Template for Four Page* Summary for VCE Physics Units 3 & 4
* A3 sheet or two A4 pages taped together

1. Decide whether you will do the multiple choice Section A, first or last.
2. Section B: From the VCAA information about the exam, determine how many questions there are and the number of pages. Then calculate when you should have completed 25% of the questions, 50%, etc.

General Hints:
- Don't include the formulae from the sheet. Although you may wish to write them down in words to remind yourself of the relationship,
- Definitions and relationships not included in the formula sheet,
- Pictures of the various diagrams, and graphs you might use, such as Force diagrams for circular motion, etc.
- Worked solutions of problems you have found difficult,
- Concept maps linking your ideas together.

Fields

Gravitational Fields
- Draw field lines around a mass and between two masses. Include direction of field
- For satellites: Always start with Net Force= ma. $GMm/r^2 = m\ 4\pi^2 r/T^2$
- Use $R^3/T^2 = GM/4\pi^2$ to compare satellites.
- Not all objects are satellites in orbit, sometimes object just fall to ground.
- Use the concepts of weight and apparent weightlessness to describe objects in orbit.
- Describe energy changes of an object moving in a gravitational field, give specific examples, refer to both kinetic and potential energies.
- Use Area under the Graph to calculate energy on an object falling to Earth Examples of using a force vs dist graph and also a field vs dist graph to calculate change in gravitational PE. NOTE: Area under Field –Dist graph = Joules per kilogram, whereas Area under Force –Dist graph = Joules.

Electric Fields
- Draw field diagrams for different combinations of charged objects, e.g. Point charges, spheres, plates, include a dipole. Include direction of the field
- Describe the action of electric field on a charge: stationary or moving in different directions
- Describe energy changes of an object moving in an electric field, give specific examples, refer to both kinetic and potential energies
- Include concept map for force, field, voltage and energy with equations and annotated lines connecting concepts.

- Sample calculations using Coulomb's law and electric field expression for point charge
- Sample calculations using F=Eq, W=Vq, E = V/d
- Diagrams of the electrical interaction between parallel and anti parallel currents.

Magnetic Fields
- Draw the magnetic field for combinations of bar magnets, wires, coils and solenoids. Note direction of field
- Dipole, but no monopole

Magnetic Force of a current
- Describe or draw your preferred hand rule
- Write equation, emphasising n, number of wires
- Force = zero, if field and current are parallel.
- Diagram of DC motor showing directions of field, current and force at different coil positions.
- Describe role of commutator, mentioning three aspects.

Magnetic force on a moving charge
- Describe the action of a magnetic field on a charge, stationary or moving in different directions
- Include expression for radius of motion
- Motion of a charge in crossed E and B fields

Comparison of fields
- a table summarising properties of the three fields
- Examples of fields for each that are static, changing, uniform and non-uniform
- Simple inverse square law calculations using ratios
- Role of electric and magnetic fields in a particle accelerator

Electrical Energy

Magnetic Flux and Electromagnetic Induction

- Define magnetic flux. Don't use n for number of turns in solenoid, just field x area.
- Diagrams of changing angle to show max flux and zero flux.
- Faraday's Law, both as an equation and word expression. Include examples
- Lenz's Law: Explain in detail with examples.
- Graphs of flux change and induced voltage. Note: The graph of induced voltage is not always the negative gradient of flux graph. It depends on how the voltmeter is connected and the labelling of the axes.
- Graph of induced AC voltage when frequency is increased.
- Slip rings and split ring (commutator): difference with diagram and roles with DC generator and AC alternator.

AC Voltage

- Graph showing peak, p to p and RMS
- Include maths relationships.
- Define time and voltage scales and put units on axes. Include common frequency / period conversions.

Transformers

- Labelled diagram with ratio formulae.
- Describe its role, benefits.
- Do a turns ratio problem with proper labeling of primary and secondary

Transmission Lines

- Worked examples of power loss, voltage drop across lines, etc, with and w/o transformers
- Emphasise: i) resistance in each wire, ii) treat as three resistors in series: wire out, load and wire back implying same current with supply voltage split across all three.

Motion

Laws of Motion

- Rules for Connected Bodies: i) The accel'n is the same for both. ii) Net Force = mass x accel'n applies to the whole system (tension cancels), as well as each part. Include a worked example.
- Draw diagrams of components of forces

- Express Forces as 'F $_{on\ A\ by\ B}$'
- Draw concept map linking "Force, Mass, Acceleration, Impulse, Momentum. KE, Work Done and Power".
- Do a typical problem of Work Done by a force such as friction or a tension.

Circular motion

- Acceleration is always inwards towards the centre. Also include diagram
- Net Force is always inwards towards the centre
- Examples of inward forces: Friction: Force by road on tyre; gravity
- Banked Curves: Draw force diagram, centripetal accel'n is provided by horizontal component of reaction force. $N \sin\theta = mv^2/r$, $N \cos\theta = mg$.
- Vertical circle: Draw a force diagram with weight and reaction forces and acceleration vector for the bottom of loop and two diagrams for the top of loop at both slow and fast speeds. Do sample calculation for reaction force at the bottom for fall around loop from the top w/o energy loss.
- Use the concepts of weight, apparent weight and apparent weightlessness to describe various scenarios in a vertical circle.

Springs

- Do example where KE is transferred into Spring Potential Energy, $\frac{1}{2} kx^2$.

Projectile motion

- Draw path showing constant weight force down at all points, constant horizontal velocity. Use different colours.
- Determine initial horizontal and vertical velocities.
- Treat horizontal and vertical aspects separately. Draw a line down middle of working area. Left: Horiz (Dist = v x t), Right: Vert u =, v =, a = - g, t = ?).
- Assign a direction as positive.
- Do typical problems: Find max height, range, time of flight.
- Do problem from energy point of view.
- Describe/draw effect of air resistance on max. height, range and time of flight.

Collisions
- Momentum is always conserved
- KE is rarely conserved and only when the word "elastic" is used in describing the collision.
- Do worked example with setting out as "Momentum before = Momentum after"
- Use time of impact to determine F_{AV} from Δp
- Use distance travelled during impact to determine change in KE
- Describe what happens to the momentum when a car hits a tree.
- Describe what happens to the energy when a car hits a tree.

Special Relativity
- Dot point comparison between relativity and classical physics
- Explain length contraction, time dilation
- Define proper time and proper length
- Table of common γ and speed values
- Do sample problems for time dilation, length contraction and $E = \Delta mc^2$
- Explain rest mass energy, total mass energy and the new definition of KE.
- Sample calculation of relativistic kinetic energy
- Describe nuclear fusion with reference to mass loss and production of EMR

Waves and Light
Wave properties
- Definition of a wave, the different types of waves with examples.
- Parameters of waves with meaning, diagrams and equation
- Describe constructive and destructive interference in terms of reinforcement and cancellation, and in terms of the meeting of crests and troughs.
- Include sample calculations of path difference and consequence for pattern.
- Explain Doppler effect in some detail and in dot point form.
- Write a brief description of meaning of resonance and how it occurs.
- Draw diagrams of the harmonics for strings, fixed at one or both ends. Include the frequency values.

Light as a wave
- Include full definition of light as an EM wave
- Include values for frequency and wavelength from across the EM spectrum

Refraction
- Include ray diagrams of refraction, total internal reflection, critical angle and reflection for angles greater than the critical angle
- Sample calculations with Snell's Law, both of angles and wave speeds.
- Explain dispersion in dot point form, include diagram of colour order.

Young's double slit experiment
- Describe the result include a diagram of the equipment.
- Describe constructive and destructive interference in terms of reinforcement and cancellation, and in terms of the meeting of crests and troughs.
- Include sample calculations of path difference and consequence for pattern.
- Include sample calculations of spacing of nodal lines.
- Describe in words and diagrams, the effect on the pattern of changing the wavelength, slit separation and distance to the screen.

Diffraction
- Describe, in words and diagrams, a diffraction pattern.
- Describe, in words and diagrams, the effect of increasing the gap width and increasing the wavelength. Be wary of using the ratio λ/w.

Light and Matter
Photoelectric Effect
- Outline the wave model predictions for the interaction of light with electrons in a metal for changing the intensity, frequency and metal.
- List the observations of the PE effect.
- Outline the particle model predictions for the interaction of light with electrons in a metal as above.
- Draw and label graphs of current vs voltage for different metals, frequencies and intensities; and of stopping voltage vs frequency for different metals.

- Describe Einstein's photon model and energy equation. Include a sample calculation.
- Examples of energy conversion between eV and Joules.
- Outline the limitations of wave model to explain PE Effect.

Electrons as waves
- Describe the evidence for wave-like nature of electrons.
- Compare patterns for electrons and photons.
- Calculate the de Broglie wavelength for an electron. Note: Correct value of Planck's constant.
- Sample calculations between an electron's energy, momentum and wavelength, going from one to the others.

Photon energy and energy levels
- Sample calculations of photon energy in Joules and eV using alternative values for Planck's constant.
- comparison of electron and photon momentum and wavelength
- Include energy levels diagram showing transitions for absorption and emission of

photons, with calculation of photon energies, numbers of transitions and photon frequency and wavelength.
- Draw sample standing wave diagrams for electrons in an energy level.
- Describe in dot point, particle-wave duality
- Explain diffraction in dot point, using Heisenberg's Uncertainty Principle
- Explain, in dot point, the limitation of classical physics to model motion a small scales

Production of light from matter
- Table comparing light is produced in lasers, synchrotrons, LEDs and incandescent lights

Practical Investigation
- Include meaning of the descriptors of variables: dependent, independent, controlled, discrete
- Include meanings of precision, accuracy, reliability, validity, uncertainty, error
- Examples of significant figures
- Sample calculation of an error bar for a set of measurements.

Advice of How to use your Four Page Summary
You are able to bring into the exam four pages of notes as a single A3 sheet or 2 A4 sheets taped together. Prepare your own summary weeks before, don't use someone else's. Preparing your own is an important learning exercise.

Doing Problems
Try doing a full practice exam in one sitting under exam conditions at least twice. Include the 15 minutes reading time, as you need to think about how you might use this time most effectively.

When you have corrected your answers to the practice exam or set of questions,
- check through your answers on the questions you got wrong, and then
- re-read your course summary to clarify your ideas, then
- modify your four page summary to give you more help next time.

Do this every time you do a practice paper or a batch of questions. The frequent rewriting of your four page summary is also a useful memory tool.

There are plenty of past exam and trial papers available. Even though the course is new, 2017 the first year at Year 12, Most of the content has been in the VCE Physics course since 1991, so there are plenty of past papers in your school.