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FRQ Practice 6.1

SUGGESTED SKILL

 *Concept Explanation*

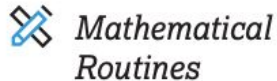
1.C

Explain environmental concepts, processes, or models in applied contexts.

Explain whether or not biomass is a renewable energy source. **Justify** your answer

Explain (1 pt.) - Can earn a point for renewable or nonrenewable, if justification supports answer

- **Biomass is a renewable energy source because the fuel source, such as trees/plants/animal waste can be continually regenerated without depletion**
- **Biomass is not a renewable energy source, because it can be harvested and used at a rate that is faster than it regenerates, eventually exhausting/depleting it**
- **Biomass is a potentially renewable energy source, if it is consumed near or below the rate at which it regenerates**

SUGGESTED SKILL

FRQ Practice 6.2

6.C

Calculate an accurate numeric answer with appropriate units.


From 2005 to 2018, the annual investment in renewable energy sources in the United States increased from \$11.4 billion to \$46.5 billion.

Calculate the percent change in renewable energy investment in the US from 2005 to 2018.


Experts estimate that for the US to reach 100% renewable energy in 2050, it will require \$7.8 trillion. **Calculate** the percent change this would represent from the 2018 investment level of \$46.5 billion.

2 pts: 1 for correct setup, 1 for correct answer w/units

$$\frac{(46.5 \times 10^9 - 11.4 \times 10^9)}{11.4 \times 10^9} \times 100 = 307.9\% \text{ or } 308\% \text{ increase}$$



Percentage
Change
Formula



$$= \frac{\text{Old Number} - \text{New Number}}{\text{Old Number}} \times 100$$

%

2 pts: 1 for correct setup, 1 for answer w/units

$$\frac{(7.8 \times 10^{12} - 46.5 \times 10^9)}{46.5 \times 10^9} \times 100 = 16,674\% \text{ increase}$$

FRQ Practice 6.3

SUGGESTED SKILL

 *Concept Explanation*

1.A

Describe environmental concepts and processes.

Natural gas is considered to be a better fossil fuel for the environment than coal is. **Describe** TWO environmental benefits of using natural gas as a fuel compared to using coal.

Benefits of natural gas (must be environmental, not economic) include the following:


- Fewer SO_x are produced, resulting in less acid rain.
- Fewer NO_x are produced, resulting in less acid rain and less photochemical smog.
- Less Hg is released. **must connect mercury to an env. Problem (toxicity to organisms)**
- Harmful mining techniques are avoided; for example, no strip mining or mountaintop removal is required.
- Fewer particulates (soot) are released. **must connect PM to an env. problem**
- Less CO_2 is produced. **must connect CO_2 to an env. problem**

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FRQ Practice 6.4

SUGGESTED SKILL

 *Visual Representations*

2.B

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts

Identify a region of the United States that is likely to be a large producer of natural gas. **Describe** the geological features associated with natural gas reserves.

a) **1 pt. for identifying any of the following**


- Southern Alabama/Mississippi/Texas/Alaska
- Michigan/Louisiana/West Virginia/Pennsylvania
- Western California/North Dakota/Wyoming
- Gulf-coast region or Midwest region

b) **1 pt. for describing:**

- Natural gas forms in areas where sedimentary rock is found beneath an impermeable rock layer above/cap rock above
- Natural gas is found in semi-permeable sedimentary rock layers such as shale
- Natural gas is found trapped in the cracks/spaces of semi-permeable sedimentary rock layers

FRQ Practice 6.5

SUGGESTED SKILL

 *Environmental Solutions*

7.A

Describe environmental problems.

- a) **Explain** one environmental consequence of tar sands petroleum extraction
- b) **Explain** a different environmental consequence of hydraulic fracturing

a) 1 pt. for any of the following explanations

- Large volume of water required for tar sands petroleum extraction can lead to depletion of nearby surface or groundwater sources
- Tar sands petroleum extraction results in more CO₂ emissions than standard petroleum extraction, contributing further to climate change/global warming
- Tar sand petroleum extraction can lead to habitat destruction as nearby land is cleared for mining/transport roads

b) 1 pt. for explaining a different consequence than in part (a)

- Fracking fluids can leak from pipe/well and contaminate groundwater sources with methane/salt/benzene/detergents/acids
- Used fracking fluid can leak or overflow from tailing ponds, contaminating surface or groundwater with salt/benzene/detergents/acids
- Large volume of water required for fracking can lead to depletion of nearby surface or groundwater sources

FRQ Practice 6.6

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts

- a) **Identify** and **describe** one letter in the diagram that is common to both nuclear and fossil fuel electricity production
- b) **Identify** and **describe** one letter in the diagram that is found ONLY in nuclear electricity production

a) 1 pt. for any of the following


- Structure B is a boiler/steam generator where water is heated into steam
- Structure C is a turbine that is spun/turned/rotated by steam
- Structure D is a generator/electric generator that produces electricity when powered/turned/driven by a turbine

b) Only letter A may earn points in part (b)

- Structure A is a nuclear reactor/reactor core/nuclear fuel rod(s) where uranium or other radioactive elements undergo fission and release heat/energy

FRQ Practice 6.7

SUGGESTED SKILL

 *Environmental Solutions*

7.B

Describe potential responses or approaches to environmental problems.

- a) **Explain** why biodiesel fuels have a different effect on atmospheric carbon levels than fossil fuels do
- b) **Describe** TWO environmental benefits of using algae for biofuel production, rather than corn, palm, or sugarcane

a) 1 pt. for an equivalent explanation of the following:

Biodiesel contains carbon that was recently present in the atmosphere rather than fossil-fuel carbon that was in the atmosphere long ago and has been sequestered beneath Earth's surface. Hence the burning of biodiesel does not contribute to a net increase in the amount of carbon dioxide currently circulating in the atmosphere, whereas the burning of fossil fuel does contribute to a net increase in the concentration of carbon dioxide in the atmosphere.


b) Answer key on next slide

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FRQ Practice 6.7

SUGGESTED SKILL

 Environmental Solutions

7.B

Describe potential responses or approaches to environmental problems.

Advantage	Description
Less land use	<ul style="list-style-type: none"> • Less habitat destruction and/or less loss of biodiversity • Protection of watersheds from agricultural runoff
Decreased tilling of soil	<ul style="list-style-type: none"> • Less soil erosion
Decreased pesticide and/or fertilizer use	<ul style="list-style-type: none"> • Less runoff of pesticides and/or fertilizers
Decreased fossil fuel consumption for tilling soil, harvesting crops, and/or manufacturing and applying fertilizers and pesticides	<ul style="list-style-type: none"> • Less mining and drilling for fossil fuels, resulting in less habitat destruction and less loss of biodiversity • Less air pollution (e.g., NO_x, O₃)
Decreased energy consumption for extracting oils from microalgae	<ul style="list-style-type: none"> • Less mining and drilling for fossil fuels, resulting in less habitat destruction and less loss of biodiversity • Less air pollution (e.g., NO_x, O₃)
Decreased irrigation of land	<ul style="list-style-type: none"> • Less soil salinization and/or less desertification • Less aquifer depletion
Less nutrient depletion of soil	<ul style="list-style-type: none"> • Less land under cultivation
Microalgae may be grown in wastewater	<ul style="list-style-type: none"> • Less runoff and less infiltration of wastewater

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FRQ Practice 6.8

SUGGESTED SKILL

Data Analysis

5.C

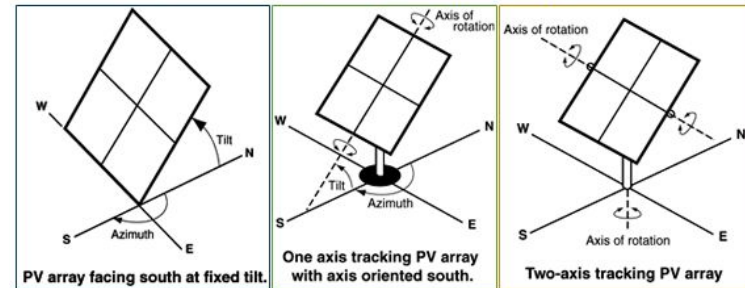
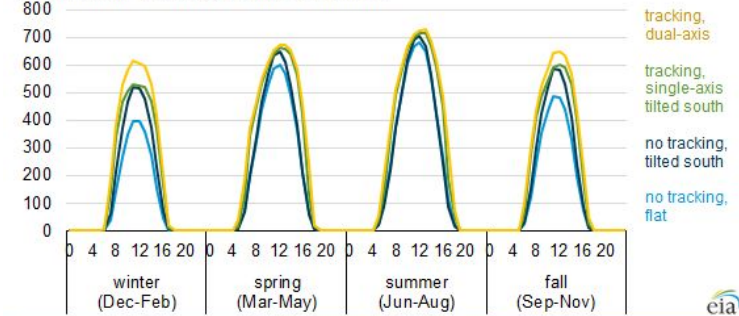
Explain patterns and trends in data to draw conclusions.

a) **Explain** the relationship between the tracking ability of a solar PV system and its energy production

1 pt. for an equivalent explanation of the following:


- Tracking PV systems with greater/dual axis produce more electricity than tracking single-axis or non-tracking systems since they are able to rotate around a vertical and horizontal axis in order to track the sun's movement more directly
- Tracking PV systems with greater/dual axis produce more electricity than tracking single-axis or non-tracking systems since they have a greater degree of motion, enabling them to spend more time directly facing the sun

Simulated energy production for one kilowatt of solar PV capacity in Los Angeles, Calif. hourly average production by season, watthours



FRQ Practice 6.9

SUGGESTED SKILL

 *Environmental Solutions*

7.F

Justify a proposed solution, by explaining potential advantages.

- a) **Explain** TWO benefits other than agriculture and recreation that people gain from constructing dams on rivers.

1 pt. for an equivalent explanation of TWO of the following:

- Hydroelectric power/affordable (inexpensive) electricity
- Flood control
- Storage of water for domestic/nonagricultural use; municipal water supply (must specify a nonagricultural use)
- Provision of/increase in navigable waterways
- Employment/stimulation of local economy (dam construction, maintenance, operation)
- Reduced air pollution as hydroelectric power replaces electrical generation from fossil fuels

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FRQ Practice 6.10

SUGGESTED SKILL

 *Concept Explanation*

1.B

Explain environmental concepts and processes.

a) **Identify** the source of initial energy in geothermal power generation and **explain** how geothermal systems can be used to generate electricity.

1 pt. for **identifying** :

- Heat from radioactive decay in the earth's core
- Heat from earth's mantle/magma deep beneath earth's surface/magma deep in the ground

1 pt. for **explaining** the geothermal systems generate electricity by:

- Hot water is pumped out of the earth and converted to steam to turn a turbine that powers an electric generator
- Water is piped/pumped into the ground to be heated and turned into steam, which is then used to turn a turbine which powers an electric generator

FRQ Practice 6.11

SUGGESTED SKILL

 *Concept Explanation*


1.C

Explain environmental concepts, processes, or models in applied contexts.

a) **Explain** how hydrogen gas can be used to generate electricity

1 pt. for **explaining**:

- Hydrogen atoms/gas is/are separated into protons and electrons by an electrolyte membrane that allows hydrogen ions/protons through while electrons take an alternate current around the membrane, generating an electrical current
- An anode oxidizes hydrogen, causing electrons to flow in a circuit to the cathode, generating an electrical current.

SUGGESTED SKILL

 Environmental
Solutions
7.B

Describe potential responses or approaches to environmental problems.

Explain an environmental benefit a town might experience if it switches from a coal fired power plant to a wind farm as its primary source of energy.



FRQ Practice 6.12


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ENVIRONMENTAL BENEFIT	EXPLANATION
Perpetual/renewable resource	If connected to a specific environmental benefit
Reduce SO ₂ , SO ₃ , or SO _x emissions	Reduce acid deposition
Reduce CO ₂ emissions Reduce CO emissions	Slow global warming/global climate change Must link increased CO ₂ as cause

ENVIRONMENTAL BENEFIT	EXPLANATION
Reduce dust and airborne particulate matter	Reduce a specific health risk
Reduce NO _x	Reduce photochemical smog; ground-level ozone and associated health risks
Multiple use of land	If connected to an environmental benefit
Reduce thermal pollution from coolant waters of coal-burning power plant	Thermal shock; decreased dissolved oxygen content of water
Eliminate/reduce Hg, Pb, Cd, radioactivity	Reduce a specific health risk
Reduce acid mine drainage from coal mines	pH change in aquatic habitats
Reduce the need for coal mining	Reduce adverse effects of mining – mine drainage, erosion, etc.

FRQ Practice 6.13

SUGGESTED SKILL

 *Mathematical Routines*

6.C

Calculate an accurate numeric answer with appropriate units.

Calculate the % change in global investment in renewable energy from 2004 to 2014.

1 pt. for **correct setup with units**

1 pt. for **correct answer with units**

$(275 \text{ billion dollars} - 50 \text{ billion dollars}) / 50 \text{ billion dollars} \times 100 = 450\% \text{ increase}$

**if student uses 2004 value anywhere between 45 billion and 50 billion or 2014 value between 270 billion and 280 billion and completes calculation correctly with these values, award credit.*