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Technological level: Advance

Programming level: Mid

Technologies used: Python 3.10 | PyCharm | Linux | OpenOffice

The program code is available on GitHub at the following link: https://github.com/AdrianSzklarski/Linkedin

Description of the problem: A glider takes off from the airport in April. The glider is towed on a rope by a small aircraft during takeoff. Rope in the initial length $L=15\,m$ had a heat capacity of $C=1.2\frac{J}{mK}$. The tensile force is given by the equation $F=0.035\,T(\frac{l}{L}-(\frac{L}{l})^2)$. The rope length at the start is $L_s=32\,m$. The ambient temperature is 18^o . After which, when unhooked at altitude $h=2000\,m$ it turned out that the glider had broken down and had to land. Glider's rate of descent $w=0.85\frac{m}{s}$. During the flight, however, it encountered an "air current stack" with an ascending vertical velocity $v=1.2\frac{m}{s}$ and was in it for 6min.

Calculate:

- the temperature of the rope under adiabatic stretching;

- after what time will the glider reach the ground?

Solution:

For an isothermal transformation of a perfect medium, the heat of transformation is equal to work:

$$L=-\int_{l1}^{l2} Fdl=-kT[(\frac{l_2^2}{2l_0}+\frac{l_0^2}{l_2})-(\frac{l_1^2}{2l_0}-\frac{l_0^2}{l_1})]$$

for the adiabatic transformation: $-dU=dL \rightarrow dU=l_0 CdT$, so:

$$-l_0 CdT=-kT[\frac{l}{l_0}-(\frac{l_0}{l})^2] \quad , \quad \int_{T1}^{T2}(\frac{dT}{T})=\frac{k}{C\,l_0}\int_{l1}^{l2}[\frac{l}{l_0}-(\frac{l_0}{l})^2]dl \rightarrow \ln\frac{T_2}{T_1}=\frac{k}{C\,l_0}([\frac{l^2}{2l_0}+(\frac{l_0^2}{l})])_{l_1}^{l_2} \quad ,$$

temperature you're looking for: $T_2=T_1\exp(\frac{k}{C\,l_0}[(\frac{l_2^2}{2l_0}+\frac{l_0^2}{l_2})-(\frac{l_1^2}{2l_0}-\frac{l_0^2}{l_1})])$

flight time: $t_{flight}=\frac{h+dh}{v}$

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"""     Adrian SZKLARSKI, 06.2022r,
        A game of guessing numbers:
A glider takes off from the airport in April. The glider is towed on a rope by a
small aircraft during takeoff. Rope in the initial length had a heat capacity of.
The tensile force is given by the equation . The rope length at the start is.
The ambient temperature is. After which, when unhooked at altitude it turned
out that the glider had broken down and had to land. Glider's rate of descent .
During the flight, however, it encountered an "air current stack" with an
ascending vertical velocity and was in it for 6min.
    Returns:      - the temperature of the rope under adiabatic stretching;
                  - after what time will the glider reach the ground?
    Parameters:   k, L, Ls, C, T, h, w, v, min
    Error:        ValueError or NameError
"""
import math



class glider:

    def __init__(self, k, L, Ls, C, T, h, w, v, min):
        self.k = k
        self.L = L
        self.Ls = Ls
        self.C = C
        self.T = T
        self.h = h
        self.w = w
        self.v = v
        self.min = min

    def line(self):
        T2_1 = (self.k / (self.C * self.L))
        T2_2 = (math.pow(self.Ls, 2) / (2 * self.L)) + (math.pow(self.L, 2) / self.Ls)
        T2_3 = (math.pow(self.L, 2) / (2 * self.L)) + (math.pow(self.L, 2) / self.L)
        self.T2 = (self.T + 273.15) * math.exp(T2_1 * (T2_2 + T2_3))
        return self.T2
```

```python
    def time(self):
        self.t0 = (((self.v * (60 * self.min)) + self.h) / self.w) // 60
        self.t1 = (((self.v * (60 * self.min)) + self.h) / self.w) % 60
        return int(self.t0), round(self.t1)

    def __str__(self):
        return f'{self.T2}, {self.t0}, {self.t1}'

if __name__ == '__main__':
    k = 0.02  # N/K
    L = 15  # m
    Ls = 32  # m
    C = 1.2  # J/mK
    T = 17  # oC
    h = 2000  # m
    w = 0.85  # m/s
    v = 1.2  # m/s
    min = 6  # min
    hear = glider(k, L, Ls, C, T, h, w, v, min)
    print('Line temperature in adiabatic tension: ', round(hear.line(), 2), 'oC\n' \
          'flight time to Earth: ', hear.time()[0], 'min', hear.time()[1], 'sek')
```

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Line temperature in adiabatic tension:  311.42 K
flight time to Earth:  47 min 41 sek
```