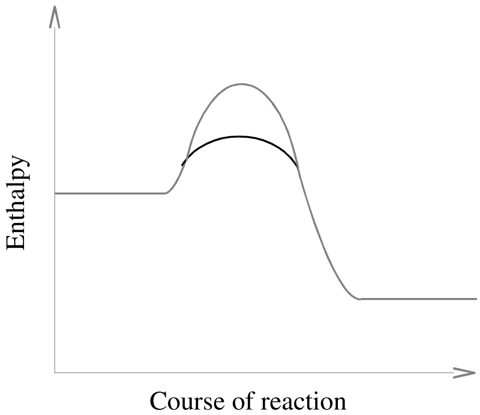
Year 11 Chemistry Test
Rate and Equilibrium

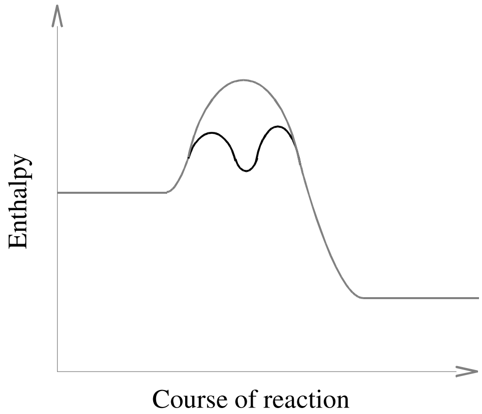
1.

(a) Exothermic, because ΔH is negative (it has decreased therefore given energy to the surroundings).

(b) *Agree:* Exothermic reactions heat up the surroundings, and increasing temperature increases rate.
Disagree: It depends on the temperature and/or the activation energy.

(c) 

or



(d) Lowers the activation energy by providing an alternative reaction pathway.

(e) Enzymes are biological catalysts.

(f) There are many possible answers to this question.

2.

(a) Closed system, fixed temperature.

(b) 1 min

(c) Rate

(d) *Agree:* There is no *net* reaction
Disagree: Reactions are still occurring but they are equal in both directions

(e) Student C. According to LCP the forward direction will be favoured (to decrease the number of molecules of gas). This means NO_2 should decrease and N_2O_4 should increase. The mole ratio shows that NO_2 should have twice the change that N_2O_4 has.

(f) $K_C = \frac{[N_2O_4]}{[NO_2]^2}$

(g) $\frac{[N_2O_4]}{[NO_2]^2} = \frac{0.11}{18^2} = 3.4 \times 10^{-4}$
This is not equal to K_C so the system is not at equilibrium.

3.

(a) coal / syngas

(b) steam

(c) The syngas could be recycled

(d)
 (i) Increasing temperature, crushing the coal
 (ii) Little-to-no ongoing costs

(e) Low temperature conditions would maximise yield. To maximise yield, conditions should favour the forward reaction. In this case the reaction to oppose change of lower temperature would release energy, which is the forward (exothermic) reaction.

BONUS QUESTIONS

Explain-y bonus question:

Exothermic. The graph shows that the yield is higher at lower temperatures. This means the forward reaction must be releasing energy, since it is favoured to oppose the change of lower temperatures.

Maths-y bonus question:

Let final concentration of NO_2 be x

Since $[NO_2]$ starts at 2, it changes by $x - 2$ (final - initial)

Mole ratio $NO_2 : N_2O_4$ is 2:1 so N_2O_4 changes by $\frac{-(x-2)}{2}$

Since $[N_2O_4]$ starts at 0, its final is equal to its change, $\frac{-(x-2)}{2}$

$$K_C = \frac{[N_2O_4]}{[NO_2]^2}$$

$$\therefore 0.5 = \frac{\frac{-(x-2)}{2}}{x^2}$$

$$\therefore 0.5x^2 = \frac{-(x-2)}{2}$$

$$\therefore x^2 = -(x-2)$$

$$\therefore x^2 + x - 2 = 0$$

$$\therefore (x-1)(x+2) = 0$$

$$\therefore x = 1 \quad \text{(can't have negative concentration so it can't be -2)}$$

$$\therefore [NO_2] = 1 \text{ mol L}^{-1}$$