.
- There are fewer health-related issues linked to the burning of natural gas than are linked to burning coal, leading to lower health care costs for individuals or society as a whole.
- There are fewer pollution controls needed for a natural gas powerplant, decreasing the cost of operation/construction/permitting.
- There are lower combustion-residue disposal costs from the operation of natural gas burning powerplants than from coal-burning power plants.
- Natural-gas-burning power plants are much more efficient (more electricity output from the same energy input) than coal-burning power plants leading to lower fuel costs.

(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. **1 point**

Accept one of the following:

- Install/use/replace/update carbon monoxide detectors/alarms/sensors or replace the batteries within these devices.
- Perform regular maintenance on natural gas furnaces to ensure that minimal carbon monoxide is created or that the combustion products are properly vented/exhausted to the building exterior.
- Create laws or regulations that mandate that carbon monoxide detectors must be installed in all homes of any type.
- Use PSA's, billboards, or other methods to inform/educate the public about carbon monoxide poisoning.
- Change the home heating system to a method that does not include the combustion of a fuel that may produce carbon monoxide.

(e) **Calculate** the percent change in the average annual $PM_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work. **1 point**

One point for the correct setup (must include units and multiplication by 100 to yield a true percentage) to calculate the percent change:

- $\frac{\left(188\,\mu g/m^3 - 85\,\mu g/m^3\right)}{85\,\mu g/m^3} \times 100$

One point for the correct calculation of the percent change: **1 point**

- 121%
- 120%
- 121.2%

Total for part (e) **2 points**

(f) Trees can remove $PM_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $PM_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $PM_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work. **1 point**

One point for the correct setup (must include units) to calculate the number of kilograms of $PM_{2.5}$:

- $(50{,}000\,\text{ha} - 43{,}000\,\text{ha}) \times \frac{2.3\,\text{kg}}{\text{hectare}}$
- $50{,}000\,\text{ha} \times 2.3\ \text{kg/ha} = 115{,}000\,\text{kg};\ 43{,}000\,\text{ha} \times 2.3\ \text{kg/ha} = 98{,}900\,\text{kg}$
  $115{,}000\,\text{kg} - 98{,}900\,\text{kg}$

	One point for the correct calculation of the number of kilograms of $PM_{2.5}$: • 16,100 kilograms of $PM_{2.5}$ • 16,000 kilograms of $PM_{2.5}$	**1 point**
		Total for part (f) 2 points
(g)	Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $PM_{2.5}$ concentration. A city experienced a 23% increase in $PM_{2.5}$ 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 $PM_{2.5}$ concentration continues to rise at an identical rate. **Show** your work. One point for the correct setup to calculate the increase in hospital admissions: • $\frac{0.23}{0.10} \times 0.01 \times 7,390 \text{ admissions}$ • $\frac{0.23}{0.10} \times \frac{1}{100} \times 7,390 \text{ admissions}$ • $\frac{23\%}{10\%} \times 1\% \times 7,390 \text{ admissions}$	**1 point**
	One point for the correct calculation of the increase in hospital admissions. Accept one of the following: • 169 more admissions • 170 more admissions	**1 point**
		Total for part (g) 2 points
		Total for question 3 10 points