

10(a)	speed is (directly) proportional to distance
	speed is speed of recession of galaxy from an observer, and distance is the distance of the galaxy from the observer
10(b)(i)	galaxy is receding from the Earth
	observed wavelength is redshifted from emitted wavelength
10(b)(ii)	$\Delta\lambda / \lambda = v / c$
	$(4.91 - 4.62) / 4.62 = v / (3.00 \times 10^8)$
	$v = 1.9 \times 10^7 \text{ m s}^{-1}$
10(b)(iii)	wavelength (of maximum intensity) is inversely proportional to temperature
	observed wavelength too high, so determined temperature too low
10(c)	$v = H_0 d$
	$d = (1.9 \times 10^7) / (2.3 \times 10^{-18})$
	$= 8.3 \times 10^{24} \text{ m}$

10(a)	• <u>redshift</u> is the increase in observed wavelength / decrease in observed frequency (caused by Doppler effect) • radiation from distant galaxies is observed to be redshifted • redshift provides evidence that galaxies are moving apart • <u>galaxies</u> moving apart means Universe must be expanding <i>Any three points, 1 mark each</i>
10(b)(i)	$F = L / 4\pi d^2$
	$d = \sqrt{(1.90 \times 10^{36} / [4\pi \times 8.42 \times 10^{-16}]})$
	$= 1.34 \times 10^{25} \text{ m}$
10(b)(ii)	$\Delta\lambda / \lambda = v / c$
	$(726 - 658) / 658 = v / (3.00 \times 10^8)$
	$v = 3.1 \times 10^7 \text{ m s}^{-1}$
10(c)(i)	line with positive gradient passing through the origin
	straight line with positive gradient
10(c)(ii)	Hubble constant