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Lecturer – Chemistry
Inverness College UHI

RATIONALE

Retention vs transfer

RATIONALE

Retention vs transfer

Retention : recall of learned facts

RATIONALE

Retention vs transfer

Retention : recall of learned facts

Transfer : applying learned material to a
novel situation

Mayer, R.E. 1998, "Cognitive, metacognitive and motivational aspects of problem solving", *Instructional Science*, **26**, 49-63

RATIONALE

Retention vs transfer

Students perform well when **recalling** learned lists (elements in a Group of the Periodic Table, lists of historical dates) but less well when applying knowledge to solve problems

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Retention vs transfer

Students perform well when recalling learned lists (elements in a Group of the Periodic Table, lists of historical dates) but less well when **applying** knowledge to solve problems

RATIONALE

Applying learned knowledge to
solve problems helps students to
generalize

RATIONALE

To allow them to do this, they
must have a store of relevant
knowledge

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knowledge

For example

“vocabulary of chemistry”

RATIONALE

Chemistry vocabulary

Type 1 words spelling and meaning unique to chemistry

Type 2 words words which occur in both general AND chemistry English, but with different meanings

RATIONALE

Type 1 words	Meaning	
Alkane	Hydrocarbon compound with no double or triple carbon to carbon bonding	
Ester	Compound formed from reaction of an alcohol with an acid with loss of a water molecule	
Exothermic	Reaction which gives out energy as heat	
Polymer	Large molecule built up of large numbers of individual units (monomers)	
Enthalpy	A thermodynamic function of state which may be considered as the “chemical potential energy” of a system	
Type 2 words	Everyday meaning(s)	Chemistry meaning(s)
Base	Headquarters, platform	Source of electrons, chemical species which will neutralise an acid
Period	Time interval, specific part of history	Row in the Periodic Table of the Elements corresponding to the filling of an electron shell
Reduce	Make smaller, make simpler	Donate electrons, change to a lower oxidation state, combine with hydrogen, remove oxygen
Saturated	Soaking wet, fully occupied	Unable to undergo addition reactions, only substitution reactions because of a lack of carbon to carbon double or triple bonds; (of a solution) – unable to dissolve any more material
Solution	The answer to a problem or question	A homogeneous mixture with a solute distributed in a solvent (a dissolving medium)

RATIONALE

Highest Order  Lowest Order	Research and Creativity Skills Project Planning and Execution
	Team Working and Inclusivity Oral Communication Scientific Literacy and Criticism Independent Thinking
	Applied Chemistry Problem Solving Practical Skills
	Chemistry fundamentals (core knowledge)

Adapted from Smith, D., 2016, "Designing Skilful Chemists", *Education in Chemistry*, **53(4)**, 18-21

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Higher order cognitive skills

CONSTRUCTIVIST MODEL

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Students combine **new information** with existing subject knowledge (vocabulary and skills) to construct new knowledge

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CONSTRUCTIVIST MODEL

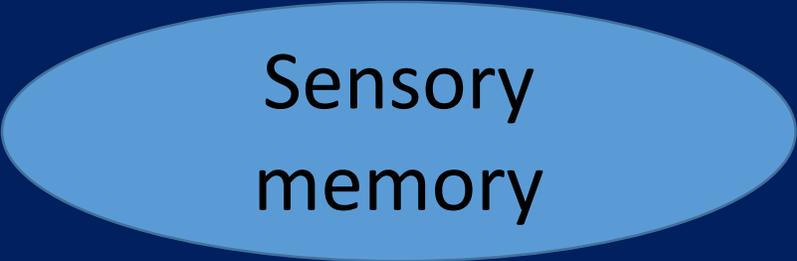
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CONSTRUCTIVIST MODEL

Students combine new information with existing subject knowledge (vocabulary and skills) to construct **new knowledge**



Sensory
memory

Receives new
information

Sensory
memory

Receives new
information

Long term
memory

Pool of existing
knowledge

Sensory
memory

Receives new
information

Long term
memory

Pool of existing
knowledge

Working
memory

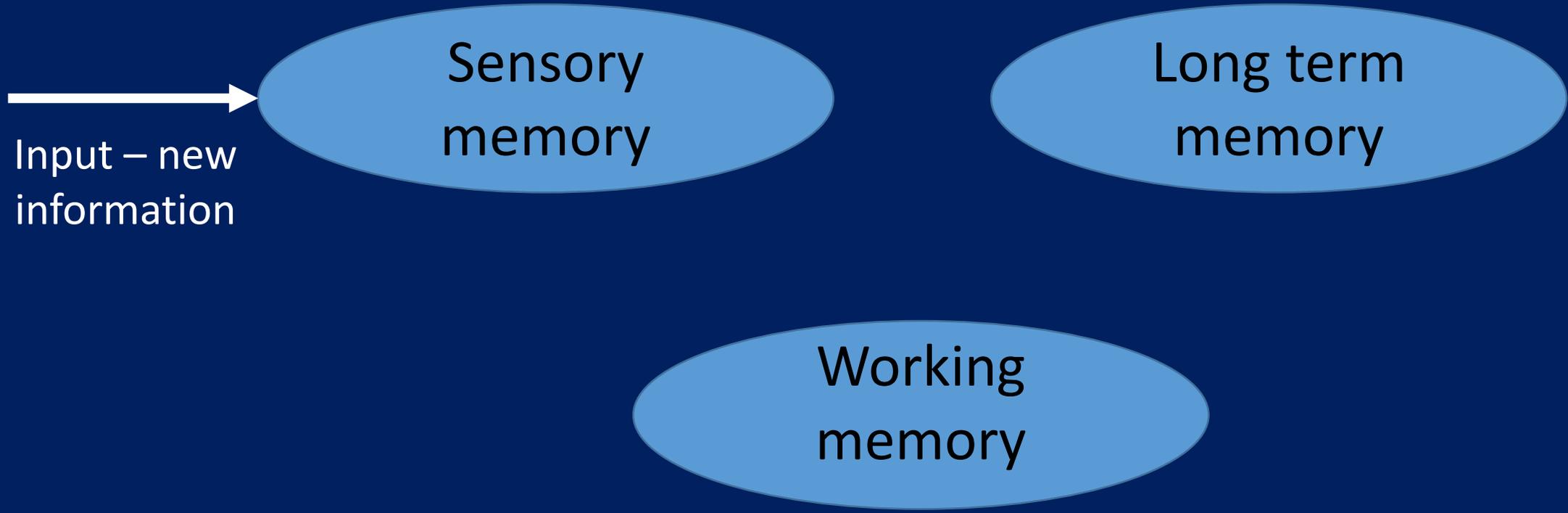
Processing of
information

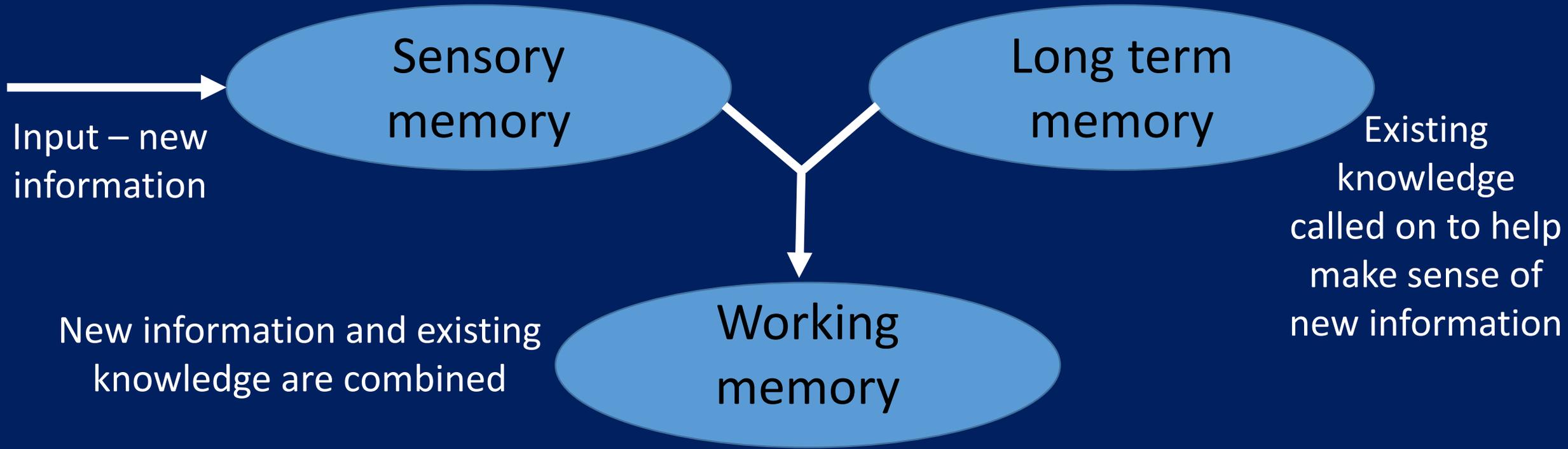
Input – new
information

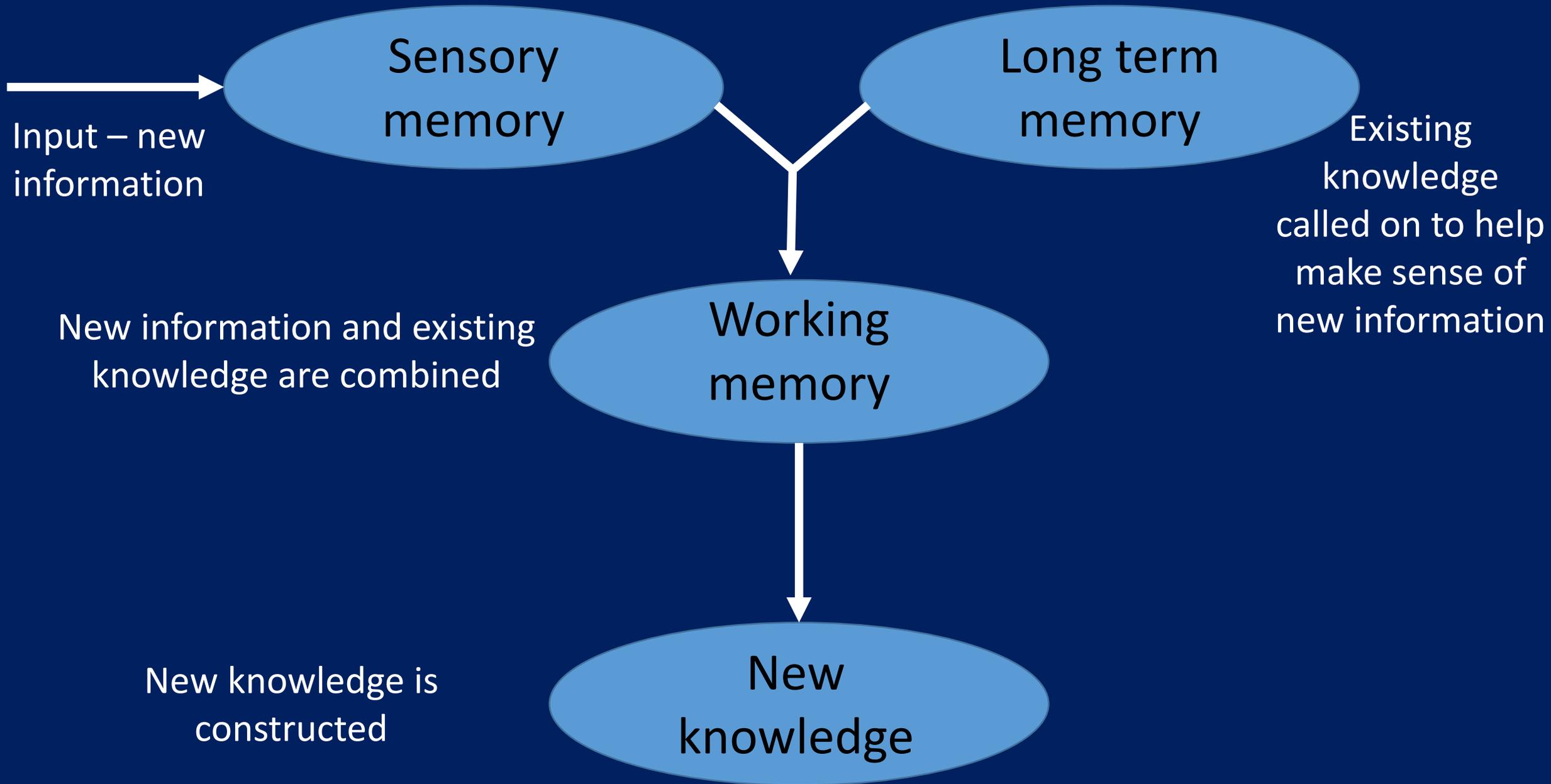
Sensory
memory

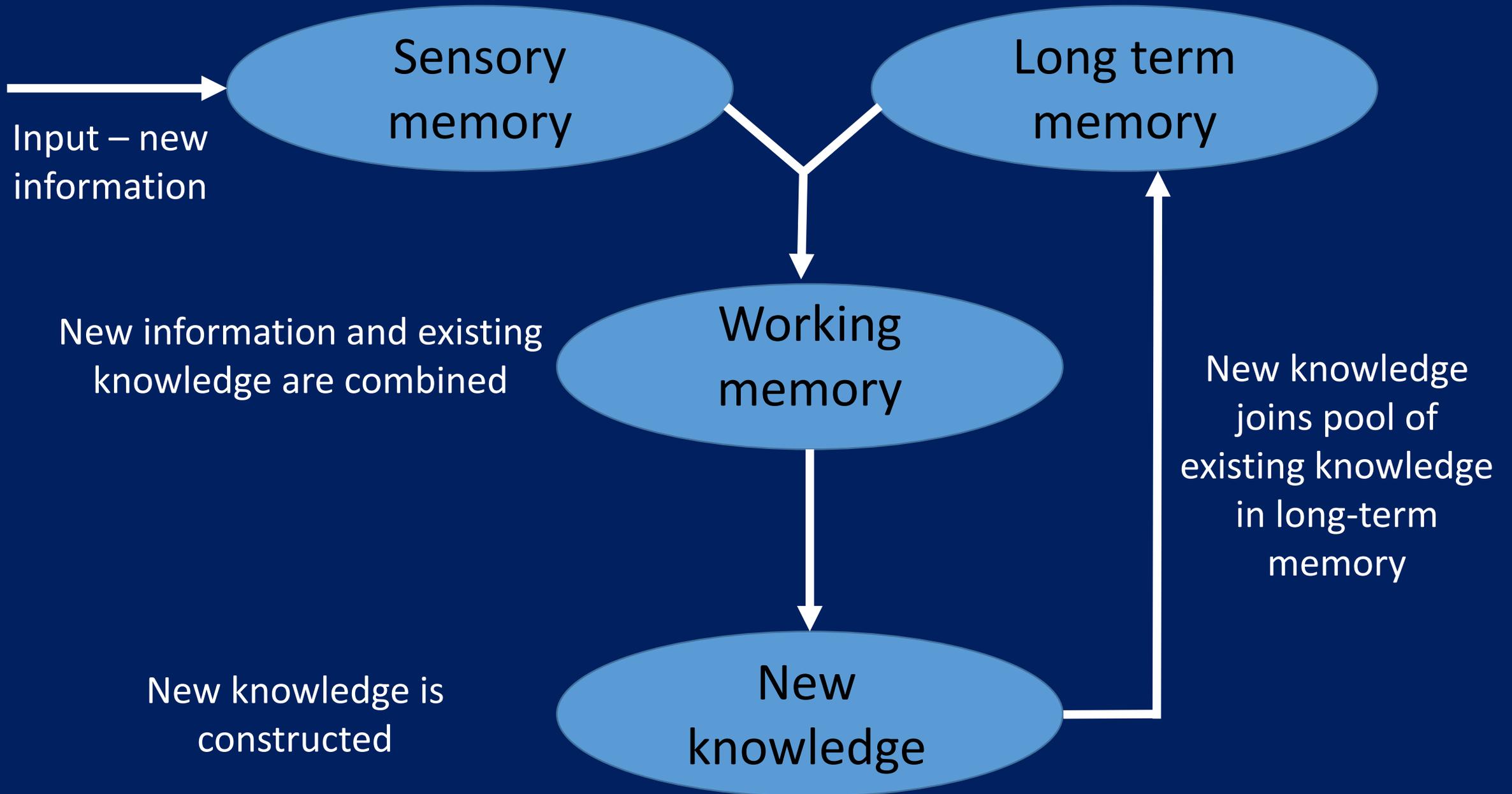
Long term
memory

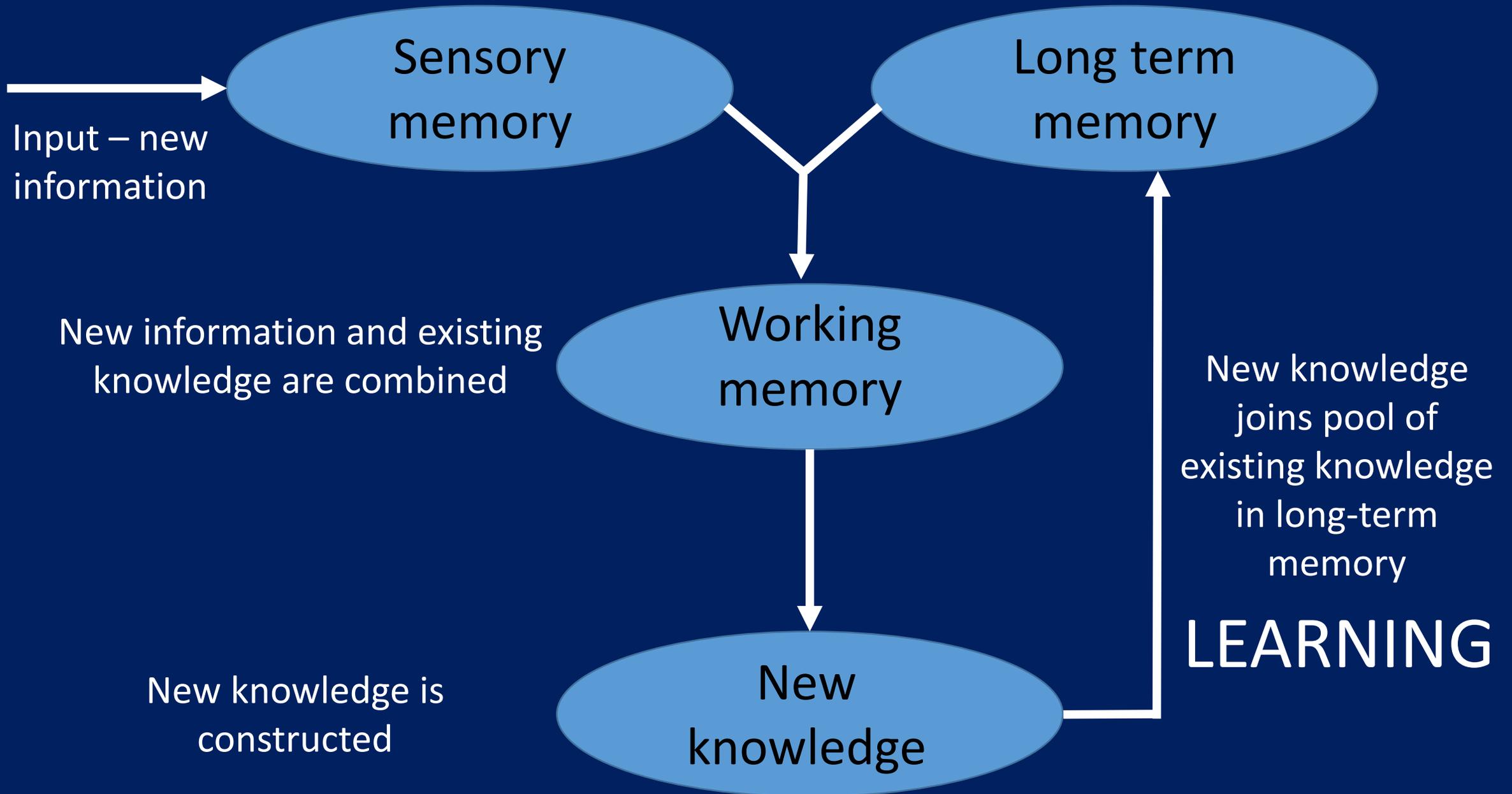
Working
memory

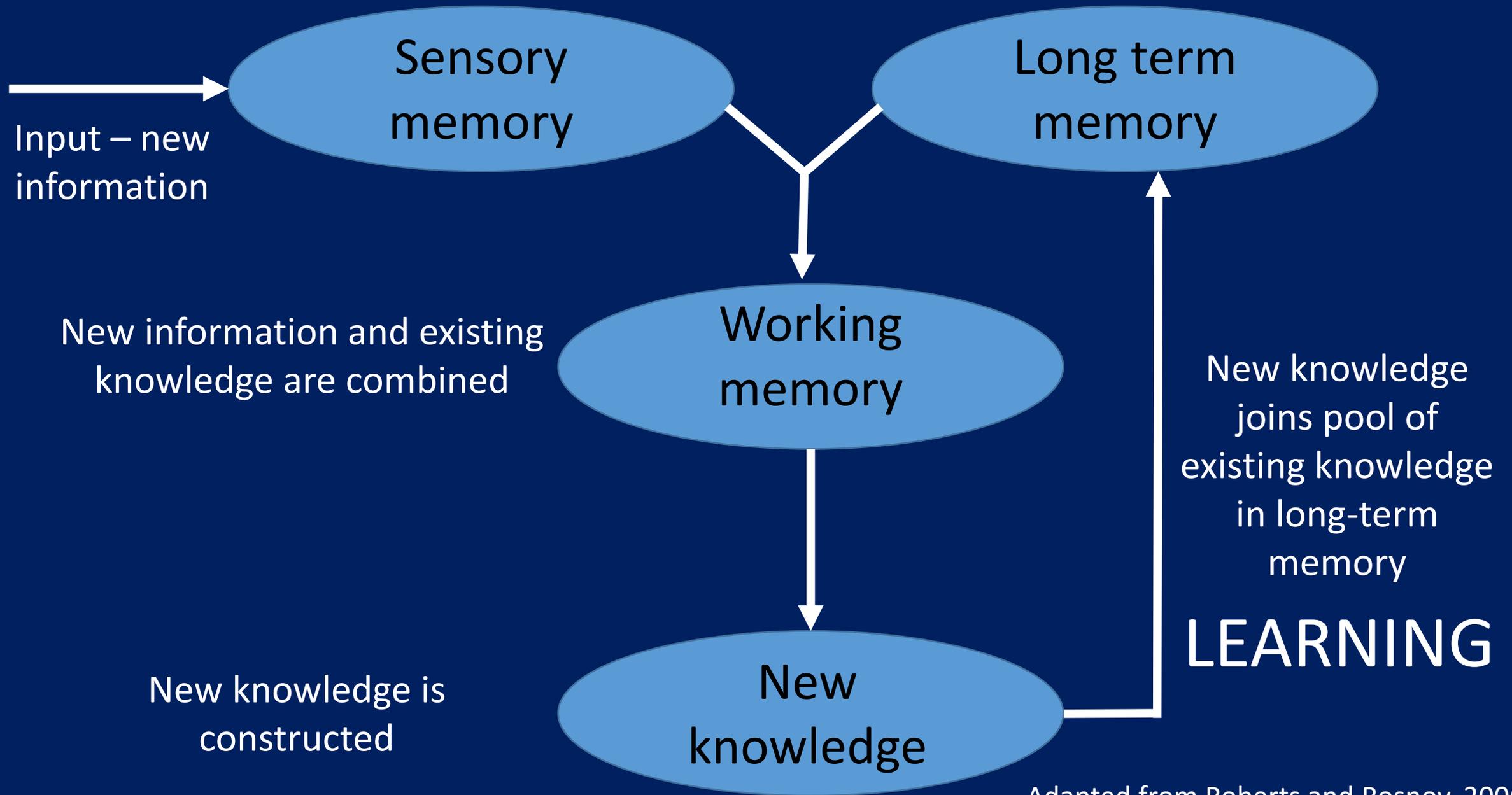












RATIONALE

Higher order cognitive skills
COMMUNITIES OF PRACTICE

RATIONALE

Higher order cognitive skills

COMMUNITIES OF PRACTICE

Fluency in the vocabulary of a discipline, and ability to solve problems, will help students to join, and *be accepted by*, the “learning community”

RATIONALE

Puzzles and games have been used throughout human history as tools to aid learning in such a way as to make learning fun

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Puzzles and games have been used throughout human history as tools to aid learning in such a way as to make learning fun

Crosswords are an example

RATIONALE

Students using crossword puzzles as a learning tool have reported:

RATIONALE

Students using crossword puzzles as a learning tool have reported:

- Having fun doing the puzzles as part of a lesson

RATIONALE

Students using crossword puzzles as a learning tool have reported:

- Having fun doing the puzzles as part of a lesson
- Enhanced learning of vocabulary associated with the discipline

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- Having fun doing the puzzles as part of a lesson
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- Ability to revise course material better
- Enhanced learning of course material
- Enhanced ability to solve problems

LITERATURE

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PLANNING

Prepare puzzles for use as part of revision for Unit assessments in the Higher Chemistry course

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Unit 1 – Chemical Changes and Structure

PLANNING

Prepare puzzles for use as part of revision for Unit assessments in the Higher Chemistry course

Unit 1 – Chemical Changes and Structure

- Controlling the rate of reaction
- The Periodic Table – bonding and structure
- Trends in The Periodic Table
- Bonding in compounds

PLANNING

Prepare puzzles for use as part of revision for Unit assessments in the Higher Chemistry course

Unit 2 – Nature's Chemistry

PLANNING

Prepare puzzles for use as part of revision for Unit assessments in the Higher Chemistry course

Unit 2 – Nature's Chemistry

- Alcohols, carboxylic acids and esters
- Fats, oils and soaps
- Proteins
- The chemistry of cooking and oxidation of food
- Fragrances
- Skin care

PLANNING

- All clues were composed by me
- Clues were composed in the cryptic style, with varying degrees of difficulty
- All solutions were to be relevant to the Course material
- Puzzle grids were generated using free online crossword puzzle compiler
Armored Penguin

Armoredpenguin (2016), crossword puzzle generator

<http://www.armoredpenguin.com/crossword/>

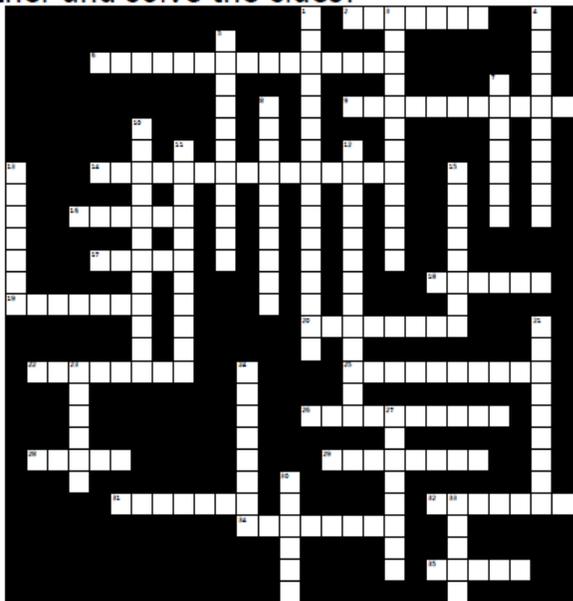
[Accessed : 28th November 2016]

The grids look quite professional! Here are a couple of examples of my puzzles.

HIGHER CHEMISTRY UNIT 1

Dr. Anthony Luke

A crossword puzzle to help you revise Unit 1 - Chemical Changes and Structure. Some clues are easy-peasy, some are harder, and some are fiendish! Work together and solve the clues!



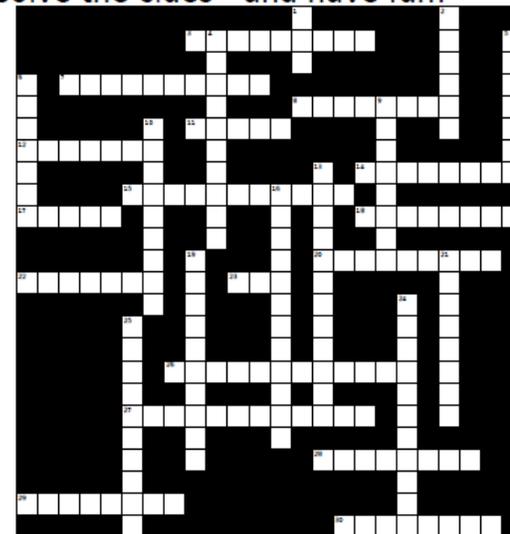
- Across
- Clue about a form of carbon is very, very hard (7)
 - What kind of structures are diamond, graphite and silicon? To find the answer, rebuild Town Centre Val, OK? (8, 7, anagram)
 - Not tied to one area, like electrons in metals? (11)
 - Difference in electronegativity between two atoms in a bond makes one of these (9, 6)
 - Time taken to get across a row of the Table (6)
 - Bonds where electrons are shared unequally - look for them in the Arctic or Antarctic (5)
 - Eight atoms in a crown in this flowery yellow element (6)
 - Spandex has what it takes to do what water does when it freezes! (7, anagram)
 - This form of carbon isn't lead, but it is in your pencil! (8)
 - 9, 17, 35, 53, 85 and 117 (8)
 - Knocking an electron off an atom, or the energy required to do the same? (10)
 - I'm a cation, you're an anion. We're opposites, so what holds us together? (5, 5)
 - Elements in the same column form a band (5)
 - H₂, N₂, O₂, F₂, Cl₂, Br₂, I₂ - get this type of molecule by changing mac, idiot! (8, anagram)
 - No charge for this sub-atomic particle (7)
 - Enclave transforms into outer electron shell (7, anagram)
 - To make a word for chemical potential energy, change then play (8, anagram)
 - This element has a covalent network structure, but is it broon? (5, anagram)

- Down
- Chemical reactions (and us!) need this to get going (10, 6)
 - 3, 11, 19, 37, 55 and 87 (6, 6)
 - Royal elements don't mix with the riff-raff from the other parts of the Table! (5, 5)
 - Searching for a reaction which absorbs heat? Examine The Micro End (11, anagram)
 - Transform nice kit into energy of motion (7, anagram)
 - Reaction gave out heat, blowing up the ox : crime! (10, anagram)
 - As this gets smaller, the rate gets..... FASTER??? (8, 4)
 - Forces between atoms and molecules - like something vandals wear (3, 3, 5, anagram)
 - This affects the rate of a reaction. To work out the answer, you need to think hard! (13)
 - Cations and anions are arranged in a 3-D structure which could be tactile (7, anagram)
 - To increase the rate of a reaction involving gases, try some squash? (8)
 - Noble gases live the single life! (9)
 - Dispersion Forces active in this big city (6)
 - The most reactive of them all! (8)
 - I made things go faster, but I'm just the same now as I was before I started (8)
 - Charged atom? I'm positive! (6)
 - Charged atom? Negative! (5)

HIGHER CHEMISTRY UNIT 2

Dr. Anthony Luke

A crossword puzzle to help you revise Unit 2 - Nature's Chemistry. Some clues are simple, others more tricky, and some of them are stinkers! Work together to solve the clues - and have fun!



- Across
- Solid fat sounds like it's soaking wet! (9)
 - It's the first step towards a free radical chain reaction (10)
 - Fibrous protein extracted from clean log (8, anagram)
 - EastEnders, Coronation Street, sodium salts of long chain carboxylic acids ... (5)
 - Find link between amino acids by rummaging around deep pit (7, anagram)
 - This class of alcohol won't oxidise: irate, try doing something different! (8, anagram)
 - Two free radicals meet and form a stable molecule - The End (11)
 - Alcohol and carboxylic acid get together and make sweet perfume! (5)
 - Where there's alcohol, you'll ALWAYS find this group! (8)
 - Oil of amino acid - we sound like you can't do without us. (9)
 - Tablets of this ester are a powerful painkiller - swallow in pairs (7, anagram)
 - Ester of glycerol and unsaturated fatty acids (3)
 - Use positive test with Tollens' reagent to check your reflection (6, 6)
 - These are added to food to stop it going off - so, possibly, I stand a toxin (12, anagram)
 - Want to know the functional group of aldehydes and ketones? Ask Bony Carl (8, anagram)
 - A molecule which has a strong flavour and odour is likely to be this: v. late oil! (8, anagram)
 - My proper name is propane-1,2,3-triol (8)

- Down
- Ester of glycerol and saturated fatty acids (3)
 - Look in basket one time to find an oxidation product of an alcohol (6)
 - When we get together we make proteins (5, 5)
 - This kind of alcohol will oxidise - twice! (7)
 - Make essential oil molecule from Pen Tree (7, anagram)
 - Halfway between Primary Alcohol and Carboxylic Acid (6)
 - Hard water stops soap working, so who do we need? Ted Regent, possibly! (5, anagram)
 - Does reaction between alcohol and carboxylic acid result in water droplets forming on the windows? (12)
 - You must transform something to make fat or oil, e.g. dirty relic (12, anagram)
 - Oil and water won't mix until one of these gets to work (10)
 - Who can change things round to make a terpene building block? I, Penrose. (8, anagram)
 - Soap molecule tail sounds like it's afraid of water (11)
 - The first one (Greek) of the protein secondary structures gets itself in a twist! (5, 5)

COMPOSING CLUES

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- Must be RELEVANT to the subject matter
- Different styles of clues make puzzles more interesting.
- Range of complexity – encourages students to work together. Some clues easy, others harder
- Include the number of letters in the solution.

From 'missing word' to 'cryptic' clues

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Cryptic with anagram – Rearrange the letters of the solution to make anagrams: great fun! – make sure that the clue includes a hint at the solution as well as an 'anagram signifier' like “break up”, “break down”, “change”, “transform” etc. for example :

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“Type of process involving protein catalyst to break down **meaty zinc**” (9, anagram) - ENZYMATIC

IMPLEMENTATION

- Puzzles were given out to the Higher Chemistry class, and completion instructions were given
- Students were allowed full access to revision materials and were **encouraged** to work together to do the puzzles – not compulsory
- Students were given anonymous written feedback forms to comment on the crossword puzzles

FEEDBACK

Anonymous written feedback form

FEEDBACK

Statement Class size = 14	Strongly agree (+2)	Agree (+1)	Neither agree nor disagree (0)	Disagree (-1)	Strongly disagree (-2)
The crossword puzzles were fun to do					
The crossword puzzles made me look at my notes and textbook more thoroughly					
The crossword puzzles helped me to understand the course material					
The crossword puzzles were relevant to the course					
The crossword puzzles helped me to understand chemical terms better					
Doing the crossword puzzles has helped me to solve chemistry problems					
Doing the crossword puzzles has helped me to revise for assessment better					
The crossword puzzles made it easier for me to learn the course materials					

FEEDBACK

Statement Class size = 14	Strongly agree (+2)	Agree (+1)	Neither agree nor disagree (0)	Disagree (-1)	Strongly disagree (-2)
The crossword puzzles were fun to do	10	4	0	0	0
The crossword puzzles made me look at my notes and textbook more thoroughly	7	4	1	0	0
The crossword puzzles helped me to understand the course material	9	2	2	0	0
The crossword puzzles were relevant to the course	12	2	0	0	0
The crossword puzzles helped me to understand chemical terms better	7	5	2	0	0
Doing the crossword puzzles has helped me to solve chemistry problems	5	6	3	0	0
Doing the crossword puzzles has helped me to revise for assessment better	9	2	3	0	0
The crossword puzzles made it easier for me to learn the course materials	7	4	3	0	0

FEEDBACK

Statement Class size = 14	Strongly agree (+2)	Agree (+1)	Neither agree nor disagree (0)	Disagree (-1)	Strongly disagree (-2)
The crossword puzzles were fun to do +24	10	4	0	0	0
The crossword puzzles made me look at my notes and textbook more thoroughly +18	7	4	1	0	0
The crossword puzzles helped me to understand the course material +20	9	2	2	0	0
The crossword puzzles were relevant to the course +26	12	2	0	0	0
The crossword puzzles helped me to understand chemical terms better +19	7	5	2	0	0
Doing the crossword puzzles has helped me to solve chemistry problems +16	5	6	3	0	0
Doing the crossword puzzles has helped me to revise for assessment better +20	9	2	3	0	0
The crossword puzzles made it easier for me to learn the course materials +18	7	4	3	0	0

FEEDBACK

No **negative feedback** ('disagree' or 'strongly disagree')

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High agreement that **puzzles were fun to do**, that they helped students understand the subject material, and that they helped students revise

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CAUTION

- Don't overuse puzzles and games
- Use them sparingly, at the right time
- Don't compel students to use them
- Offer them as an additional, fun learning tool
- Students must be more than good crossword solvers!

Thank you for listening!

Anthony.Luke.ic@uhi.ac.uk

Please get in touch for copies of
crossword puzzles, libraries of
clues and other useful stuff