Neap

HSC Trial Examination 2020

Physics

Solutions and marking guidelines

Section I

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 1 **B** Newton's Laws of Gravitation are related to two bodies with space and the forces related. Kinetic energy and Kepler's Laws are not associated nor involve work within their equations or theory. The only plausible answer is **B**, which is the work to place an object in space against gravity or within space.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3
Question 2 **A** Orbital decay refers to satellite motion, and the quantum model refers to atomic theory. Wave-particle duality refers to light, leaving **A** as the only plausible answer. Transmutation is the decay of one element into another.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 3 **B** This is related to $Fc = \frac{mv^2}{r}$. The larger the mass, the more centripetal force; however, with a large radius there is less centripetal force.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3
Question 4 **B** The stator within a DC motor is the stationary component of the motor. The permanent magnets or electromagnets remain stationary and provide a magnetic field, and the armature or coil rotates.	Mod 6 Electromagnetism PH12–13 Bands 2–3
Question 5 **D** Charm, strange and bottom are all quarks, while upper is not.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3
Question 6 **D** $\lambda_{\max} = \frac{b}{T}$ $= \frac{2.898 \times 10^{-3}}{3\ 500\ \text{K}}$ $= 828\ \text{nm}$	Mod 7 The Nature of Light PH12–14 Bands 3–4
Question 7 **B** Lenz's Law states that the induced current will always flow in a direction such that the resultant magnetic field opposes the original magnetic field. All other responses do not describe Lenz's Law.	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 8 **C** $E = mc^2$ $= 0.129 \times (3.00 \times 10^8)^2$ $= 1.16 \times 10^{16}\ \text{J}$	Mod 7 The Nature of Light PH12–14 Bands 3–4
Question 9 **C** $B = \frac{F}{I_L \sin\theta}$ $= \frac{1.84}{3.6 \times 92 \times 10^{-3} \times \sin 90}$ $= 5.56\ \text{T}$	Mod 6 Electromagnetism PH12–13 Bands 3–4

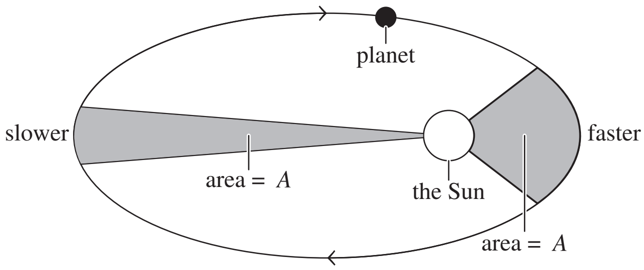
Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 10 **A** Within the first 100 seconds of the beginning of the Big Bang, all the fundamental particles were present, which includes options **B**, **C** and **D**. Helium was made after hydrogen formed, which was well past the first 100 seconds.	Mod 8 From the Universe to the Atom PH12–15 Bands 3–4
Question 11 **B** $\lambda = \frac{h}{mv}$ $= \frac{6.626 \times 10^{-34}}{5 \times 12.6}$ $= 1.05 \times 10^{-35}$ m	Mod 8 From the Universe to the Atom PH12–15 Bands 3–4
Question 12 **A** Incomplete flux linkage and magnetic flux density are not consequences of the conservation of energy, so **B** and **D** are incorrect. AC generators do not operate by the laws of conservation of energy, so **C** is incorrect. Magnetic braking is the cause of eddy currents generated by the conservation of energy.	Mod 6 Electromagnetism PH12–13 Bands 3–4
Question 13 **D** When an electron moves from a higher energy state to a lower state, it emits a photon. This phenomenon is often referred to as emission spectra.	Mod 7 The Nature of Light PH12–14 Bands 3–4
Question 14 **C** $\sin\theta = \sqrt{\frac{2gh}{u^2}}$ $\sin\theta = \sqrt{\frac{2 \times 9.8 \times 105}{49^2}}$ $\sin\theta = 0.92582$ $\theta = \sin^{-1}0.92582$ $= 67°\ 48'$ $\approx 68°$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5
Question 15 **D** $\tan\theta = \frac{v^2}{gr}$ $\tan\theta = \frac{\left(\frac{300}{3.6}\right)^2}{9.8 \times 750}$ $\theta = \tan^{-1}0.94482$ $= 43°\ 23'$ $\approx 43°$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5

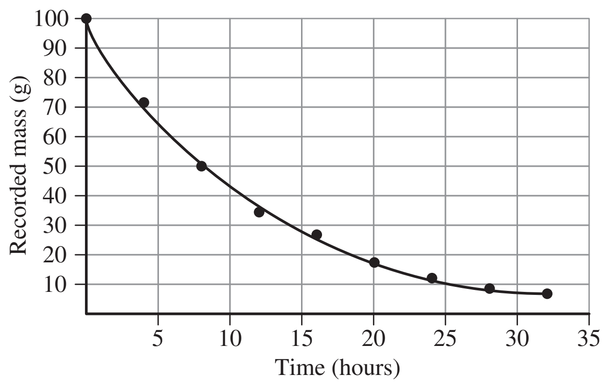
Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 16 **D** $E_{\text{k max}} = hf - \phi$ $0 = hf - 4.5$ $f = \frac{4.5}{4.14 \times 10^{-15}}$ $= 1.09 \times 10^{15}$ Hz $\lambda = \frac{c}{f}$ $= \frac{3.0 \times 10^{8}}{1.09 \times 10^{15}}$ $= 2.76 \times 10^{-7}$ m	Mod 7 The Nature of Light PH12–14 Bands 4–5
Question 17 **A** Low-density stellar atmospheres produce a bright, narrow line on the emission spectrum or a dark line on the absorption line. The only plausible answer is **A**.	Mod 8 From the Universe to the Atom PH12–15 Bands 4–5
Question 18 **A** $g = \frac{GM}{r^2}$ $= \frac{6.67 \times 10^{-11} \times 4.87 \times 10^{24}}{(6\ 050\ 000)^2}$ $= 8.87 \text{ m s}^{-2}$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5
Question 19 **D** $E = mc^2$ $= 3.60 \times 10^{-28} \times (3.0 \times 10^{8})^2$ $= 3.24 \times 10^{-11}$ J $E \text{ MeV} = \frac{3.24 \times 10^{-11}}{1.602 \times 10^{-19}}$ $= 202$ MeV	Mod 8 From the Universe to the Atom PH12–15 Bands 5–6

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 20 **A** At a speed of 1.25×10^8 m s^{-1}, relativistic effects will take effect and the mass of the proton will dilate. The relativistic mass of the proton will therefore be: $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$ $= \frac{1.673 \times 10^{-27}}{\sqrt{1 - \frac{(1.25 \times 10^8)^2}{(3.0 \times 10^8)^2}}}$ $= 1.840 \times 10^{-27}$ kg Thus: $B = \frac{mv}{qr}$ $= \frac{1.840 \times 10^{-27} \times 1.25 \times 10^8}{1.602 \times 10^{-19} \times 82}$ $= 0.0175$ T	Mod 6 Electromagnetism PH12–13 Bands 5–6

Section II

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 21	
Air resistance is prevalent in projectile motion, especially when conducting practical investigations. Air resistance or drag that acts on a projectile can be described with the following: • The greater the velocity of the projectile, the greater the air resistance or drag force. • The design of the projectile can have two effects. If the cross-sectional area is greater, or the shape of the projectile is not streamlined, then the air resistance or drag force is greater. • The higher the air density, the greater the drag on the projectile. The graphs clearly demonstrate that one or more of the effects described above had an impact on the flight path recorded. The experiment was conducted the same in both the evacuated chamber and the classroom, meaning that the projectile was the same. Therefore, the graphs show that it was the air resistance in the classroom that changed the flight path of the projectile.	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Describes all the effects of air resistance AND relates it to the diagrams. . . . 4 • Describes all the effects of air resistance. . . . 3 • Describes some effects of air resistance. OR • States ONE relation to the graphs. . . . 2 • Gives some correct information . . . 1
Question 22	
(a) $\frac{78}{3} = 26$ seconds per revolution $v = \frac{2\pi r}{T}$ $= \frac{2\pi \times 4.4}{26}$ $= 1.1 \text{ m s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates time for ONE revolution. AND • Calculates the correct linear speed . . . 2 • Any ONE of the above points. . . . 1
(b) $w = \frac{2\pi}{T}$ $= \frac{2\pi}{26}$ $= 0.24 \text{ rad s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates the correct angular velocity. . . 1
(c) $F_c = \frac{mv^2}{r}$ $= \frac{65 \times 1.1^2}{4.4}$ $= 18 \text{ N}$	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Calculates the correct centripetal force. . . 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 23	
(a) The Second Law of Kepler's Laws of Planetary Motion describes the speed of a planet orbiting the Sun. Kepler stated that the line between the Sun and the planet sweeps equal areas in equal times, meaning the speed of the planet increases as it nears the Sun and decreases as it moves away from the Sun.  	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • States Kepler's Second Law. AND • Provides an accurate diagram to support Kepler's Second Law .... 3 • Any ONE of the above points .... 2 • Gives some correct information........ 1
(b) Equate $F_c = \frac{mv^2}{r}$ and $F = \frac{GMm}{r^2}$. $\frac{mv^2}{r} = \frac{GMm}{r^2}$ $v^2 = \frac{GM}{r}$ Let T = the period of orbit to complete one revolution. $v = \frac{2\pi r}{T}$, substitute $v^2 = \frac{GM}{r}$ $\left(\frac{2\pi r}{T}\right)^2 = \frac{GM}{r}$ $\frac{4\pi^2 r^2}{T^2} = \frac{GM}{r}$ Hence $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$ Or $\frac{r^3}{T^2} = k$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5 • Relates circular motion AND orbital velocity to derive Kepler's law. AND • Demonstrates manipulation of equations to find solution. AND • Correctly derives Kepler's Third Law... 3 • Any TWO of the above points......... 2 • Any ONE of the above points 1
Question 24	
$\tau = rF\sin\theta$ $F = \frac{\tau}{r\sin\theta}$ $= \frac{31}{0.9 \times \sin 72}$ $= 36$ N	Mod 5 Advanced Mechanics PH12–12 Bands 2–3 • Correctly manipulates torque equation to find force. AND • Calculates the correct force .... 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 25	
For example: In the early 1600s, Galileo attempted to discover the speed of light. He stood on a hilltop and had an assistant stand on a separate hilltop, having measured the distance between the two hills. Both participants had a lamp, and Galileo also had a timepiece. Galileo uncovered his lamp and begin to keep time; when his assistant saw the light from Galileo's lamp, they uncovered their lamp. Galileo recorded the time until he saw the light from his assistant's lamp. By doing so, he was able to determine that the speed of light was ten times greater than the speed of sound. Foucault improved the calculation of the speed of light by using a similar apparatus to that used in Fizeau's method. Foucault shone a bright light through a rotating mirror that would block the light's path. Foucault observed the light hitting a plane surface 8 km away from the rotating mirror and was able to determine the speed of light based on the speed of rotation of the mirror, which periodically blocked the light from hitting the observed surface. His method determined the speed of light to be 298 000 km s^{-1}.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Discusses ONE historical method used to determine the speed of light. AND • Provides the historical speed of light. AND • Discusses ONE contemporary method used to determine the speed of light. AND • Provides the contemporary speed of light. . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
Question 26	
(a) $d\sin\theta = m\lambda$ $\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right)$ $= \sin^{-1}\left(\frac{1 \times 854 \times 10^{-9}}{2.00 \times 10^{-4}}\right)$ $= 0.245°$	Mod 7 The Nature of Light PH12–14 Bands 5–6 • Correctly manipulates SI units. AND • Calculates correct first-order maximum . . 2 • Any ONE of the above points. 1
(b) distance $= L\tan\theta$ $= 2.5 \times \tan 0.2446$ $= 0.011$ m	Mod 7 The Nature of Light PH12–14 Bands 5–6 • Calculates correct distance between maximums 1
Question 27	
(a) 	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3 • Gives correct labels and units. AND • Uses correct scale. AND • Correctly plots data with line of best fit . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
(b) Either reading from the table or the graph, the half-life for the isotope is 8 hours.	Mod 8 From the Universe to the Atom PH12–15 Bands 2–3 • States correct half-life value 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(c) (i) 16 hours × 60 × 60 = 57 600 seconds $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ $= \frac{\ln 2}{57\,600}$ $= 1.20 \times 10^{-5}\ s^{-1}$	Mod 8 From the Universe to the Atom PH12–15 Bands 4–6 • Calculates the correct decay constant . . . 2 • Gives some correct information. 1
(ii) $n = \frac{48\ \text{hours}}{16\ \text{hours}}$ $= 3$ percentage of sample left undecayed $= \left(\frac{1}{2}\right)^3$ $= \frac{1}{8} = 0.125$ $= 12.5\%$	Mod 8 From the Universe to the Atom PH12–15 Bands 4–6 • Determines the correct percentage of the sample left undecayed . . . . 2 • Gives some correct information. 1
Question 28	
Cathode ray tubes, or discharge tubes, were invented in the mid-1800s by a scientist named Heinrich Geissler. They were invented after the vacuum pump was developed. The vacuum pump was crucial in the development of cathode ray tubes as it created extremely low pressures. This led to the discovery of the electron. Cathode rays were discovered by electrodes being inserted into these vacuum tubes and high voltages being applied. This led scientists to discover and investigate the properties of cathode rays. A variety of different cathode ray tubes were made, which improved the scientists' understanding of the nature of cathode rays. A particular cathode ray experiment demonstrated that cathode rays can be influenced by both electric and magnetic fields. This led scientists such as JJ Thomson to use cathode ray tubes to discover the electron. Thomson deflected a beam of cathode rays with electric fields in order to measure the charge-to-mass ratio of the cathode rays. He called the particles that he discovered electrons. Without the discovery of the vacuum pump, cathode ray tubes would have not been able to be produced, which in turn would have affected the discovery of the electron.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Discusses how the vacuum pump led to the invention of cathode ray tubes. AND • Discusses the structure of a typical cathode ray tube. AND • Discusses the discovery of cathode rays. AND • Links cathode ray discovery to discovery of the electron . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 29	
JJ Thomson's discovery of the electron led him to propose the plum pudding model of the atom. This model shows that there is a positively charged fluid with electrons scattered inside this fluid, just as plums are scattered in a plum pudding mixture. Many years after Thomson's discovery, scientists such as Rutherford, Geiger and Marsden found that firing alpha particles at a thin foil of gold produced a scattering of those particles. Rutherford then proposed a planetary model of the atom. This model shows that there is a positive centre (nucleus) and electrons orbiting the nucleus, similar to planets orbiting around the Sun. Rutherford also described a particle that was similar to a proton that would be found inside the nucleus. He predicted that this particle would be neutrally charged. Chadwick submitted a scientific paper many years later called the 'Possible Existence of a Neutron'. Chadwick conducted experiments based on measurements of the recoil of hydrogen and nitrogen after interactions with his proposed neutron. He calculated the neutron's mass to be 1.15 times greater than the proton. Bohr used ideas from previous scientists in developing his model of the atom through the quantum ideas proposed by Planck and Einstein. Bohr described orbital shells/states that electrons occupy and how the movement of electrons between the shells/states must meant energy is being absorbed or emitted. This was the first leap from classical physics to quantum physics. It was further improved by de Broglie, who suggested that electrons may demonstrate wave-like properties. After de Broglie's contribution, the next contributions were from Heisenberg and Schrödinger, two scientists prominent in quantum physics. Heisenberg's uncertainty principle states that, for an electron, its velocity and its position cannot be exactly measured concurrently. Schrödinger then used Heisenberg's uncertainty principle to describe the position of electrons to be in a cloud around the nucleus, where the exact position of an electron can only be known as a probability within this cloud.	Mod 8 From the Universe to the Atom PH12–15 Bands 5–6 • Discusses Thomson's model. AND • Discusses Rutherford's model. AND • Discusses discovery of the neutron. AND • Discusses Chadwick's discovery of the neutron. AND • Discusses Bohr's contribution. AND • Discusses de Broglie's contribution. AND • Discusses Heisenberg's uncertainty principle. AND • Discusses Schrödinger's contribution . . . 8 • Any SEVEN of the above points . . . . 7 • Any SIX of the above points . . . . 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
Question 30	
(a) $\varepsilon = -n\dfrac{\Delta\theta}{\Delta t} = -n\dfrac{\Delta BA}{\Delta t}$ $\lvert\varepsilon\rvert = n\dfrac{\Delta BA}{\Delta t}$ $= 1 \times \dfrac{0.80 \times 0.37^2}{0.04}$ $= 2.74$ V	Mod 6 Electromagnetism PH12–13 Bands 4–5 • Calculates the area of the loop. AND • Calculates the change in flux. AND • States the direction of the change in flux. AND • Calculates the correct induced emf/voltage . . . . 4 • Any THREE of the above points . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1

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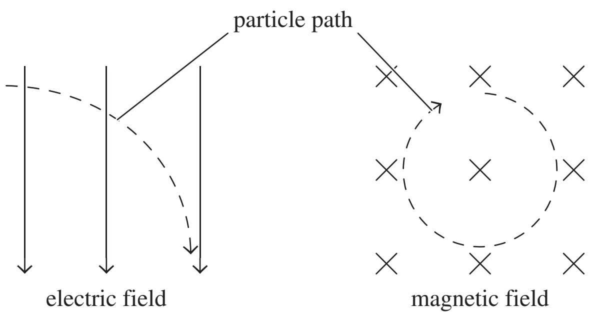
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(b) The change in flux is into the page. The direction of the induced magnetic field will be out of the page, meaning the direction of the induced current will be anticlockwise.	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Correctly identifies direction of the induced current 1
Question 31	
(a) *Any two of:* • increasing the force acting on the sides • increasing the width of the coil • adding more coils around the armature • any other reasonable answer	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Gives TWO modifications to increase speed 2
	• Gives ONE modification to increase speed 1
(b) In a DC motor, as the coil rotates in one direction, the current flowing through the loop must reverse direction just as the coil reaches the position where it is perpendicular to the direction of the magnetic field. A commutator, which acts as a switch, is used to reverse the direction of the current. Each part of the commutator is connected to each end of the coil. When the commutator rotates with the coil, contact with the brushes changes just as the coil reaches the position where the plane of the coil is perpendicular to the field direction. This reverses the direction of the current in the coil. As a result, the direction of the force on each side of the coil is reversed and the loop continues to rotate in the same direction.	Mod 6 Electromagnetism PH12–13 Bands 2–3 • Outlines how the commutator interacts with the direction of the current in the coil. AND • Outlines how the commutator interacts with the direction of the force in the coil 2
	• Any ONE of the above points 1
Question 32	
Both electric and magnetic fields exert force on a charged particle. The difference between the effect that electric and magnetic fields have on a charged particle has to do with the particle's trajectory. An electric field exerts a force on a charged particle that is directed in the same direction as the field. A magnetic field exerts a force moving across the field, so the force will be directed perpendicularly to the field and the velocity of the charged particle. This will result in the different trajectories; an electric field will produce a parabolic trajectory, whereas a magnetic field will produce a circular trajectory. This is shown in the following diagrams: 	Mod 6 Electromagnetism PH12–13 Bands 4–5 • States ONE similarity between magnetic and electric fields. AND • States that the trajectories of particles in electric and magnetic fields are different. AND • States that different forces are applied. AND • Draws correct diagrams to show the different trajectories. 4
	• Any THREE of the above points 3
	• Any TWO of the above points. 2
	• Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 33	
force of repulsion = mg $= 0.06 \times 10^{-3} \times 9.8$ $= 5.88 \times 10^{-4}$ N $\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$ $I = \sqrt{\frac{F \times 2\pi r}{l \times \mu_0}}$ Since the current is the same for both conductors, the magnitude of the current will be:	Mod 6 Electromagnetism PH12–13 Bands 3–4 • Calculates the correct force of repulsion. AND • Rearranges equation to find current. AND • States that the current is the same for both conductors. AND • States the correct magnitude of the current. 4
$I = \sqrt{\frac{5.88 \times 10^{-4} \times 2\pi \times 5.00 \times 10^{-3}}{29.0 \times 10^{-2} \times 4\pi \times 10^{-7}}}$	• Any THREE of the above points 3
	• Any TWO of the above points 2
$= 7.12$ A	• Any ONE of the above points. 1
Question 34	
input power = $V_1 I_1$ $= 240 \times 0.02$ $= 4.8$ W output power = $V_2 I_2$ $= 12 \times 0.28$ $= 3.36$ W	Mod 8 From the Universe to the Atom PH12–15 Band 1 • Calculates the correct input power AND output power. AND • Calculates the correct efficiency AND • Gives an account for energy loss 3
efficiency = $\frac{3.36}{4.8} \times 100$	• Any TWO of the above points 2
$= 70\%$ The efficiency is 70%, with losses potentially resulting from eddy currents, wind resistance or flux leakage.	• Any ONE of the above points. 1
Question 35	
(a) $\phi = 5.1$ eV *Note: As the answer is read from the graph, allow responses in the range of 5.1–5.3.*	Mod 7 The Nature of Light PH12–14 Bands 4–6 • Gives response obtained from reading the graph 1
(b) $\lambda = 180$ nm $\phi = 5.1$ eV *Note: ϕ value is dependant on answer to part (a).* $K_{max} = hf - \phi$ $= (4.14 \times 10^{-15} \times 1.25 \times 10^{14}) - 5.1$ $= 0.075$ eV	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Identifies correct equation to calculate K_{max}. AND • Demonstrates working with correct values. AND • Provides correct answer between 0.03–0.075 eV 3
	• Any TWO of the above points 2
	• Any ONE of the above points. 1

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Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(c) $\varnothing = hf_0$ $f_0 = \frac{\varnothing}{h}$ $= \frac{5.10}{4.14 \times 10^{-15}}$ $= 1.23 \times 10^{15}$ Hz From the graph, the line of best fit cuts the x-intercept at approximately 1.25×10^{15} Hz, which supports the answer given above.	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Identifies correct equation to calculate cut-off frequency. AND • Supports answer with evidence from the graph. AND • Gives answer between $1.23–1.26 \times 10^{15}$ Hz . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
Question 36	
(a) $t_{\text{Earth}} = \frac{s}{v}$ $= \frac{20}{0.38}$ $= 52.6$ $= 53$ years	Mod 7 The Nature of Light PH12–14 Bands 3–4 • Calculates correct number of years 1
(b) $l_0 = 20$ light years $v_0 = 0.38c$ $l = l_0\sqrt{1 - \frac{v_0^2}{c_0^2}}$ $= 20\sqrt{1 - \frac{0.38^2}{1^2}}$ $= 18.5$ light years $t_{\text{atomic clock}} = \frac{s}{v}$ $= \frac{18.5}{0.38}$ $= 48.7$ years	Mod 7 The Nature of Light PH12–14 Bands 4–5 • Calculates correct number of years. AND • Correctly converts light years into Earth years . . . . 2 • Any ONE of the above points 1
Question 37	
(a) $r = 35\,800\,000 + 6\,371\,000$ $= 42\,171\,000$ $E = -\frac{GMm}{2r}$ $= -\frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 2550}{2 \times 42\,171\,000}$ $= -1.210 \times 10^{10}$ J	Mod 5 Advanced Mechanics PH12–12 Bands 4–5 • Identifies correct equation. AND • Gives the correct answer in joules . . . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(b) $k = \frac{GMm}{2r}$ $= \frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 2550}{2 \times 42\,171\,000}$ $= 1.210 \times 10^{10}$ J $k = \frac{1}{2}mv^2$ $\therefore 1.210 \times 10^{10}\text{ J} = \frac{1}{2}mv^2$ $v^2 = 9\,490\,196.078$ $v = 3081\text{ m s}^{-1}$	Mod 5 Advanced Mechanics PH12–12 Bands 4–5 • Identifies relationship between kinetic energy and total mechanical energy from part (a). AND • Demonstrates working for calculating kinetic energy. AND • Calculates the correct answer . . . . 3 • Any TWO of the above points . . . . 2 • Any ONE of the above points. 1
(c) Geostationary satellites orbit within this range (35 000–36 000 km) away from Earth. A geostationary satellites use is generally specific to one of the following: • communication • GPS • military uses • weather predictions *Note: Only two uses required for full marks.*	Mod 5 Advanced Mechanics PH12–12 Band 2–3 • Gives correct satellite type. AND • Gives TWO uses of geostationary satellites . . . . 2 • Any ONE of the above points. 1

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