SCIENCE TEXTBOOK ACCURACY REVIEW FORM
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## ACCURACY REPORT

1. On page 4 , last paragraph before the "Materials and Technology" section, the author makes an overly simplistic and incorrect implication that harnessing of solar energy has no detrimental effects on the environment. This is a serious error. The author's point about the direct emissions from fossil fuel burning is well taken. However, the fact is that all human activity affects the environment. The difference is a matter of degree in their effect. A caveat should be used that manufacture of the apparatus used and its placement in a local environment results in some environmental impact. An example follows:

"Harnessing solar energy does not directly emit such harmful pollutants and offers a 'cleaner' source of energy. Even such 'environmentally-friendly' technology impacts the environment from the manufacture of its components and local placement, but offers opportunities to increase energy supplies with less environmental impact, albeit at higher energy prices."

In this early section of the textbook it is difficult and not pedagogically necessary to expand on such a complex issue.

2. On page 9 and later page 47, the author claims only 83 elements "…occur naturally on Earth." The consensus has been that the "naturally occurring" elements come from the atomic numbers 92 and less. Technetium and promethium are generally agreed to not "naturally occur" on Earth, as their half lives are too short to be currently present in any significant amounts from the primordial matter that resulted in the proto-Earth, and occur now as fission products from man-made activities, defined as "not natural." This is a serious error or discrepancy. I believe the problem here is one of semantics or definition. I infer from later sections in the book that the author does not consider any elements to be "naturally occurring on Earth" with the following characteristics: (1) no stable isotopes, only radioisotopes, (2) atomic number of 92 or less, and (3) not present "naturally" as is the case for Tc and Pm or present only in natural radioactive deposits in vanishingly small amounts as decay chain byproducts in secular equilibrium with "natural" U and/or Th. There are 9 elements that meet this definition: Tc, Pm, Pa, Ac, Ra, Fr, Rn, At, and Po. Removing these 9 from the first 92, leaves the 83 "naturally occurring elements to which the author refers I believe. The author did not list these, so the list is inferred. However, despite this assertion, the last 7 are naturally occurring wherever U and/or Th is found on Earth. Since U and Th are ubiquitous, that means they are pretty much everywhere. At least 3 of these play an important role in human lives and history and have nothing to do with mankind's venture into atomic power and its subsequent legacy of radioactive waste. These 3 are Ra, Rn, and Po. Ra was separated and identified by Madame Curie and used for luminescent watch dials, to the detriment of the workers that painted these dials. Rn is the single largest contributor to our background or "natural" dose of radiation that everyone continually receives. Po has been identified as a possible culprit in lung cancer from its presence in tobacco. For these reasons, I believe the error is serious at this level of education. The author should at least define what he means by "naturally occurring" and acknowledge the "natural" presence of the decay chain products wherever U and Th are found, which is pretty much everywhere. Leaving high school students with the impression that these radioactive elements have not been present naturally throughout Earth's history is wrong. A long explanation is not needed, if the number designated as "natural" is changed to 90 rather than 83. Whichever number is adopted, a footnote or paragraph should identify which elements out of the first 92 are the outliers and some explanation. An example follows:

"The elements past atomic number 92 are considered 'manmade' and do not occur naturally on Earth. Of the remaining 92, several are not stable and only occur as radioactive isotopes. Of these, two — technetium and promethium — are not present among the 'naturally occurring' radioactive elements on Earth. Their half-lives are short compared to the Earth's age and they are not continuously produced from the radioactive decay of the long-lived radioactive elements that do occur naturally: uranium and thorium. Hence, they cannot be found among the natural radioactive elements found worldwide. Thus, only 90 elements occur 'naturally' on Earth."

The definition of "naturally occuring element" is open to interpretation.

3. On page 75, last sentence before Sect. 3.5, "spectrometer" should be "spectrometry." This is a typographical (typo) error.

This will be addressed in reprint.

4. On page 79, the author unnecessarily inserts a politically controversial claim for vitamin C, curing the common cold, into Example 3.9. This is a serious error. Even though the author properly caveats this possible benefit with "may," I am not sure I would insert this controversial claim into a high school textbook. If you do, you are obligated to present both sides of this debate for a textbook. Instead only a passing reference is made to this claim and the average person would tend to only remember the claim, not the caveat, making them easy future targets of vitamin C vendors. Hopefully future debate and unbiased data will help settle this issue. Right now I see even highly educated people accepting this theory, as though the issue is settled. From what little I know about this subject, the blind studies conducted to date have not revealed any significant benefits. Future work may eventually vindicate Linus Pauling's claims, but he had not replicated the careful science he used on understanding protein structure and folding and he blew off the independent studies conducted to study his many claims. For these reasons, I believe this is a serious error for a high school textbook.

The author stands by his assertion that vitamin C may cure the common cold.

5. On page 124, the two metals being displaced in the example given in the last paragraph are not listed among the metals in Fig. 4.15. This is a serious error. Why present all those other metals and not the two the author is using in his example? This oversight will lose many students having trouble following the steps being used to determine displacement reactions and whether they are favored. V and Ti should be added to Fig. 4.15 or a different displacement reaction should be used in the examples given that uses metals listed in Fig. 4.15.

The author does not feel it is practical to list all the metals is Figure 4.15

6. On page 163, Fig. 5.8 shows liquid Hg above a gas phase. This is a typo error. The correct apparatus is shown in Fig. 5.5 or conceptually in Fig. 5.6. The space in the margin limits showing the apparatus. I suggest keeping the figure the same size and changing to the piston concept as used in Fig. 5.6, rather than showing the unrealistic situation of liquid Hg suspended above a gas.

The author does not agree. There is nothing wrong with showing a liquid (mercury or water) over gas like in Figure 5.8. If you try to pour a liquid down narrow tubing, you'll find the liquid does not reach the bottom because of the trapped air.

7. On page 164, second paragraph about mid-page, "amount" should be plural as "amounts," to reflect that both the gas and volume are constant for the P-T discussion. This is a typo.

This is a typo now that I look at it and will be addressed in the appropriate reprint..

8. On page 218, the red print in the margin is faint. This is a typo and results from the printing process rather than the manuscript preparation.

We could not see this on our copies.

9. On page 402, fourth paragraph just below mid-page about He2+, it is not clear whether H should not be He in the second sentence, but I had trouble following the dialogue in this paragraph. This paragraph needs to be clearer. This is a typo.

We could not find the error indicated by the reviewer.

10. On page 718, the claim is made that nuclear power plants are more prone to accidents than conventional power stations and refers the reader to Chapter 23. This claim is not true and the discussion in Chapter 23 does not support the claim. This is a serious error. In the history of commercial nuclear power, there have been only two documented accidents, hardly an indication of being prone to accidents. The author gives careful balanced arguments in most of the textbook-Hazard analysis of power production indicates that the greatest loss of life is most likely from hydroelectric power (dam collapse), not nuclear accidents. Historically, more radioactivity is emitted from coal-fired plants (naturally-occurring radioisotopes from smokestacks) than nuclear power plants during routine operation (not addressing the worst case accident scenarios). This is not to minimize, the possible serious consequences of an accident at a nuclear power plant. By all means, discuss the large energies from nuclear reactions and the radioactive fission products that result in the waste and the need to resolve the waste disposal issue.

Nuclear chemistry is a broad and complex area. In the typical introductory college or advanced placement high school chemistry course, this topic would be covered in a very short period of time. This limits the depth at which the topic can be covered in a text. The additional coverage the reviewer looking for may be technically correct, however, the author believes his coverage of this topic is appropriate for the time available for instructors and students at the introductory level.

11. On page 927, strontium-90 is given as an example of a fission product with a long half life and plutonium-239 is identified as one of the most toxic substances known. This is a serious error. Strontium-90 has a half life of only about 30 years, which may be long in terms of a human life, but is not a long-lived radioisotope. A more appropriate example would have been technetium-99, which is also a bone seeker like strontium-90 but has a half life close to 100,000 years. Actually, many of the chemical poisons already discussed in this book are far more toxic than plutonium-239. Ingesting cyanide or inhaling hydrogen cyanide or carbon monoxide will kill far quicker than plutonium-239, not to mention many deadly poisons found in nature. The point about plutonium needs to be put in context. Plutonium itself is not a deadly poison. In fact, ingested plutonium oxide might be excreted without any long term harm, which is not the case for most poisons like cyanide. The context for plutonium oxide is inhalation and lodging in the lungs can lead to cancer over decades. Plutonium-239 emits alpha particles and has the highest alpha surface activity of all the long-lived radioisotopes. Alpha radiation does little harm externally, but great harm internally, lodged in the lungs. These statements about plutonium toxicity result from the fact that only an incredibly small particle or quantity need be lodged in the lung to result in high risk of lung cancer in a matter of decades. Thus, one tiny submicron particle of plutonium-239 in the lung could be equivalent to a lifetime of smoking (I do not know the actual equivalence of risks, but the Pu-239 lodged in the lung continually emits its damaging alpha over the years and decades, the same as one continually bathing the lungs with damaging cigarette smoke). That is why aerosols of Pu-239 and other alpha emitters are considered such health risks. This is not the same risk as deadly toxins and what=y statements such as “the most deadly toxin known to mankind” are inflammatory and not accurate. Comparing Pu-239 to poisons like neurotoxins or orthophospates is comparing apples and oranges. Pu-239 will not kill quickly and efficiently like such poisons, but it is a deadly contaminant and one must avoid inhaling it.

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12. On page 927, the accident at Three-Mile Island is cited as first bringing the hazards of nuclear power to public attention. I disagree with that statement. This is a typo or minor error. Those hazards had been debated for many years. This accident certainly was the most widely publicized event up to that point and can be viewed as the trigger event in the loss of economic attractiveness of nuclear power. From a safety standpoint,

the safety systems worked as intended even when operators made serious errors of judgement, little radiation was released, and no deaths resulted.

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13. On page 927, the accident at Chernobyl with its loss of life and spread of contamination is presented in the same paragraph as the one at Three-Mile Island without any explanation of the big differences between these two accidents. This is a serious error. The author gives a good explanation of light water reactors (LWR), such as at Three-Mile Island, in earlier sections, but not the Soviet graphite design used at Chernobyl. These differences are important in the differences between the consequences of these accidents. Loss of the cooling water in LWRs results in loss of moderation and shutdown of the nuclear reactions (besides the automatic insertion of control rods and emergency core coolant flow during an accident), making the design inherently safer than the graphite reactor (graphite is the moderator, so loss of the cooling gas flow does not affect moderation and shut down the nuclear reactions).

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14. On page 935, Table 23.6 lists a dose of 2 mR/yr from nuclear waste. This could be a serious error, depending on the source of information. I have seen all of the other sources before in similar tables, but not that one.. Perhaps this is an estimate of the contamination now estimated released over 50 years of the cold war, but these are mainly local, not the general population. A pie chart on page 725 may be similarly flawed about the estimate of man made radiation contribution to background, but I am less concerned about it. The other contributions in the pie chart seem about right, just not sure if the other man made is as high as 3%, but should be in the ball park of 1-3%.

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