Qualitative Final Exam Topics for IPOL 512 Fall 2012

The complete list of possible qualitative exam topics will provide the best review (http://institutebishop.org/IPOL_512_Fall_2012_Exam_Topics_Qualitative.pdf), but you might emphasize the following for the final exam. The topics that came from before the midterm and that are still listed here either relate to topics covered since the midterm or are just especially important.

1. Convert between the terms and definitions found in the IPOL 512 Glossary (http://institutebishop.org/Glossary_IPOL_8512.pdf).
2. Describe the factors that determine Earth's energy balance, and describe the factors that could affect this balance.
3. Describe the three fates of solar energy striking Earth.
4. Describe the percentage of the incoming solar energy that is reflected by the atmosphere, absorbed by the atmosphere, absorbed by the surface of the Earth, and reflected by the surface of the Earth.
5. Describe what happens to the solar energy that reaches the surface of the Earth.
6. Describe how the greenhouse effect traps energy radiated from the Earth's surface.
7. List the most important greenhouse gases.
8. Describe what the solar energy reaching Earth is distributed among the hydrologic cycle, the generation of wind, and the biosphere.
9. Describe the factors that could change Earth's energy balance and increase Earth's temperature.
10. Explain how global warming potential (GWP) describes the relative effects of greenhouse gases on global warming, and list the relative GWPs of carbon dioxide, methane, nitrous oxide, CFC-12, and HCFC-22.
11. Describe the atmospheric concentration trends for the greenhouse gases of carbon dioxide, methane, nitrous oxide, and CFCs.
12. Describe the role of humans in the increased concentration of CO_2 in the atmosphere.
13. List at least four biogenic sources and four non-biogenic sources of methane in the atmosphere.
14. Describe the role of humans in the release of N_2O into the atmosphere.
15. Describe the International Energy Agency (IEA) and describe their objectives.
16. Describe the 2 °C Scenario (2DS), and describe how, according to the IEA's ETS 2012 document, we are doing in our attempts to meet the 2DS goals.
17. Describe how carbon capture and storage (CCS) can decrease the amount of CO_2 released into the atmosphere.
18. Describe the recent heat and temperature changes in the ocean.
19. Describe the ocean's effect on CO_2 in the atmosphere, describe the changes in pH and carbonate ion concentration associated with the solution of CO_2 in the ocean, and explain why these changes can be significant.
20. Describe the effect of climate change on the Earth's oceans.

21. For the carbon, nitrogen, sulfur, and phosphorus biogeochemical cycles, answer the following questions.
    What is the **importance** of the cycle to life?
    What different **chemical forms** (species) are involved?
    What are the main **processes and chemical reactions**?
    What are the **stocks and flows** of the element in its different forms?
    What are the **human impacts** on the cycle?
22. Describe how carbon enters and leave the oceans.
23. Describe the human effect on the sulfur cycle that leads to acid rain.
24. Describe the role of phosphorus and nitrogen in the eutrophication of lakes.
25. Describe how ozone is formed and destroyed in the stratosphere.
26. Describe how CFCs and HCFCs can lead to the depletion of the ozone layer.
27. List the most important natural and anthropogenic sources of chlorine in the stratosphere.
28. List the most important natural and anthropogenic sources of bromine in the stratosphere.
29. Describe the Montreal Protocol and describe the effect on the ozone layer if it is followed.

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30. Describe the three forms of acid deposition that lead to acids moving from the atmosphere to the surface of the Earth.
31. Explain why sulfuric acid and nitric acid have a greater effect on the pH of rain and snow than other acids such as carbonic acid, formic acid, and acetic acid.
32. List the most important anthropomorphic and natural sources of sulfur dioxide, SO_2.
33. *Describe how SO_2 forms H_2SO_4 in the atmosphere.*
34. Explain how the sulfur dioxide released in a coal-fired power plant in the U.S. can decrease the pH of a lake in Canada.
35. Explain why the pH of rainfall in 1999 was lower in the Northeastern U.S. than in the Western U.S.
36. List the most important anthropomorphic and natural sources of nitrogen oxides.
37. *Describe how nitrogen oxides form HNO_3 in the atmosphere.*
38. *Explain why there can be brief periods during which pH levels in a lake decrease due to runoff from melting snow. Explain why the runoff can have concentrations 5 to 10 times more acidic than rainfall.*
39. Describe how some of the acid in precipitation is neutralized when it reaches the surface of the Earth.
40. *Describe what an equivalent of a base, such as carbonate, is.*
41. Describe what acid-neutralizing capacity, ANC, represents and explain how it relates to the effects of acid rain on a lake.
42. *Describe what a buffer solution is, and explain how buffers are able to keep the pH of a solution at a relatively constant level even when small amounts of a strong acid are added.*
43. Explain why it is said that healthy lakes have an ANC > 100 μeq/L but that water with an ANC < 50 μeq/L is highly sensitive to problems caused by acidification.
44. *Describe what nutrient leaching is, and explain how acid rain contributes to it.*
45. *Describe what aluminum toxicity is, and explain how acid rain contributes to it.*

46. Describe the impact on acid rain on Freshwater ecosystems, forests, agriculture, human health, and buildings and property.
47. Describe the ways that the effects of acid rain can be mitigated.
48. *Describe the flue-gas desulfurization process.*
49. *Describe the coal gasification process and explain how it can contribute to mitigating the effects of sulfur on acid rain.*
50. *Describe the two ways to achieve air quality standards, command-and-control and market-based mechanisms.*
51. Explain why the concentrations of carbonate, CO_3^{2-}, and hydrogen carbonate, HCO_3^-, are important is natural systems.
52. Explain why increased partial pressure of a gas above a liquid leads to increased solubility of the gas in the liquid.
53. Describe what $[H_2CO_3^*]$ describes in the following equation, and explain why it is in the equation instead of $[H_2CO_3]$.

$$K_{a1} = \frac{[H^+][HCO_3^-]}{[H_2CO_3^*]} = 4.6 \times 10^{-7}$$

54. Describe the variation in $[H_2CO_3]$, $[HCO_3^-]$, and $[CO_3^{2-}]$ in water with changes in pH.
55. *Describe the relationship between rate of change in pH and ANC when acid is added to water.*
56. Describe the effect on coral reefs of the decrease in pH of the ocean, and explain why this happens.
57. Convert among the nuclide symbol, number of protons, number of neutrons, atomic number, and nucleon number (mass number).
58. *Describe the two forces that determine nuclear stability, and in terms of these forces, explain why larger atoms require a greater ratio of neutrons to protons to be stable.*
59. Describe the changes that take place for alpha, beta, and gamma emission, and explain why each leads to products that are more stable than the reactants.
60. List four differences between nuclear reactions and chemical reactions.
61. Explain why a radioactive sample is not gone after two half-lives.
62. Explain why nuclides with relatively short half-lives are found in nature.
63. Explain why alpha particles, beta particles, gamma rays, and neutrons are all ionizing radiation.
64. Describe the effects of ionizing radiation on the human body.
65. List the types of radioactive emissions that can do damage from external sources (external emitters) and those whose source must be ingested (internal emitters), and explain why each type is in each category.
66. List the relative biological effectiveness of gamma rays, X-rays, beta particles, alpha particles, and neutrons.
67. Describe the difference between the deterministic effects and stochastic effects of radiation exposure.
68. Using a graph of binding energy vs. atomic number for nuclides, explain why energy is released when small atoms combine to form larger one (nuclear fusion) and why energy is also released when large atoms split to form medium-sized atoms (nuclear fission).
69. Describe the fission process for uranium-235, and explain how it can lead to a chain reaction.

70. Describe the general structure of a nuclear power plant.
71. Describe the sources of heat in a nuclear power plant, and explain why the core of a nuclear reactor must still be cooled even after the fission reaction has stopped.
72. Describe what happens when uranium-238 atoms absorb neutrons, explain how this affects the need to enrich uranium in U-235 for use in nuclear power plants, and explain how this relates to the reprocessing of spent nuclear fuel.
73. *Describe the role of a moderator in a thermal nuclear power plant, and explain how the use of a moderator affects the percentage of uranium-235 necessary for the reactor.*
74. Describe the roles of control rods in a nuclear reactor.
75. *Describe what prompt neutrons, prompt criticality, and delayed neutrons in nuclear reactors are, and with reference to them, explain how nuclear reactors can run below prompt criticality.*
76. Describe the nuclear fuel cycle, including the source of uranium, the enrichment process using gas centrifuges, the storage of depleted uranium, fuel reprocessing, and the possibilities for the ultimate storage for nuclear wastes.
77. Describe what spent fuel rods from nuclear reactors contain.
78. Describe the process of removing plutonium from spent fuel rods, and explain why this process is cause for concern.
79. *Describe the status of nuclear power in the world and in the U.S.*
80. *Describe the effects that the Fukushima Daiichi accident has had on nuclear power as a source of electricity.*
81. Describe the level of carbon emissions from the operation of nuclear power plants, and describe the impact on CO_2 levels in the atmosphere from the retirement of nuclear power plants.
82. Describe the sequence of events that led to the Fukushima Daiichi accident (including how the core came to be exposed, the reason for the fuel cladding breaking and releasing fission products, how hydrogen gas was generated, why the core melted, why the pressure built up in the containment vessel, why the containment vessel was depressurized and the pros and cons of doing so, why the hydrogen burned, and why the fuel rods in the spent fuel ponds melted), and describe the results of the accident.
83. *Describe the percentage of heat released from the fission products (1) immediately after SCRAM, (2) 1 day after SCRAM, and (3) 5 days after SCRAM.*
84. *Describe the radioactive substances that were released in the Fukushima accident.*

Student Presentations

Climate Change Resources

Name three government or UN supported organizations which research or create strategies to address Climate Change?

Name at least two non-governmental and non-UN climate change focused organizations, their purpose (as an organization) and their sources of funding.

Name at least two climate change skeptic think-tanks or organizations. Discuss the organization's main goals and explain how they receive their funding.

Discuss the United Nations Frameworks Convention on Climate Change. In particular, discuss where it took place and its main objectives.

Evidence of Climate Change

Describe the different effects global warming is having on the Arctic and Antarctic Sea Ice--include what the trends have been for each over the past two decades?

Why is the melting of the majority of global glaciers a concern to people?

What climate change events are contributing to coral bleaching? Describe the climate change factors, coral bleaching, and how coral is being affected.

What is "local" or "relative" sea level rise?

Global warming increases the number of droughts, but also increases the number of intense rainfall events. Explain how this is possible.

Name two primary issues concerning the existence/cause of climate change. In other words, why are so many people still skeptical about climate change?

Energy Balance Models

Explain the importance of the Albedo effect.

Explain the difference in Earth's energy balance when assuming the earth to be a black body compared to its real emissivity.

Explain the different ways Earth's surface cools.

Global Warming Potential

What factors are taken into consideration when determining global warming potential of greenhouse gases?

How is a CO_2 equivalent calculated (qualitative description) and why is it used?

Why is the time horizon important to take into consideration when discussing GWP?

How might a GWP change over time and what would cause this change?

Positive and negative radiative forcing from aerosols

- Describe the effects of aerosols in both the lower and upper atmospheres.
- How do aerosols contribute to the ozone hole that is formed in polar regions during the winter months?
- Explain why the net effect of aerosols in the atmosphere is a cooling effect. What are the implications of this for climate change policy?
- Name 2 anthropogenic and 2 natural sources of aerosols in the atmosphere.

Positive and Negative Feedbacks

- Give 2 examples of positive climate change feedback cycles, and explain their effect on global warming.
- Give 2 examples of negative climate change feedback cycles, and explain their effect on global warming.
- Explain why the Arctic experiences an amplified global warming effect.

Climate Change Mitigation Strategies

- Socolow:
  - What is the "stabilization triangle"?
  - What is a "stabilization wedge"?
  - How has this approach changed over time?
- McKinsey:
  - How does the McKinsey Cost Curve approach climate change mitigation?
  - What are some critiques of the McKinsey Cost Curve?
- Theory to Practice:
  - What sorts of mitigation measures might require prescriptive/command and control regulation? Market-based regulation?
- McKibben:
  - What are the three types of numbers we should be concerned about for mitigating climate change?

Scenarios for the future - Special Report on Emissions Scenarios (SRES) reported by the Intergovernmental Panel on Climate Change (IPCC)

- Why was the Intergovernmental Panel on Climate Change Special Emission Scenario Report (SRES) published?
- What are the main economic and social drivers of the A1, A2, B1, and B2 scenarios described in the SRES?
- What are some of the potential consequences associated with each of the scenarios described in the SRES?
- Which scenario from the SRES most closely matches our current scenario?

United Nations Framework Convention on Climate Change and the Kyoto Protocol

What's the key difference between the UNFCCC and the Kyoto Protocol?

What are some failures and/or challenges related to the Kyoto Protocol?

What do climate change advocates hope to see achieved at the upcoming Doha Conference?

What are states in the U.S. and other countries doing?

Describe the national policies of two high ranking countries on the Climate Change Performance Index.

The Endangerment Findings: Under the Clean Air Act, in 2009 the 6 greenhouse gases the EPA found were a threat to public welfare are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

The 2012 Fuel Efficiency Standards will decrease emissions from vehicles by half by the year 2025. What other benefits will the Fuel Efficiency Standards have?

Describe how California's Cap and Trade System works.