PiXL Independence:

Chemistry – Student Booklet

KS5

Equilibria and Le Chatelier

Contents:

PiXL Independence – Level 1
Multiple Choice Questions
A Level Chemistry – Equilibria and Le Chatelier

INSTRUCTIONS **Score: /20**

- **Read the question carefully.**
- **Circle the correct letter.**
- **Answer all questions.**

1. Which of the following statements about dynamic equilibria is FALSE?
   a. The concentration of the reactants and products do not change.
   b. The rate of the forward and reverse reactions is zero.
   c. The rate of forward and reverse reactions are the same.
   d. It exists in a closed system.

2. Which of the following does NOT affect the position of equilibrium?
   a. Change in temperature.
   b. Change in concentration.
   c. Change in pressure.
   d. Catalyst.

3. Look at the following reaction:

   $$H_{2(g)} + I_{2\,(g)} \rightleftharpoons 2HI_{(g)}$$

   What impact would increasing the pressure have upon the reaction?
   a. Nothing.
   b. Position of equilibrium will move to the right.
   c. Position of equilibrium will move to the left.
   d. Position of equilibrium will move forward.

4. Which of the following best describes the impact of a catalyst on equilibrium?
   a. It has no impact on the reaction.
   b. It has no impact on the position of equilibrium.
   c. It increases the rate of the forward and reverse reactions.
   d. b & c

5. Look at the reaction:

   $$2SO_{2(g)} + O_{2\,(g)} \rightleftharpoons 2SO_{3(g)} \quad \Delta H = -197\ Kj\ mol^{-1}$$

   Which of the following is TRUE?
   a. Increasing the pressure would have no impact on the position of equilibrium.
   b. Increasing the temperature would move the position of equilibrium to the left.
   c. Increasing the temperature would move the position of equilibrium to the right.
   d. Decreasing the concentration of SO_3 would move the position of equilibrium to the left.

6. What effect would decreasing the temperature have upon a reversible reaction, with an endothermic forward reaction?
   a. Increase the yield.
   b. Decrease the yield.
   c. No impact.
   d. Move the position of equilibrium to the left.

7. Look at the reaction:

$$N_{2(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -45.8 \text{ Kj mol}^{-1}$$

Which of the following is FALSE for the reaction?
   a. Increasing the pressure would move the position of equilibrium to the right.
   b. Increasing the temperature would move the position of equilibrium to the left.
   c. Increasing the temperature would move the position of equilibrium to the right.
   d. Removing NH_3 would move the position of equilibrium to the right.

8. Look at the reaction:

$$N_2O_{4\,(g)} \rightleftharpoons 2NO_{2(g)} \quad \Delta H = -57 \text{ Kj mol}^{-1}$$

Which of the following is TRUE for the reaction if we were to increase the pressure?
   a. More reactants would form.
   b. There would be no impact on equilibrium.
   c. More products would form.
   d. None of the above.

9. Look at the reaction:

$$N_2O_{4\,(g)} \rightleftharpoons 2NO_{2(g)} \quad \Delta H = -57 \text{ Kj mol}^{-1}$$

Which of the following would NOT result in the formation of new products at equilibrium?
   a. Decreasing the pressure.
   b. Removing NO_2 from the reaction.
   c. Adding N_2O_4 to the reaction.
   d. Increasing the temperature.

10. Look at the reaction:

$$Fe^{3+}_{(aq)} + CNS^{-}_{(aq)} \rightleftharpoons Fe(CNS)^{2+}_{(aq)}$$

Which of the following is FALSE?
   a. Increasing the pressure would increase the amount of product.
   b. Adding Fe^{3+} would have no impact on the position of equilibrium.
   c. Adding Fe^{3+} would move the position of equilibrium to the right.
   d. Adding Fe^{3+} would increase the amount of product.

11. Look at the reaction:

$$aA + bB \rightleftharpoons cC$$

Which of the following is the correct expression for K_c for this reaction?
   a. $K_c = \dfrac{[C]}{[A]\ [B]}$
   b. $K_c = \dfrac{[A]^a\ [B]^b}{[C]^c}$
   c. $K_c = \dfrac{[c]^C}{[a]^A\ [b]^B}$
   d. $K_c = \dfrac{[C]^c}{[A]^a\ [B]^b}$

12. Look at the reaction:

$$aA + bB \rightleftharpoons cC$$

What are the units for K_c for this reaction?

a. $mol^2\ dm^{-6}$
b. $mol\ dm^{-3}$
c. $mol^{-1}\ dm^3$
d. There are no units.

13. Look at the reaction:

$$N_{2(g)} + 3H_{2\ (g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -45.8\ Kj\ mol^{-1}$$

Which of the following is the correct expression for K_c for this reaction?

a. $Kc = \dfrac{[NH_3]^2}{[N_2]\ [H_2]}$
b. $Kc = \dfrac{[NH_3]}{[N_2]\ [H_2]^3}$
c. $Kc = \dfrac{[NH_3]^2}{[N_2]^3\ [H_2]}$
d. $Kc = \dfrac{[NH_3]^2}{[N_2]\ [H_2]^3}$

14. Look at the reaction:

$$N_{2(g)} + 3H_{2\ (g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -45.8\ Kj\ mol^{-1}$$

What are the units for K_c for this reaction?

a. $mol^2\ dm^{-6}$
b. $mol\ dm^{-3}$
c. $mol^{-1}\ dm^3$
d. There are no units.

15. Look at the reaction:

$$N_{2(g)} + 3H_{2\ (g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -45.8\ Kj\ mol^{-1}$$

Calculate the equilibrium constant for the reaction with the following concentrations: Nitrogen = 0.780 mol dm^{-3}; Hydrogen = 0.500 mol dm^{-3}; Ammonia = 0.077 mol dm^{-3}. Give your answer to 4 significant figures.

a. 0.103
b. 0.1027
c. 0.1026
d. 0.1260

16. Look at the reaction:

$$CO_{(g)} + 2H_{2\ (g)} \rightleftharpoons CH_3OH_{(g)}$$

The concentration of each substance at equilibrium is as follows: CO = 3.10 $x10^{-3}$; H_2 = 2.40 $x10^{-2}$; CH_3OH = 2.60 $x10^{-5}$. Calculate Kc for this system to 4 significant figures.

a. 14.6 $mol^{-2}\ dm^6$
b. 14.6 $mol\ dm^3$
c. 14.56 no units
d. 14.56 $mol^{-2}\ dm^6$

17. Look at the reaction:

$$A_{(g)} + 2B_{(g)} \rightleftharpoons 2C_{(g)}$$

The mixture was transferred to a new container with a larger volume. What would happen the amount of C in the equilibrium mixture?

a. Decrease.
b. Increase.
c. It would stay the same.

18. Look at the reaction:

$$A_{(g)} + 2B_{(g)} \rightleftharpoons 2C_{(g)} \quad \Delta H = -65 Kj\ mol^{-1}$$

The mixture was transferred to a new container the same volume at a different temperature. The value for Kc increased. What does this tell you about the temperature?

a. Nothing – Kc is not affected by temperature.
b. Temperature increased.
c. Temperature decreased.
d. Temperature remained constant.

19. Which of the following affect the value of Kc?

a. Temperature only.
b. Temperature and pressure.
c. Temperature and a catalyst.
d. Temperature and concentration.
e. Temperature, pressure and concentration.

20. Look at the following expression for Kc:

$$Kc = \frac{[A]^2\,[B]}{[C]\ [D]^3}$$

Which of the following is TRUE for this expression?

a. $2A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D^3{}_{(g)}$ units = $mol^{-1}\ dm^3$
b. $2A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + 3D_{(g)}$ units = $mol\ dm^{-3}$
c. $2A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + 3D_{(g)}$ units = $mol\ dm^{-3}$
d. $2A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + 3D_{(g)}$ units = $mol^{-1}\ dm^3$

PiXL Independence – Level 2
5 questions, 5 sentences, 5 words
A Level Chemistry – Equilibria and Le Chatelier

INSTRUCTIONS

- **For each statement, use either the suggested website or your own text book to write a 5-point summary. In examinations, answers frequently require more than 1 key word for the mark, so aim to include a few key words.**
- **It is important to stick to 5 sentences. It is the process of selecting the most relevant information and summarizing it that will help you remember it.**
- **Write concisely and do not elaborate unnecessarily, it is harder to remember and revise facts from a big long paragraph.**
- **Finally, identify 5 key words that you may have difficulty remembering and include a brief definition. You might like to include a clip art style picture to help you remember it.**

Example:

QUESTION:	**Explain the term dynamic equilibrium.**
Sources:	**Website –** http://chemguide.co.uk/physical/equilibria/introduction.html **Video –** https://www.youtube.com/watch?v=JsoawKguU6A

1. **Involves a reversible reaction.**
2. **In a closed system – no substances are added to or lost from the system; energy can be transferred in or out.**
3. **Although there is no change in the concentrations, the reaction is still continuing in both directions.**
4. **The position of equilibrium can be affected by a change in concentration, pressure and temperature.**
5. **A catalyst speeds up the reaction in both directions so has no impact on the position of equilibrium.**

Reversible reaction	**Closed system**	**Reaction in both directions**	**Affected by temperature, pressure, concentration**	**Catalyst no impact on equilibrium**

QUESTION 1:	**What is Le Chatelier's Principle?**
Sources:	**Website –** http://chemguide.co.uk/physical/equilibria/lechatelier.html **Interactive –** https://www.khanacademy.org/science/chemistry/chemical-equilibrium/factors-that-affect-chemical-equilibrium/v/le-chatelier-s-principle

QUESTION 2:	**Explain how Le Chatelier's Principle can be used to predict what will happen to a reaction at equilibrium. Use a specific example in your explanation.**
Sources:	**Website –** http://www.thebigger.com/chemistry/free-energy-and-chemical-equilibria/explain-le-chateliers%E2%80%99s-principle-with-example/ **Website –** https://www.albert.io/blog/le-chateliers-principle-review-ap-chemistry-crash-course/

QUESTION 3:	**Explain why, for a reversible reaction used in industry, a compromise temperature and pressure may be used.**
Sources:	**Website –** http://www.chemguide.co.uk/physical/equilibria/haber.html **Website –** https://haberprocess2012.weebly.com/le-chacircteliers-principle.html

QUESTION 4:	Explain how the equilibrium constant is deduced from the equation for a reversible reaction.
Sources:	**Website –** http://www.chemguide.co.uk/physical/equilibria/kc.html **Website –** https://www.thoughtco.com/equilibrium-constant-606794

QUESTION 5:	**Explain how to carry out test-tube equilibrium shifts to show the effect of concentration and temperature on a reversible reaction.**
Sources:	**Website –** http://www.rsc.org/learn-chemistry/resource/res00000001/the-equilibrium-between-two-coloured-cobalt-species **Website –** http://www.chemistrylabmanual.com/uploads/2/5/6/1/25614215/lechatprinciple.pdf

PiXL Independence – Level 3
Science in the News
A Level Chemistry – Equilibria and Le Chatelier

Fake news

Sensationalised news stories have been around for some time, but with the mass growth of social media, the problem seems to have grown in recent years.
Therefore, the ability to identify real information, track it back to the source article and make your own judgement is a very important skill. This activity will help you develop that skill.

Acid attacks increase
News article – http://www.mirror.co.uk/news/uk-news/ex-melted-face-acid-stop-10806888
News article – http://www.bbc.co.uk/news/uk-england-london-40604002
News article – https://www.theguardian.com/uk-news/2017/jul/07/surge-in-acid-attacks-in-england-leads-to-calls-to-restrict-sales
Data - https://www.theguardian.com/world/2017/aug/31/nhs-acid-attacks-report-remove-rinse
Journal article – http://journals.sagepub.com/eprint/FpTyAUQyvhe7invYXdtx/full
NHS Choices – https://www.nhs.uk/conditions/acid-and-chemical-burns/pages/overview.aspx

Task
You need to produce a 1-page essay on the health effects of artificial sweeteners.

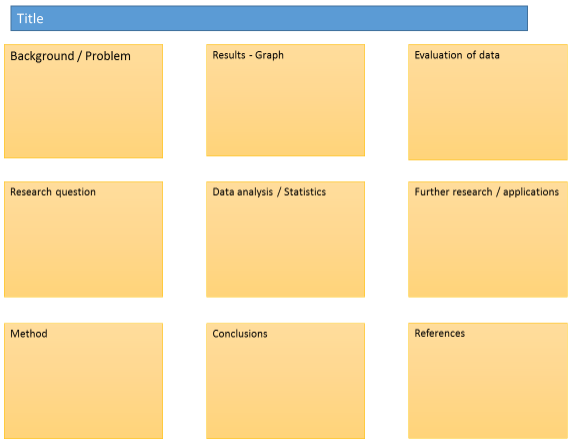
Essay section	Activity
Introduction	Outline the uses of sulfuric acid.
Describe	How sulfuric acid is manufactured. Provide statistics on acid attacks in this country.
Evaluate	Evaluate whether sulfuric acid should be readily available to purchase. Why do you think the number of incidents of acid attacks have increased?
Conclude & Reflect	Should we change the law regarding the purchase of sulfuric acid or one which prevents people from carrying it?

PiXL Independence – Level 4
Scientific Posters
A Level Chemistry – Equilibria and Le Chatelier

Scientific Posters - Scientists communicate research findings in three main ways. Primarily, they write journal articles much like an experiment write up. These are very concise, appraise the current literature on the problem and present findings. Scientists then share findings at conferences through talks and scientific posters. During a science degree, you would practice all three of these skills.

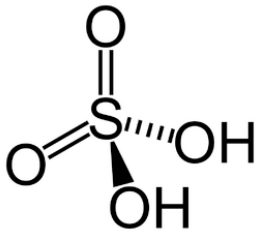
Scientific posters are a fine balance between being graphically interesting and attracting attention and sharing just the right amount of text to convey a detailed scientific message. They are more detailed than a talk and less detailed than a paper.
Use this information to help structure your poster – https://www.wikihow.com/Make-a-Scientific-Poster
More detailed guidance is available at: https://guides.nyu.edu/posters

Creating your poster
It is easiest to create a poster in PowerPoint, however you need to add custom text boxes rather than using the standard templates.



Posters need to be eye catching, but readable from a distance. If you use PowerPoint, start with a 4:3 slide (for easier printing, it can then be printed on A3) and use a 14-16 pt font. The first box could be larger to draw people in. You can use a background image, but pick a simple one that is of high quality. Select 'text box fill' and select 'change the transparency' to maintain the contrast and partially show the picture.
You can experiment with different layouts and you should include images. Avoid a chaotic layout, posters are read from top left column downwards.
Remember to include the authors and references.
Finally, look at the examples given on the University of Texas website which also offers an evaluation of each https://ugs.utexas.edu/our/poster/samples

The Contact Process



Background

Sulfuric acid is manufactured by the Contact Process which involves a reversible reaction in dynamic equilibrium. It has many uses from fertilisers to batteries. The Contact Process must be efficient for manufacture to ensure its production is economically viable.

Source article: http://www.docbrown.info/page07/equilibria3.htm#3.3
Source article: https://www.chemguide.co.uk/physical/equilibria/contact.html
Animation: https://www.youtube.com/watch?v=p-EbpRpFqv0
Use other sources as necessary.

Task

Produce a scientific poster on the Contact Process.
You should link this to your understanding of chemical equilibria and reversible reactions.

Recall	Define the terms dynamic equilibrium and reversible reactions.
Describe	Describe how sulfuric acid is manufactured using the Contact Process.
Explain	Explain how changing the conditions affects the yield and cost of production of sulfuric acid by this process. You may wish to use a graph to aid your explanation.
Discuss	Discuss the compromises in temperature and pressure that manufacturers have to make when manufacturing sulfuric acid via this method.

PiXL Independence – Level 5
Video summaries
A Level Chemistry – Equilibria and Le Chatelier

Cornell Notes

At A level and University, you will make large amounts of notes, but those notes are only of use if you record them in a sensible way. One system for recording notes is known as the Cornell notes system. This method encourages you to select relevant information, rather than trying to write a transcript of everything said. More importantly, it forces you to spend a few minutes reviewing what you have written, which has been scientifically proven to aid learning and memory retention.

The ideal is to write everything on one page, but some students may prefer to type and others will to handwrite their notes. Whichever option you use, remember the aim is to summarise and condense the content with a focus on the objectives that you are trying to learn and understand.

There are three main sections to the Cornell notes

1. **Cue/ Objectives** – This can be done before or after the lecture. You may have been provided with the objectives or you may need to decide what they were or you may want to make the link to your learning if this is an additional task or lecture you are viewing, such as this video.
2. **Notes** – In this space you record concisely, simply the things you are LESS likely remember - **The NEW knowledge.**
3. **Summary** – The most important step that is carried out after the lecture or video. This helps to reinforce learning.

Background

The following series of videos link to your learning.

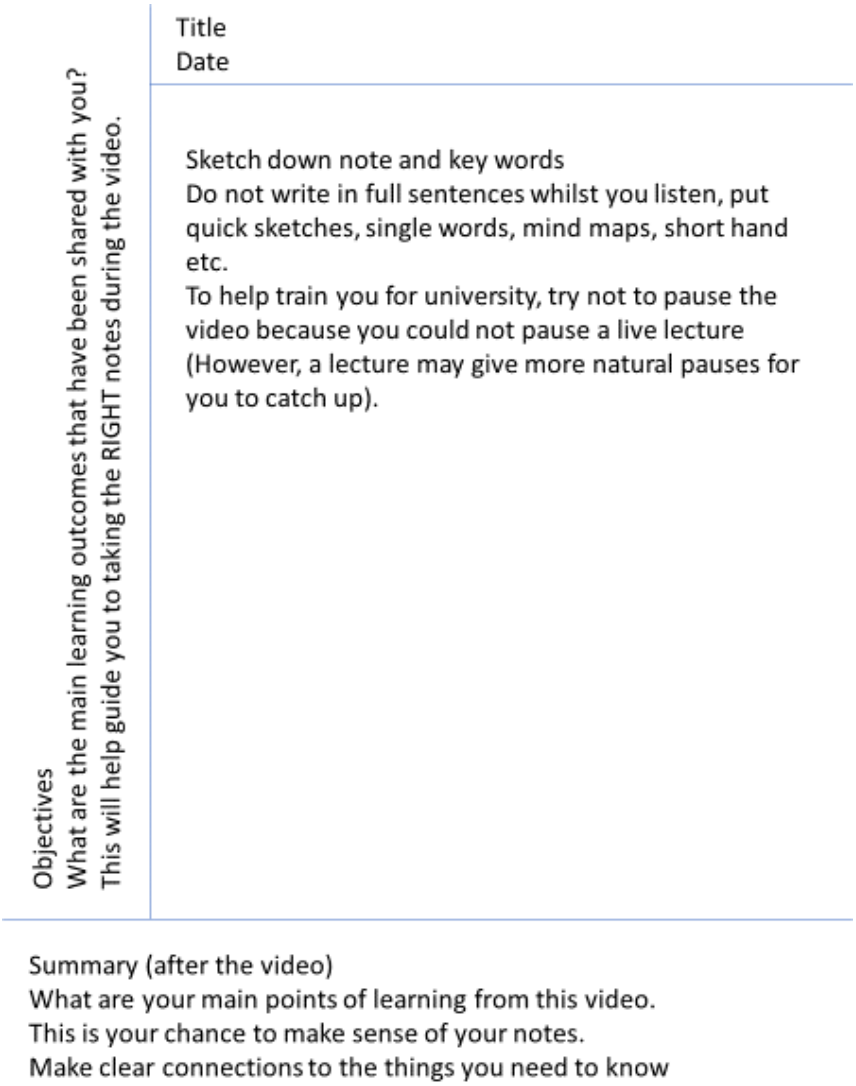
Source article:
Video 1 – What is Chemical Equilibrium?
TEDEd : https://www.youtube.com/watch?v=dUMmoPdwBy4

Video 2 – Equilibrium
TEDEd: – https://ed.ted.com/on/jlKYTd8G#finally

Task:

You need to produce a set of Cornell notes for each of the videos given above.
Use the following objective to guide your note taking, this links to your learning.

1. Explain the term dynamic equilibrium.
2. Summarise your learning from the CrashCourse video.



	Title **Date**
Objectives	
Summary	

	Title **Date**
Objectives	
Summary	

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