

# Kinetics Review Key

1. a) 
$$\frac{43.2 \text{ g H}_2\text{O}}{3.00 \text{ mins.}} \left| \frac{1 \text{ mol H}_2\text{O}}{18.0 \text{ g H}_2\text{O}} \right| \frac{7 \text{ mol O}_2}{6 \text{ mol H}_2\text{O}} \left| \frac{32.0 \text{ g O}_2}{1 \text{ mol O}_2} \right| \frac{1 \text{ min}}{60 \text{ sec}} = 0.498 \text{ g O}_2 \text{ per sec.}$$

b) 
$$\frac{0.045 \text{ mol NH}_3}{1 \text{ s}} \left| \frac{4 \text{ mol NO}_2}{4 \text{ mol NH}_3} \right| \frac{15 \text{ s}}{15 \text{ s}} = 0.68 \text{ mol NO}_2 \text{ per 15 s.}$$

2. a) i) Increase the SURFACE AREA of the iron (slivers).  
ii) Increase the  $[\text{HCl}]$   
iii) Increase the temperature.

Reasoning using collision theory:

- i)  $\uparrow$  overall collisions  $\rightarrow$   $\uparrow$  effective collisions  $\rightarrow$   $\uparrow$  rate  
ii)  $\uparrow$  overall collisions  $\rightarrow$   $\uparrow$  effective collisions  $\rightarrow$   $\uparrow$  rate  
iii)  $\uparrow$  KE, leading to: a)  $\uparrow$  overall collisions  $\rightarrow$   $\uparrow$  effective collisions  
b)  $\uparrow$  % of a collision being effective  $\rightarrow$  (i.e.  $\uparrow$  fraction of effective collisions)  $\rightarrow$   $\uparrow$  effective collisions (collisions are harder)

- b) i) Monitor the mass loss of Fe per unit time.  
ii) Monitor the volume  $\text{H}_2$  gas produced per unit time.

3. a) 
$$\frac{167.12 \text{ g} - 164.51 \text{ g}}{0.00 - 30.0 \text{ s}} = \frac{2.61 \text{ g}}{-30.0 \text{ s}} = 0.0870 \text{ g H}_2 \text{ produced/s}$$
  
*attributed to  $\text{H}_2$  produced, then lost... once interpreted, drop the negative*

b) 
$$\frac{167.12 \text{ g} - 163.32 \text{ g}}{0.00 - 60.0 \text{ s}} = \frac{3.80 \text{ g}}{-60.0 \text{ s}} = 0.0633 \text{ g H}_2 \text{ produced/s}$$

c) Reaction rate decreases as a chemical reaction proceeds. (less reactants  $\Rightarrow$  less collisions)

d) From b:

$$\frac{0.063333 \text{ g H}_2}{1 \text{ s}} \bigg| \frac{1 \text{ mol H}_2}{2.0 \text{ g H}_2} \bigg| \frac{2 \text{ mol Fe}}{3 \text{ mol H}_2} \bigg| \frac{55.8 \text{ g Fe}}{1 \text{ mol Fe}} = \boxed{1.2 \text{ g Fe}^{\text{used}}/\text{s}}$$

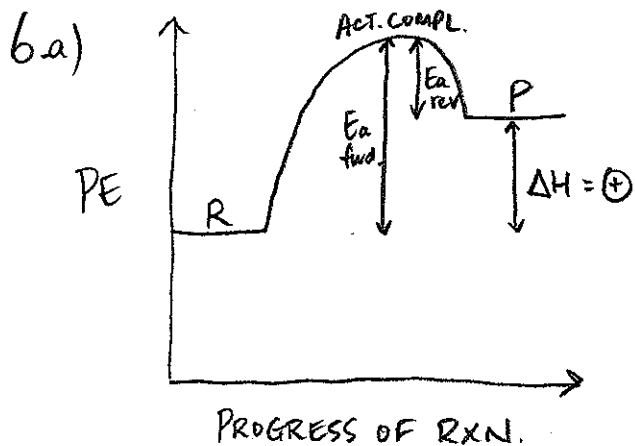
4.  $\downarrow \text{temp} \Rightarrow \downarrow \text{KE} \Rightarrow$  i)  $\downarrow$  overall collisions  $\Rightarrow \downarrow$  effective collisions

ii)  $\downarrow$  % of a collision being effective  $\Rightarrow \downarrow$  effective collisions  
(ie. collisions are 'softer')  
(ie.  $\downarrow$  fraction of successful collisions)

5. i) Approach:  $\text{PE} \uparrow$  ;  $\text{KE} \downarrow$   
(due to electron repulsion)

ii) Collision:  $\text{PE}$  at its highest ;  $\text{KE}$  at its lowest  
(not zero, however, as molecules still vibrating).

iii) Moving Away:  $\text{PE} \downarrow$  ;  $\text{KE} \uparrow$



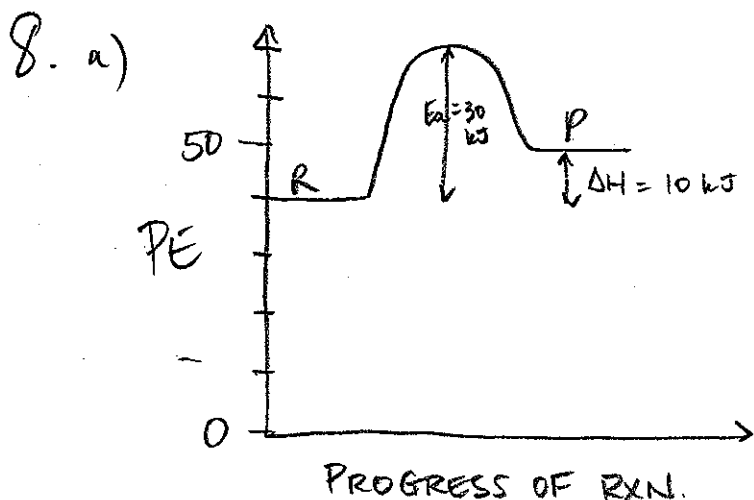
b)  $\Delta H_{\text{rev}} = \text{negative}$  (exothermic)

7. a)  $E_a$  remains unchanged (but the amount of molecules/collisions that can achieve  $E_a \uparrow$ ).

$\Delta H$  remains unchanged.

b)  $E_a \downarrow$  with addition of catalyst (lower energy (more stable) activated complex is formed).

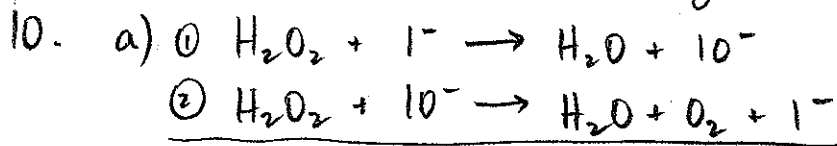
$\Delta H$  remains unchanged.



b)  $E_{a(\text{rev})} = 20 \text{ kJ}$

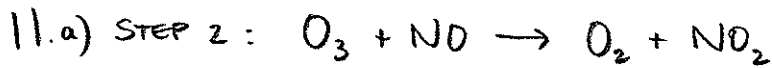
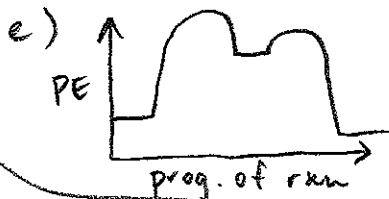
c)  $PE_{\text{activated complex}} = 70 \text{ kJ}$

9. Aqueous solutions possess MAXIMIZED surface area, meaning that all ions are spread out 'evenly', but are able to move more freely through the solvent. The greater the SA  $\rightarrow \uparrow$  overall collisions  $\Rightarrow \uparrow$  effective collisions  $\Rightarrow \uparrow$  rxn. rate. The S.A. of the other phases is not as high.



b)  $\text{IO}^-$  c) Yes;  $\text{I}^-$

d) Step 1.



b) Yes; it would improve upon the rate in step 3, but not step 1. Still, an improvement in step 3 would help  $\uparrow$  the rate.

c) Yes;  $\uparrow [\text{O}_3]$  would  $\uparrow$  the rate of step 1.