Electro-oscillator

Republic of Belarus
Statement of the problem

A mass is hung from the middle of a horizontal wire. When a current is passed through the wire, the mass may start to oscillate. Describe and explain this phenomenon.
Experimental setup

The resistor

The wire

The waveform oscilloscope

The bob

Tianjin 2009
Experimental setup

The bob
The wire
The resistor
The waveform oscilloscope

Electro-oscillator

Tianjin 2009
Oscillations
Experimental setup
Dependence $T$ against $P$

$T$ – the period of oscillations

$P$ – the power of heating

Tianjin 2009
Dependence X against T & Dependence I against T
Dependence R against L
Dependence $R$ against $T^\circ$

$T$ – the temperature
Current-voltage characteristic

Electro-oscillator

Charging

Discharging
Stimulate force

\[ L = L_0 (1 + \alpha \Delta T) \]
Stimulate force

\[ P = \frac{U^2}{R(T)} \]

\[ R(T) = \rho_0 (1 + \beta \Delta T) \frac{L(T)}{S} \]
Stimulate force

\[ F_r = \frac{E(T)S}{L(T)} dL \]

\[ E(T) = E_0 (1 - \gamma \Delta T) \]
Decay factor: \( \beta = 0.021 \) sec\(^{-1} \)
Heat loss

\[ P_l = 2\pi r L(T) \left[ K_1 (T - T_0) + K_2 V (T - T_0) \right] \]

- Doesn’t depend on speed
- Depend on speed
## Computer model

![Computer model interface](image.png)

### Input data:

- **U, V:** 60
- **L0, m:** 2.68
- **r, mm:** 0.1
- **E, J:** 4E11
- **m, kg:** 0.02
- **Temp0, C:** 21
- **X 0, m:** 0.01
- **Speed0, m/s:** 0
- **R0, Om:** 30
- **C:** 420
- **a1:** 0.2
- **K1:** 20
- **K2:** 100
- **dt:** 0.005
- **a2:** 0.02
- **A:** 0.1
- **b:** 0.02
- **aE:** 0.02

### Table:

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<th>X, m</th>
<th>Temp., celsius</th>
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Natural oscillations (model)
Natural oscillations (comparison)
Oscillations (model)

taking into account: $L(\Delta T)$
Oscillations (model) $+ L(\Delta T)$ and $E(\Delta T)$

taking into account: $L(\Delta T)$ and $E(\Delta T)$
Oscillations (model)

Taking into account: $L(\Delta T)$ and $E(\Delta T)$

Electro-oscillator

Initial shrinkage

Establishment regime

Steady-state vibration

Time, sec
Resonance

• Max oscillations if:

\[ \nu_{\text{natural}} = k \nu_{\text{forced}} \]

\[ k \in \mathbb{N} \]
Dependence Amplitude against m

A, mm

Electro-oscillator
The oscillations are observed.

- **T** – the period of oscillations
- **P** – the power of heating
Total

- We detected main dependences for oscillations: $L(\Delta T)$, $\rho(\Delta T)$, $E(\Delta T)$;
- We should be take into account what all dependences are important for electro-oscillations.
Results

• Max oscillations was condition of resonance;
• All dependences are important for oscillation;
• We made the computer model for oscillations.
THANKS FOR ATTENTION
References

• Savljev “General physics course”;
• A. I. Slobodianuk “Mehanics”;
• R. P. Feynman “The Feynman Lectures on Physics”.