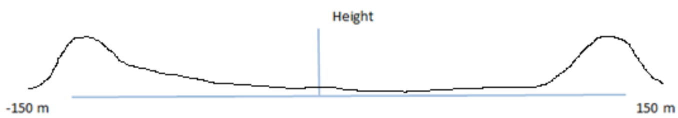
Assessment Schedule – 2018

Scholarship Physics (93103)

Evidence Statement

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
ONE (a)(i)	The restoring force must be directly proportional to the negative of the displacement.	Thorough understanding of these applications of physics. OR		
(a)(ii)	$\omega = \frac{2\pi}{T}$ $v_{max} = A\omega = \frac{2\pi \times 150}{60} = 15.7079 \text{ m s}^{-1}$			
(b)	Total energy = $GPE_{\text{half way}} + KE_{\text{half way}}$ Total energy is found by $\frac{1}{2}mv^2 = mgh$ and that gives 12.58 m $Mg \times 12.58 = Mgh + ½ M (\omega^2 (150^2 - 75^2))$ Gives $h = 3.15$ m	Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(c)(i)	 The profile is higher on each side (points A and C) with the shallowest region at point B. The profile is higher at A and C because the wagon, moving slowly at these points of the motion, spends more time at these locations. The sideways motion of the falling sand can be ignored if the distance fallen to the track is regarded as negligible.			
(ii)	Everything is constant apart from the total energy and force of the system.			
(d)	$R^2 = (R - 12.58)^2 + 150^2$ $R = \frac{150^2 + 12.58^2}{25.16} = 901 \text{ m}$ Angle the wagon moves through = $\sin^{-1}\left(\frac{150}{901}\right) = 9.6°$ This is close to the small angle limit so the motion should be acceptable to be treated as SHM.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
TWO (a)	The sources must have: 1) the same wavelength 2) fixed phase difference 3) a separation, d, greater than the wavelength 4) comparable amplitudes.	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics
(b)	By realising that a rotation of φ for the slits will produce the standard interference pattern. The zero of intensity will be when $\frac{\lambda}{2} = d\sin\varphi$. Answer = 0.18134 degrees			
(c)	At this point there is no path difference so the only factor is the reflection phase change, and since this is 180 degrees, the two waves cancel, leading to a dark fringe.			
(d)	$\theta = \frac{t}{x}$ $n = \frac{2t}{\lambda}$ $\frac{n}{x} = \frac{2\theta}{\lambda}$ Answer approx. 1270 lines per m. or 1300 to 2 sig fig.			
(e)	The lines become so close together that they are unresolvable.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
THREE (a)	$F_g = \dfrac{6.67\times10^{-11}\times9.11\times10^{-31}\times9.11\times10^{-31}}{R^2}$ $F_e = \dfrac{8.98\times10^{9}\times1.60\times10^{-19}\times1.60\times10^{-19}}{R^2}$ $\dfrac{F_g}{F_e} = 2.40\times10^{-43}$	Thorough understanding of these applications of physics. OR		
(b)	Two in parallel (capacitor and inductor), one in series (resistor). Evidence: Finite current at a zero and high frequency implies resistor in series. Can't have the capacitor in series (at low frequency – current would be zero). Can't have inductor in series (at high frequency – current would be zero). Zero current at finite frequency implies infinite impedance – this can happen with parallel branch containing an inductor and a capacitor.	Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(c)	Take voltage to be V $I_4 = \dfrac{V}{r+4}$ $I_1 = \dfrac{V}{r+1}$ $I^2R = 16 = \dfrac{4V^2}{(r+4)^2} = \dfrac{V^2}{(r+1)^2}$ $V^2 = 16(r^2+2r+1)$ and $V^2 = 4(r^2+8r+16)$ $r^2+8r+16 = 4r^2+8r+4$ $3r^2 = 12$ $r = 2\ \Omega$ $V^2 = 144$ $V = 12$ volts			
(d)	The electron associated with a single proton (forming a hydrogen atom) has a restricted set of possible energy values. We say the potential energy held by the electron is quantised because when the electron changes from large PE to less PE, the energy change is released as an electromagnetic photon. These photons always have precise values, forming the hydrogen emission spectrum.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
FOUR (a)	This system of two springs in series is equivalent to a single spring, of spring constant k. For spring 1, from Hooke's Law $F = k_1 x_1$ where x_1 is the deformation of spring. Similarly if x_2 is the deformation of spring 2 we have $F = k_2 x_2$ Total deformation of the system $x_1 + x_2 = \frac{F}{k_1} + \frac{F}{k_2}$ $\Rightarrow x_1 + x_2 = F\left(\frac{1}{k_1 + k_2}\right)$ Rewriting and comparing with Hooke's law we get: $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(b)	$F_o = k\Delta x_2$ from Using part a $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$ – this rearranged gives the above expression.			
(c)	Different amplitudes, both masses will move in negative phase with each other because the centre of mass will stay at a constant position – overall motion is SHM.			
(d)	Energy conservation and momentum conservation. $k_{\text{effective}} = 3.3\frac{N}{m}$ using the expression in (a). Using the numbers provided ($F = 2N$ and k =3.3) implies that $\Delta x_2 = 0.6$ m. That extension produces the store of energy $= \frac{1}{2}k_{\text{eff}}x^2$ – that energy will be shared between the masses. When they are at max velocity (no stored elastic energy) – all energy will be kinetic therefore $\frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2 = \frac{1}{2}kx^2 = 0.6$ J and $m_1 v_1 = m_2 v_2$ due to conservation of momentum (or the fact that the centre of mass doesn't move). This gives $v_1 = \frac{3}{2}v_2$ substituting into the above energy equation and solving gives $v_2 = 0.4$ m s^{-1}			
(e)	The period of oscillation will alter and increase as there is more mass in system. The amplitude will be unchanged (since no E_k at end points). The maximum speed will decrease as overall E is constant. The centre of mass motion will be unchanged.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
FIVE (a)	Material must be an insulator (have no "free" electrons), and its atoms / molecules must be easily polarised (distinct charge separation shown in an imposed electric field).	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(b)(i)	Work needed $= \Delta E = E_F - E_1 = \frac{1}{2}\frac{Q^2}{C_F} - \frac{1}{2}\frac{Q^2}{\varepsilon_r C_F}$ $= \frac{1}{2}\frac{Q^2(\varepsilon_r - 1)}{\varepsilon_r C_F}$ $Q = C_F V_F$ So work needed $= \frac{1}{2} C_F V^2 \left(\frac{\varepsilon_r - 1}{\varepsilon_r}\right)$			
(ii)	With the charge constant and the capacitance decreased, the voltage (potential energy per coulomb) must have increased.			
(c)	Because the voltage must remain constant across the capacitor, the stored charge must reduce, as the capacitance is reduced by the dielectric withdrawal. The excess charge is returned to the battery and work must be done (by the withdrawing dielectric) to send the charge back into the battery.			
(d)(i)	The capacitance has increased, the charge is constant, therefore voltage is reduced.			
(ii)	Because the edge field of the capacitor has a component acting perpendicular to the plates which will attract material (electrostatically upwards).			

Cut Scores

Scholarship	Outstanding Scholarship
21 – 30	31 – 40