Q5 $\boxed{E}$ The temperature observed in direction θ by an observer travelling at speed v in the direction $\theta = 0°$ is given by

$$T = \frac{T_0\sqrt{1 - v/c}}{\left(1 - \dfrac{v}{c}\cos\theta\right)}$$

(See Subsection 6.2.2 of Unit 13)

The maximum value of T will be observed when $\cos\theta = 1$ and the minimum value when $\cos\theta = -1$. It follows that

$$6\,\text{K} = \frac{T_0\sqrt{1 - v/c}}{1 - v/c} \quad\text{and}\quad 2\tfrac{2}{3}\,\text{K} = \frac{T_0\sqrt{1 - v/c}}{(1 + v/c)}$$

Dividing the first of these relations by the second

$$\frac{6}{2\tfrac{2}{3}} = \left(\frac{1 + v/c}{1 - v/c}\right)$$

i.e. $\dfrac{18}{8} = \left(\dfrac{1 + v/c}{1 - v/c}\right)$

i.e. $\dfrac{v}{c} = \dfrac{5}{13}$

$0.6\left(\dfrac{247 + x}{4}\right) + 35.3 = 85$

Q6 $\boxed{D}$ The temperature deduced from the observations of Penzias and Wilson, combined with the assumption of a black body spectrum lead to a temperature of about 3 K (*not* 3° C). (It is worth noting that Penzias and Wilson actually quoted a blackbody temperature of 3.5 K, and that the *assumption* of a black body spectrum is now justified by the *observations* across a range of frequencies by the COBE satellite.)

Q7 $\boxed{B,D}$ Decoupling occurred about 300 000 years after nucleosynthesis, and the Universe was radiation dominated at the time of nucleosynthesis. (Unit 15, Section 7.)

Q8 $\boxed{A,D}$ Statement (i) is true since an open universe is spatially infinite, thus a homogeneous open universe that contains any matter at all must contain an infinite amount of matter. (Of course, it is not the case that a given observer will necessarily be able to detect all this matter.) Statement (ii) cannot be true as it stands since the effective curvature depends on $R(t)$, which varies with time in both open *and* closed universes. (Unit 15, Section 3.2.)

Q9 $\boxed{A,C,E}$ Statement (i) is supported by Section 7.3 of Unit 13. Consequently the measured abundance of deuterium indicates some other process was responsible for its creation. Big Bang nucleosynthesis provides the main contender for this other process. Thus, statement (ii) is also true and is closely related to statement (i).

Q10 $\boxed{C}$ $\rho_{\text{matter}} \propto 1/R^3$, see Section 2.2 of Unit 15.

Q11 $\boxed{H}$ k is a constant, zero in this case.

Q12 $\boxed{A}$ In a matter-dominated universe of critical density, $R \propto t^{2/3}$ (see SAQ 12 of Unit 15). Since $H = \dfrac{1}{R}\dfrac{dR}{dt}$ it follows that $H \propto t^{-1} \propto R^{-3/2}$.