

# SYSTEMIC MULTIPLE CHOICE QUESTIONS IN CHEMISTRY

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**19th ICCE, Seoul, Aug. 12-17 (2006)**

In the last nine years, we have designed, implement, and evaluated the systemic approach to teaching and learning chemistry (**SATLC**)[1-4]. In continuing this work, we have designed a new kind of objective test based on systemics, which is presented here.

The questions in objective tests require a very short answer. The questions are related to facts (thus, objective) which have unequivocal answers. Objective questions can be multiple choice, true/false, and fill in the blank. The scoring procedure for an objective test is completely specified enabling agreement among different scorers. Traditional objective tests are usually good instruments examining the recall of information and the application of terms, but they cannot assess learning beyond comprehension. However, systemic objective tests can challenge students and potentially can test higher learning levels (e.g., analysis, synthesis, and evaluation in Bloom's taxonomy [5,6]).

We illustrate here examples of systemic multiple choice questions that can form the basis of conventional objective tests and which require a choice from a list of possible systemic-related answers. Each systemic choice represents three to five physical, or chemical relations, between concepts, atoms, or molecules.

Various types of systemic multiple choice questions from the fields of general, organic, heterocyclic, and physical, chemistry are presented here.

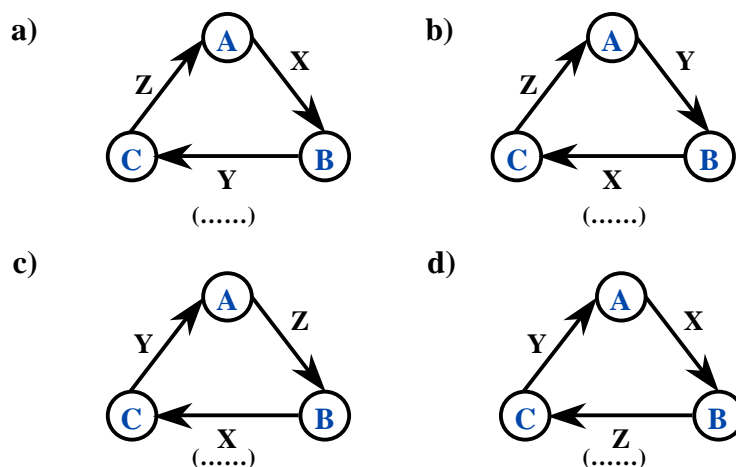
## Type (I): Choices from among triangular systemics:

### General Description:

Which of the following systemic diagrams represents the correct relations between (A→C)? Indicate the correct systemic diagram by a (✓):

(A, B, C) are concepts, atoms, or compounds.

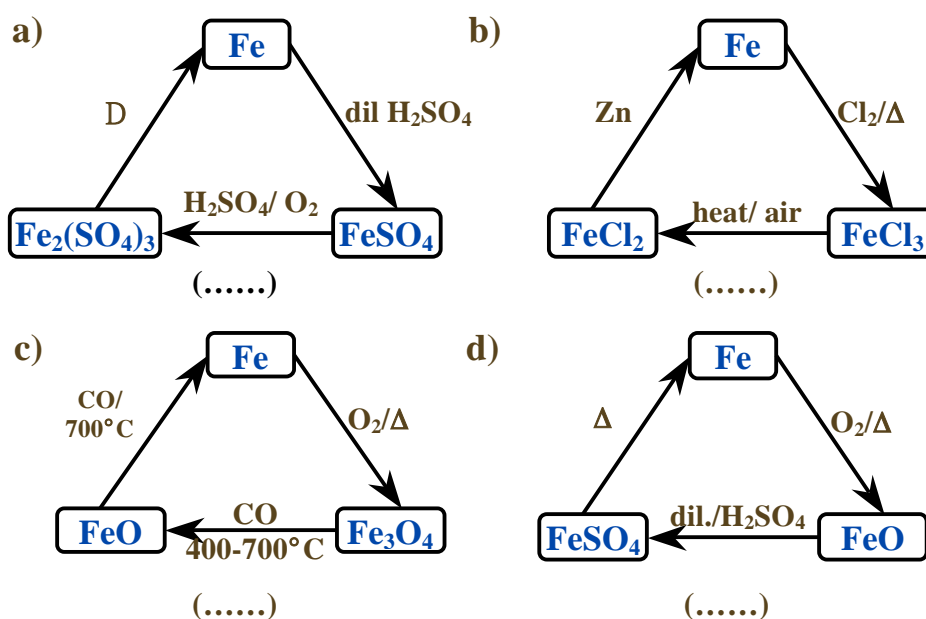
(X, Y, Z) are physical or chemical relations.



Correct answer (✓) is (a)

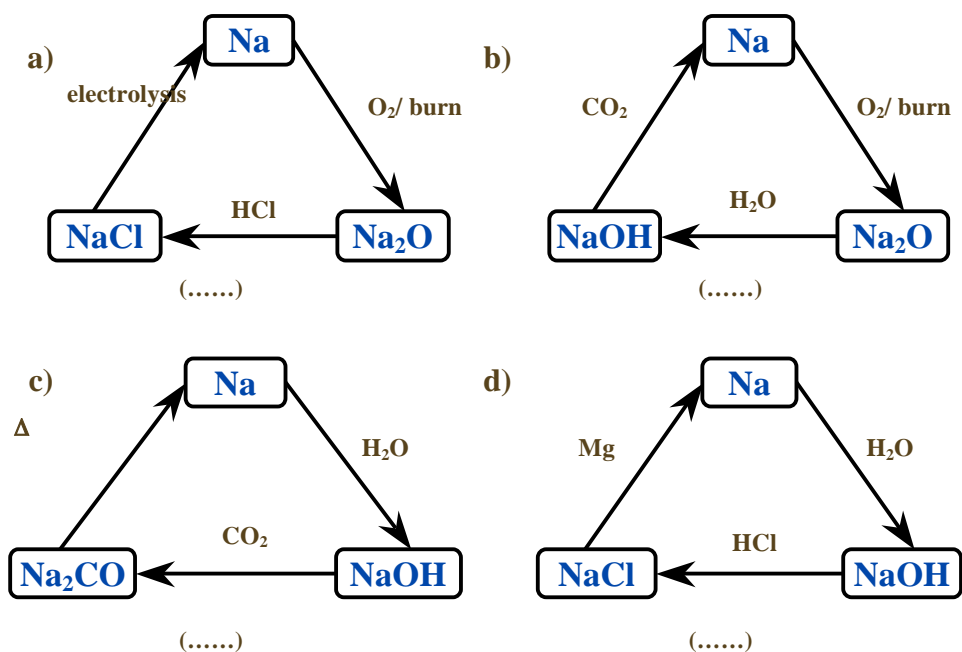
### Specific Examples:

Q1. Which systemic diagram represents the correct chemical relations between iron and its compounds?



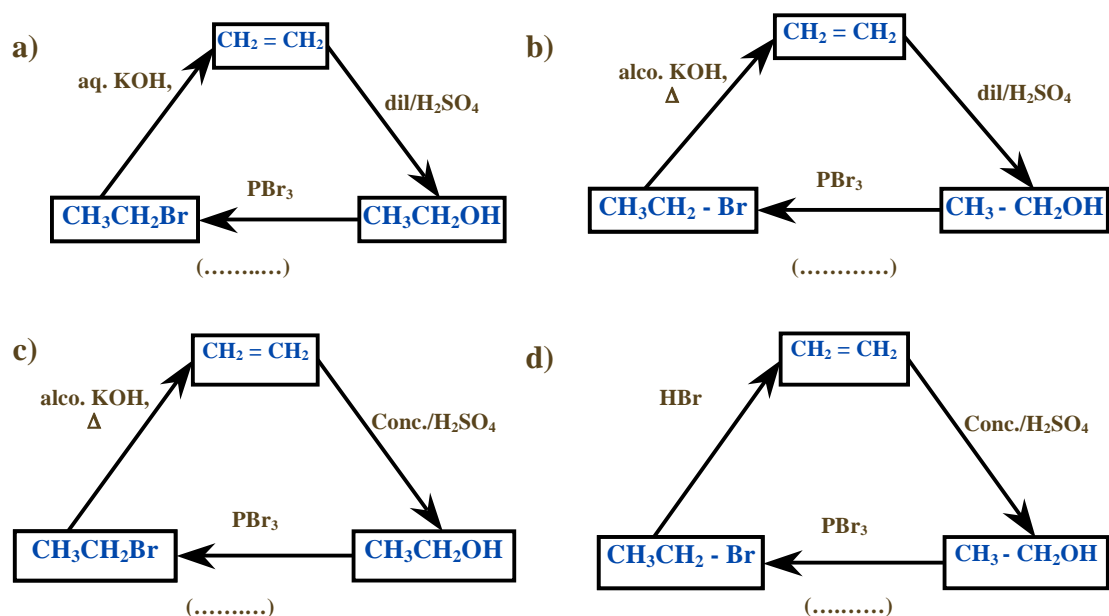
Correct answer (✓) is (c)

**Q2. Which systemic diagram represents the correct chemical relations between sodium and its compounds?**



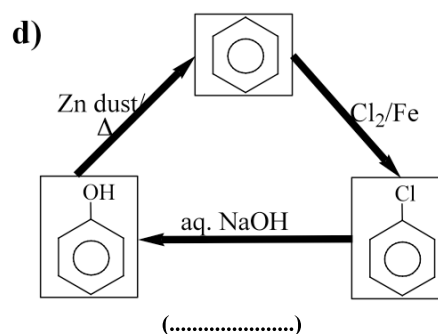
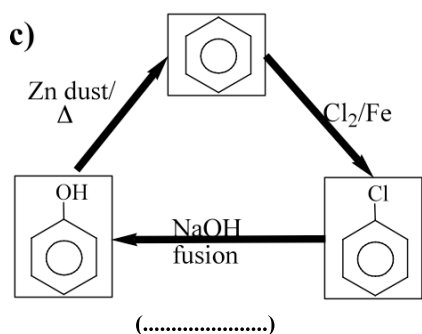
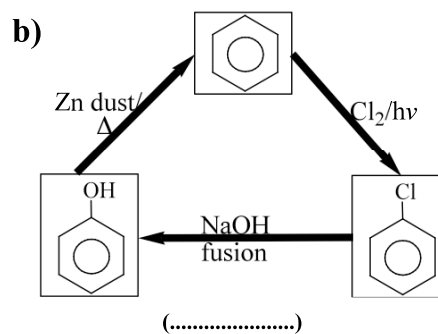
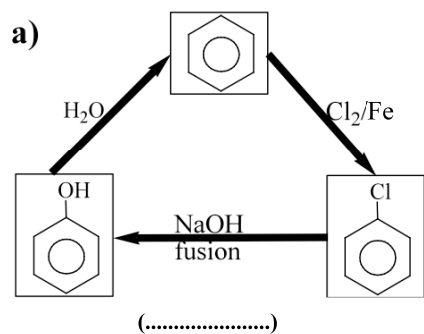
Correct answer is (✓) (a)

**Q3. Which systemic diagram represents the correct chemical relations between ethylene, ethanol, ethyl bromide?**



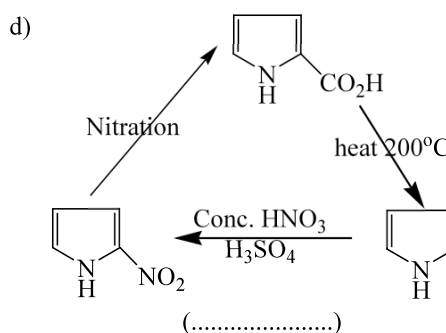
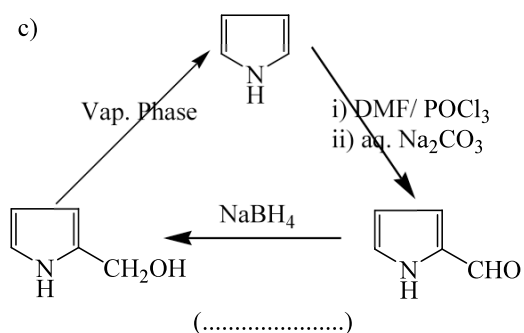
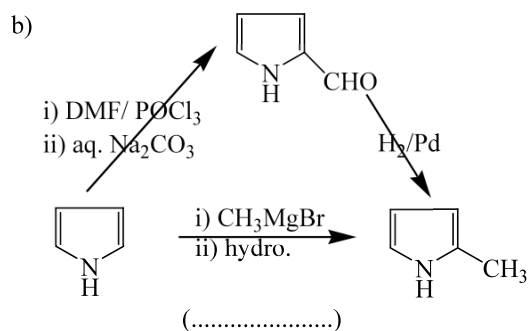
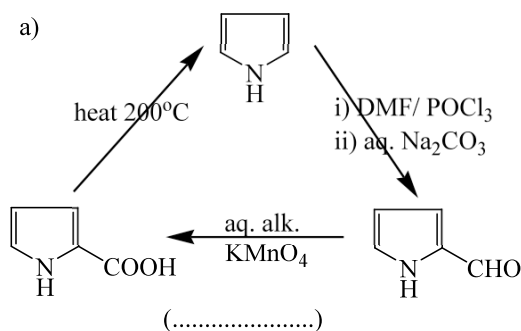
Correct answer (✓) is (b)

**Q4. Which systemic diagram represents the correct chemical relations between benzene/ chlorobenzene, and phenol?**



Correct answer is (✓) (c)

**Q5. Which systemic diagram represents the correct chemical relations between pyrrole and its related compounds?**



Correct answer (✓) is (a)

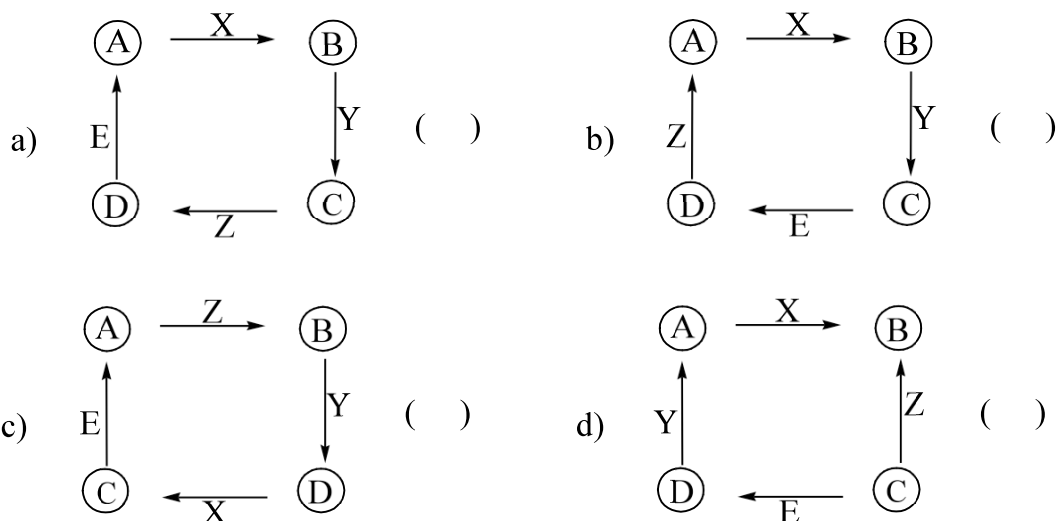
**Type (II): Choices from among quadrilateral systemics:**

**Q1. Which systemic diagram represents the correct relations between (A→D)**

**Indicate the correct systemic diagram by a (✓):**

(A, B, C, D) are concepts, atoms, or compounds.

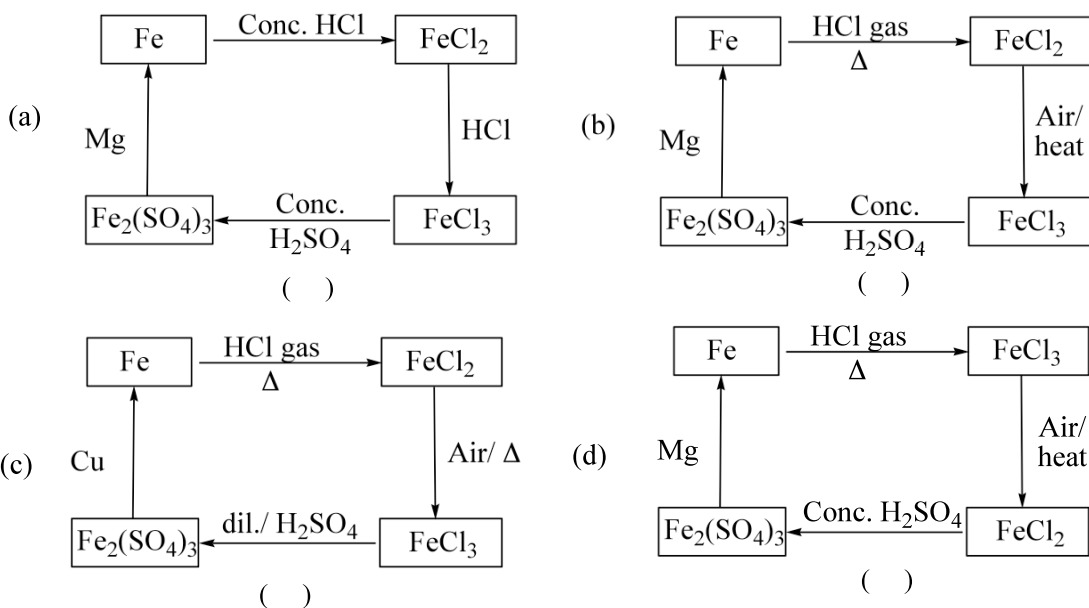
(X, Y, Z, E) are relations.



**Correct answer (✓) is (a)**

**Specific Examples:**

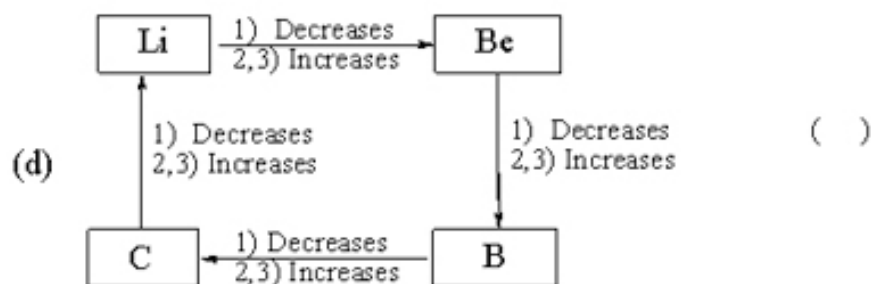
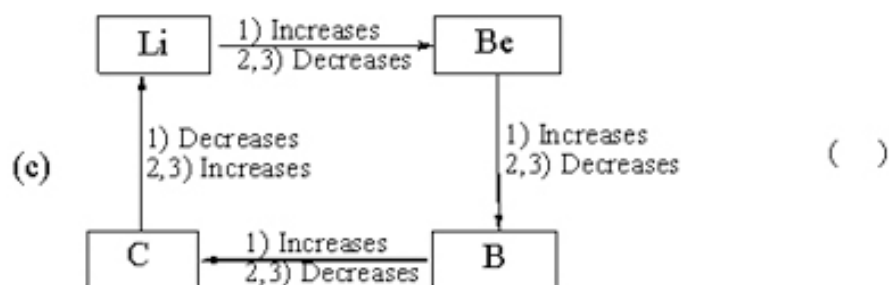
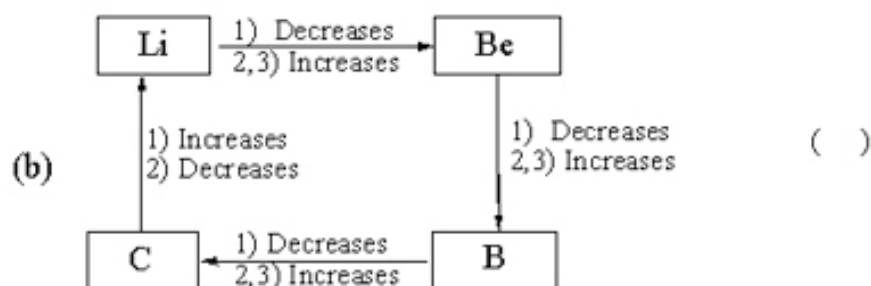
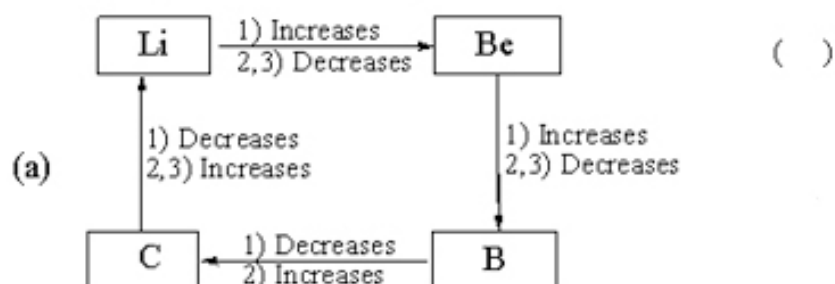
**Q1. Which systemic diagram represents the correct chemical relations between iron and its compounds?**



**Correct answer (✓) is (b)**

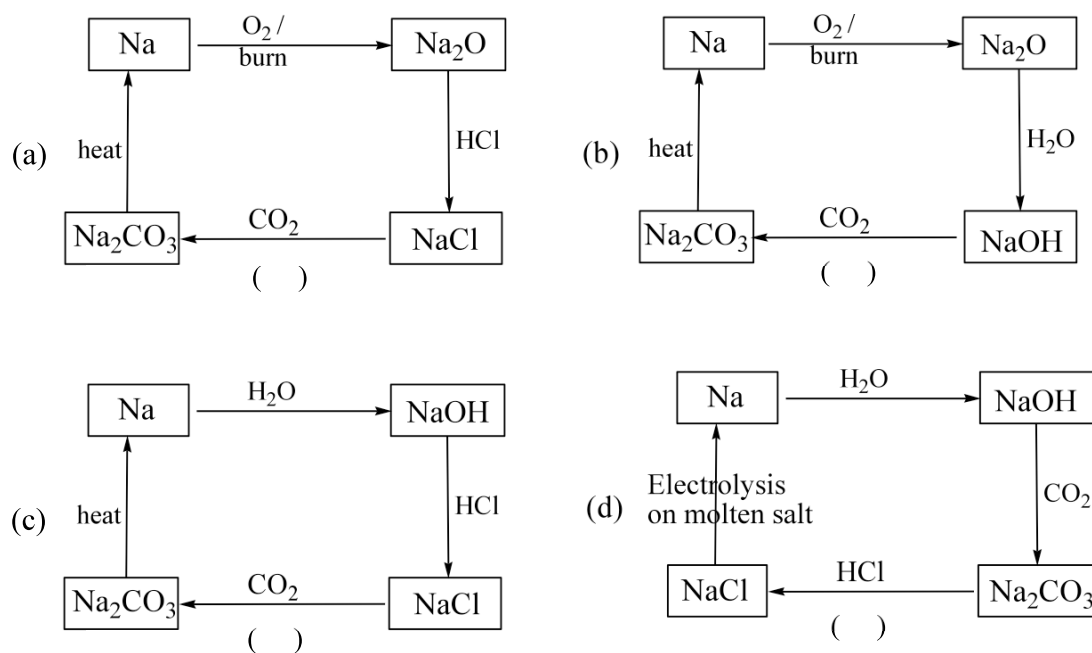
**Q2. Which systemic diagram represents the correct sequence of physical properties?**

No.	Property
1	Electronegativity
2	Metallic property
3	Atomic radius



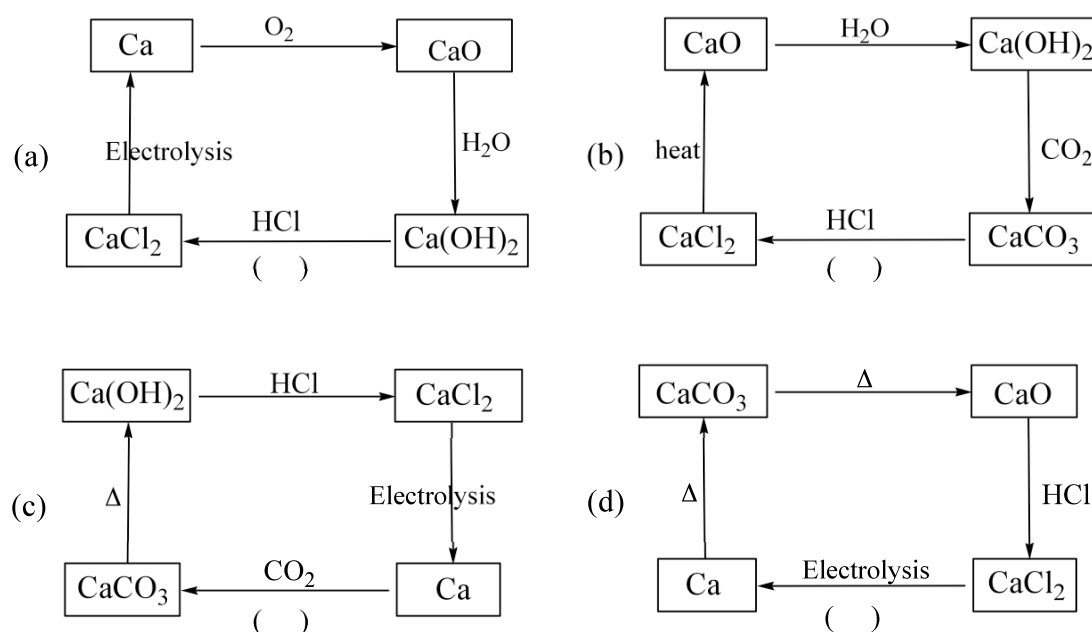
**Correct answer (✓) is (c)**

**Q3. Which systemic diagram represents the correct chemical relations between sodium and its compounds?**



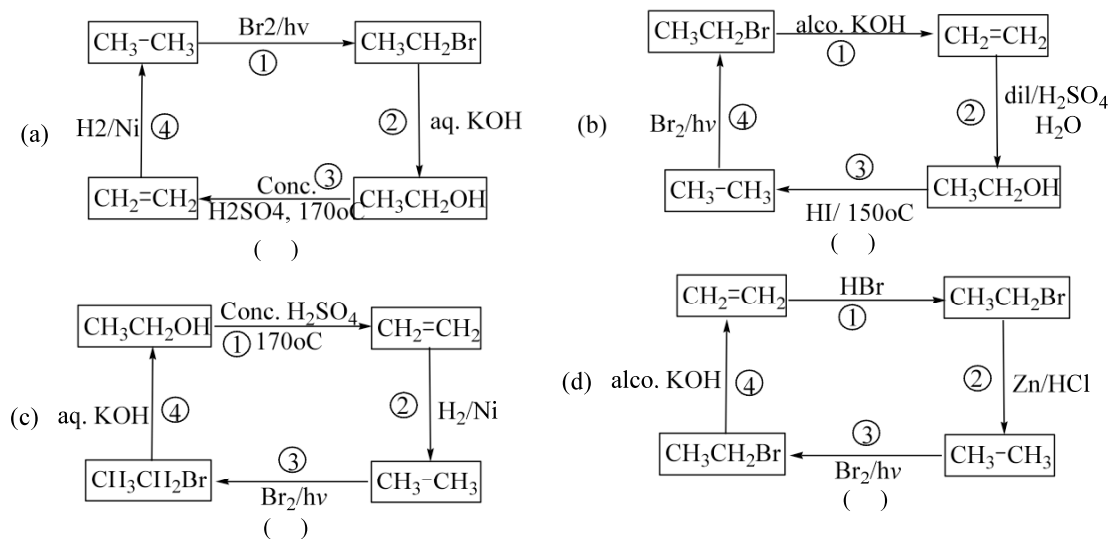
**Correct answer (✓) is (d)**

**Q4. Which systemic diagram represents the correct chemical relations between calcium and its compounds?**



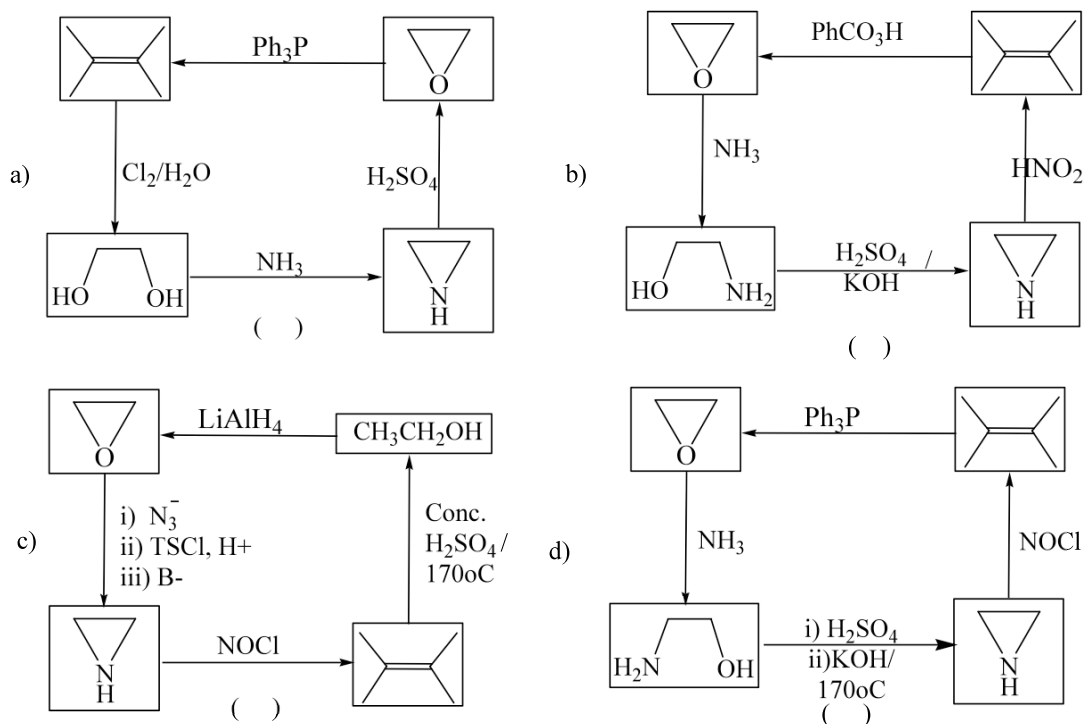
**Correct answer (✓) is (a)**

**Q5. Which systemic diagram represents the reaction sequence Substitution – Substitution – Elimination – Addition?**



**Correct answer (✓) is (a)**

**Q7. Which Systemic diagram represents the chemical relations between oxirane, aziridine, ethanolamine, and ethylene?**



**Correct answer (✓) is (b)**

**Type (III): Choices from among pentagonal systemics:**

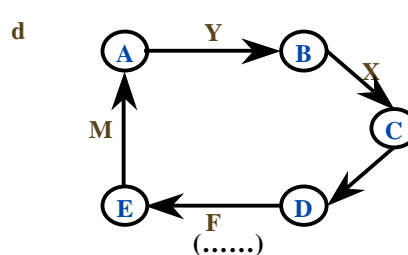
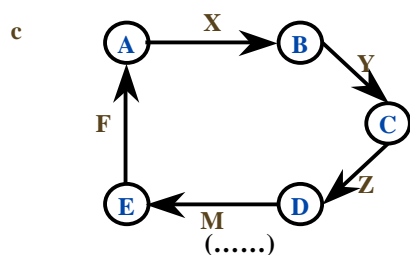
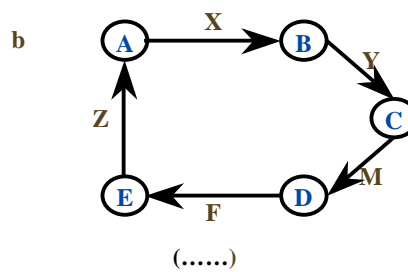
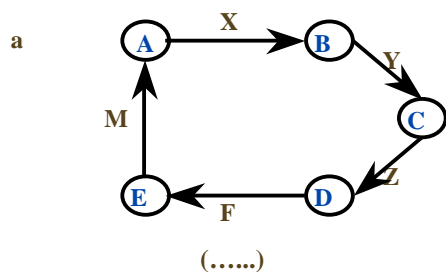


Which systemic diagram represents the correct relations between (A→E)?

Indicate the correct systemic diagram by a (✓):

(A→E) are concepts, atoms or compounds.

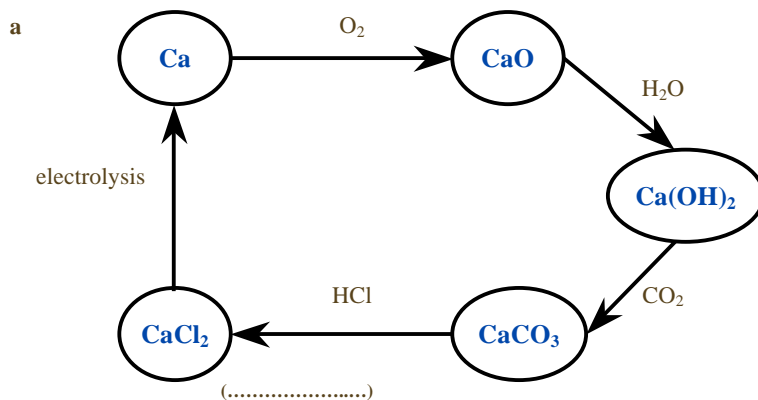
(X, Y, Z, M, F) are physical or chemical relations.

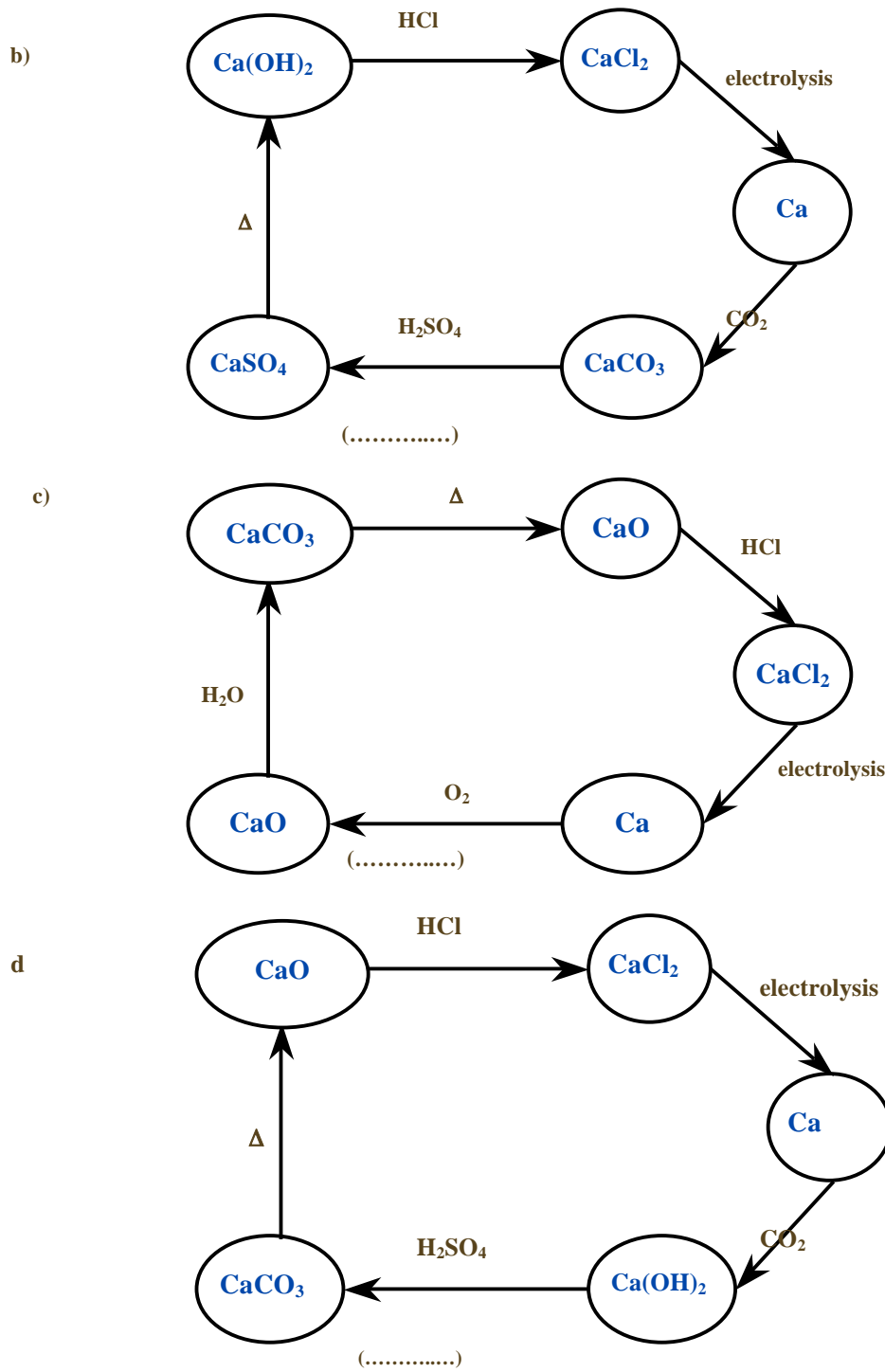


Correct answer (✓) is (a)

### Specific Examples:

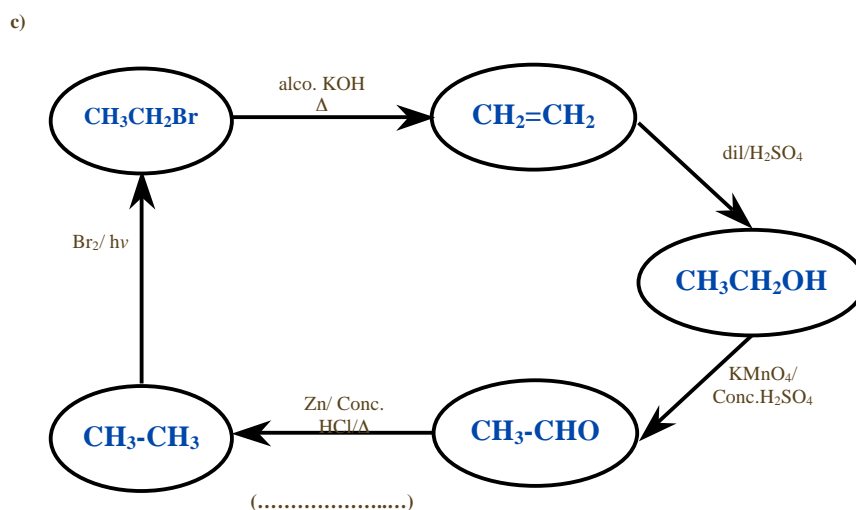
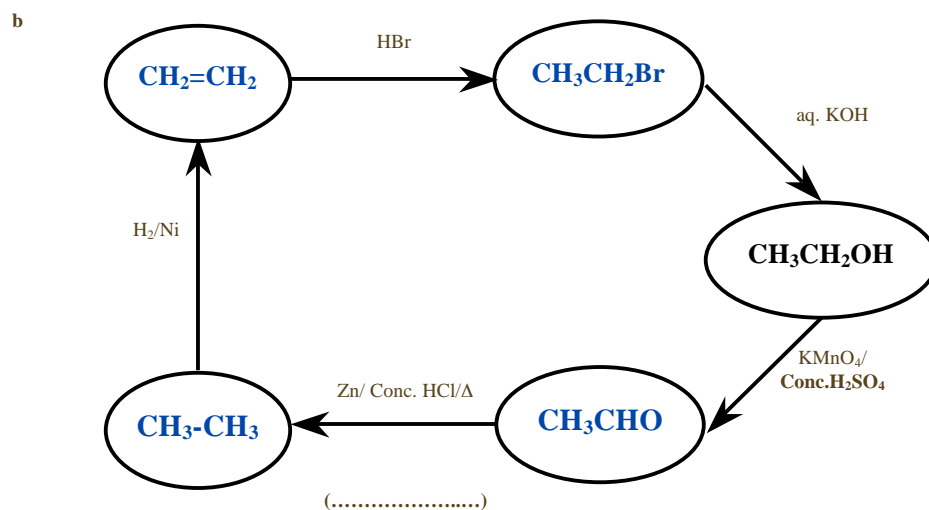
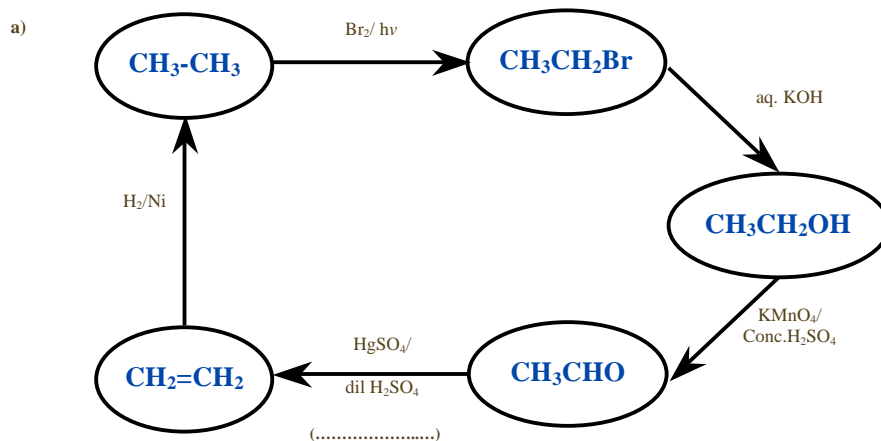
Q1. Which systemic diagram represents the correct chemical relations between calcium and its compounds?

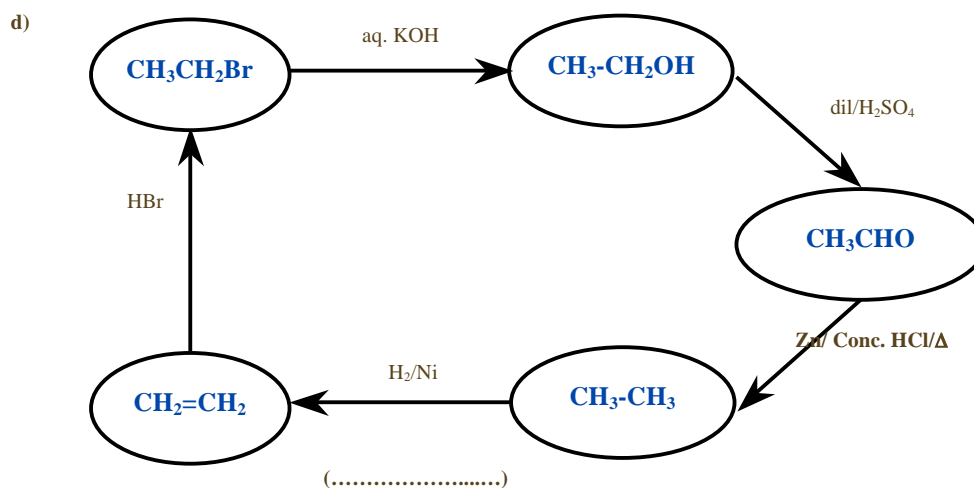




Correct answer (✓) is (a)

**Q2. Which systemic diagram represents the correct chemical relations between ethylene, ethane, acetaldehyde, ethylbromide, and ethanol?**





Correct answer (✓) is (c)

## CONCLUSIONS

We have shown how the ubiquitous multiple choice format for questions can be adapted to evaluate student learning using the systemic method of teaching. These kinds of questions probe the student's ability to make maximum connections between classical concepts, elements, compounds, and their reactions. Additionally, students' recognition of patterns of connection instead of the individual convictions is an important outcome of teaching and learning. Using systemic methods are important outcomes of that process and the evaluation technique described here probes that characteristic.

### Keywords:

Systemics, objective tests, evaluation

### References:

- 1- Fahmy, A. F. M., Lagowski, J. J., *J. Pure and Appl.* **1998**, [15th ICCE, Cairo, August 1998].
- 2- Fahmy, A. F. M., Hamza, M. A., Medien, H. A. A., Hanna, W. G., Abdel-Sabour, M. : and Lagowski, J.J., *Chinese J.Chem. Edu.* **2002**, 23(12),12 [17th ICCE, Beijing, August 2002].
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- 5- Bloom, B.; Englehart, M.; Furst, E.; Hill, W. and Krathwohl, D. (1956) *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain*. New York, Toronto: Longmans, Green.
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