Victorian Physics Teachers' Network
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Sessions A1 and B1

VCE Physics beyond the current mess

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Abstract

The current VCE Physics study design lacks clear narrative lines. With a review in sight, now is the time to consider the logic behind a well-constructed VCE Physics course. This workshop is designed to explore possible ways to make the current design less incoherent and the next study design positively coherent.

Session Overview

1. **Problem and delimitations**
   - 1.1. General comments
     - 1.1.1. Incoherence: circular motion/gravitational motion
     - 1.1.2. Canon without reason
   - 1.2. Unit 3 and Unit 4

2. **Proposal**
   - 2.1. Useful organising principles
   - 2.2. Other issues: timing

Response

3. **Something to take away**
   - 3.1. Current Unit 3 and Unit 4 re-organised to be more coherent
   - 3.2. How does the re-organisation relate to the proposal? Ins/Outs

Response

4. **Review**
   - 4.1. Summary
   - 4.2. Evaluation sheets

Unit	Topic	Extended model	Concepts
1	Heating processes	large neutral ‘balls’ colliding radiant waves	energy transfer & transformation thermodynamic laws energy budget
	Ionising radiation/nuclear reactions	small neutral and charged ‘balls’ radiant waves	conservation laws: particle/charge/energy energy budget
	Electrical circuits	small charged ‘balls’	energy transformation conservation laws: particle/energy
2	Linear motion	small point masses	description/dynamics: Newton momentum energy transfer & transformation conservation laws: energy & momentum
	Waves	travelling energy disturbances	description radiant energy transport

3	Motion : normal	small point masses gravitational fields: constant; space varying	description/dynamics: Newton momentum energy transfer & transformation conservation laws: energy & momentum
	Motion: extreme	particle/extended particle time dilation/Length contraction energy/momentum	relativistic correction equations
	Gravity	small, point masses gravitational field	energy 'in field' (not particle) Field: constant/space-varying Law: Universal Gravitation
	Electromagnetism: Electrical field	small, point charged particles small 'test compass' current element	energy transfer & transformation conservation laws: energy energy 'in field' (not particle) Electric fields: constant; space varying Law: Coulomb
	Electromagnetism: Magnetic field	magnetic field current element	energy transfer & transformation conservation laws: energy Vector field: constant; static: current
	Electromagnetism: Induction	field interactions induction	Field: time-varying current Energy transfer Laws: Faraday, Lenz, Neumann
4	Quantum theory	Wave Particle Matter	*emr* matter interactions of matter with electromagnetic radiation

	Standard model	fundamental particle	compound particles interactions of particles

Unit 3 and Unit 4

1. **Normal Motion: kinematics**
   - 1.1. Kinematics: uniformly accelerated motion
     - 1.1.1. Straight line motion
     - 1.1.2. Projectile motion
   - 1.2. Circular motion at constant speed
     - 1.2.1. Centripetal acceleration

2. **Normal Motion: dynamics**
   - 2.1. Force by agent on receiver
   - 2.2. Newton's First Law
     - 2.2.1. inertia
   - 2.3. Newton's Second Law
     - 2.3.1. Net force
   - 2.4. Newton's Third Law
     - 2.4.1. Four criteria
   - 2.5. Impulse-momentum
     - 2.5.1. Momentum transfer
     - 2.5.2. Relationship to Newton's Third Law
   - 2.6. Work-energy
     - 2.6.1. Transfer and transformation
       - 2.6.1.1. Kinetic energy
       - 2.6.1.2. Potential energy
   - 2.7. Circular motion at constant speed
     - 2.7.1. Net force
   - 2.8. Energy transformations in spring systems
     - 2.8.1. Energy transfer and transformation *in system*
     - 2.8.2. Hooke's Law
     - 2.8.3. Strain energy

3. **Extreme Motion: Special relativity**
   - 3.1. Two postulates of special relativity
   - 3.2. Proper time
   - 3.3. Proper length
   - 3.4. Relativistic corrections
     - 3.4.1. Length contraction
     - 3.4.2. Time dilation
       - 3.4.2.1. Muon decay
     - 3.4.3. Energy
     - 3.4.4. Momentum
   - 3.5. Classical *cf* relativistic kinematics

4. **Gravitational force fields**
   - 4.1. Model of a field
     - 4.1.1. Energy transformations in springs
   - 4.2. Gravitational mass as monopole (point mass)
     - 4.2.1. Attraction force
   - 4.3. Describe gravitational force using a field model
     - 4.3.1. Uniform gravitational field: "near the Earth"

4.4. Changing gravitational fields: spatial change - inverse-square law (Newton's Universal Law of Gravitation)
4.5. Application of Universal gravitation field
4.5.1. Satellites in orbit
4.5.2. Kepler's Law
4.5.3. Weight
4.5.4. Apparent weightlessness

5. **Electric force fields**
5.1. Elecric charge as monopole (point charge)
5.1.1. Attraction force
5.1.2. Repulsion force
5.2. Describe electrostatic force using a field model
5.2.1. Uniform electrostatic field: parallel plates
5.2.2. Changing electrostatic field: spatial change - inverse-square law (Coulomb's Law)

6. **Energy transformations: gravitational and electric fields**
6.1. Energy transformations in *g*-field
6.1.1. Uniform field
6.1.2. Inverse-square law field (Universal gravitation)
6.2. Energy transformations in *E*-field
6.2.1.1. Uniform field
6.2.1.1.1. Linear accelerator
6.2.1.2. Inverse-square law field (Coulomb)
6.3. Comparing energy transformations in gravitational and electrostatic fields
6.3.1. Uniform fields
6.3.2. Spatially varying fields
6.4. Energy transformations in nuclear fusion
6.4.1. Mass-energy equivalence
6.4.2. Mass defect
6.4.3. Total mass-energy

7. **Magnetic force fields**
7.1. Magnetic dipole (opposite poles)
7.2. Uniform magnetic field
7.2.1. Horseshoe magnet
7.3. Changing magnetic field: spatial change
7.3.1. Bar magnet
7.3.1.1. Combinations of bar magnets
7.3.2. Long straight current-carrying wire
7.3.2.1. Parallel wires
7.3.2.2. Antiparallel wires
7.3.3. Current-carrying loop
7.3.3.1. Combination of loop and bar magnet
7.3.4. Solenoid
7.3.4.1. Combination of solenoid and bar magnet
7.4. Changing magnetic field: time rate of change
7.4.1. Constant change with time
7.4.2. Alternating current: sinusoidal change with time

8. **Energy transformation by electromagnetic induction**
    8.1. Magnetic flux
    8.2. Magnetic flux change
        8.2.1. Constant magnetic flux change with time
        8.2.2. Sinusoidal (AC) magnetic flux change with time
    8.3. Generation of *emf*
        8.3.1. Faraday's Law (*emf*)
        8.3.2. Lenz's Law (energy conservation)
        8.3.3. Neumann's Law (number of loops)
        8.3.4. AC *emf:* sinusoidal (AC) flux change with time
            8.3.4.1. Maximum *emf*
            8.3.4.2. Average *emf* (rms)
    8.4. Transmission of electricity
        8.4.1. Ideal transformer
        8.4.2. Power loss in wires

9. **Wave concepts**
    9.1. Energy transfer
    9.2. Types of wave
        9.2.1. Longitudinal
        9.2.2. Transverse
    9.3. Graphs of waves: (x, y, t)
        9.3.1. Wavelength: (x,y), t = constant
        9.3.2. Period: (t,y), x = constant
        9.3.3. Wavespeed
        9.3.4. Superposition
        9.3.5. Energy and amplitude
    9.4. Resonance
    9.5. Doppler effect (qualitative)

10. **Light *acts like* a wave**
    10.1. Light phenomena
        10.1.1. Refraction
        10.1.2. Diffraction
        10.1.3. Interference
            10.1.3.1. Pattern spread
    10.2. Electromagnetic waves
        10.2.1. Accelerating charges and emission of emr
        10.2.2. Spectrum
    10.3. Dispersion
    10.4. Polarisation

11. **Lights *acts like* particles (photon)**
    11.1. Photoelectic effect
        11.1.1. Photocurrent vs. potential difference
        11.1.2. Kinetic energy of photoelectrons vs. frequency
        11.1.3. Effect of intensity
    11.2. Failure of wave model of light

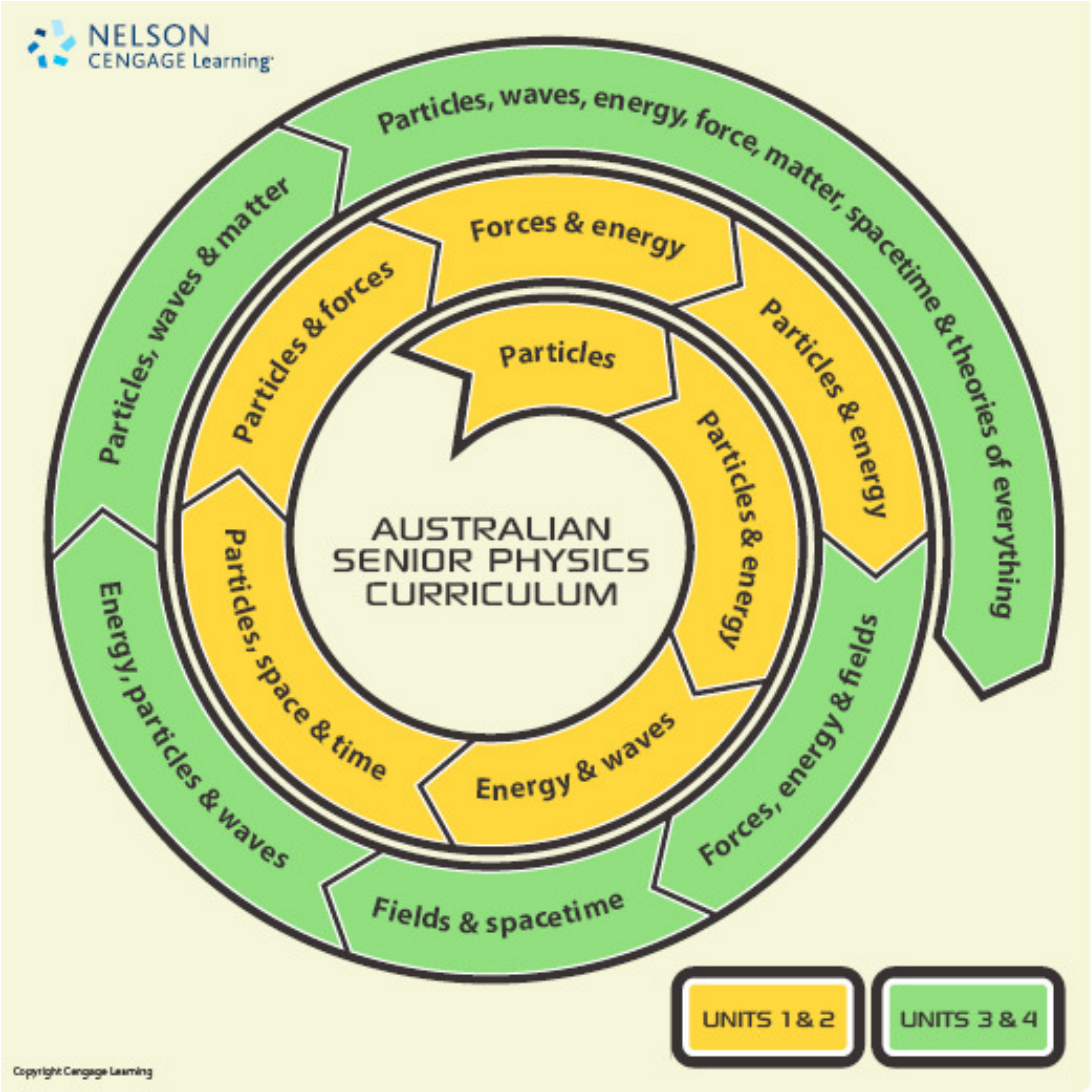
12. **Particles *act like* waves**
    - 12.1. de Broglie wavelength
    - 12.2. Electron diffraction
    - 12.3. Photon diffraction *cf* particle diffraction
    - 12.4. Quantisation of energy levels
    - 12.5. Spectra
        - 12.5.1. Emission
        - 12.5.2. Absorption
13. **Dual nature of *emr* and matter**
    - 13.1. *emr* phenomena
        - 13.1.1. *emr* acts *like* waves
        - 13.1.2. *emr* acts *like* particles
    - 13.2. Moving particle phenomena
        - 13.2.1. Particles act *like* particles
        - 13.2.2. Particles act *like* waves

14. **Production of light from matter**
    - 14.1. Light Amplification by Stimulated Emission of Radiation
    - 14.2. Synchrotron
    - 14.3. LED
    - 14.4. Incandescent light

15. **Practical investigation**
    - 15.1. Variables
    - 15.2. Measurement
    - 15.3. Validity and reliability
        - 15.3.1. Accuracy
        - 15.3.2. Precision
    - 15.4. Uncertainty
        - 15.4.1. Systematic
        - 15.4.2. Random
        - 15.4.3. Error
        - 15.4.4. Uncertainty/error bars
    - 15.5. Tolerance
        - 15.5.1. Percentage error?
    - 15.6. Conclusions
        - 15.6.1. Relation to hypothesis
    - 15.7. Compounding uncertainties
        - 15.7.1. Additive
        - 15.7.2. Multiplicative
        - 15.7.3. Numerical method

16. **Significant figures**
    - 16.1. Standard notation
        - 16.1.1. Leading zeroes
        - 16.1.2. Trailing zeroes
    - 16.2. Experimental data
        - 16.2.1. Becoming an expert
    - 16.3. Data supplied for text and exam problems

16.3.1. Retention of significant figures in calculations
16.3.2. Rule for reporting results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