Answer on Question #44687 – Physics – Other

(a) Assume your heart uses 1.2 J of energy per heartbeat.?

(i) Write down a plausible number for the rate (i.e. number of times per second) at which your heart is beating now. [2]
(ii) What is the rate at which your heart uses energy per second (in J s−1
) ?
[2]
(iii) If you live to be 90 years old, how many heartbeats would you have had ? [2]
(b) Your brain uses energy at a rate of ∼ 1.5 × 106
J per day.
(i) What is the rate at which which your brain uses energy per second ? [2]
(ii) Over the course of this exam, how much energy will your brain have used ?

Seems easy enough,but just can't get it right.

Thank you ! :)

Solution:

#1

$$\mathrm{P} = 1.2\,\frac{\mathrm{J}}{\mathrm{heartbeat}}$$

The average heart beat of an adult human is 72 beats per minute, i.e. 72 heart beats in 60 seconds.

$$\mathrm{heartbeats\ in\ 60\ sec.} = 72$$
$$\mathrm{heartbeats\ in\ 1\ sec.} = 72 / 60$$
$$\mathrm{heartbeats\ in\ 1\ sec.} = 1.2$$

Plausible number for the rate

$$\mathrm{N} = 1.2\ \frac{\mathrm{heartbeats}}{\mathrm{s}}$$

Rate at which my heart uses energy per second:

$$\mathrm{R} = \mathrm{P} \cdot \mathrm{N} = 1.2\,\frac{\mathrm{J}}{\mathrm{heartbeat}} \cdot 1.2\ \frac{\mathrm{heartbeats}}{\mathrm{s}} = 1.44\ \frac{\mathrm{J}}{\mathrm{s}}$$

Answer: Rate at which my heart uses energy per second is equal to $1.44\ \frac{\mathrm{J}}{\mathrm{s}}$.

#2

$$\mathrm{T} = 90\ \mathrm{years} = 90 \cdot 365\ \mathrm{days} = 90 \cdot 365 \cdot 24\ \mathrm{hour} = 90 \cdot 365 \cdot 24 \cdot 60\ \mathrm{minutes}$$
$$= 90 \cdot 365 \cdot 24 \cdot 60 \cdot 60\ \mathrm{s}$$

Number of heartbeats during 90 years:

$$\mathrm{n} = \mathrm{T} \cdot \mathrm{N} = 90 \cdot 365 \cdot 24 \cdot 60 \cdot 60\ \mathrm{s} \cdot 1.2\ \frac{\text{heartbeats}}{\mathrm{s}} = 3\ 405\ 888\ 000\ \text{heartbeats}$$

Answer: number of heartbeats during 90 years is equal to $3\ 405\ 888\ 000$

#3

Your brain uses energy at a rate of ~1.5 × 106 J per day.

$$\mathrm{P} = 1.5 \cdot 10^6\ \frac{\mathrm{J}}{\text{day}} = \frac{1.5 \cdot 10^6\ \mathrm{J}}{24\ \text{hours}} = \frac{1.5 \cdot 10^6\ \mathrm{J}}{24 \cdot 60\ \text{minutes}} = \frac{1.5 \cdot 10^6\ \mathrm{J}}{24 \cdot 60\ \text{minutes}} =$$

$$= \frac{1.5 \cdot 10^6\ \mathrm{J}}{24 \cdot 60\ \cdot 60\ \text{seconds}} = 17.36\ \frac{\mathrm{J}}{\mathrm{s}}$$

$\mathrm{t} = 1\ \text{hour} = 60\ \text{min} = 60 \cdot 60\ \text{seconds} - \text{duration of the exam;}$
Over the course of this exam, your brain have used

$$\mathrm{W} = t \cdot P = 17.36 \frac{J}{s} \cdot 60 \cdot 60\ s = 62\ 496\ J$$

Answer: during the exam my brain have used $62\ 496\ J$.