Question Number	Answer		Mark
19(a)(i)	The distance between pylons **Or** length of cable **Or** the weight/mass/density of the cable/material	(1)	**1**
19(a)(ii)	• See $Mg = 2T \sin\theta$ **Or** weight (or W or Mg) is proportional to $T \sin\theta$ • as the sag increases, θ (or $\sin\theta$) increases (for a constant weight) • (as the sag increases) $\sin\theta$ increases hence T decreases	(1) (1) (1)	**3**
19(b)(i)	• Use of region of graph 0 to 300 MPa to determine the gradient **Or** tangent from origin • E_{steel} = 1.5 × 10^{11} (Pa) to 1.8 × 10^{11} (Pa) Example of calculation $E_{steel} = \frac{\mathbf{200 \times 10^6\ Pa}}{\mathbf{0.0013}} = 1.53 \times 10^{11}$ Pa	(1) (1)	**2**
19(b)(ii)	• Use of $\sigma = \frac{F}{A}$ to obtain the stress • stress = 73 MPa Example of calculations F = 0.62 N m^{-1} × 270 m = 167.4 N $\sigma = \frac{0.62\ \text{N m}^{-1} \times 270\ \text{m}}{2.3 \times 10^{-6}\ \text{m}^2}$ σ = 72.8 MPa	(1) (1)	**2**
19(b)(iii)	METHOD 1 • Use of graph to obtain the strain in steel **Or** use of Young Modulus • Use of $\varepsilon = \frac{\Delta e}{l}$ (for steel $\Delta e = 0.14$ m) • Comparison of the two extensions/strains e.g. the extension/strain of aluminium is larger than that of steel, so steel is used to reduce the (total) extension/sag Or Comparison of two strains/extensions e.g. lower strain for steel so stiffness of cable increased to reduce (total) extension/sag	(1) (1) (1)	**3**

	METHOD 2 • Use of $\varepsilon = \frac{\Delta e}{l}$ to find strain (for extension of 0.95 m) • Use of graph to obtain the stress in aluminium and steel. • Comparison of two stresses (e.g. greater stress required for steel) so stiffness of cable increased to reduce (total) extension/sag Example of calculation Read off strain (when stress is 70 MPa) on Steel graph (0.0005) For Steel, Δe = 0.0005 × 270 m = 0.14 m	
	Total for question 19	**11**