1. Bleach is a solution of sodium hypochlorite (NaClO).

Chlorine gas is produced when bleach reacts with hydrochloric acid.

$$NaClO(aq) + 2HCl\ (aq) \rightleftharpoons NaCl(aq) + H_2O(l) + Cl_2(g)$$

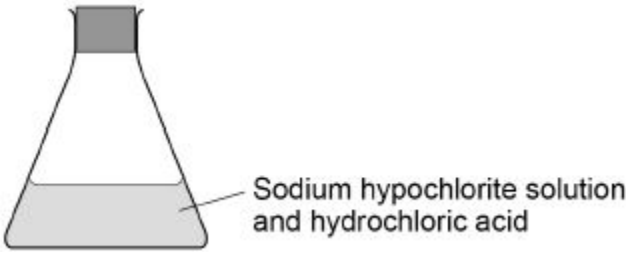
(a) Give the test and result for chlorine gas.

_____

_____

(2)

The diagram below shows a sealed flask of sodium hypochlorite and hydrochloric acid at equilibrium.



(b) Explain why equilibrium is reached in this reaction.

_____

_____

_____

_____

_____

_____

(2)

(c) The stopper in the diagram above is removed and hydrochloric acid is added.

The stopper is replaced.

Explain what happens to the equilibrium.

(4)

Chlorine gas is also produced when hydrogen chloride decomposes.

$$2HCl(g) \rightleftharpoons H_2(g) + Cl_2(g)$$

The forward reaction is endothermic.

(d) Predict the effect of increasing the temperature on the amount of chlorine gas produced at equilibrium.

Explain your answer using Le Chatelier's Principle.

(2)

(e) Explain the effect of increasing the pressure on this equilibrium.

(2)

(Total 12 marks)

2. Sulfur dioxide (SO_2) is used to manufacture sulfuric acid.

(a) Explain why sulfur dioxide has a low boiling point.

(3)

(b) The equation shows one stage in the manufacture of sulfuric acid from sulfur dioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The reaction is exothermic in the forward direction.

Use Le Chatelier's Principle to predict the effect of increasing the temperature on the amount of sulfur trioxide (SO_3) produced at equilibrium.

Give a reason for your answer.

(2)

(c) Use Le Chatelier's Principle to predict the effect of increasing the pressure on the amount of sulfur trioxide (SO_3) produced at equilibrium.

Give a reason for your answer.

(2)

(Total 7 marks)

3. This question is about catalysts and equilibrium.

(a) What type of substance is a catalyst in biological systems?

Tick (✓) **one** box.

Algae ☐

Alkene ☐

Enzyme ☐

Formulation ☐

(1)

(b) Explain how a catalyst increases the rate of a reaction.

_____

_____

_____

_____

(2)

The reversible reaction for the production of ammonia is:

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$

(c) What can scientists predict using Le Chatelier's Principle?

_____

_____

(1)

(d) Describe how a reversible chemical reaction is able to reach equilibrium.

_____

_____

_____

_____

(2)

(e) Explain the effect of increasing the pressure on the yield of ammonia.

_____

_____

_____

_____

(2)

(f) The forward reaction to produce ammonia is exothermic.

Explain the effect of increasing the temperature on the yield of ammonia.

_____

_____

_____

_____

(2)

(Total 10 marks)

Mark schemes

1.

(a) <u>damp / moist</u> litmus paper

ignore colour of litmus paper

1

bleaches / goes white

1

(b) forward and reverse rates equal

1

because no escape of reactants or products

allow closed system
allow particles for reactants or products

1

(c) equilibrium shifts

allow no longer in equilibrium

1

to right-hand side

allow in favour of forward reaction

1

to produce more of any products
or
to reduce any reactants

allow correct references to Le Chatelier's Principle

1

(new) equilibrium will be established

1

(d) amount of chlorine gas increases

1

(because) system shifts to counteract the change

allow (because) system shifts to take in energy
allow (because) system shifts in endothermic direction

1

(e) no change

1

because equal numbers of molecules
or
moles (of gas) on each side

1

[12]

2.

(a) small molecules

1

with weak intermolecular forces

1

(so) only a small amount of energy is needed to separate the molecules

any reference to bonds being weak or being broken negates the second and third mark unless they are stated to be intermolecular bonds or bonds between molecules

1

(b) decreases

1

because the equilibrium shifts in the endothermic direction

allow reverse reaction favoured if forward reaction is exothermic

1

(c) increases

1

because there are more molecules of gas on the left-hand side

or converse

1

[7]

3. (a) enzyme

1

(b) has a lower activation energy

1

(because) it provided / gives a different reaction pathway

1

(c) the effects of changing conditions on a system at equilibrium

1

(d) (when) the forward and reverse reactions have the same rate

1

in apparatus which prevents the escape of reactants and products

allow in a closed system

1

(e) yield increases

1

(because) the system responds to counteract the change

allow (because) there are more moles of gas on the left hand side

1

(f) yield decreases

1

(because) the system responds to counteract the change

allow (because) equilibrium shifts to favour endothermic (reverse) reaction

1

[10]