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How fast would a baboon have to run to catch fire?

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Abstract
Silly Old Baboon is a poem that features a Baboon who runs so fast it catches fire. This paper determines the speed a baboon should be required run at in order for it to catch on fire due to friction with the air. Through calculations involving the heat energy equation and drag force energy equation the speed at which a baboon must run at is determined.

Keywords: *Poem; Physics; Aerodynamics; Silly Old Baboon*

Introduction
In the poem "Silly Old Baboon" (see Appendix A) by Spike Milligan [1] a baboon attempted to fly to the sun by strapping two large palms to his arms and running, in an attempt to lift off of the ground. The baboon was told to run faster by a passing crow and so the baboon ran so fast that it's feet caught fire. In this paper I determine how fast the baboon would have to run in order to catch fire due to resistance from the air using a simple model that has been adapted from The Theorizer [2] in which the speed a human would have to run to catch fire is calculated.

Assumptions
The calculations use a simple model to determine how fast the baboon would have to run to catch fire due to friction with the air around it, not considering the effect of the wind and other variables. The heat energy equation is used to calculate the amount of heat energy that needs to be transferred for the baboon to catch fire and the specific heat capacity (c) value refers to that of human hair as it is lower than that of skin, so it would be the first to catch fire. The specific heat value for hair refers to human virgin hair, natural hair that has not been bleached or dyed, as there are no values for baboon hair.

The drag equation is used to convert the energy required for combustion into the speed required to produce it and the drag coefficient is taken from the lower end of an upright human, due to no values being available for baboons. The surface area of the baboon was calculated assuming an average height of 0.595 m and width of 0.39 m [3]. It is assumed that the baboon runs for 30 minutes before catching fire as it gives it time to run "mile after mile", as the poem states. The air temperature is the average yearly temperature of Ethiopia as this is a common location for baboons [4].

Method
The heat energy equation, as can be seen below, is utilised to calculate the amount of energy, Q, that would need to be transferred in order for the baboon to catch fire. Hair is used for the specific heat capacity value as it combusts at a lower temperature than skin.

$$Q = mc\Delta T$$

The average mass (m) of a baboon was taken as 31 kg [4], the specific heat capacity (c) for virgin hair is 2512.08 J/Kg$^{\circ}$C [5]. The temperature for the hair to catch fire can be calculated by converting the specific heat capacity value into Kelvin (K) which is 2785.23 K and the outdoor temperature was assumed to be 290.15 K, the average yearly temperature in Ethiopia [6]. The heat energy needed to be transferred was calculated to be 194,303,057.6 J:

$$Q = 31 \times 2512.08 \times (2785.23 - 290.15)$$

$$Q = 194{,}303{,}057.6\,J$$

As energy is assumed to be conserved, the heat energy is equal to the drag force energy. The drag force energy equation can be rearranged to calculate the velocity needed to reach this value [2].

$$F_D = \frac{1}{2}\rho A C_D v^2$$

$$v = \left(\frac{2E}{\rho A t C_D}\right)^{\frac{1}{3}}$$

Using the values for Energy (E) as 194,303,057.6 J, density of air (ρ) as 1.204kg m^{-3} [7], the surface area of the baboon as 0.232 m^3, drag coefficient (C_D) as 1.0, and time (t) as 1800 s the velocity the baboon would have to run to catch fire is calculated.

$$v = \left(\frac{2 \times 194{,}303{,}057.6}{1.204 \times 0.232 \times 1800 \times 1.0}\right)^{\frac{1}{3}}$$

$$v = 91.771\ ms^{-1}$$

$$v = 330.4\ km\ hr^{-1}$$

Conclusion

These calculations are based off of the assumptions that there is no cooling effect by the wind and no interference from other factors such as internal body temperature increasing due to increased activity. They also assumed that energy would be conserved but in practice this would be unavoidable due to a variety of factors including those previously discussed. Friction with the ground would play a very important role in the combustion of the baboon's hair but to simplify this model it has been excluded.

From the calculations above, the baboon would be required to run at a speed of 330.4 km hr^{-1} to produce enough energy as a whole catch fire due to friction with the air. The crow suggested running at the speed of sound, however being 4 times faster than this value, the baboon would burst into flames long before it reached that speed.

References

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Appendix A

Silly Old Baboon
By Spike Milligan

There was a Baboon
Who, one afternoon,
Said "I think I will fly to the sun."
So, with two great palms
Strapped to his arms,
He started his take-off run.
Mile after mile
He galloped in style
But never once left the ground.
"You're running too slow"
Said a passing crow,
"Try reaching the speed of sound."
So he put on a spurt –
By God how it hurt!
The soles of his feet caught fire.
There were great clouds of steam
As he raced through a stream
But he still didn't get any higher.
Racing on through the night
Both his knees caught alight
And smoke billowed out from his rear.
Quick to his aid
Came a fire brigade
Who chased him for over a year.
Many moons passed by.
Did Baboon ever fly?
Did he ever get to the sun?
I've just heard today
That he's well on his way!
He'll be passing through Acton at one.
P.S. Well, what did you expect from a Baboon?