Neap:

HSC Trial Examination 2019

Physics

Solutions and marking guidelines

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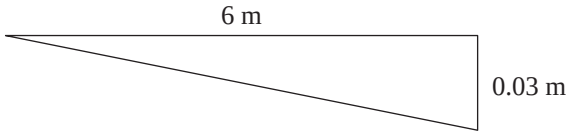
Section I

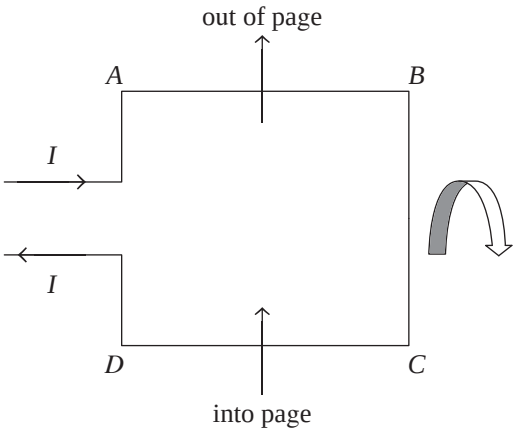
Answer and explanation	Syllabus content and course outcomes
Question 1 **A** $s = ut + \frac{1}{2}at^2$ $22.8 = 0 + \frac{1}{2} \times 9.8 \text{ m s}^{-2} \times t^2$ $t = \sqrt{\frac{22.8}{4.9}}$ $= 2.16 \text{ s}$	Mod 5 Advanced Mechanics PH12–12 Bands 3–4
Question 2 **C** $v = \sqrt{rg\tan(\theta)}$ $= \sqrt{4500 \times 9.8 \times \tan(8)}$ $= 78.7 \text{ m s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 3–5
Question 3 **C** $v = \frac{2\pi r}{T}$ $= \frac{2 \times \pi \times 8}{0.32}$ $= 157 \text{ m s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 3–4
Question 4 **A** The units for angular velocity are either degrees^{-1} or rad s^{-1}. The only possible answer is **A**.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3
Question 5 **D** **A**, **B** and **C** are all Kepler's Laws. **D** is not, but is rather relating to gravity.	Mod 5 Advanced Mechanics PH12–12 Bands 3–4
Question 6 **C** $E = \frac{V}{D}$ $= \frac{240}{1.2}$ $= 200 \text{ V m}^{-1}$ $W = qEd$ $= 1.602 \times 10^{-19} \times 200 \times 0.47$ $= 1.77 \times 10^{-17} \text{ J}$	Mod 6 Electromagnetism PH12–13 Bands 3–5
Question 7 **B** $F = qvB\sin(\theta)$ $= 1.602 \times 10^{-19} \times 1.5 \times 10^{8} \times 2.0 \times 10^{-2} \times \sin(7.5°)$ $= 6.273 \times 10^{-4} \text{ N}$ The only possible answer after rounding is **B**.	Mod 6 Electromagnetism PH12–13 Bands 4–5

Answer and explanation	Syllabus content and course outcomes
Question 8 **A** $\frac{F}{L} = \frac{4\pi \times 10^{-7} \times 1.37 \times 0.74}{2\pi \times 0.02}$ $= 1.0 \times 10^{-5}$ N m^{-1} attractive	Mod 6 Electromagnetism PH12–13 Bands 4–5
Question 9 **B** $\frac{I_p}{I_s} = \frac{n_s}{n_p}$ $I_p = \frac{800 \times 3.34}{1600}$ $= 1.67$ amp	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 10 **D** Maximum torque is achieved when the force is applied at right angles with the largest distance possible; hence $\tau = r_{\perp} F$.	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 11 **C** Faraday related electricity and magnetism, while Maxwell linked that an electromagnetic wave consists of oscillating electric and magnetic fields that included visible light. This meant that Maxwell unified light as a form of an electromagnetic wave.	Mod 7 The Nature of Light PH12–14 Bands 2–4
Question 12 **C** $\lambda_{max} = \frac{b}{T}$ $T = \frac{b}{\lambda_{max}}$ $= \frac{2.898 \times 10^{-3}}{550 \times 10^{-9}}$ $= 5269$ K	Mod 7 The Nature of Light PH12–14 Bands 2–4
Question 13 **C**  angle $= \tan^{-1}\left(\frac{0.03}{6}\right)$ $= 28.65°$ $\lambda = \frac{90 \times 10^{-6} \times \sin(0.2865)}{1}$ $= 4.50 \times 10^{-7}$ m or 450 nm	Mod 7 The Nature of Light PH12–14 Bands 3–5
Question 14 **A** Polarisation occurs only in transverse waves and in one direction; hence, only answer **A** is possible.	Mod 7 The Nature of Light PH12–14 Bands 2–3

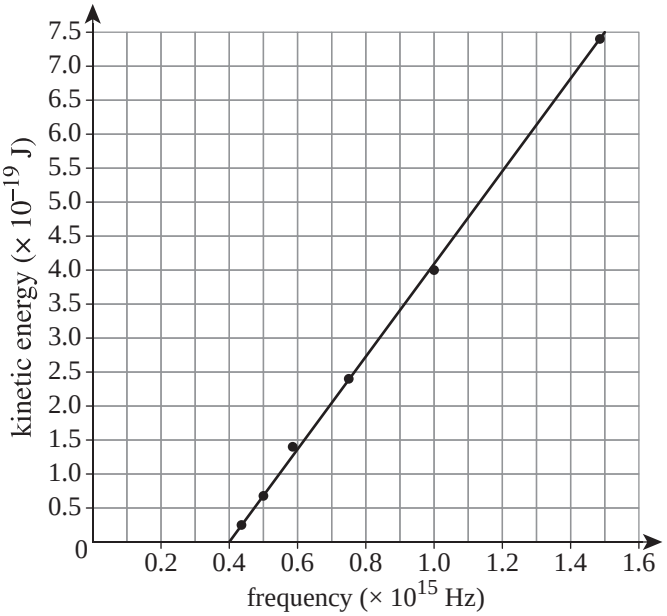
Answer and explanation	Syllabus content and course outcomes
Question 15 **A** $L = 42 \times \sqrt{\left(1 - \frac{(2.75 \times 10^8)^2}{(3.0 \times 10^8)^2}\right)}$ $= 16.79$ m	Mod 7 The Nature of Light PH12–14 Bands 4–5
Question 16 **D** $\lambda = \frac{h}{mv}$ $= \frac{6.626 \times 10^{-34}}{9.109 \times 10^{-31} \times 2.2 \times 10^6}$ $= 3.3 \times 10^{-10}$ m or 0.33 nm	Mod 8 From the Universe to the Atom PH12–15 Bands 3–4
Question 17 **C** **A** is an example of nuclear fusion; **D** is not a definition for nuclear fission; and **B** is incorrect due to the release of protons and positrons. The only correct answer is **C**.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 18 **D** Alpha particles are heavy compared to beta particles and have a charge of +2, as in the helium nucleus.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 19 **D** Binding energy is the only suitable answer as it is the separation or combining of protons and neutrons into its constituents. The CNO cycle is when stars convert hydrogen to helium, which is incorrect for this question. Gravitational potential energy and elastic potential energy do not separate nor combine atoms together to satisfy the question; neither is related.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 20 **B** All but **B** are fundamental forces of nature. Electrostatic charge is not a force.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3

Sample answer	Syllabus content, course outcomes and marking guide
Question 21	
(a) You need to find t_1 and t_2 of the projectile. To find t_1, $vy = u_y + at$. $t_1 = \frac{17 \text{ m s}^{-1} \times \sin(45)}{-9.8}$ $= 1.23$ s To find t_2, $\Delta y = u_y t + a_y t^2$. $t_2 = \sqrt{\frac{2x(-y)}{g}}$ $= \sqrt{\frac{2x(-8.17)}{-9.8}}$ $= 1.29$ s To find total time, $t_1 + t_2 = 2.52$ s.	Mod 5 Advanced Mechanics PH12–12 Bands 4–6 • Gives correct equation to determine time. AND • Demonstrates manipulation of the correct equation. AND • States correct answer with units. . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points 1
(b) $u_x = u\cos(\theta)$ $= 17 \times \cos(45)$ $= 12.02 \text{ m s}^{-1}$ $v_x = u_x$ $= 12.02 \text{ m s}^{-1}$ $v_y = u_y + a_y t$ $= 0 + (-9.8) \times 1.29$ s $= -12.64 \text{ m s}^{-1}$ $v^2 = (12.02 \text{ m s}^{-1})^2 + (-12.64 \text{ m s}^{-1})^2$ $v = 17.44 \text{ m s}^{-1}$ $\tan^{-1}\left(\frac{-12.64}{12.02}\right) = 46°$ 17.44 m s^{-1} at 46° below the horizontal	Mod 5 Advanced Mechanics PH12–12 Bands 4–6 • Calculates horizontal velocity with units. AND • Calculates vertical velocity with units. AND • Calculates correct final velocity with units. AND • Gives angle . . . . . 4 • Any THREE of the above points . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points 1
Question 22	
(a) $\tau = rF\sin(\theta)$ $= (0.46) \times 92 \times \sin(90)$ $= 42.32$ N m	Mod 6 Electromagnetism PH12–13 Band 1 • Provides correct torque equation OR demonstrates calculation. AND • Gives correct answer and units . . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, course outcomes and marking guide
(b) $\tau = rF\sin(\theta)$ $F = \frac{\tau}{r\sin(\theta)}$ $= \frac{42.32}{0.46 \times \sin(50)}$ $= 120.1$ N	Mod 6 Electromagnetism PH12–13 Band 2 • Correctly identifies a valid method for measuring the force AND • Gives correct answer. . . . . 2 • Gives some correct information 1
Question 23	
For Earth: $F = \frac{GMM}{r^2}$ $= \frac{6.67 \times 10^{-11} \times 6.00 \times 10^{24} \times 2.00 \times 10^{30}}{(1.50 \times 10^{11})^2}$ $= 3.56 \times 10^{22}$ N directed towards the Sun For Mercury: $F = \frac{GMM}{r^2}$ $= \frac{6.67 \times 10^{-11} \times 3.29 \times 10^{23} \times 2.00 \times 10^{30}}{(5.79 \times 10^{10})^2}$ $= 1.31 \times 10^{22}$ N directed towards the Sun ratio = 2.71 : 1 Therefore, the Sun exerts a force 2.71 times greater on Mercury than it does on Earth.	Mod 5 Advanced Mechanics PH12–12 Band 4 • Provides correct Earth equation OR demonstrates working for Earth. AND • Gives gravitational force for Earth. AND • Provides correct Mercury equation OR demonstrates working for Mercury. AND • Gives gravitational force for Mercury. AND • Gives correct ratio . . . . . 5 • Any FOUR of the above points . . . . . 4 • Any THREE of the above points . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
Question 24	
(a) Escape velocity is when a projectile wants to escape the influence of gravity by a planet/moon, while orbital velocity is when a projectile is under the influence of gravity in uniform circular motion. escape velocity formula: $v_{escape} = \sqrt{\frac{2GM}{r}}$ orbital velocity formulas: $v_{orbital} = \sqrt{\frac{GM}{r}}$	Mod 5 Advanced Mechanics PH12–12 Band 1 • Defines escape velocity. AND • Defines orbital velocity. AND • States escape velocity formula. AND • States orbital velocity formula . . . . . 4 • Any THREE of the above points . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
(b) *For example*: **Geostationary satellites** GPS; communication **Low-Earth orbit satellites** weather; military surveillance; mapping	Mod 5 Advanced Mechanics PH12–12 Band 1 • Gives a correct use for geostationary satellites. AND • Gives a correct use for low-Earth orbit satellites . . . . . 2 • Any ONE of the above points. 1

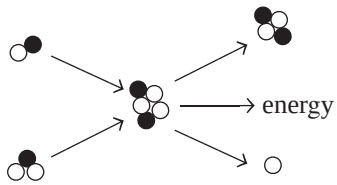
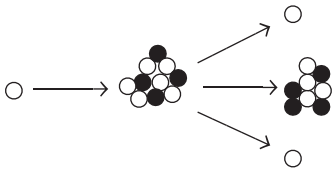
Sample answer	Syllabus content, course outcomes and marking guide
Question 25	
(a) $F = nLIB$ $= 150 \times 1.5 \times 0.12 \times 0.06$ $= 1.62$ N out of the page	Mod 6 Electromagnetism PH12–13 Band 1 • Correctly identifies $F = nLIB$. AND • Gives direction as out of the page AND • Gives the correct answer . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points 1
(b) The magnitude is zero, as it is $\sin(0)$, to which the answer is 0.	Mod 6 Electromagnetism PH12–13 Band 1 • Identifies that force is zero as current is parallel to the magnetic field 1
(c)  The coil will rotate counter-clockwise when viewed from the left of the page.	Mod 6 Electromagnetism PH12–13 Band 3 • Correctly labels or indicates direction of force 1
Question 26	
A split-ring commutator ensures that the output current to the external circuit is direct current and not alternating current. Slip rings provide electrical contact between the rotating coil and the external circuit to ensure alternating current is produced by the generator and is delivered to the external circuit.	Mod 6 Electromagnetism PH12–13 Bands 3–5 • Explains the purpose of a split-ring commutator. AND • Explains the purpose of slip rings . . . . . 2 • Any ONE of the above points 1
Question 27	
$\Phi = BA\cos(\theta)$ $B = \dfrac{\Phi}{A\cos(\theta)}$ $= 84.85$ T	Mod 6 Electromagnetism PH12–13 Band 3 • Gives correct equation for magnetic flux density. AND • Calculates correct value with units . . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, course outcomes and marking guide
Question 28	
(a) $\alpha = \frac{Eq}{m}$ $= \frac{6000 \times (1.2 \times 10^{-6})}{2.0 \times 10^{-2}}$ $= 0.36 \text{ m s}^{-2}$	Mod 6 Electromagnetism PH12–13 Band 3 • Gives correct equation for acceleration. AND • Correctly manipulates equation with correct variables. AND • States correct answer with units. . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
(b) $v_{\perp} = -0.25 \text{ m s}^{-1}$ $v_{\parallel} = u + at$ $= u + \frac{Eq}{m} \times t$ $= 0 + (0.36) \times 0.5$ $= 0.18 \text{ m s}^{-1}$ $v = \sqrt{(v_{\perp})^2 + (v_{\parallel})^2}$ $= \sqrt{(-0.25)^2 + (-0.18)^2}$ $= 0.31 \text{ m s}^{-1}$	Mod 6 Electromagnetism PH12–13 Bands 3–6 • Identifies correct perpendicular speed. AND • Identifies correct equation for parallel speed. AND • Uses Pythagoras' theorem to find final speed. AND • States correct answer with units. . . . . 4 • Any THREE of the above points . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
Question 29	
(a) Newton's corpuscular theory proposed that light was made of small particles, while Huygens' theory suggested that light was a wave. Newton also stated that light travelled faster in more optically dense media, whereas Huygens suggested the opposite – that the light waves should slow down. However, both theories suggested that they could explain refraction and Snell's law.	Mod 7 The Nature of Light PH12–14 Band 3 • Identifies Newton's corpuscular theory and Huygens' light-wave theory. AND • States ONE similarity between the two theories. AND • States ONE difference between the two theories. . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
(b) Huygens' theory of light was more correct than Newton's. This is because when Foucault conducted his experiment, he found that the speed of light travels slower in water than air. This went against Newton's theory of light.	Mod 7 The Nature of Light PH12–14 Band 3 • Identifies that Huygens' model was more correct than Newton's. AND • States a reason proving Huygens' model was correct OR discusses an experiment proving Huygens' model was correct. . . . 2 • Any ONE of the above points. 1

Sample answer	Syllabus content, course outcomes and marking guide
Question 30	
(a) 	Mod 7 The Nature of Light PH12–14 Band 2 • Correctly plots data. AND • Includes line of best fit. . . . . 2 • Any ONE of the above points 1
(b) From the graph, the x-intercept is 0.4×10^{15} Hz. $E = hf$ $= 6.626 \times 10^{-34} \times 0.4 \times 10^{15}$ $= \dfrac{2.6504 \times 10^{-19}}{1.602 \times 10^{-19}}$ $= 1.654$ eV	Mod 7 The Nature of Light PH12–14 Bands 4–6 • Identifies stopping frequency. AND • Uses correct formula. AND • Converts work function into electron voltage . . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
(c) $\dfrac{(7.3 \times 10^{-19} - 0.23 \times 10^{-19})}{(1.49 \times 10^{15} - 0.43 \times 10^{15})} = 6.67 \times 10^{-34}$ J s^{-1}	Mod 7 The Nature of Light PH12–14 Band 3 • Uses gradient formula to gain Planck's constant. AND • Answer is within range of 6.6×10^{-34} J s^{-1} . . . . . 2 • Uses gradient formula to gain Planck's constant 1

Sample answer	Syllabus content, course outcomes and marking guide
Question 31	
Particles cannot exceed the speed of light as this is the upper limit of speed in the Universe. This was postulated by Einstein when discussing special relativity. His second postulate states that the speed of light is constant for all observers, which means that it is the upper limit of speed in the Universe. This holds true as recent experiments have not demonstrated that a particle can exceed this speed.	Mod 7 The Nature of Light PH12–14 Bands 2–4 • Explains that the speed of light is the upper limit of speed. AND • Attributes the speed of light being constant to Einstein's postulate. AND • Provides a reasoning for particles never exceeding the speed of light . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
Question 32	
Any one of: • Stand back at least three metres from the apparatus as it produces X-ray radiation. • Handle the tubes with care, as they are made of glass and contain hazardous chemicals such as mercury and sodium. • Do not stare at the light when in operation. • Do not look directly at the Sun, with or without the spectroscope. • any other reasonable safety precaution	Mod 7 The Nature of Light PH12–14 Band 1 • Gives ONE safety procedure for spectroscopy 1

Sample answer		Syllabus content, course outcomes and marking guide
Question 33		
(a)	Rutherford's model of the atom was superior in the beginning; however, it had many limitations, including: • an inability to explain the nucleus; • an uncertainty on how to place the electrons around the dense region that is now known as the nucleus, and; • an uncertainty on why the electrons orbiting the nucleus did not slow down and crash into each other. A couple of years later, a scientist named Niels Bohr created a model of the atom that improved Rutherford's model. Over time, however, Bohr's model of the atom also had limitations, which include: • an inability to predict the spectra of multi-electron atoms, and; • an inability to explain the different intensities of lines or why some lines split into multiple, closely spaced lines. It did not take long before scientists improved Bohr's theory when studying emission line spectroscopy.	Mod 8 From the Universe to the Atom PH12–15 Bands 3–6 • Provides ONE limitation of Rutherford's model about the nucleus. AND • Provides ONE limitation of Rutherford's model about the electrons. AND • Provides ONE limitation of Rutherford's model about the electron orbits. AND • Explains how Bohr's model was superior to Rutherford's model. AND • Provides ONE limitation of Bohr's model about multi-electron atom spectra. AND • Provides ONE limitation of Bohr's model about different spectra-line intensities or why some lines split into multiple, closely split lines . . . . . 6 • Any FIVE of the above points . . . . . 5 • Any FOUR of the above points . . . . . 4 • Any THREE of the above points . . . . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points 1
(b)	Schrödinger's model of the atom was developed mathematically and the equations that he used could explain the probability or the certainty of a quantum event or quantum position in quantum mechanics. This improved the model of the atom from Bohr's model, as Schrödinger identified that the electrons were orbiting the nucleus within probability clouds and not fixed positions within the shell.	Mod 8 From the Universe to the Atom PH12–15 Band 2 • Describes Schrödinger's contribution to quantum mechanics. AND • Describes how the model changed from Bohr's to Schrödinger's . . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, course outcomes and marking guide
Question 34	
Students can discuss any one of: • Thomson's plum pudding model of the atom using cathode ray tubes • Thomson's charge-to-mass ratio experiment • Millikan's oil drop experiment *For example:* Robert Millikan created an oil drop experiment to measure the charge of the electron. Millikan's apparatus comprised two metal electric plates within a container of water. Millikan sprayed oil drops within the container of water and applied a potential difference between the two plates to suspend the oil between them. This meant that the oil drop was balanced between the electrostatic and gravitational forces, and from this Millikan used $q_E = mg$ to determine that the charge on a drop was a multiple of 1.6×10^{-19} C.	Mod 8 From the Universe to the Atom PH12–15 Band 3 • States experimental evidence to support the existence of the electron. AND • Provides supporting evidence for how the electron was discovered. AND • Names the correct scientists or models. . . 3 • Any TWO of the above points . . . . . 2 • Any ONE of the above points. 1
Question 35	
Fission:  Fusion: 	Mod 8 From the Universe to the Atom PH12–15 Band 1 • Gives correct drawing for fission. AND • Gives correct drawing for fusion . . . . . 2 • Any ONE of the above points. 1
Question 36	
$\lambda = \dfrac{\ln(2)}{t_{\frac{1}{2}}}$ $t_{\frac{1}{2}} = \dfrac{\ln(2)}{\lambda}$ $= 4.1 \times 10^{8}$ s	Mod 8 From the Universe to the Atom PH12–15 Band 3 • Gives correct formula for half-life. AND • Gives correct answer with units . . . . . 2 • Any ONE of the above points. 1
Question 37	
(a) Emission spectra are the production of bright lines against a dark background by the excitation of a low density gas. Absorption spectra are produced by stars and show dark lines against a continuous background spectrum.	Mod 8 From the Universe to the Atom PH12–15 Band 2 • States the difference between emission spectra and absorption spectra. AND • Provides some relevant information about either emission spectra OR absorption spectra. . . . . 2 • Provides some relevant information about either emission spectra OR absorption spectra. 1

Sample answer	Syllabus content, course outcomes and marking guide
(b) *Any two of:* • temperature (K) • luminosity (Sun = 1) • absolute magnitude	Mod 8 From the Universe to the Atom PH12–15 Band 3 • Names TWO correct factors . . . . . 2 • Names ONE correct factor. 1
Question 38	
(a) When using spectroscopy on common elements such as hydrogen and helium in space, scientists discovered that the spectral lines of these elements were shifted towards the red end of the spectrum. This means that the objects being studied are moving or accelerating away from each other.	Mod 8 From the Universe to the Atom PH12–15 Band 3 • Explains spectral lines shifting on the light spectrum. AND • States that the objects are moving or accelerating away from each other . . . . . 2 • Any ONE of the above points 1
(b) Edwin Hubble (He discovered that redshift was useful to support the Big Bang Theory, as it identifies that the Universe is expanding.)	Mod 8 From the Universe to the Atom PH12–15 Bands 2–4 • Names correct scientist 1
Question 39	
(a) $E = mc^2$ $= 5.6 \times 10^9 \times (3.0 \times 10^8)^2$ $= 5.04 \times 10^{26}$ J	Mod 8 From the Universe to the Atom PH12–15 Band 3 • Gives correct equation AND/OR manipulation. AND • Gives correct answer . . . . . 2 • Gives some relevant information. 1
(b)	Mod 8 From the Universe to the Atom PH12–15 Band 3 • Correctly places TWO terms . . . . . 2 • Correctly places ONE term 1

	Stage of stellar evolution
1.	**protostar**
2.	main sequence star
3.	**red giant**
4.	white dwarf