13.

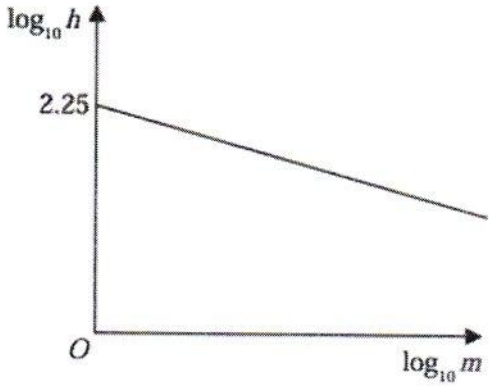

Figure 2

The resting heart rate, h, of a mammal, measured in beats per minute, is modelled by the equation

$$h = pm^q$$

where p and q are constants and m is the mass of the mammal measured in kg.

Figure 2 illustrates the linear relationship between $\log_{10} h$ and $\log_{10} m$

The line meets the vertical $\log_{10} h$ axis at 2.25 and has a gradient of -0.235

(a) Find, to 3 significant figures, the value of p and the value of q.

(3)

A particular mammal has a mass of 5 kg and a resting heart rate of 119 beats per minute.

(b) Comment on the suitability of the model for this mammal.

(3)

(c) With reference to the model, interpret the value of the constant p.

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(1)

(a) $h = pm^q$ Take $\log_{10}$ of both sides

$\log_{10} h = \log_{10}(pm^q) = \log_{10} p + \log_{10}(m^q)$

$= \log_{10} p + q \log m$

This is a straight line graph between $\log_{10} h$ and $\log_{10} m$ where the slope is q and the intercept on the $\log_{10} h$ axis (when $\log_{10} m = 0$) is $\log_{10} p$.

So $q = -0.235$ the slope

and intercept $\log_{10} p = 2.25$

$p = 10^{2.25} = 178.$ is $h = 178m^{-0.235}$

(b) The model predicts $h = 178 \times 5^{-0.235} = 122$ beats/min

Within 2 sig fig this agrees with 119 so confirming suitability of the model.

(c) Note $1^x = 1$ so if mass were 1, $1^{-0.235} = 1$. So $h = 178 \times 1$. So p is the heart rate of a 1kg mammal.