

**Question 8**

part a, 9%

part b, 3%

(a) Five methods of estimating the masses of galaxies are described in Book 3: the rotation curve; velocity dispersion; X-ray haloes; binary galaxies; cluster dispersion. Outline any *two* of the methods, and state whether the mass it gives includes the dark matter associated with the galaxy.

(b) A galaxy has a rotation curve as shown in Figure 4. If the mass enclosed within  $r$  is  $M(r) = rv^2/G$ , find the mass of the galaxy.

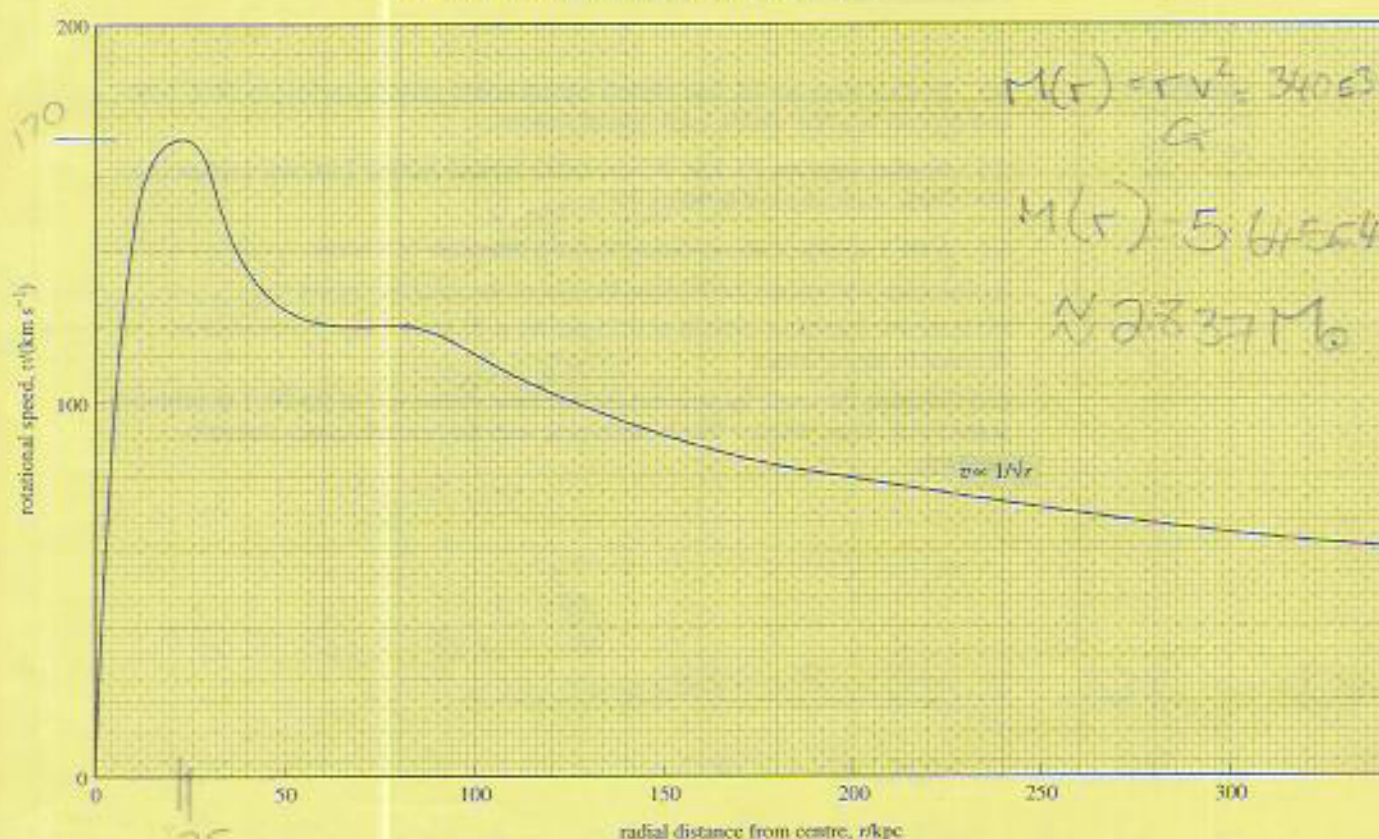


Figure 4 The rotation curve of a galaxy (for use with Question 8).

**Question 9**

part a, 4%

part b, 4%

part c, 2%

part d, 2%

(a) Outline, in a few sentences, *two* pieces of evidence that galaxies provide for the existence of dark matter. *rotation curve is slowly beyond vir*

(b) Explain the difference between cold dark matter and hot dark matter, and outline why both are believed to exist.

(c) The future of the Universe depends on the amount of dark matter in the Universe. Explain this statement in a few sentences.

(d) Name two examples of baryonic dark matter, and state approximately what fraction of the total dark matter can be baryonic.

[END OF QUESTION PAPER]