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

**A** **Identify** the sea surface condition for the eastern equatorial area of the Pacific Ocean illustrated in Figure 1. **Point 01**

Acceptable identification point:

- (Ocean water) cooler than average

**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. **Point 02**

Acceptable identification point:

- La Niña

**C** Based on the information in Figure 2, **describe** a difference in climate patterns between the regions A and B. **Point 03**

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** **Describe** one reason why there is an increased risk of flooding in urban areas during extended periods of precipitation. **Point 04**

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** **Propose** a realistic solution a city could implement to decrease the risk of flooding in urban areas. **Point 05**

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<br>• Decreased pollution in runoff |
| Plant vegetation/establish parks/create rain gardens/build green roofs | • Vegetation absorbs pollutants<br>• Vegetation stores carbon dioxide/produces oxygen<br>• Decreased erosion<br>• Increased/restored habitat for wildlife<br>• Increased biodiversity<br>• Helps reduce urban heat island effect<br>• Aesthetic enjoyment/improved quality of life<br>• Creates jobs (in landscaping/park maintenance) |
| Install retention ponds/stormwater basins | • Decreased pollution in runoff<br>• 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.<br><br>Acceptable description point:<br><br>• 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.<br><br>Examples of acceptable responses may include the following:<br><br>• Prescribed burns can remove excess fuel/dead leaves/underbrush.<br>• Brush removal can remove excess fuel/dead leaves/underbrush.<br>• Selective cutting can create a fire break.<br>• 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.<br><br>Accept one of the following:<br><br>• Nonrenewable energy sources like coal exist in a fixed/finite/limited amount.<br>• The formation rate of coal is less than the consumption/combustion rate of coal. | **1 point** |
| **(b)** | **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.<br><br>Accept one of the following:<br><br>• Natural gas combustion emits fewer greenhouse gases/less $CO_2$.<br>• Natural gas combustion does not emit mercury/lead/cadmium/uranium.<br>• Natural gas combustion emits less $NO_x$/$SO_x$/reduces acid precipitation.<br>• Natural gas combustion produces less/no particulate matter/soot/smog.<br>• Transport of natural gas destroys/fragments less habitat or requires less fossil fuel use than transport of coal.<br>• Habitat destruction due to the impoundment of coal ash or coal slurry is negated.<br>• Coal extraction destroys habitat by strip mining or mountaintop removal. | **1 point** |
| **(c)** | **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity.<br><br>Accept one of the following:<br><br>• Transport of natural gas (in pipelines) costs less than transport of coal (by rail).<br>• Natural gas (methane) harvested from a decomposition reaction (landfills, wastewater treatment plants, biodigesters) costs less than coal.<br>• 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.<br>• There are fewer pollution controls needed for a natural gas powerplant, decreasing the cost of operation/construction/permitting.<br>• There are lower combustion-residue disposal costs from the operation of natural gas burning powerplants than from coal-burning power plants.<br>• 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. | **1 point** |

**(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 $PM_{2.5}$: **1 point**

- 16,100 kilograms of $PM_{2.5}$
- 16,000 kilograms of $PM_{2.5}$

**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. **1 point**

One point for the correct setup to calculate the increase in hospital admissions:

- $\frac{0.23}{0.10} \times 0.01 \times 7{,}390\,\text{admissions}$
- $\frac{0.23}{0.10} \times \frac{1}{100} \times 7{,}390\,\text{admissions}$
- $\frac{23\%}{10\%} \times 1\% \times 7{,}390\,\text{admissions}$

One point for the correct calculation of the increase in hospital admissions. **1 point**

Accept one of the following:

- 169 more admissions
- 170 more admissions

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

**Total for question 3** **10 points**