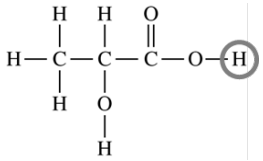
Question 1: Long Answer — 10 points

(a) For the correct circled atom: **1 point**

The rightmost hydrogen atom should be circled.



(b) For the correct calculated value: **1 point**

$$\frac{(10.22\text{ g})\left(\frac{1\text{ mol}}{40.00\text{ g}}\right)}{0.500\text{ L}} = 0.511\ M$$

(c) For the correct $\text{p}K_a$: **1 point**

3.9 *(acceptable range: 3.7 – 4.0)*

(d) (i) For the X at the correct point: **1 point**

The X should be at a point greater than or equal to 3 mL *and less than* 8 mL.

(ii) For a correct justification: **1 point**

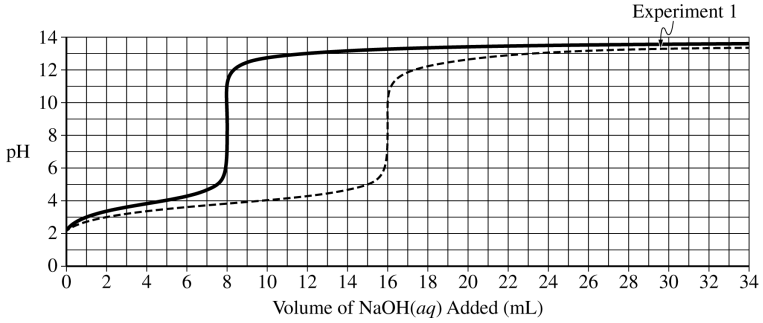
More acid particles are present than conjugate base particles, meaning that the titration is before the half-equivalence point.

(iii) For a curve showing the correct equivalence point: **1 point**

The equivalence point should be at 8 mL. *See example response below.*

For a curve with appropriate initial and final pH with a correct shape: **1 point**

The drawn curve should begin at the same pH, *gradually increase, rise sharply at a volume different than* 16 mL, *and end at a* pH *similar to the first curve.*



Total for part (d) 4 points

(e) (i) For the correct calculated value: **1 point**

$q = mc\Delta T = (200.0\text{ g})(4.2\text{ J/(g}\cdot\text{°C)})(23.2\text{°C} - 20.0\text{°C}) = 2700\text{ J}$

(ii) For the correct calculated value: **1 point**

$q_{rxn} = -q_{soln} = -2700\text{ J} = -2.7\text{ kJ}$

$$\Delta H_{rxn} = \frac{q_{rxn}}{\text{mol}} = \frac{-2.7\text{ kJ}}{(0.100\text{ L})(0.500\text{ mol/L})} = -54\text{ kJ/mol}_{rxn}$$

(iii) For the correct answer and a valid justification: **1 point**

Agree. The heat lost from the system would result in a lower final temperature, which results in values of ΔT, q_{soln}, *and* ΔH *that are smaller than the actual value.*

Total for part (e) 3 points

Total for question 1 10 points