Week 2 Assessed Question – Solutions

Rest-frame wavelength: $\lambda_{em} = 166.59\ nm$

Resolution in $\mu as = 10^{-6}$ arcsec.

(a) Redshift: $1 + z = \dfrac{\lambda_{obs}}{\lambda_{em}}$ [1 MARK]

Recession velocity: $v_{rec} \approx cz$ [1 MARK]

Galaxy	z	v_{rec}	
A	0.0030	899	km/s
B	0.0067	2009	km/s
C	0.0113	3388	km/s
D	0.0058	1739	km/s

[2 MARKS FOR CORRECT VALUES]

[1 MARK FOR APPROPRIATE SIG. FIGS]

(b) Parallax distance: $\dfrac{\Delta\theta}{\text{arcsec}} = \left(\dfrac{d}{pc}\right)^{-1}$ [1 MARK]

$\rightarrow d = \left(\dfrac{\Delta\theta}{\text{arcsec}}\right)^{-1} pc$; notice that $d = \left(\dfrac{\Delta\theta}{\mu as}\right)^{-1} Mpc.$

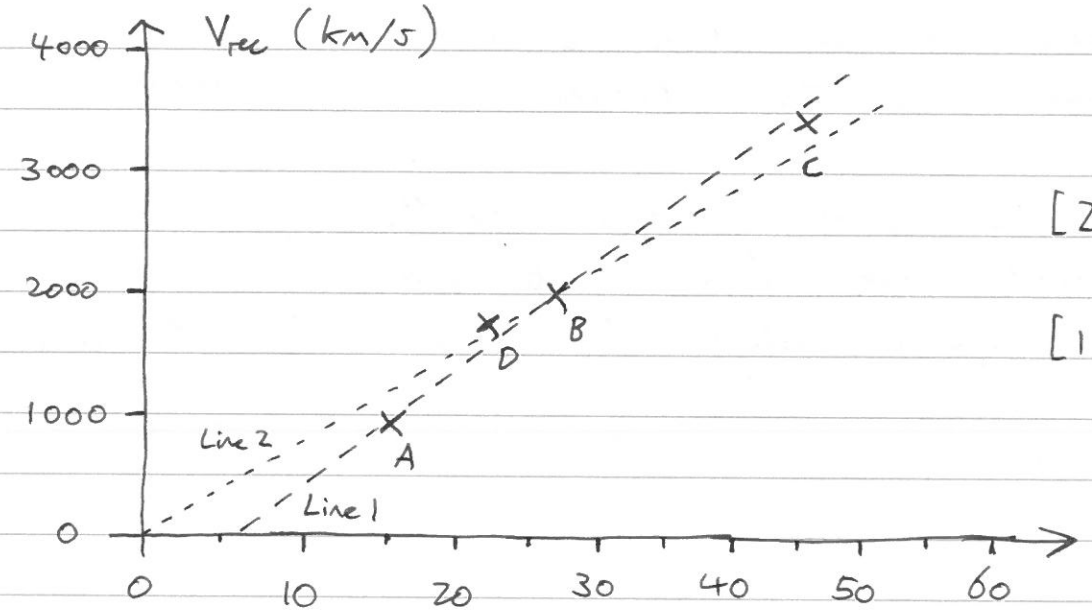
Galaxy	d (Mpc)
A	15.77
B	27.11
C	45.23
D	21.64

[1 MARK FOR NOTICING Mpc CONVERSION]

[3 MARKS FOR CORRECT VALUES]

(c) Plot quantities on graph

Question is ambiguous - 3 quantities to choose from (z, v_{rec}, d)
To estimate H_0, (v_{rec}, d) is the easiest pair.



[2 MARKS FOR GRAPH WITH SENSIBLE POINTS]
[1 MARK FOR LABELS]

Line 1: Intercept at $d \simeq 6$ Mpc, gradient $\simeq \frac{2250 - 0 \text{ km/s}}{30 - 6 \text{ Mpc}}$

$= \underline{93.8 \text{ km/s/Mpc}}$

[2 MARKS FOR SENSIBLE INTERCEPT/GRADIENT CALCULATION]

(d) Measure H_0 from plot.

Notice Hubble Law $v_{rec} = H_0 d$ [2 MARKS]

should have intercept at $d = 0$ Mpc! [1 MARK]

Line 2: gradient $\simeq \frac{2250 - 0 \text{ km/s}}{30 - 0 \text{ Mpc}} \simeq \underline{75 \text{ km/s/Mpc}}$

gradient $= H_0 \Rightarrow H_0 \simeq 75$ km/s/Mpc

[1 MARK FOR ANSWER, 1 ADDITIONAL MARK FOR ANSWER WITH INTERCEPT AT 0 Mpc]

(e) Do the points follow a perfectly straight line?

No - there are small deviations from a straight line [2 MARKS]

The deviations are even clearer if we fit a line beginning at zero intercept. [1 MARK]

Peculiar velocities of the galaxies alter their recession velocity, making them deviate from the perfect (expansion-only) Hubble Law. [2 MARKS]