Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

A study of equilibrium is important for understanding chemical reactions.

(a) State le Chatelier's principle.

_____

_____

_____

_____

(1)

(b) Catalysts play an important role in many reactions.

(i) State the meaning of the term *catalyst*.
Explain, in general terms, how catalysts work.

Meaning of the term *catalyst* _____

_____

_____

How catalysts work _____

_____

_____

_____

(3)

(ii) State the effect, if any, of a catalyst on the time taken to reach equilibrium.

_____

(1)

(iii) State the effect, if any, of a catalyst on the position of an equilibrium.

_____

(1)

(c) Consider the following equilibrium reactions.

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				$\Delta H^{\ominus}$ / kJ mol^{-1}
P	$H_2(g) + I_2(g)$	⇌	$2HI(g)$	−10
Q	$CO_2(g) + 3H_2(g)$	⇌	$CH_3OH(g) + H_2O(g)$	−49
R	$N_2O_4(g)$	⇌	$2NO_2(g)$	+58
S	$N_2(g) + 3H_2(g)$	⇌	$2NH_3(g)$	−92
T	$C_2H_4(g) + H_2O(g)$	⇌	$CH_3CH_2OH(g)$	−42

In each of parts (c)(i) to (c)(v), you should record in the box one of the letters, **P, Q, R, S** or **T**, that corresponds to the equilibrium that best fits the information provided.
You may use each letter once, more than once or not at all.

(i) A decrease in temperature at constant pressure shifts the position of this equilibrium from right to left.

☐

(1)

(ii) This equilibrium uses concentrated phosphoric acid as a catalyst in a hydration reaction.

☐

(1)

(iii) A decrease in pressure at constant temperature shifts the position of this equilibrium from left to right.

☐

(1)

(iv) There is no change in the position of this equilibrium when the pressure is increased at constant temperature.

☐

(1)

(v) An increase in the concentration of steam at constant temperature and constant pressure shifts the position of this equilibrium from right to left.

☐

(1)

(Total 11 marks)

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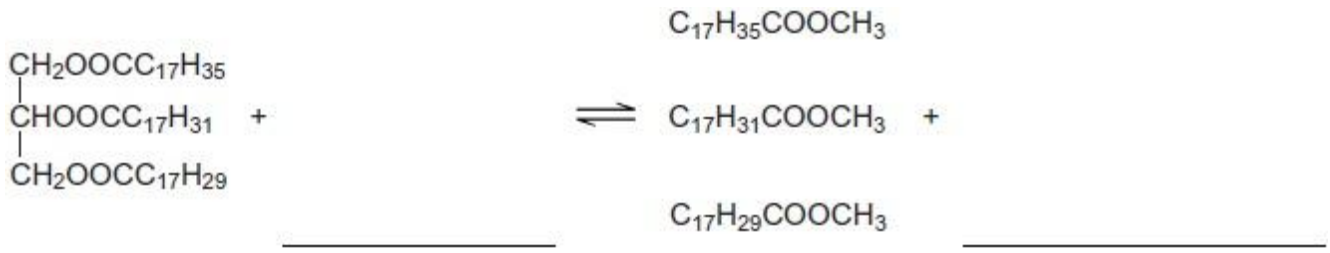
Q2.

Esters are produced by the reaction of alcohols with other esters and by the reaction of alcohols with carboxylic acids.

(a) The esters which make up biodiesel are produced industrially from the esters in vegetable oils.

(i) Complete the equation for this formation of biodiesel.



(2)

(ii) Write an equation for the complete combustion of $C_{17}H_{35}COOCH_3$.

_____

(2)

(b) The ester commonly known as diethyl malonate (**DEM**) occurs in strawberries and grapes. It can be prepared from acid **A** according to the following equilibrium.

A **DEM**

(i) A mixture of 2.50 mol of **A** and 10.0 mol of ethanol was left to reach equilibrium in an inert solvent in the presence of a small amount of concentrated sulfuric acid.
The equilibrium mixture formed contained 1.80 mol of **DEM** in a total volume, *V* dm^3, of solution.

Calculate the amount (in moles) of **A**, of ethanol and of water in this equilibrium mixture.

Moles of **A** _____

Moles of ethanol _____

Moles of water _____

(3)

(ii) The total volume of the mixture in part (b)(i) was doubled by the addition of more of the inert solvent.

State and explain the effect of this addition on the equilibrium yield of **DEM**.

Effect _____

Explanation _____

_____

(2)

(iii) Using **A** to represent the acid and **DEM** to represent the ester, write an expression for the

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equilibrium constant K_c for the reaction.

_____

_____

(1)

(iv) In a second experiment, the equilibrium mixture was found to contain 0.85 mol of **A**, 7.2 mol of ethanol, 2.1 mol of **DEM** and 3.4 mol of water.

Calculate a value of K_c for the reaction and deduce its units.

Calculation _____

_____

_____

_____

_____

_____

_____

_____

Units _____

_____

(3)

(Total 13 marks)

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