

Passage III (Questions 13–20)

To study how various salts can depress the freezing point of a solution, a researcher adds 1.0 g of a different salt to four beakers, each containing 100 mL of water at 25°C. The solutions are cooled, and the temperature at which ice crystals first form is recorded for each beaker. The solutions are then thawed, in order to verify their observed freezing points (the temperature at which the last sign of ice remains). Additional salt is added in specific mass increments and the freezing point is measured for solutions with one, two, three, five, and ten grams of salt. The results are shown in Table 1.

| Solute            | Freezing Temperature |        |        |        |        |
|-------------------|----------------------|--------|--------|--------|--------|
|                   | 1.0g                 | 2.0g   | 3.0g   | 5.0g   | 10.0g  |
| NaCl              | -0.6°C               | -1.3°C | -2.0°C | -3.3°C | -6.5°C |
| MgCl <sub>2</sub> | -0.6°C               | -1.2°C | -1.8°C | -2.9°C | -5.9°C |
| CaCl <sub>2</sub> | -0.5°C               | -1.0°C | -1.5°C | -2.5°C |        |
| KCl               | -0.5°C               | -1.0°C | -1.5°C | -2.5°C | -4.9°C |

Table 1

The solubility of each chloride salt is assumed to be complete at the reduced temperatures. The experiment could not be carried out with 10.0 grams of CaCl<sub>2</sub> because calcium chloride is insoluble at the lower temperatures.

13. The GREATEST cation concentration is found in which of the following solutions?
- 1.0 grams NaCl in 100 mL aqueous solution.
  - 1.0 grams MgCl<sub>2</sub> in 100 mL aqueous solution.
  - 1.0 grams CaCl<sub>2</sub> in 100 mL aqueous solution.
  - 1.0 grams KCl in 100 mL aqueous solution.
14. What is the [Cl<sup>-</sup>] after mixing 50 mL 0.1 M KCl(aq) with 25 mL 0.2 M MgCl<sub>2</sub>(aq)?
- 0.133 M Cl<sup>-</sup>
  - 0.167 M Cl<sup>-</sup>
  - 0.200 M Cl<sup>-</sup>
  - 0.250 M Cl<sup>-</sup>
15. How can the relatively similar freezing points of the CaCl<sub>2</sub> and KCl solutions be explained?
- CaCl<sub>2</sub> has a greater molecular mass than KCl but does not dissociate into as many ions as KCl.
  - CaCl<sub>2</sub> has a lower molecular mass than KCl and does not dissociate into as many ions as KCl.
  - CaCl<sub>2</sub> has a greater molecular mass than KCl and dissociates into more ions than KCl.
  - CaCl<sub>2</sub> has a lower molecular mass than KCl but dissociates into more ions than KCl.

16. Which of the salts in Table 1 has the GREATEST percent of chlorine?
- NaCl
  - MgCl<sub>2</sub>
  - CaCl<sub>2</sub>
  - KCl

17. Why does the addition of 1.0 g NaCl(s) to 100 mL of water lower its freezing point more than the addition of 1.0 g KCl(s)?
- NaCl has a greater *i*-value than KCl.
  - NaCl has fewer moles per gram than KCl.
  - NaCl has a lower affinity for water than KCl.
  - NaCl has more moles per gram than KCl.

18. Which of the following concentration units change with temperature?
- Molality
  - Molarity
  - Density
  - Specific gravity

19. Which of the following solutions has the GREATEST salt concentration?
- 10 g NaCl mixed with 100 grams water (total volume 102.5 mL)
  - 10 g NaCl mixed with enough water to make an aqueous solution of  $\rho = 1.06$  g/mL
  - 10 g KCl mixed with 100 grams water (total volume 103.1 mL)
  - 10 g KCl mixed with enough water to make an aqueous solution of  $\rho = 1.03$  g/mL

20. Which of the following solutions has the GREATEST concentration of chloride anion as measured in molarity?
- Aqueous NaCl with a boiling point of 101°C
  - Aqueous MgCl<sub>2</sub> with a boiling point of 101°C
  - Aqueous NaCl with a boiling point of 102°C
  - Aqueous MgCl<sub>2</sub> with a boiling point of 102°C

Questions 21 through 25 are NOT based on a descriptive passage.

21. What volume of O<sub>2</sub>(g) is produced from 1.0 g BaO upon its decomposition to Ba(s) and O<sub>2</sub>(g) at STP?
- 0.074 L
  - 0.100 L
  - 0.148 L
  - 0.166 L

22. Which of the following compounds has the LOWEST mass percent of nitrogen?
- H<sub>2</sub>NCONH<sub>2</sub>
  - NH<sub>4</sub>NO<sub>3</sub>
  - (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>
  - NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>

23. What is the molecular formula for an unknown gas with the empirical formula C<sub>2</sub>H<sub>3</sub>O, if 1.00 grams of the unknown gas occupies 260 mL at STP?
- C<sub>2</sub>H<sub>3</sub>O
  - C<sub>4</sub>H<sub>6</sub>O<sub>2</sub>
  - C<sub>6</sub>H<sub>9</sub>O<sub>3</sub>
  - C<sub>8</sub>H<sub>12</sub>O<sub>4</sub>

24. 11.89 grams of hot iron are exposed to a continuous stream of pure oxygen for ten minutes. At the end of this time, the completely oxidized sample weighs 16.99 grams. The empirical formula for the compound thus formed is MOST accurately written as:
- Fe<sub>3</sub>O<sub>2</sub>
  - FeO
  - Fe<sub>2</sub>O<sub>3</sub>
  - FeO<sub>3</sub>

25. Which of the following organic compounds has the GREATEST mass percent of carbon?
- Acetic acid (CH<sub>3</sub>CO<sub>2</sub>H)
  - Ethanol (CH<sub>3</sub>CH<sub>2</sub>OH)
  - Methyl acetate (CH<sub>3</sub>CO<sub>2</sub>CH<sub>3</sub>)
  - Glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)