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P2_10 Toasty Candles

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Abstract

The majority of houses use gas boilers to heat them up. This paper looks into an alternative method of heating up one room in a house. This paper investigates how many tea light candles it would take to heat up an empty room with a volume of 63.2 m^3 by 5°C as a potential alternative. We found that the total number of lit tea light candles it would take to achieve this in 15 minutes was 5 in a 100% insulated room.

Introduction

Central heating can be used to heat up rooms in houses. Boilers in houses work to transport hot water to radiators in the rooms, transferring this heat to the room's surroundings. For this paper, we considered if a different method could be used to heat up a room in a house. We investigated how many tea light candles it would take to heat up a room by 5°C in 15 minutes.

Discussion

Firstly, we calculated the volume of an average large room. On average, a large bedroom has the dimensions 4.3×4.9 m [1]. For this paper, we assumed the height of the room to be 3 m. The volume of an average large bedroom was calculated to, therefore, be 63.2 m^3 (to 3 significant figures). We made more assumptions for this paper, one being that the room is empty, so no heat is absorbed by furniture. The other is that no heat is lost through the walls, ceiling and floor in the room.

The mass of the air in the room was calculated using the following equation:

$$m = \rho V, \tag{1}$$

where ρ is the density of air and V is the volume of the room. The density of air is 1.15 kg m^3 [2]. It should be noted that the paper this value was taken from mentions that the density of air varies slightly with temperature, altitude and humidity. Therefore, this value was used as an approximation. By multiplying the density of air by the volume of the room, we found that the mass of the air in the room was 48.4 kg (to 3 significant figures).

This paper uses tea light candles to heat up the room. The dimensions of a tea light candle we used were 3.8×1.5 cm [3]. The volume of a cylinder is:

$$V = \pi r^2 h, \tag{2}$$

where r is the radius of the tea light candle and h is the height of the tea light candle. As the diameter of the tea light candle we used was 3.8 cm, the radius was, therefore, 1.90 cm. By substituting our known value of the radius and height of a tea light candle into Equation 2, we found that the volume of one tea light candle was 17.0 cm^3. This is equivalent to 17.0×10^{-6} m^3.

Tea light candles are made of paraffin wax.

The density of paraffin wax is 0.921 g cm^{-3} [3]. This is equivalent to 921 kg m^{-3}. By using Equation 1 to multiply the volume of one tea light candle by the density of paraffin wax, we found that the mass of paraffin in one tea light candle was 0.0155 kg.

The equation for heat of combustion is:

$$\Delta H_{comb} = \frac{q}{m}, \quad (3)$$

where q is the heat energy and m is the mass of the substance. The heat of combustion of paraffin wax is known to be 42 kJ g^{-1} [4]. The heat of combustion is the heat released when a substance, (in this case, paraffin wax) completely burns in oxygen. By substituting our known values for heat combustion and the mass of one tea light candle into Equation 3, we found that one tea light candle would produce 651 kJ of energy when completely burnt. The specific heat capacity of air is 1 kJ/kg/K [5]. The equation for specific heat capacity is:

$$c = \frac{Q}{m\Delta t}, \quad (4)$$

where q is the thermal energy, m is the mass of the substance and Δt is the change in temperature. This means that for a room where the mass of air is 72.7 kg, 72.7 kJ of energy is required to heat up the room by one degree. In this paper we wanted to find out how many candles are required to heat up a room from 15°C to 20°C. The energy required to heat up the room by 5°C was calculated to be 363 kJ (to 3 significant figures).

A paraffin wax candle burns 0.00216 g of paraffin wax a second [6]. This means that in 15 minutes, 1.94g (to 3 significant figures) of paraffin wax would be burnt. From our knowledge of the heat combustion, this is equivalent to 81.5 kJ of energy. Therefore, the number of candles it would take to heat up a room with a volume of 63.2 m^3 by 5°C in 15 minutes would be at least 5 tea light candles.

Conclusion

The purpose of this paper was to investigate how many tea light candles it would take to increase the temperature of a 63.2 m^3 room by 5°C in 15 minutes. This was found to be at least 5 candles. However, this paper assumes that no heat would be lost within the room. In reality, this would not be the case as heat would be lost through the walls and windows in the room. Our calculation would be true for a room that was 100% insulated. Further research could include how to make a room as close to 100% insulated as possible for 5 tea light candles to heat up a room by 5°C in 15 minutes.

References

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