**My Assessment**

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**Motivation of the Problem**

• Why is this problem important in chemistry/materials science?

Protonic ceramic electrochemical cells (PCECs) are promising energy storage technologies due to their high performance and ability to convert several gas feedstocks into value-added chemicals. However, the design of the anode is integral to optimizing the performance, efficiency, and durability of the cells, making it a critical area of research and development.

• What challenges exist in solving this problem using traditional LLM approaches?

Solving problems with the traditional LLM approaches gives conclusion at every prompt and that usually will not give a sense of probing the situation further. It appears everything has been done. It is time-consuming as they give lengthy responses, and you have to think and read through all responses to be able to generate probing questions.

• How could a structured Socratic approach improve reasoning and outcomes?

A structured Socratic approach can significantly enhance reasoning and outcomes by fostering critical thinking, encouraging deep exploration of ideas, and promoting collaborative learning. It saves time and helps with identifying important questions to come up with and in refining individual thoughts and probing questions.

• The specific sequence of Socratic principles applied (e.g., Definition → Hypothesis Elimination → Dialectic → Analogy).

• Justification for choosing this approach—link to the scientific method if possible.

**Initial prompt** (automatically selected by SM): Hypothesis Elimination, Definition

**1st follow-up prompt** (manually selected from suggestions): Definition → Hypothesis Elimination

* The Socratic assistant’s suggestion to the initial prompt was examination and definition of parameters for the anode design. The hypothesis elimination dug deeper to be specific with the parameters instead of being general which kind of make sense. It would not go through the route of assuming common parameters with electrolyzers which are also function dependent. It sets the tune of what should be sorted.

**2nd follow-up prompt** (automatically selected by SM): Definition → Hypothesis Elimination

It came up with some answers and further push for what is specific for the PCEC anode> This is done after Identifying a material towards the anode design as asked. It further drove into variant and peculiar materials that suit the purpose.

**3rd follow-up prompt** (manually selected from suggestions): Elenchus, Recollection

This examines the properties of the suggested materials at large and the challenges for the anode function.

**4th follow-up prompt** (manually selected from suggestions): Elenchus, Analogy, Induction

This examines the design approach for the anode side of the PCEC and suggests effective advancement in the field.

**5th follow-up prompt** (manually selected from suggestions): Elenchus, Analogy, Induction

This discusses one of the suggested design techniques and compared with other methods for the same purpose,

**6th follow-up prompt** (manually selected from suggestions): Generalization, Recollection, Induction

It dug dept into recent successes of the selected design technique

**7th follow-up prompt** (manually selected from suggestions): Generalization, Recollection, Induction

**7th follow-up prompt** (manually selected from suggestions): Generalization, Recollection, Induction

**7th follow-up prompt** (manually selected from suggestions): Elenchus, Analogy, Induction

**What Are the Prompts Used?**

• The initial user input or problem statement.

• The system reformulation into Socratic prompts.

• The follow-up questions guiding the LLM through structured reasoning.

• Indicate whether the model-generated follow-up prompts were used or if you created your own.

Check the other document “downloadedArgoTranscript\_ljolaoso.docx”.

**What Are the Outcomes of This Example?**

• How did the LLM refine its answers over iterations?

It refined its answers very well with brevity as it goes series of follow-up questions, this drives the answers toward the potential need. In all cases concluding answers were not given.

• What key insights or discoveries emerged?

The Socratic assistant revealed an important point, as it mentioned knowledge on the mechanisms of aliovalent doping and its effects on material properties.

• Any unexpected results or challenges?

Yes, sample of the concept mentioned which I am personally not familiar with.

**Comparison to a Non-Socratic Approach**

• How did reasoning depth, self-correction, and hypothesis refinement compare?

Comparing the SM and the non-SM might be regarded as two different tools with similar and varying functions. The non-SM gives lengthy and more comprehensive answers with usually no follow up question ideas, it also concludes. The SM is brief and with a lot of questions and suggestions.

• Would a traditional direct-answer prompt have produced different results?

NO

• Did the Socratic method improve clarity, adaptability, or accuracy?

Yes. it did improve clarity.