



## AP Environmental Science 2000 Scoring Guidelines

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# AP<sup>®</sup> Environmental Science 2000 — Scoring Standards

## Question 1 Scoring Guide

(a) 3 POINTS MAXIMUM

**1 point earned each for i, ii, and iii for correct setup and answer (units not required in answer)**  
**1 point deducted if proper units not included within calculation in i and ii**

Several different styles of equations earn credit. Some examples are:

i.  $\frac{1.2 \times 10^7 \text{ kWh}}{\text{day}} \times \frac{1.0 \times 10^4 \text{ BTUs}}{\text{kWh}} = 1.2 \times 10^{11} \text{ BTUs/day}$

$$1.2 \times 10^7 \text{ kWh} \times \frac{1.0 \times 10^4 \text{ BTUs}}{\text{kWh}} = 1.2 \times 10^{11} \text{ BTUs/day}$$

$$\frac{1.0 \times 10^4 \text{ BTUs}}{1 \text{ kWh}} = \frac{x}{1.2 \times 10^7 \text{ kWh}} ; x = 1.2 \times 10^{11} \text{ BTUs/day}$$

$$12,000,000 \text{ kWh} \times 10,000 \text{ BTU/kWh} = 120,000,000,000 \text{ BTUs/day}$$

ii.  $\frac{1.2 \times 10^{11} \text{ BTUs}}{\text{day}} \times \frac{1 \text{ lb coal}}{5.0 \times 10^3 \text{ BTUs}} = 2.4 \times 10^7 \text{ lbs coal/day}$

$$1.2 \times 10^{11} \text{ BTUs} \times \frac{1 \text{ lb coal}}{5.0 \times 10^3 \text{ BTUs}} = 2.4 \times 10^7 \text{ lbs coal/day}$$

$$\frac{1 \text{ lb coal}}{5.0 \times 10^3 \text{ BTUs}} = \frac{x}{1.2 \times 10^{11} \text{ BTUs}} ; x = 2.4 \times 10^7 \text{ lbs coal/day}$$

$$120,000,000,000 \text{ BTUs/day} \div 5,000 \text{ BTUs/lb coal} = 24,000,000 \text{ lbs coal/day}$$

iii.  $\frac{2.4 \times 10^7 \text{ lbs coal}}{\text{day}} \times \frac{0.01 \text{ lb sulfur}}{1 \text{ lb coal}} = 2.4 \times 10^5 \text{ lbs sulfur/day}$

$$2.4 \times 10^7 \text{ lbs coal} \times \frac{0.01 \text{ lb sulfur}}{1 \text{ lb coal}} = 2.4 \times 10^5 \text{ lbs sulfur/day}$$

$$\frac{1 \text{ lb sulfur}}{100 \text{ lbs coal}} = \frac{x}{2.4 \times 10^7 \text{ lbs coal}} ; x = 2.4 \times 10^5 \text{ lbs sulfur/day}$$

$$24,000,000 \text{ lbs of coal/day} \times 1\% \text{ sulfur} = 240,000 \text{ lbs of sulfur/day}$$

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(b) 2 POINTS MAXIMUM

**1 point earned for an appropriate method that shows how the conclusion was reached (units of measurement not required)**

$$\frac{1.2 \times 10^{11} \text{ BTUs}}{\text{day}} \times \frac{1.2 \text{ lbs}}{1.0 \times 10^6 \text{ BTUs}} = 1.44 \times 10^5 \text{ lbs sulfur/day maximum allowable release}$$

$$120,000,000,000 \text{ BTUs} \times \frac{1.2 \text{ lbs}}{1,000,000 \text{ BTUs}} = 144,000 \text{ lbs sulfur/day maximum allowable release}$$

$$\frac{2.4 \times 10^5 \text{ lbs sulfur}}{1.2 \times 10^{11} \text{ BTUs}} \times \frac{1.0 \times 10^6 \text{ BTUs}}{1 \text{ million BTUs}} = 2 \text{ lbs sulfur/million BTUs actually released}$$

$$\frac{2.4 \times 10^5 \text{ lbs sulfur}}{1.2 \times 10^{11} \text{ BTUs}} = \frac{x}{1.0 \times 10^6 \text{ BTUs}} ; \quad x = 2 \text{ lbs sulfur per million BTUs}$$

$$1,000,000 \text{ BTUs} \times \frac{1 \text{ lb coal}}{5,000 \text{ BTUs}} = 200 \text{ lbs coal}$$

$$200 \text{ lbs coal} \times \frac{1 \text{ lb sulfur}}{100 \text{ lbs coal}} = 2 \text{ lbs sulfur/million BTUs}$$

**1 point earned for reaching a conclusion that is consistent with the method used to compare the permissible sulfur level with the sulfur level determined in (a) iii or with the 1.2 lbs permitted by the EPA. (Conclusions that are incorrect due to mathematical errors, but are based on valid calculations, earn the point.)**

The power plant is NOT in compliance, because it releases

- 2 lbs of sulfur per million BTUs instead of the 1.2 lbs per million BTUs as the EPA allows

OR

- $2.4 \times 10^5$  lbs of sulfur/day when the limit is  $1.44 \times 10^5$  lbs/day

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(c) 3 POINTS MAXIMUM

### **1 point earned for EACH method DESCRIBED (two methods are requested)**

Methods are associated to the point in the process where the reduction may occur. Simply listed, these methods, which are NOT considered descriptions, include:

Input, where 1) using low-sulfur coal; 2) “washing” the coal; 3) coal gasification; and 4) using alternative combustible fuels are identified in textbooks.

Example of description: “Coal can be chemically treated to reduce its sulfur content.”

Combustion, where 1) fluidized-gas combustion and 2) burning low-sulfur coal are identified in textbooks.

Example of description: “Plant can add limestone to the coal when it is burned.”

Output, where 1) using scrubbers and 2) treatment with NH<sub>3</sub> are identified in textbooks.

Example of description: “Plant can install scrubbers in its smokestacks.”

Other, where 1) conservation education is common and 2) source reduction, which includes reducing the electricity generated by the plant and/or increasing the efficiency of the plant, are identified in textbooks

Example of description: “Plant can develop conservation education programs to reduce electricity demand.”

### **1 point earned for elaboration on either, but not both, methods. Elaborations must include a detailed description of how the described method is related to the sulfur emissions.**

Elaboration point examples:

*Discussion of fluidized-bed combustion:* crushed limestone is introduced into the crushed coal, which is then burned. The calcium in the limestone reacts with the sulfur in the coal to produce calcium sulfite (CaSO<sub>3</sub>), calcium sulfate (CaSO<sub>4</sub>), or gypsum (CaSO<sub>4</sub>).

*Discussion of wet vs dry scrubbing:* Injected crushed limestone or lime slurry into emission (wet scrubbing); Injected sodium carbonate or bicarbonate into emission (dry scrubbing)

*Discussion of source reduction:* the plant reduced the amount of electricity it generates by reducing its capacity, thereby burning less coal, or by increasing the efficiency of the plant to increase the amount of electricity generated, which reduces the absolute amount of its emissions.

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(d) 3 POINTS MAXIMUM

**1 point for DISCUSSION of the problem (must include either how or why the emissions are a problem)**

Two commonly recognized problems: 1) increasing acidification of ecosystems (how or why), and 2) increased oxides of sulfur aerosols leading to regional cooling, smog, or respiratory distress (how or why).

**1 point possibly earned for elaboration**

Elaboration point examples:

- Formation of  $\text{H}_2\text{SO}_4$  from  $\text{SO}_2$  ( $\text{SO}_2 \Rightarrow \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$ )
- Wet vs. dry deposition
  - $\text{SO}_2$  and  $\text{SO}_3$  wind transport and reaction with water in ecosystems is dry
  - $\text{H}_2\text{SO}_4$  in precipitation is wet
- increased amounts of sulfur oxide aerosols absorb incoming UV-radiation, thereby cooling the lower atmosphere
- increased amounts of sulfur oxide aerosols irritate mucous linings in respiratory system (aerosols NOT disease-causing agents)

**1 point earned for description of negative effect**

Possible Negative Effects:

- Increased solubility of toxic metals as a result of the increased acidity in the ecosystem
- Increased leaching of soil nutrients
- Reduced buffering capacity of soil
- Fisheries kills as a result of changes in pH of aquatic ecosystems (In addition to deaths of adults, survival of eggs, young, fry, fingerlings are reduced.)
- Fisheries kills as a result of increase of toxic chemicals in aquatic ecosystems due to changes in pH
- Tree deaths as a result of changes in pH of soil ecosystems
- Tree deaths as a result of increase of toxic chemicals in soil ecosystems due to changes in pH
- Change in species composition due differences in range of tolerance for pH.
- Increase in disease-susceptibility of plants
- Disruption (simplification) of food webs as a result of the decline or loss of pH-sensitive organisms at various trophic levels
- Increased solubility of methyl mercury
- Interferes with calcium deposition and/or uptake as a result of the increased acidity in the ecosystem
- Changes in vegetation, including crops, due to changes in regional climate
- Changes in fauna distribution due to changes in regional climate
- Changes in fauna distribution due to changes in vegetation
- Changes in precipitation patterns due to changes in regional climate

**1 point possible for elaboration (must demonstrate a more detailed understanding of the negative effect)**

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## Question 2 Scoring Guide

(a) 1 point for each argument plus 1 elaboration point (3 POINT MAXIMUM)

i. In FAVOR of Recycling Newspapers (1 point)

a. Saves resources – must cite an example SPECIFIC for paper

- Reduces number of trees cut down
- Many paper products already made with a percentage of post-consumer paper
- Recycled paper requires less virgin material

**OR**

b. Reduces economic and environmental costs

- Frees up landfill space
- Reduces costs and environmental impacts associated with timber harvesting (clear cutting, deforestation)

Possible Elaboration Points:

- Most recycled paper is made from no more than 50% recycled fibers (10% post-consumer waste); examples include packing material, cardboard, writing paper, napkins, paper plates, and insulation
- Although newspapers are biodegradable, they do not readily degrade under landfill conditions
- Conservation of trees preserves habitats and biodiversity
- Conservation of trees reduces CO<sub>2</sub> (greenhouse gas) levels
- Conservation of trees increases O<sub>2</sub> levels

ii. AGAINST Recycling Newspapers (1 point)

a. Wastes resources – must cite an example SPECIFIC for paper

- Recycled paper is a lower grade product with limited use.
- Energy is required to de-ink, bleach and reprocess.
- Paper is biodegradable (compostable) and requires less energy than recycling.
- Human effort is required to separate newspapers from other grades of paper

(NO CREDIT earned for copying example in article by substituting “paper” for “aluminum.”)

**OR**

b. Economic costs

- Recycled products can be more expensive to purchase than virgin products

(NO CREDIT earned for environmental costs because they are not addressed in this section of the original article)

Possible Elaboration Point:

- Older trees can be cut for paper and replaced with younger trees that have a higher photosynthetic rate.

Elaboration points earned by adding specific examples and /or supporting details

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- (b) Scientific Information (4 POINT MAXIMUM)
- Environmental benefits (1 point for each piece of scientific information with a 2 POINT MAXIMUM – no credit earned for economic statements)
  - Environmental costs (1 point for each piece of scientific information with a 2 POINT MAXIMUM – no credit earned for economic statements or any negative variation of a statement from part i)

From the following list of pieces of scientific information that might be needed to evaluate the environmental benefits and costs of recycling newspapers, four different items should be included in the answer, two of which should clearly be identified as benefits and two as costs. No credit is earned for a negative or opposite variation of any statement given as a previous answer.

- Amount of energy required to recycle vs. the use of virgin materials or the reuse of newspapers
- Amount of water used to recycle vs. the use of virgin material or the reuse of newspapers
- Number of trees harvested for virgin materials vs. number of trees harvested for recycled material
- Volume of newspapers in landfills
- Time required for newspaper to decompose
- Effect of timber harvesting on soil erosion or water quality
- Effect of pollution from paper reprocessing vs. processing or the reuse of newspapers on air quality
- Effect of pollution from paper reprocessing vs. processing or the reuse of newspapers on water quality
- Effect of timber harvesting on habitats/ecosystems/biodiversity
- Effect of recycling plant construction on habitats/ecosystems/biodiversity
- Volume of newspapers required to support a recycling plant
- Amount of virgin material required to strengthen recycled fibers
- Amount and types of toxic waste produced from reprocessing (de-inking and bleaching) vs. processing (inking) or reusing newspapers.
- Effect of newspapers on leachate in landfills

- (c) Recommendation and Two Reasons- 1 point for each reason (2 POINT MAXIMUM)

Aluminum:

- Non-renewable resource as opposed to trees which are a renewable resource
- There is a greater demand for recycled aluminum than recycled paper
- Reduces U.S. dependence on other countries for virgin aluminum (bauxite)
- Monetary return for aluminum is greater than that for newspapers (\$800 per ton of aluminum vs. \$160 per ton of newspaper – 1996. Some states have passed legislation that requires a monetary deposit on aluminum cans.)
- Cost of baling and organizing newspapers is greater than aluminum
- Negative effects of mining are greater than the negative effects of timber harvest\*
- Newspapers are more likely to be reused
- As more newspapers become available on the internet, fewer people may purchase paper copies, thereby reducing the supply of newspapers to be recycled
- Paper can be made from the fibers of rapidly growing plants other than trees
- Recycling aluminum is more energy efficient than recycling newspapers
- Some states have banned aluminum cans from disposal in landfills but not newspapers
- Newspapers are biodegradable, whereas aluminum is not
- Aluminum can be recycled more times than newspaper without significant effect on quality

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(c) (continued)

### **OR**

#### Newspapers:

- Paper is the number one source of municipal solid waste/ used in greater amounts than aluminum
- As aluminum cans are replaced by refillable glass bottles or PET plastic bottles, there will be fewer aluminum cans to recycle
- Recent legislation mandates a greater amount of recycled paper (30%-40%) be included in finished products
- Positive effects of trees on the environment are greater than aluminum ore (bauxite)\*\*

(d) Two Difficulties -- 1 point for each difficulty (2 POINT MAXIMUM)

- Obtaining adequate funding to support the program (increased taxes)
- Difficult to enforce or monitor public compliance/participation
- Opposition from virgin material industries
- Short term reduction in jobs (from virgin resource industries)
- Public resistance to recycling plants located in their community (NIMBY)
- Organization of the infrastructure to collect, process and transport recyclables
- Supply and demand for recycled materials
- Fluctuation in market price of recycled material
- Opposition from groups that promote reduction in resource use as opposed to recycling or from groups that are opposed to recycling
- Legal implications of ownership of the recyclable materials (township vs. individual)
- Organization of publicity and education to encourage public support for the program

\* Environmental effects of mining include acid mine drainage, contamination from tailings, increase in particulates (dust) as well as disruption of the land surface and dam construction to provide electricity for the extraction and processing of ore.

\*\* Positive environmental effects of trees (forests) include oxygen production, preservation of habitats and biodiversity, and their role as carbon sinks. No point earned if previously stated as an elaboration point in (a), i.

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## Question 3 Scoring Guide

### (a) 2 POINTS MAXIMUM

1 point earned for identification of a specific species. General names are not accepted (e.g., whale, owl), unless all members of the group are endangered (e.g., elephant).

#### Examples of Species Accepted

Giant panda, elephant, whooping crane, manatee, rhinoceros, California condor, bald eagle, western lily, woolly spider monkey, Florida panther, blue whale, Galapagos tortoise

1 point earned for explanation linked to species above

#### Examples of Explanations Accepted

- habitat alteration for a specific reason, such as:
  - human encroachment (urban sprawl)
  - fragmentation (building highways)
  - conversion (building a marina)
  - simplification (agriculture)
- OR
- identification of the specific habitat altered (e.g., “The bamboo forest needed by the giant panda has been destroyed.”)
- hunting or poaching for a specific reason (e.g., food, sport, commercial, cultural beliefs)
- inability to compete with non-native or invasive species (must be specific, e.g., “Arrowroot is outcompeted by the non-native purple loosestrife.”)
- pollution (must be specific, e.g., “Lead poisoning of bottom-feeding waterfowl.”)
- pest control (must be specific, e.g., “DDT causes thin egg shells in bald eagles.”)

### (b) 3 POINTS MAXIMUM

Each characteristic must be clearly described, explained, **or** a specific example must be provided (only first three are graded)

#### Acceptable characteristics (need description)

- specialized feeding behavior/food source
- requires large territory
- preys on livestock/people
- competition with humans (for space/food)
- no natural defense (against introduced species)
- fixed migratory patterns
- specialized reproductive behavior, breeding
- low reproductive rate
- limited geographic range, habitat
- specific behavior patterns
- exploited for economic value (specific)
- *k*-strategist
- feed at high trophic level, biomagnification
- large size
- slow speed
- limited range of tolerance
- small population linked to lack of genetic diversity

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## (c) 3 POINTS MAXIMUM

1 point earned for each argument (only first three are graded)

- ecosystem function and/or stability based on a specific reason such as
  - organism's role in food web (e.g., keystone species, predator-prey relationships)
  - organism's role as a pollinator
  - organism's role in nutrient cycles (e.g., decomposer, nitrogen-fixer)
- future medical resources
- future food resources
- economic potential (ecotourism, future products with market value)
- genetic bank (species diversity to allow continued evolution)
- recreation (hiking, camping, hunting, fishing, etc.)
- scientific value for research/natural lab
- scenic/aesthetic value
- symbolic/religious value
- intrinsic value/ethical reasons (organism have inherent right to live, ecological wealth)
- provides resources for indigenous human population
- minimizes spread of infectious diseases

## (d) 2 POINTS MAXIMUM

1 point earned for naming the law or treaty

1 point earned for describing the law

### Federal Laws (1 point)

Endangered Species Act  
(ESA)

### Components (1 point; need ONE of the following)

- identify species that are endangered/threatened or
- protect endangered species from one of the following:  
import/export, taking, harassing, harming, hunting, shooting,  
wounding, trapping, killing, capturing, collecting, possessing,  
selling, delivering, transporting, shipping, receiving or
- penalize violators or
- design protection plans or
- reintroduce species or
- protect habitat

Lacey Act - prohibits transport of protected species between states

### The following are also acceptable with a correct description:

Wild Bird Conservation Act	Eagle Protection Act
Migratory Bird Treaty Act	African Elephant Conservation Act
Whaling Conservation and Protection Study/Act	Fur Seal Act
Marine Mammal Protection Act	Whaling Convention Act
Migratory Bird Conservation Act	Fish and Wildlife Conservation Act
Fish and Wildlife Coordination Act	Fish and Game Sanctuary Act
Marine Protection, Research and Sanctuary Act	Fish and Wildlife Act
Wildlife Restoration Act of 1937 (Pittman-Robertson Act)	
National Wildlife Refuge System Administration Act	

### International Treaties:

- CITES (Convention on International Trade in Endangered Species) – regulates international trade of protected species and their products
- Convention on Biological Diversity – treaty signatories are expected to adopt biodiversity plans, establish protected ecosystems, promote sustainable use of biological resources, restore degraded habitats, protect threatened species
- International Whaling Commission Ban on Whaling – imposed moratorium on whaling

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## Question 4 Scoring Guide

### (a) Comparing Population Growth Rates (3 POINTS MAXIMUM)

1 point earned for naming  $X$  as the country with the largest rate of population growth

1 point earned for naming  $Y$  as the country with the smallest growth/replacement level fertility

1 point earned for a statement explaining why country  $X$  has the largest growth rate *and/or* country  $Y$  has the smallest growth rate (only *first* explanation is graded)

Example: A relatively large segment of the population of country  $X$  is currently in the **prereproductive/reproductive years** and will soon begin having children (giving the population momentum). In contrast, the prereproductive cohorts in county  $Y$  are about equal in size to the reproductive and postreproductive cohorts. (Country  $Y$  exhibits zero population growth/reaches recruitment.)

Notes of things to look for:

- Broad base and pyramid shape indicative of large rate of population growth (population momentum, reproduction, etc.)
- Compare cohort ages of the lower cohorts (must include prereproductive/reproductive or population momentum idea)
- Mere description of the histogram itself earns no credit

### (b) Infant Mortality Rates (2 POINTS MAXIMUM)

1 point earned for stating that country  $X$  has a higher infant mortality rate than country  $Y$ , or that country  $Y$  has a lower infant mortality rate than country  $X$ .

1 point earned for explanation

Examples of accepted explanations:

- Larger drop in population from one cohort to the next in bottom of histogram of country  $X$
- Little change in cohorts on histogram of country  $Y$
- Country  $Y$  probably is an industrialized/developed country (MDC), which usually has a lower infant mortality rate
- Country  $X$  probably is an unindustrialized/developing country (LDC), which usually has a higher infant mortality rate
- Infant mortality is lower in country  $Y$  due to, for example,
  - uncontaminated drinking water
  - better nutrition
  - better health care
  - education of women
- Infant mortality higher in country  $X$  due to, for example,
  - contaminated drinking water
  - poor nutrition
  - poor health care
  - few or no educational opportunities for women

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### (c) Changes in Birth and Death Rates During Transition (3 POINTS MAXIMUM)

1 point earned for *preindustrial phase* (term not necessary): initially birth rate and death rate are both high

1 point earned for *transition phase*: birth rate remains high, death rate declines (because of better health care, etc.)

1 point earned for *industrial phase*: birth rate declines and approaches death rate (mention of postindustrial phase with explanation is acceptable)

### (d) Government Incentives (3 POINTS MAXIMUM)

1 point earned for describing a government incentive to reduce population growth rate (only first incentive given is graded)

#### Examples of Incentives Accepted:

- Free/more accessible/government-subsidized family planning -- must be linked to specific example, such as: free clinical services like birth control, free education about birth control, birth spacing, etc.
- Economic rewards or penalties -- must be linked to specific example, such as:
  - payment for sterilization
  - eliminating income tax deductions for more than one child
  - free health-care benefits for families with 0-1 children
  - free higher education for women/child of single-child family
  - increased social security or pension benefits for couples with 0-1 children
  - better job opportunities for women/couples with 0-1 children
  - monetary bonus at end of year if only have 0-1 children
  - giving free counseling to teenagers that have had a child
  - government subsidized housing if have 0-1 children
  - bonus at end of year if woman remains under single-child limit
  - couples pay a tax for each child after the first one
  - other logical methods of negative economic incentives or rewards.
- Raising legal marriage age
- Specific examples with explanation (e.g., China)
  - paid leave to women for fertility operations
  - monthly subsidy to single-child families
  - job priorities for only children
  - housing preferences for single-child families
  - additional food rations for one-child families
  - monetary compensation for single-child families

#### Examples of Incentives NOT Accepted:

- Decrease immigration – legal and/or illegal. (Because the question refers to current citizens of a country. However, arguments that *definitely* link a government plan to reduce immigration through incentives to citizens, such as rewards for reporting illegal immigrant workers, are accepted.)

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(d) (continued)

1 point earned for explaining how the given incentive works to reduce growth rate of population

### Examples of Explanations Accepted:

- Government provides free education for mother of 0-1 children. This enables the mother to get a better job and make more money. Studies show as women have higher education and better jobs, they tend to have fewer children, thus lowering the population growth rate.
- Government will give free health care to families of 0-1 children. They can then get the necessary medical care to keep that child alive and healthy, as well as themselves. This raises their quality of life and may be a strong incentive to have 0-1 children, thus lowering the population growth rate.

1 point earned for a rational drawback that follows up on the incentive given (acceptable incentive must be given to earn a point for drawback)

### Examples of Drawbacks Accepted:

- Cultural/social issues in countries
- Interference with religious teaching
- Children punished for actions of parents
- Fewer workers to support an aging population/fill jobs/military strength
- Cost of programs to government and citizens
- Difficulty of dissemination of information/enforcement of regulations
- Rewards likely to attract people who already have all the children they want
- Reduced tax revenues
- Civil unrest
- Emigration/immigration with explanation on why a drawback
- Infringement of human rights
- May not work in rural or other areas because of need for child labor
- Increased government spending and debt leading to inflation
- Decreased quality of life for family without children
- Child dies (tied back to incentive)
- Increase in number of abandoned children/orphans
- Consequences/punishment for multiple births (e.g., twins)
- Increase in STDs, unwanted pregnancies, etc., that may accompany free birth control