**2024 Stage 6 Consultation – Physics: Science Teachers' Association of NSW Response**
**https://www.nsw.gov.au/education-and-training/nesa/news/syllabus-consultations**

| | |
|---|---|
| 1. What are the strengths of the draft syllabuses? | ○ Clear statements of the outcomes<br>○ Nicely unpacked content as individual points<br>○ Reducing Y11 to 3 logical FA<br>○ Nice additions<br>  ○ Permittivity, permeability & c<br>  ○ r=mv/qB<br>  ○ Double slit equation<br>  ○ Stopping voltage<br>  ○ Thermionic emission (implicitly)<br>  ○ PET<br>  ○ supernovae |
| 2. Are there any content points requiring further refinement? | **General feedback on content points:**<br>○ Missing impulse<br>○ Need to add v=r ω and ω = $\theta^c$/t for circular motion<br>○ We cannot say 'assess' the effectiveness of Aboriginal and/or Torres Strait Islander Peoples – this requires making a judgement.<br>○ Drop vector notation for friction equation as perpendicular<br>○ Some points are vague. Eg. "Apply the law of conservation of mechanical energy to determine relationships between $W$, $\Delta U$ and $\Delta K$" - This could be more specific.<br>○ Need consistent powers +/- i.e. 10^-12 (pico) to 10^12 (tera) at least<br>○ Condense doppler content from 3 to 2 or even 1 content point<br>○ Add pipes as well as strings<br>○ W=mg has to appear somewhere<br>○ Denote orbital velocity $v_{orb}$<br>○ What about brushless DC motors?<br>○ Add back "diffraction gratings" to be used with the equation<br>○ black body (ideal thermal radiator & ABSORBER) |

| | |
|---|---|
| | ○ Expand the following: Explain how the balance between the strong nuclear force and the electrostatic repulsion force DUE TO THE RATIO OF PROTONS AND NEUTRONS impacts the stability of the nucleus.<br>○ Should be "Analyse the relationship between gravitational potential energy, kinetic energy and total energy for a satellite in CIRCULAR orbit".<br>○ Change to "Analyse the CAUSES AND effects of moving to a different circular orbit on the gravitational potential energy, kinetic energy and total mechanical energy of a satellite".<br><br>**<u>Working scientifically</u>**<br><br>**Analysing data**<br>○ <u>Suggestion</u>: Add the outcome "applies physics principles to examine and explain real world applications and situations" as students are doing this in several topics.<br><br>## <u>Yr 11</u><br><br>**<u>Fundamentals of mechanics</u>**<br><br>**Momentum and energy**<br><br>• "Apply the law of conservation of mechanical energy to determine relationships between $W$, $\Delta U$and $\Delta K$"<br>○ <u>Suggested solution</u>: Change this to "Apply the law of conservation of mechanical energy and use $W = \Delta K = ½\,mv^2$ and $W = \Delta U$"<br><br>• "Solve problems involving momentum using $\vec{p} = m\vec{v}$""<br>○ <u>Suggested solution</u>: Adjust this to "Solve problems involving momentum using $\vec{p} = m\vec{v}$ and impulse $\Delta p = F_{av} .t$" to give a better understanding of the physics of collisions, and to make the this more applicable and relatable to students that drive.<br><br>• "Solve problems relating to the conservation of momentum in elastic collisions using ∑....."<br>○ <u>Suggested solution</u>: Change this to "Compare elastic collisions and inelastic collisions" to make this more concise and more applicable and relatable to students that drive. |

| | |
|---|---|
| | **Waves**<br><br>**Wave properties**<br><br>• "Use data to construct graphs of displacement against time and displacement against distance from the source for longitudinal and transverse waves"<br>  ○ Suggested solution: Change this to "analyse graphs of displacement v time and displacement v distance for longitudinal and transverse waves" in order to make the outcome simpler and more applicable.<br><br>**Light and Sound**<br><br>• "Interpret representations of the electromagnetic spectrum to determine relationships between frequency, wavelength and energy" and "Relate colour to frequency, energy and wavelength of visible light" and "Describe the frequency and wavelength of waves using the different scale prefixes for powers of 10: nano, micro, milli, kilo, mega, giga, tera".<br>  ○ Suggested solution: Change this to "analyse diagrams of the electromagnetic spectrum to solve problems involving wave type, frequency, wavelength, scale prefixes, colour and energy" to make the outcome simpler, more concise and more applicable.<br><br>**Wave behaviours**<br><br>• "Use models to demonstrate refraction between 2 media"<br>  ○ Suggested solution: Change this to "Use models with pulses to demonstrate refraction between 2 media" in order to make the outcome more clear.<br><br>• "Relate the change in velocity of a light wave crossing an interface to differences between refractive indices"<br>  ○ Suggested solution: Delete this outcome as it is already apparent in the other outcomes, in order to make the outcome simpler.<br><br>• "Conduct a practical investigation to show the diffraction of waves with wavelengths, openings and obstacles of different sizes".<br>  ○ Suggested solution: Delete this outcome as it is unnecessary, to make the outcome simpler. |

| | |
|---|---|
| | • "Analyse the frequency and wavelength of standing waves in strings fixed at both ends using $v = f\lambda$"<br>○ Suggested solution: Change this to "Analyse the frequency and wavelength of standing waves in strings and pipes using $v = f\lambda$" to make this more generally applicable since many instruments and sound sources use pipes and tubes.<br><br>• "Explain why an observer records a change in pitch as a sound source moves towards and away from them", and "Explain why an observer records blueshift and redshift as a light source moves towards and away from them".<br>○ Suggested solution: Rewrite this as "explain the Doppler effect for sound waves and light waves" to make the outcomes simpler and more concise.<br><br>• "Solve problems involving frequency changes for an observer, using $f' = f\ (v_{wave} + v_{observer})/(v_{wave} - v_{source})$"<br>○ Suggested solution: Modify the equation to $f' = f\ (v + v_0)/\ (v - v_s)$ to make it simpler<br><br>**Electricity and magnetism**<br><br>**Electrostatics**<br><br>• "Examine how the electric permittivity of a material affects the ability of an electric field to pass through it" and "Compare the permittivity of free space $\varepsilon_0$ with other transparent materials"<br>○ Suggested solution: Remove these outcomes to make the outcome list simpler, as they are unnecessary and add clutter.<br><br>• "Solve problems relating to the electrostatic force and acceleration of charged particles using $\vec{F}=q\vec{E}$, $E=V\ d$ and $\vec{F}$net$=m\vec{a}$"<br>○ Suggested solution: Change this to "Solve problems relating to the charged particles in electric fields using $\vec{F}=q\vec{E}$, $E=V\ d$, $\vec{F}$net$=m\vec{a}$, and W = ΔK" in order to make the outcome more applicable and cover the physics concept better.<br><br>• "Solve problems involving changes in electric potential energy in a uniform electric field using $\Delta U= qEd$". |

| | |
|---|---|
| | ○ Suggested solution: Change this to "Solve problems involving changes in electric potential energy in a uniform electric field using W = qV = qEd and W = ∆K" in order to make the outcome more applicable and cover the physics concept better.<br><br>• "Analyse relationships between voltage, potential energy difference and work when changing the position of a charge in a uniform electric field using $V=\Delta U\ q$"<br>○ Suggested solution: Remove this as the suggested alterations above already cover this.<br><br>**Electric circuits**<br><br>• "Compare the connection of components in series and in parallel circuits", and "Construct and analyse diagrams of series and parallel circuits" and "Account for the size of the current at any point in a series circuit"<br>○ Suggested solution: Change to "Construct and analyse series circuits and parallel circuits" in order to condense the outcome sand make them more concise.<br><br>• "Use field line diagrams to describe the magnetic fields around and through a single bar magnet" and "Use field line diagrams to describe the magnetic fields between bar magnets" and "Use diagrams to describe the shape and direction of the magnetic field around a current-carrying wire"<br>○ Suggested solution: Change this to "Use field line diagrams to analyse the magnetic field around a bar magnetic, a current carrying wire, and a current loop" to make the outcomes more condensed and simpler.<br><br>## Yr 12<br><br>**Advanced Mechanics**<br><br>**Projectile motion**<br><br>• "Analyse the factors that affect the force of gravity between 2 objects with reference to the law of universal gravitation: $F=GMm\ /r^2$" |

| | |
|---|---|
| | ○ Suggested solution: Change this to “Analyse the factors that affect the force of gravity using W = mg and $F=GMm/r^2$” in order to make the outcome more applicable and match physics contexts.<br><br>• “Solve quantitative problems involving projectile motion”<br>○ Suggested solution: Remove this as it is duplication and it is clear that students will be doing problem solving in physics.<br><br>• “Analyse how Aboriginal and/or Torres Strait Islander Peoples use projectile motion”.<br>○ Suggested solution: Change this to “Describe how Aboriginal and/or Torres Strait Islander Peoples use projectiles” to make the outcome simpler and more applicable, and less complex.<br><br>• “Analyse the forces acting on a mass in horizontal circular motion, suspended by a string and acting as a conical pendulum”<br>○ Suggested solution: Change this to “Analyse the forces acting on a mass in horizontal circular motion, a conical pendulum and vehicle on a banked track” in order to make the outcome more applicable and relatable to students that drive.<br><br>**Electromagnetism**<br><br>**Charged particles in electric and magnetic fields**<br><br>• “Apply conventions for describing the electric field between parallel charged plates”.<br>○ Suggested solution: Remove this outcome as it is unnecessary and adds clutter.<br><br>• “Analyse the motion of a charged particle in a uniform electric field using $E=V\ d$ , $F = qE$ , $F_{net} = ma$ , and the equations of uniformly accelerated motion”<br>○ Suggested solution: Change this to ‘‘Analyse the motion of a charged particle in a uniform electric field using $E=V\ d$ , $F = qE$ , $W = qV = \Delta K$, $F_{net} = ma$ and the acceleration equations”, to make it more applicable and more in line with physics principles.<br><br>• “Relate the size of the magnetic field produced by a moving charge to its charge and velocity" and “Explain why a charged particle will experience a force when moving in an external magnetic field” and “Predict the direction of the force acting on a moving charged particle in a magnetic field” |

| | |
|---|---|
| | ○ Suggested solution: Replace these three outcomes with one outcome – "Explain how a charged particle moving in a magnetic field experiences a force given by F = qvB = $qvB\sin\theta$" in order to simplify the outcomes and make them more concise.<br><br>• "Outline the role of electric and magnetic fields in a mass spectrometer"<br>○ Suggested solution: Change this to "Outline the role of electric and magnetic fields in a mass spectrometer and an electron gun" in order to make the outcome more applicable to physics.<br><br>• "Explain the effects of electromagnetic induction in straight conductors, metal plates and solenoids experiencing a change in magnetic flux"<br>○ Suggested solution: Change to "Explain the effects of electromagnetic induction in coils, metal plates and solenoids experiencing a change in magnetic flux" since coils are often used in questions with changing flux and induced emf.<br><br>**Electromagnetic induction**<br><br>**The wave model of light**<br>• "Analyse the factors involved in the production of an interference pattern from a double slit using $d\sin\theta = m\lambda = dy/L$" and "Solve problems involving double slit interference patterns"<br>○ Suggested solution: Condense these into one outcome "analyse and solve problems involving the double slit interference pattern using $d\sin\theta = m\lambda = dy/L$" in order to make the outcomes simpler and more concise.<br><br>• "Solve problems involving double slit interference patterns"<br>○ Suggested solution: Adjust this with "Solve problems involving double slit interference patterns and the diffraction grating" as it is more applicable and shows modern usage.<br><br>**The quantum model of light**<br><br>• Problem: "Explain why hot objects radiate electromagnetic radiation" and "Use models to represent a theoretical black body (ideal thermal radiator)"<br>◦ Suggested solution: Replace this with "explain that a black body is a perfect absorber and emitter of energy", to be clearer about the correct physics. |

| | |
|---|---|
| | • "Explain how the ultraviolet catastrophe showed the difference between classical physics predictions and experimental observations of the intensity of black-body radiation", and "Explain how the ultraviolet catastrophe shows the importance of a theory being supported by experimental observations"<br>○ Suggested solution: Replace both these with "Explain how investigations of black body spectrum and the ultraviolet catastrophe brought about a change to classical physics", to make the outcomes simpler and more concise.<br><br>**Light and special relativity**<br><br>• "Apply the first and second postulates to a simultaneity thought experiment involving 2 events occurring at opposite ends of a vehicle moving at relativistic speed when viewed from different frames of reference"<br>○ Suggested solution: Change to: "Apply the first and second postulates to a simultaneity thought experiment" to make the outcomes simpler and more concise.<br><br>**Matter, energy and the Cosmos**<br><br>**Modelling the atom**<br><br>• "Explain how limitations of atomic models led to the development of the planetary model proposed by Niels Bohr."<br>○ Suggested solution: Change to "Explain how the change from Rutherford's planetary model to Bohr's Stationary Energy Levels model occurred."<br>○ The Bohr model should be called the *stationary energy levels* model, and the Rutherford model should be called *the planetary model* to lessen confusion.<br><br>• "Explain how the planetary model of the atom uses a mixture of classical and quantum physics to address the limitations of the previous mode."<br>○ Suggestion: Change to "Explain how the Bohr model of the atom uses a mixture of classical and quantum physics" to make this clearer and more concise.<br><br>• "Identify that the planetary model was unable to explain the line emission spectra of elements other than hydrogen" |

| | |
|---|---|
| | ○ Suggestion: Change to "Identify the limitations of the Bohr model" to make this clearer and more concise.<br><br>• "Explain how the equation $\lambda = h/mv$ demonstrates wave–particle duality"<br>○ Suggestion: Change to "Explain how De Broglie's' equation $\lambda = h/mv$ demonstrates wave–particle duality" in order to cite the scientist and make this clearer.<br><br>**Radioactivity**<br><br>• "Explain how the properties of radioactive isotopes will determine their use in medicine and industry"<br>○ Suggestion: Change to "Explain how radioactive isotopes and tracers are used in medical scans and industry, including the gamma camera scan and PET" to make it clearer and more specific.<br><br>**Nuclear energy**<br><br>• "Use nuclear equations to describe the fusion of small nuclei"<br>○ Suggestion: Change to 'Use nuclear equations to describe fission and fusion' to cover both the processes referred to.<br><br>• "Evaluate the ethics of obtaining and managing energy from nuclear fuel in comparison to fossil fuel sources"<br>○ Suggestion: change to "Evaluate the benefits and problems and ethical considerations associated with using nuclear energy, and with fossil fuels" to make it clearer.<br><br>• "Describe nuclear binding energy" And "Solve problems relating to nuclear binding energy using $E = mc2$" and "Solve problems using mass defect and $E = mc2$ for nuclear decay, nuclear fission, nuclear fusion, and positron–electron annihilation"<br>○ Suggestion: change to "Solve problems relating to mass defect and nuclear binding energy using $\Delta m = m_i - m_f$ and $E = mc^{2"}$ to simplify and condense these outcomes.<br><br>**Astrophysics** |

| | |
|---|---|
| | • "Explain how cosmological background radiation (CBR) and the relative abundances of helium-4, helium-3, lithium-7 and deuterium support the Big Bang theory"<br>  ○ Suggested solution: Change to "discuss the strengths and limitations of the Big Bang theory, including the Cosmic Microwave Background (CMB) radiation", to make the outcome less repetitive and more scientifically sound.<br>• "Analyse H-R diagrams to classify stars and determine their surface temperature, colour, luminosity and size."<br>  ○ Suggested solution: Change to "Analyse H-R diagrams to classify stars and determine information about surface temperature, colour, luminosity, size and energy generation for different types of stars"' in order to make the outcome more specific.<br>• "Explain in terms of binding energy why the heaviest element that can be synthesised in a red supergiant is iron" and "Explain why a supernova event is necessary to produce elements heavier than iron"<br>  ○ Suggested solution: change this to 'Explain how stars synthesise elements up to iron, and how larger atoms are synthesised' in order to make the outcome simpler and more concise. |
| 3. Are scientific investigations sufficiently flexible for implementation by teachers? | They are good apart from need explicit permission to use simulation where resources are lacking. |
| 4. Do the syllabuses provide flexibility for teachers to support diverse learners? | Yes. |
| **General Comments:**<br>○ Working Scientifically in Stage 6 needs to work with the new 7-10 syllabus. The continuum of skills does not currently work.<br>○ A datebook is needed for Stage 6.<br>○ While it is good to be moving to 3 modules in year 11, the 120 hours teaching requirement in Year 11 is not feasible.<br>○ A glossary of terms is needed, with correct definitions.<br>○ Numbers (and letters) are needed to number all the headings and sections and outcomes, so that teachers all know which we are refereeing to.<br>○ Consistent language is needed across the syllabus for all terminology (eg. Representations and models - what is the difference? Also 'Investigation' and 'demonstration' isn't well delineated). This will be particularly important for early career teachers.<br>○ Schools in Rural and Remote areas might struggle with this syllabus if they do not have adequate resources. | |

- NESA guidance for Aboriginal & Torres Strait Islander perspectives is needed.
- The addition of data science in the new 7-10 is good, however there is currently no progression for data science in Stage 6. It is a shame to lose data science completely - it should not be just for science extension.
- The balance between using pracs to demonstrate a concept versus having student do authentic scientific investigation isn't there.
- Explicit permission structure for investigations needed.

**Physics specific comments:**

- Outcomes and content need to be numbered/coded.
- Need a Data Sheet (in line with 7-10 plus extras).
- WS is inconsistent with new 7-10 i.e. Observing missing as WS1.
- Removing all but 2 scientists is a shame. We need Einstein, Newton, Maxwell, Rutherford, Farady, Lenz etc.
- Year 11 Focus Areas have been fleshed out to >30 hours each to =120 indicative hours – the whole point to reducing FAs was because there are only 3 terms of time in Y11 but 4 in HSC, so Y11 should have ¾ indicative hours of HSC.
- Removing Inquiry Questions is a shame – instead they could be renamed to focus questions and provide one for each Content Group.