Experiment: Determination of Mechanical Equivalent of Heat

Purpose

To determine the equivalent of heat J.

Theory

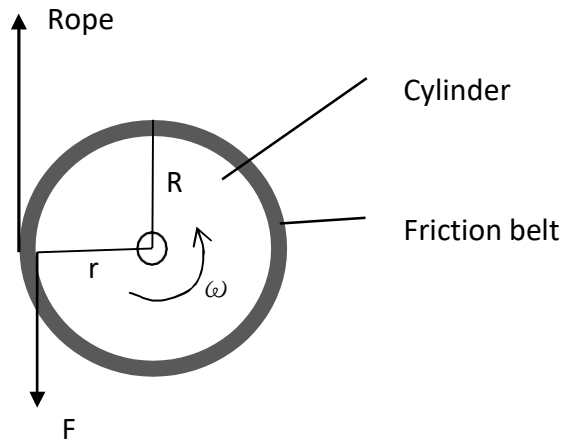
From physics we know that the heat generated by a frictional force is proportional to the work of the friction. The energy conservation law shows that the relationship between the work W and heat ΔH:

$$W = J\Delta H$$

Joule constant is the ratio between heat and work.

W: Joule

H: Cal



In this experiment, use the aluminum cylinder as the thermodynamic system. Fix one end to the motor shaft, as shown in Figure 1. Use the motor to make the cylinder rotate at the angular velocity ω. The tension produced by the rope and makes the friction belt fixed. We obtain the tension T, and can express the equation as below:

$$W = F \cdot S = f_k \cdot N \cdot 2 \quad r$$

S: cylinder rotating cumulative distance

r: the radius of the aluminum cylinder

N: the cylinder rotating cumulative rounds

The system temperature increases ΔT and the relationship as follows

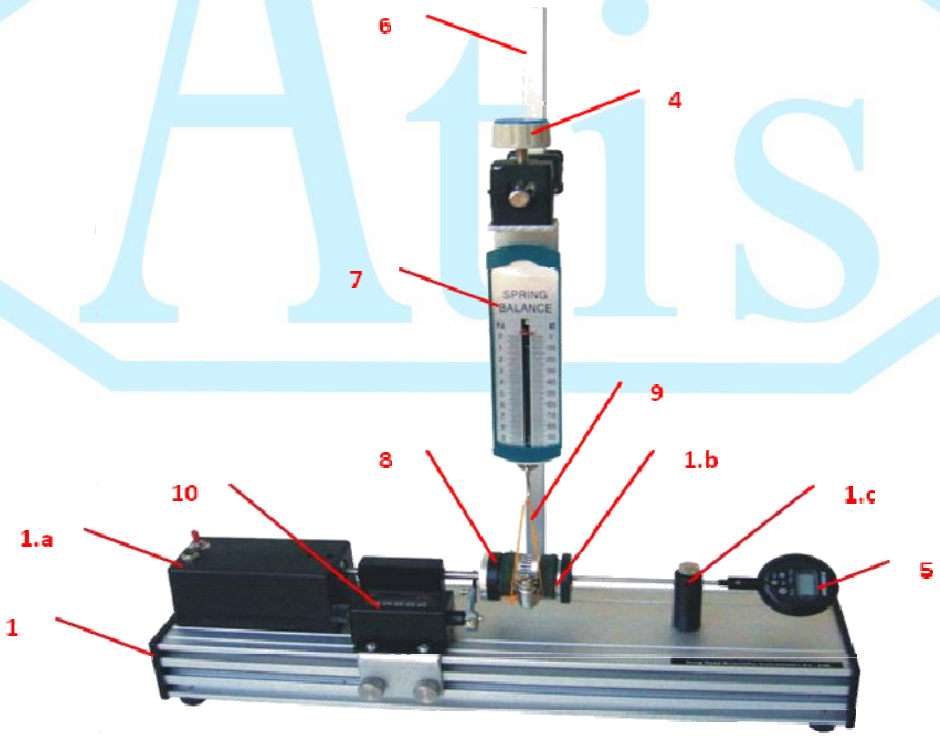
$$\Delta H = m \cdot s \cdot \Delta T$$

m: cylinder mass

s: cylinder specific heat (aluminum specific heat at room temperature 25 ° C: 0.215001cal/g.deg).

Instrument

NO	Accessory	Quantity
1	Equivalent of Heat Experimental Device A. double groove extrusion aluminum base 400×100x50mm B. heating part: aluminum alloy ϕ31mm, with thermometer jack, both ends of the insulation gasket C. turning part: DC motor speed 0 to 300RPM, attached with a tachometer, a power socket and a switch D. fixed clip: vertical and horizontal dual-use E. support rod 13x13x400mm	1
2	Spring Balance 10N/0.1N	1
3	Electronic Thermometer :10° to 200 °	1
4	DC Power Supply: DC9V/1A	1



Procedure

1. The experimental setup is shown as Figure 1. Fix the friction belt on the cylinder and connect to the motor shaft.

2. Connect the removable connector to the support rod, then hang the hook and spring balance hook up. Tie up the strings, set the length approximately between the S-shaped ring and the hook holes of the friction belt, and set the string on the tangent of the center horizontal line of the cylinder.

3. Connect the motor power, and put some appropriate thermal conductivity paste on the tested end of the thermometer. Insert it into the cylinder and return the stopwatch to zero.

4. Measure the room temperature of the cylinder before the experiment. First cool it down about 5 ° C, and then wait for the temperature of the cylinder to heat up about 2 to 3 ℃ below the original room temperature. Next, adjust the string to be parallel to the contact surface, and then you can turn the motor power on.

5. When the rotation number reaches about 30 to 50 times, read the spring balance on the average reading (g) values, and calculate the average tension value (kgw).

(the product of g value of the spring balance and the gravity value is the value of tension)

6. For every 0.5 ℃ or 1 ℃ rise in temperature, record the terminal temperature and the cumulative number of turns. With every 2 ℃ to 3 ℃ rise in temperature, turn the motor off.

7. Calculate the j value of the mechanical equivalent of heat and the error value.

8. Draw the diagram of the work and thermal energy (W-ΔH) and analyze the J values of slope.

Note: The range of the cumulative number should be approximately 200 to 700 turns.

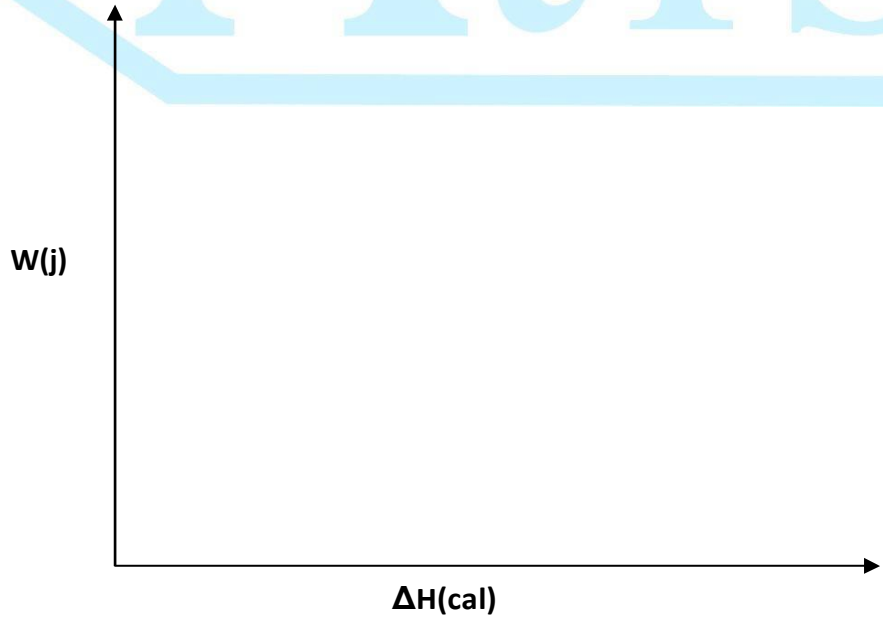
Experimental Record

Mechanical equivalent of heat experimental record form

Room temperature___26.5____℃
Gravity value___9.8_____
Cylinder radius___0.01___m
Cylinder quality___26.18___g
Specific heat___0.217___of the cylinder

Trial	Kgw	N	W	t_i (℃)	t_f (℃)	ΔH	J	Error%
1	0.363	247	55.209	24.7	27.1	13.635	4.049	-3.27
2	0.363	338	75.549	24.7	28.0	18.747	4.030	-3.73
3	0.363	440	98.348	24.7	29.0	24.429	4.026	-3.82
4	0.363	550	122.935	24.7	30.0	30.110	4.083	-2.46
5	0.363	696	155.569	24.7	31.1	36.359	4.279	2.20

Mechanical equivalent of heat experimental record form (1)								
Room temperature_____℃ Gravity value _____ Cylinder radius_____m Cylinder quality_____g Specific heat_____of the cylinder								
Trial	Kgw	N	W	t_i (℃)	t_f (℃)	ΔH	J	Error%
1								
2								
3								
4								
5								



Questions and Discussions

1. Compare the experimental and theoretical values the main factors causing the errors/.

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