

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

- (a) (i) Based on the data in the graph, **identify** the highest methane concentration found in well water in Pennsylvania. **1 point**

- 64 mg/L

- (ii) 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. **1 point**

Accept one of the following:

- Methane concentration decreases as distance from the fracking well increases.
- Methane concentration increases as distance from the fracking well decreases.
- There is an inverse/nonlinear relationship/negative correlation between the two variables.

- (iii) 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. **1 point**

Accept any value between:

- 1,800 – 2,200 meters

- (iv) **Explain** how fracking fluid is used to access oil and natural gas in sedimentary rock, such as shale, during the fracking process. **1 point**

Accept one of the following:

- Fracking fluid is injected/pumped into the well under high pressure, opening rock fissures, releasing oil and natural gas.
- Sand grains in the fracking fluid hold the newly formed cracks/fractures open to allow the oil and natural gas to flow up the well.

- (v) **Identify** one negative geologic effect in an area where hydraulic fracturing (fracking) occurs. **1 point**

Accept one of the following:

- Earthquakes/seismic activity
- Ground subsidence/sinkholes

Total for part (a) 5 points

- (b) (i) 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. **1 point**

- Tragedy of the Commons

- (ii) **Describe** one environmental problem that may result from increased use of groundwater for fracking in arid or semiarid regions. **1 point**

Accept one of the following:

- Loss of habitat/productivity in spring-fed ecosystems as springs dry up
- Loss of habitat/productivity/degraded water quality in streams and estuaries fed by groundwater discharge
- Soil erosion as vegetation dies as a result of lowered water table and roots no longer hold soil
- Desertification as a result of lowered water table

- (iii) **Describe** how overuse of coastal groundwater supplies can result in water that is unsuitable for human consumption. **1 point**

- The ocean water flows into aquifers (saltwater intrusion), contaminating the aquifer with saltwater.

Total for part (b) 3 points

- (c) (i) **Make a claim** for a realistic governmental action to improve air quality by reducing consumption of oil. **1 point**

Accept one of the following:

- Increase fuel economy standards for motor vehicles.
- Invest in renewable energy resources.
- Use tax incentives to encourage sales of hybrid/electric vehicles.
- Subsidize projects that increase the use of public transportation/walking/cycling.
- Create tax incentives for companies offering work-from-home options.
- Increase gasoline tax/reduce oil subsidies.

- (ii) **Justify** the action proposed in part (c)(i) by stating a potential environmental advantage of that action, other than slowing global climate change. **1 point**

Accept one of the following:

Governmental action proposed in (c)(i)	Justification of the action proposed by stating a potential environmental advantage
Increase fuel economy standards for motor vehicles	• Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain • Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations

	Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Invest in renewable energy resources	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Use tax incentives to encourage sales of hybrid/electric vehicles	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Subsidize projects that increase the use of public transportation/walking/cycling	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Create tax incentives for companies offering work-from-home options	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater

	depletion/contamination from fracking/drilling operations Decreased oil consumption which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Increase gasoline tax/reduce oil subsidies	- Decreased oil/fuel consumption, which leads to reduced particulates, surface ozone/photochemical smog or acid rain - Decreased oil consumption, which leads to fewer oil spills/decreased groundwater depletion/contamination from fracking/drilling operations - Decreased oil consumption, which leads to decreased disruption to wildlife/habitats (habitat fragmentation, noise pollution) from drilling operations
Total for part (c) 2 points Total for question 2 10 points	