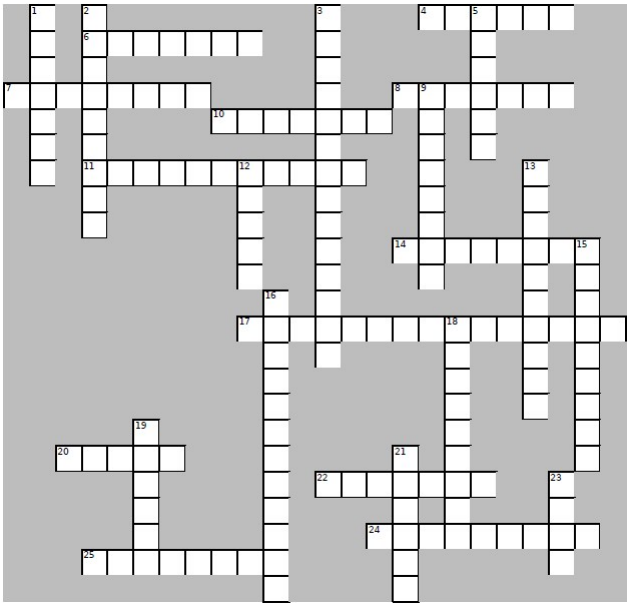
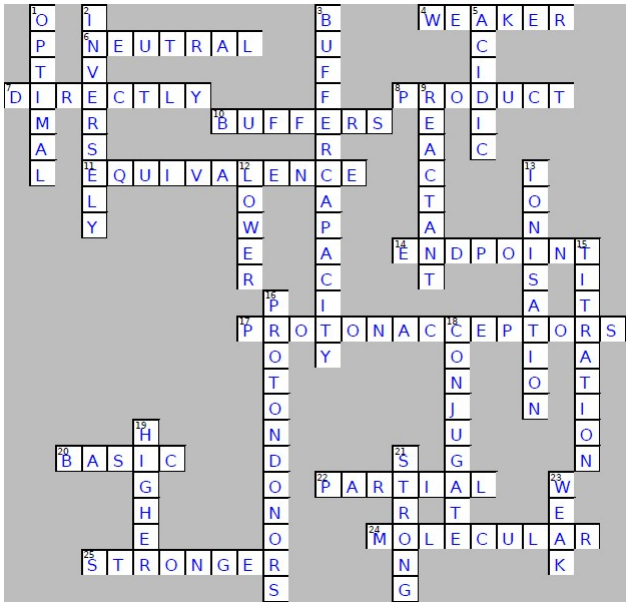
Appendix 1: Ionic Equilibria crossword puzzle





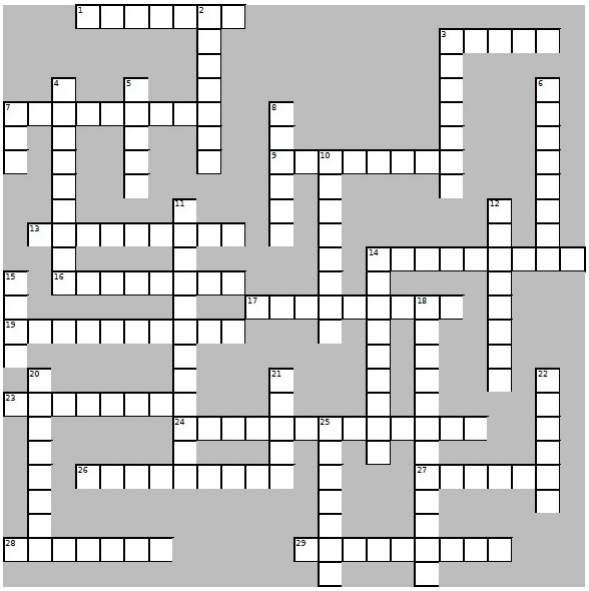
Across:

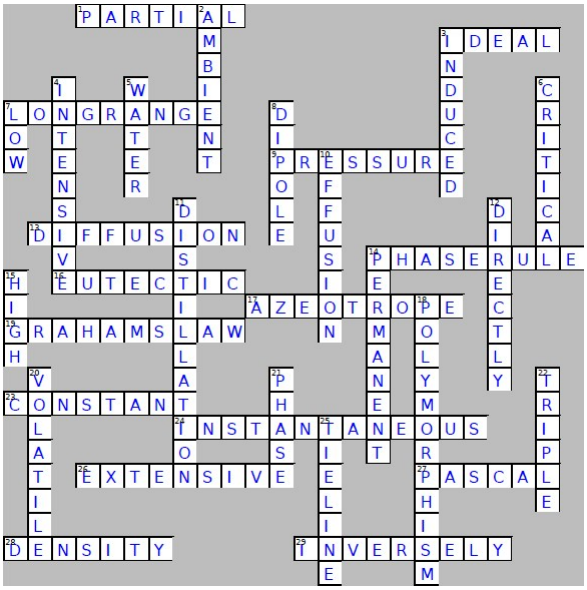
4. The stronger the acid, the _____ its conjugate base.
6. Salts of strong bases and strong acids produce _____ solutions.
7. Base strength is _____ proportional to the basicity constant K_b.
8. Strong acid hydrolysis is _____ dominant.
10. Solutions that resist a change in pH when small amounts of strong acid or base are added.
11. The theoretical point in a titration, at which the amounts of the reactants are equivalent.
14. The experimental estimate of the equivalence point in a titration.
17. Bases are molecules or ions that are ____ _____ . (two words)
20. Salts of weak acids and strong bases produce _____ solutions.
22. A buffer is prepared by _____ neutralisation, when a limiting amount of strong base is added to an excess amount of weak acid.
24. For good absorption, a substance needs to be in its _____ form to be able to cross cellular barriers.
25. Base A (pK_b 3.5) is _____ than base B (pK_b 5.2).

Down:

1. Level of buffering occurring when the ratio b/a (amounts of base (b) and its conjugate acid (a)) equals 1.
2. Acid strength is _____ proportional to pK_a.
3. The measure of the amount of protons (or hydroxide ions) a buffer can absorb without a significant change in pH. (two words)
5. Salts of weak bases and strong acids produce _____ solutions.
9. Weak base hydrolysis is _____ dominant.
12. In the titration of a weak base with a strong acid, the pH of the stoichiometric point is _____ than 7.
13. For weak acids and bases, the more dilute the solution the greater its extent of _____.
15. Adding a titrant solution (with an accurately known concentration) from a burette to a flask containing the sample of an analyte.
16. Acids are molecules or ions that are ____ _____ . (two words)
18. For a _____ acid/base pair: $pK_a + pK_b = 14$
19. A buffer with _____ concentrations of the constituents will have a greater buffer capacity.
21. Acids and bases that are effectively completely ionised in water.
23. Acids and bases that ionise in water to a slight extent (<5-10%).

Appendix 2: Phase Equilibria crossword puzzle





Across:

1. The pressure that the gas would exert if it occupied the container alone.

2. A gas whose behaviour follows the relationship: ***PV = nRT***.

7. Crystalline solids exhibit ____ _____ order. (two words)

9. Measure of force per unit area.

13. A gradual dispersal of one substance through another substance.

14. ***F = C – P + 2***, where ***F*** = degrees of freedom, ***C*** = number of components, ***P*** = number of phases. (two words)

16. A mixture of two solids, which has a melting point lower than the melting point of either solid.

17. A mixture of compounds that boils with a constant composition.

19. At constant temperature, the rate of effusion of a gas is inversely proportional to the square root of its molar mass. (two words)

23. All systems prepared on a tie line separate into two phases of _____ compositions.

24. Non-polar compounds possess _____ dipoles.

26. Volume is an _____ property.

27. SI unit of pressure.

28. A unique property of water that causes the negative slope of the solid/liquid boundary on its phase diagram.

29. The volume of a quantity of gas is _____ proportional to pressure at constant temperature.

Down:

2. 25 degrees Celsius is a standard _____ temperature.

3. A disruption of an electron cloud on a neighbouring molecule leads to _____ dipoles.

4. Temperature is an _____ property.

5. Solids are of greater density than liquids. Exception?

6. The point on a single component phase diagram, where there ceases to be any difference between liquid and gas phases.

7. Real gasses obey The Ideal Gas Law at ___ pressure.

8. Two partially charged particles (or parts of a structure) of opposite sign which are separated by a finite distance.

10. The process of a gas passing through a small hole into a vacuum.

11. The process of separating compounds with different boiling points.

12. The pressure of a fixed amount of gas is _____ proportional to its temperature at constant volume.

14. Polar molecules possess _____ dipoles.

15. Real gasses behave in ideal manner at ___ temperature.

18. The existence of at least two different crystal structures for the same substance.

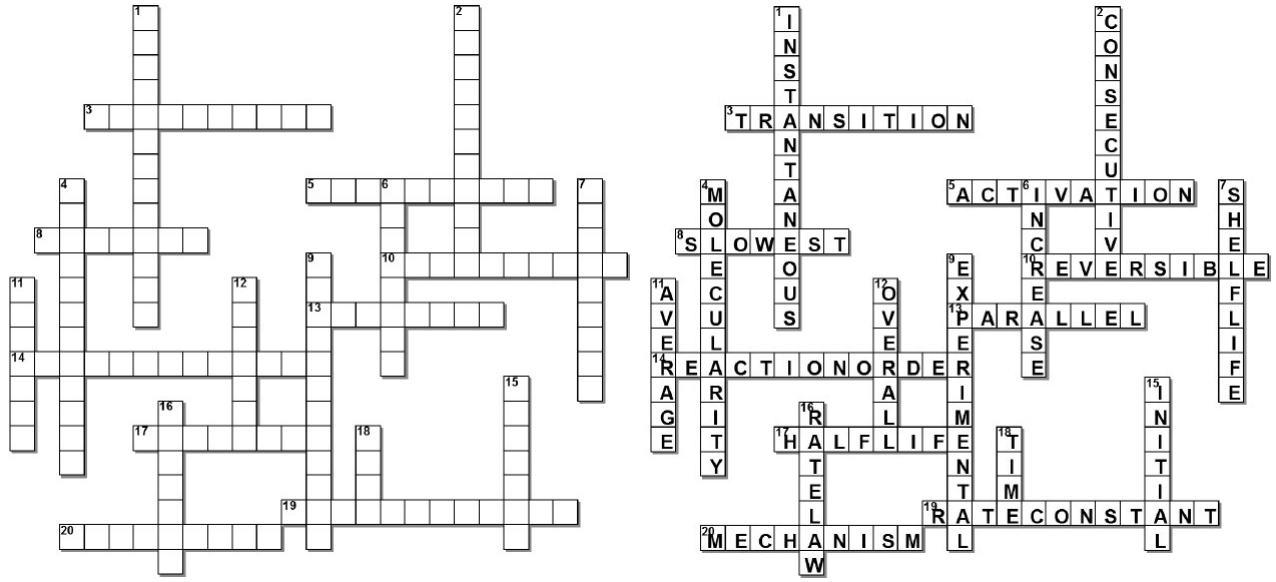
20. The greater the vapour pressure, the more _____ the compound and the weaker the intermolecular forces in the liquid.

21. A form of matter that is uniform throughout in both chemical composition and physical state.

22. The point on a single component phase diagram, where three phases can co-exist in dynamic equilibrium.

25. A horizontal line drawn across the region of two phases.

Appendix 3: Chemical Kinetics crossword puzzle



Across:

3. _____ state – a combination of molecules, which is not a molecule in its own right.

5. Chemical reactions must go over an energy barrier - _____ energy - before a reaction can take place.

8. Rate-determining step – the _____ elementary step of a multi-step process.

10. Any reaction that can exist at equilibrium is a _____ reaction.

13. A reaction where a reactant either forms a product via two different mechanistic pathways or forms two (or more) different products.

14. Exponents ***x*** in a rate law: **rate = *k* [A]^{x}** (two words)

17. The time (from the beginning of a reaction) it takes for the concentration of a reactant to decrease by half of its original value.

19. Proportionality constant ***k*** in a rate law: **rate = *k* [A]^{x}** (two words)

20. Sequence of steps by which a reaction occurs.

Down:

1. Rate at a particular moment in time.

2. A reaction, in which the product from the 1st step becomes the reactant for the 2nd step, and so on.

4. The number of molecules that come together in an elementary step.

6. Catalysts – species which _____ the rate of chemical reactions by lowering the activation energy.

7. The time from the manufacture or preparation until the original potency or content of active ingredient has been reduced by 10%.

9. Rate Laws are derived from _____ observations on the macroscopic level.

11. Rate over a certain time interval.

12. Order reflects the _____ change in going from reactants to products.

15. Rate at the beginning of the reaction.

16. The relationship between the reactant concentrations and the chemical rate. (two words)

18. Rate is a change (in a property) over _____.

Appendix 4: Meaning of terms used in thermodynamics[a]

Term[b]	Everyday language / common usage	Context-specific scientific language	Clue(s) (**Figure 1**)
bond	• A thing used to tie something or to fasten things together • An agreement with legal force	Bond is a strong force of attraction holding atoms together in a molecule or crystal, resulting from the sharing or transfer of electrons	12 down
capacity	• The maximum amount that something can contain or produce • The ability or power to do or understand something • A specified role or position	Heat capacity is the ratio of heat supplied to the rise in temperature produced.	22 across
condensed	• Made denser or more concise; compressed or concentrated	Condensed phase is a solid or liquid phase, not a gas.	5 down
decomposition	• The state or process of rotting; decay	Decomposition is reaction in which a substance is broken down into simpler substances.	21 across
element	• An essential or characteristic part of something abstract • Any of the four substances (earth, water, air, and fire) regarded as the fundamental constituents of the world in ancient and medieval philosophy • A person's or animal's natural or preferred environment • A part in an electric kettle, heater, or cooker which contains a wire through which an electric current is passed to provide heat	Element is (i) a substance that cannot be separated into simpler components by chemical techniques; (ii) a substance consisting of atoms of the same atomic number.	8 down
formation	• The action of forming or process of being formed • A group of people or things in a particular arrangement or pattern	Standard enthalpy of formation refers to the formation of a substance from its elements in their most stable form.	21 across 8 down
spontaneous	• Performed or occurring as a result of a sudden impulse or inclination and without premeditation or external stimulus • Having an open, natural, and uninhibited manner	Occurring without needing to be driven by an external influence.	16 across 19 down
state	• A nation or territory considered as an organized political community under one government • The civil government of a country	State function is a property of a substance that is independent of how the sample was prepared. State of matter is the physical condition a sample.	7 across
surroundings	• The things and conditions around a person or thing	Surroundings is the region outside a system, where observations are made.	14 down
universe	• A particular sphere of activity or experience • All existing matter and space considered as a whole	Universe is the system and its surroundings.	18 across 14 down

[a] Definitions are from the Oxford Dictionary. Where scientific definitions are not available in the Oxford Dictionary, definitions from the prescribed textbook were used (Atkins P. W., Jones L. and Laverman L., (2013), *Chemical principles : the quest for insight*, New York: W H Freeman). [b] Similar or identical terms with different technical meanings in different contexts are shown in bold.

Appendix 5: Meanings of terms used in ionic equilibria[a]

Term[b]	Everyday language / common usage	Context-specific scientific language	Clue(s) (**Figure S1**)
acceptor	• A person or thing that accepts or receives something • An atom or molecule which is able to bind to or accept an electron or other species	A base is a proton acceptor (Brønsted-Lowry theory).	17 across
capacity	• The maximum amount that something can contain or produce • The ability or power to do or understand something • A specified role or position	Buffer capacity is an indication of the amount of acid or base that can be added before a buffer loses its ability to resist the change in pH.	3 down
dominant	• Having power and influence over others	Indicating a position of equilibrium: product-dominant (prevalence of product(s)), reactant-dominant (prevalence of reactant(s)).	8 across 9 down
donor	• A person who donates something, especially money to charity • A person who provides blood, an organ, or semen for transplantation, transfusion, etc. • An atom or molecule that provides a pair of electrons in forming a coordinate bond	An acid is a proton donor (Brønsted-Lowry theory).	16 down
limit/limiting	• A point or level beyond which something does not or may not extend or pass • A restriction on the size or amount of something permissible or possible	Limiting reagent is the reactant that governs the theoretical yield of product in a given reaction.	22 across
strength	• The quality or state of being physically strong • The capacity of an object or substance to withstand great force or pressure • The potency or degree of concentration of a drug, chemical, or drink • A good or beneficial quality or attribute of a person or thing	Strong acids and bases are acids and bases that are fully deprotonated or protonated, respectively, in solution.	4, 7, 8, 25 across 2, 9, 21, 23 down

[a] Definitions are from the Oxford Dictionary. Where scientific definitions are not available in the Oxford Dictionary, definitions from the prescribed textbook were used (Atkins P. W., Jones L. and Laverman L., (2013), *Chemical principles : the quest for insight*, New York: W H Freeman). [b] Similar or identical terms with different technical meanings in different contexts are shown in bold.

Appendix 6: Meanings of terms used in phase equilibria[a]

Term[b]	Everyday language / common usage	Context-specific scientific language	Clue(s) (**Figure S2**)
critical	• Expressing adverse or disapproving comments or judgements • Expressing or involving an analysis of the merits and faults of a work of literature, music, or art • Having the potential to become disastrous; at a point of crisis	Relating to or denoting a point of transition from one state to another.	6 down
dynamic	• (Of a process or system) characterized by constant change, activity, or progress • (Of a person) positive in attitude and full of energy and new ideas	Dynamic equilibrium is the condition in which a forward process and its reverse are taking place simultaneously at equal rates.	22 down
extensive	• Covering or affecting a large area; large in amount or scale	Extensive (property) is a physical property that depends on the size of the sample.	26 across
ideal	• Satisfying one's conception of what is perfect • Existing only in the imagination; desirable or perfect but not likely to become a reality	Ideal gas is a gas that satisfies the ideal gas law and is described by a kinetic model.	2 across
instantaneous	• Occurring or done instantly	Instantaneous dipole moment is a dipole moment that arises from a transient distribution of charge and is responsible for the London force.	24 across
intensive	• Concentrated on a single subject or into a short time; very thorough or vigorous • Achieving maximum production with limited resources • Concentrating on or making much use of a specified thing	Extensive (property) is a physical property that is independent of the size of the sample.	4 down
phase	• A distinct period or stage in a process of change or forming part of something's development	Phase is a specific physical state of matter. In certain cases, some substances can exist in more than one solid or liquid phase.	21 down
tie	• Attach or fasten with string or similar cord • Restrict or limit (someone) to a particular situation or place • Connect; link • Achieve the same score or ranking as another competitor or team	Tie line – a horizontal line drawn across the region of two phases.	25 down
volatile	• (Of a person) liable to display rapid changes of emotion	(Of a substance) easily evaporated at ambient temperature.	20 down

[a] Definitions are from the Oxford Dictionary. Where scientific definitions are not available in the Oxford Dictionary, definitions from the prescribed textbook were used (Atkins P. W., Jones L. and Laverman L., (2013), *Chemical principles : the quest for insight*, New York: W H Freeman). [b] Similar or identical terms with different technical meanings in different contexts are shown in bold.

Appendix 7: Meanings of terms used in chemical kinetics[a]

Term[b]	Everyday language / common usage	Context-specific scientific language	Clue(s) (**Figure S2**)
elementary	• Relating to the rudiments of a subject: an elementary astronomy course • Straightforward and uncomplicated	Elementary reaction/step is an individual step in a proposed reaction mechanism.	8 across
instantaneous	• Occurring or done instantly	Instantaneous rate is the slope (gradient) of the tangent of a graph of concentration against time.	1 down
order	• The arrangement or disposition of people or things in relation to each other according to a particular sequence, pattern, or method • An authoritative command or instruction • A particular social, political, or economic system • A society of monks or nuns living under the same religious, moral, and social regulations and discipline; an institution; a fraternity • The degree of complexity of an equation, expression, etc., as denoted by an ordinal number (mathematics)	Order of a reaction is the power to which the concentration of a single substance is raised in a rate law.	12 down
rate	• The speed with which something moves or happens • A fixed price paid or charged for something • A tax on commercial land and buildings paid to a local authority (usually plural)	Reaction rate is the unique rate of a chemical reaction calculated by dividing the change in concentration of a substance by the interval during which the change takes place and by taking into account the stoichiometric coefficient of the substance.	1, 11, 15, 16, 18 down

[a] Definitions are from the Oxford Dictionary. Where scientific definitions are not available in the Oxford Dictionary, definitions from the prescribed textbook were used (Atkins P. W., Jones L. and Laverman L., (2013), *Chemical principles : the quest for insight*, New York: W H Freeman). [b] Similar or identical terms with different technical meanings in different contexts are shown in bold.