Summary Quiz (Chapter 45)

Section A: Multiple Choice

1. Which of the following do NOT comply with the principle of green chemistry?
   A. Reducing the consumption of organic solvents
   B. Reducing the generation and emission of wastes
   C. Eliminating the use of toxic reagents
   D. Reducing the use of renewable raw materials

2. Which of the following statements about the atom economy of a reaction is correct?
   A. It indicates the percentage yield of a chemical reaction.
   B. The greater the atom economy of a reaction, the greener it is.
   C. Exothermic reactions have a higher atom economy than endothermic reactions.
   D. A reaction with 100% atom economy implies that it has no side reactions.

3. Which of the following reactions has an atom economy of 100%?
   A. $BaO_2(s) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + H_2O_2(l)$
   B. $CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$
   C. $C_2H_4 + H_2O(l) \longrightarrow C_2H_5OH(l)$
   D. $PbO(s) + C(s) \longrightarrow Pb(s) + CO(g)$

4. Which of the following shows that Haber process practises green chemistry?
   (1) Finely divided iron is used as catalyst.
   (2) The atom economy of the reaction is 100%.
   (3) It makes use of a heat exchanger.
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

5. Which of the following statements about volatile organic compounds is INCORRECT?
   A. Volatile organic compounds are commonly used as solvent in industry.
   B. Chloroform is an example of volatile organic compounds.
   C. Volatile organic compounds are responsible for the formation of photochemical smog.
   D. The use of volatile organic compounds complies with the principles of green chemistry.

6. Which of the following combinations are correct?

	Process of the production of acetic acid	Feedstock
(1)	Fermentation	Glucose
(2)	Wacker process	Ethane
(3)	Monsanto process	Methanol and carbon monoxide

   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

7. Hydrogen peroxide and chlorine can undergo bleaching by oxidation. The reactions involved are shown below ([dye + O] is a colourless substance):

H_2O_2 + dye $\longrightarrow$ [dye + O] + H_2O
Cl_2 + H_2O + dye $\longrightarrow$ [dye + O] + 2HCl
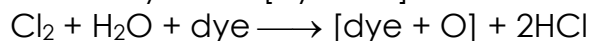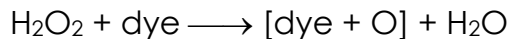
According to the principles of green chemistry, hydrogen peroxide is said to be a greener bleaching agent because
A. hydrogen peroxide is a stronger oxidizing agent than chlorine.
B. no water is required for hydrogen peroxide bleaching.
C. no toxic substance forms in hydrogen peroxide bleaching.
D. excess hydrogen peroxide can be washed away easily.

8. CATIVA process is a green method for the manufacture of acetic acid because
 (1) the atom economy of the reaction is 100%.
 (2) it uses iridium metal as the catalyst.
 (3) the reaction occurs at room conditions.
A. (1) and (2) only   B. (1) and (3) only
C. (2) and (3) only   D. (1), (2) and (3)

Section B: Structural Question

The following equation shows how methanol is produced from syngas.
$CO(g)$ + $2H_2(g)$ $\rightleftharpoons$ $CH_3OH(g)$
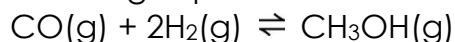
Excess hydrogen is allowed to react with 84.0 g of carbon monoxide. 81.6 g of methanol is obtained.
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(a) Calculate the percentage yield of methanol.

(b) Calculate the atom economy of the reaction.

(c) Suggest TWO reasons why the manufacture of methanol from $CO(g)$ and $H_2(g)$ is a green reaction.

(d) Suggest ONE reason why the manufacture of methanol from $CO(g)$ and $H_2(g)$ is NOT a green reaction.

The End

Suggested Answer

Section A

1.	D		5.	D
2.	B		6.	B
3.	C		7.	C
4.	D		8.	A

Section B Structured questions

(a) Number of moles of CO = 84.0 / (12.0 + 16.0) = 3.0 mol

∴ number of moles of CH_3OH formed = 3.0 mol

Theoretical mass of CH_3OH = 3.0 mol x (12.0 + 1.0 × 4 + 16.0) g mol^{-1} = 96.0 g

Percentage yield of CH_3OH = (81.6 / 96.0) x 100% = 85.0%

(b) Mass of atoms in 1 mole of CO = (12.0 + 16.0) g = 28.0 g

Mass of atoms in 2 moles of H_2 = (1.0 x 2) x 2 g = 4.0 g

Mass of atoms in 1 mole of CH_3OH = (12.0 + 1.0 x 4 + 16.0) g = 32.0 g

Atom economy of the reaction = [(28.0 + 4.0) / 32.0] x 100% = 100%

(c) The atom economy of the reaction is 100%.

The reaction involves the use of catalyst ($Cu/ZnO/Al_2O_3$).

(d) The reaction involves the use of toxic carbon monoxide / a high pressure is required for the reaction. (Accept other reasonable answers)

The End