

1. A reservoir of 50 l is filled once with octane (liquid) and once with hydrogen (to a pressure of 1 atm). Assume the ideal gas law for the calculations.
  - a) In which case is the combustion (complete reaction with O<sub>2</sub>) of the entire content of the reservoir delivering more energy at 25 °C.
  - b) What H<sub>2</sub> pressure is needed so that the combustion of it provides the same amount of energy as octane?
  - c) For which if the questions a) and b) is the assumption of ideal gas behavior justified?

density octane: 0.703 g/mL

C<sub>8</sub>H<sub>18</sub>(l) liquid -250.2 kJ mol<sup>-1</sup>

H<sub>2</sub>O(l) liquid water -285.83 kJ·mol<sup>-1</sup>

H<sub>2</sub>O(g) water vapor -241.82 kJ·mol<sup>-1</sup>

CO<sub>2</sub>(g) carbon dioxide gas -393.51 kJ·mol<sup>-1</sup>

2. What properties of hydrogen argue against its classification as a Group 17 element?
  - A) Hydrogen has no *p*-electrons and has a very low electron affinity.
  - B) Hydrogen is more metallic.
  - C) Hydrogen forms two bonds with other elements unlike one bond for Group 17.
  - D) Hydrogen is inert like a noble gas.
3. What is the balanced chemical equation for the reaction of potassium and water?
  - A)  $\text{K(s)} + 2 \text{H}_2\text{O(l)} \rightarrow \text{KO}_2\text{(s)} + 2 \text{H}_2\text{(g)}$
  - B)  $2 \text{K(s)} + \text{H}_2\text{O(l)} \rightarrow \text{K}_2\text{O} + \text{H}_2\text{(g)}$
  - C)  $2 \text{K(s)} + 2 \text{H}_2\text{O(l)} \rightarrow 2 \text{KOH(aq)} + \text{H}_2\text{(g)}$
  - D)  $\text{K(s)} + 2 \text{H}_2\text{O(l)} \rightarrow \text{KO(s)} + \text{H}_2\text{(g)}$
4. What is the balanced chemical equation for the reaction of lime and water to form slaked lime?
  - A)  $\text{CaCO}_3\text{(s)} + \text{H}_2\text{O(l)} \rightarrow \text{Ca(s)} + \text{H}_3\text{O}^+\text{(aq)} + \text{CO}_2\text{(g)}$
  - B)  $\text{CaCO}_3\text{(s)} + \text{H}_2\text{O(l)} \rightarrow \text{CaO(s)} + \text{H}_2\text{CO}_3\text{(aq)}$
  - C)  $\text{CaO(s)} + 2 \text{H}_2\text{O(l)} \rightarrow \text{CaCO}_3\text{(s)} + 2 \text{H}_2\text{(g)}$
  - D)  $\text{CaO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{Ca(OH)}_2\text{(s)}$
5. What do chalk, marble, and limestone all have in common?
  - A) They are all common terms for the same silicon-based mineral.
  - B) They are all silicates.
  - C) They are all non-crystalline.
  - D) They are all calcium carbonate.
6. Which oxidation numbers can nitrogen have in its oxides?
  - A) +1 and +3
  - B) +1, +3, and +5
  - C) +2, +4, and +5
  - D) +1, +2, +3, +4, and +5

7. Tetraphosphorus decoxide reacts with water to produce phosphoric acid. What is the balanced reaction for this process?
- A)  $\text{P}_4 + 3 \text{O}_2 + 6 \text{H}_2\text{O} \rightarrow 4 \text{H}_3\text{PO}_4$   
B)  $\text{P}_2\text{O}_5 + 3 \text{H}_2\text{O} \rightarrow 2 \text{H}_3\text{PO}_3$   
C)  $\text{P}_4\text{O}_{10} + 6 \text{H}_2\text{O} \rightarrow 4 \text{H}_3\text{PO}_4$   
D)  $\text{P}_4\text{O}_{10} + 4 \text{H}_2\text{O} \rightarrow 4 \text{H}_3\text{PO}_3$
8. What is the balanced chemical equation for the reaction of sulfur dioxide and water?
- A)  $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{S}(\text{s}) + \text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$   
B)  $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_3(\text{aq})$   
C)  $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{SO}_3(\text{g}) + \text{H}_2(\text{g})$   
D)  $\text{SO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_4(\text{aq}) + 2 \text{H}_2(\text{g})$
9. Write the chemical equation for the reaction between lithium and oxygen.
10. Write the chemical equation for the reaction between potassium and oxygen.
11. Like  $\text{KO}_2$ , cesium superoxide,  $\text{CsO}_2$ , can be used to remove exhaled  $\text{CO}_2$  and generate oxygen from water. Explain why  $\text{KO}_2$  is preferred over  $\text{CsO}_2$  for this purpose on spacecraft.
12. (a) Draw the Lewis structure for the azide ion and assign formal charges to the atoms. (b) You will find it possible to write a number of Lewis structures. Which is likely to make the biggest contribution to the resonance? (c) Predict the shape of the ion and its polarity.

## Short Answers

1. a) octane  $1.683 \times 10^6$  kJ;  $H_2 = 1.68 \times 10^6$  kJ  
 b) 2882 atm  
 c) a

2. A

3. C

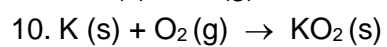
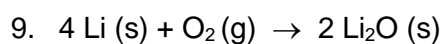
4. D

5. D

6. D

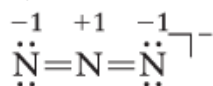
7. C

8. B



11. Less weight

12. A)



B) structure above is the most stable

C) linear, non polar