

This program solves problems involving heat transfer between components of an isolated system. It handles phase changes as well as processes involving temperature changes.

Either numerical or symbolic solutions can be found.

Copyto_h() is used in the main program. Place calrmtry() and copyto_h() in the same folder, then run calrmtry().

Example 1: An aluminum calorimeter with a mass of 100 g contains 250 g of water, all in equilibrium at 10° C. A 50 g piece of copper at 80° C and a second 70 g piece of metal at 100° C are added to the system. The entire system stabilizes at a final temperature of 20° C. Determine the specific heat of the second metal.

Run calrmtry()

1: Numerical solution
2: Symbolic solution

CALORIMETRY
Enter # of substances which undergo either a temperature change or a phase change
N: 4
Enter=OK ESC=CANCEL

Substance #1
Mass: 1
Init. Temp.: 10
Final Temp.: 20
Any phase changes?
1 = YES, 0 = NO: 0
Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #2
Mass: 25
Init. Temp.: 10
Final Temp.: 20
Any phase changes?
1 = YES, 0 = NO: 0
Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #3
Mass: 05
Init. Temp.: 80
Final Temp.: 20
Any phase changes?
1 = YES, 0 = NO: 0
Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #4
Mass: 07
Init. Temp.: 100
Final Temp.: 20
Any phase changes?
1 = YES, 0 = NO: 0
Enter=OK ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Enter any needed values
Specific Heat of
Solid: 900
Liquid: c1
Vapor: cv1
Enter=OK ESC=CANCEL

MAIN DEGAUTO FUNC 30/30

Substance #1 begins as a
1: Solid
2: Liquid
3: Vapor

MAIN DEGAUTO FUNC 30/30

Substance #2 begins as a
1: Solid
2: Liquid
3: Vapor

TYPE OR USE ←+1+ [ENTER] OR [ESC]

Substance #3 begins as a
1: Solid
2: Liquid
3: Vapor

TYPE OR USE ←+1+ [ENTER] OR [ESC]

Substance #4 begins as a
1: Solid
2: Liquid
3: Vapor

TYPE OR USE ←+1+ [ENTER] OR [ESC]

20408. - 11.2 · cs4 = 0
cs4 = 1822.14

MAIN DEGAUTO FUNC 30/30

Example 2.

What mass of steam initially at 130° C is needed to warm 200 g of water in a 100 g glass container from 20° C to 50° C? Assume the system is isolated.

Run calrmty()

1: Numerical solution
2: Symbolic solution

TYPE OR USE \leftarrow + \rightarrow + \rightarrow + \rightarrow [ENTER] OR [ESC]

CALORIMETRY

Enter # of substances which under30 either a temperature change or a phase change

N=: 3

<Enter=OK >ESC=CANCEL

MAIN DEGAUTO FUNC 30/30

Substance #1 begins as a

1: Solid
2: Liquid
3: Vapor

MAIN DEGAUTO FUNC 30/30

Substance #1

Mass=: m1

Init. Temp.=: 130

Final Temp.=: 50

Any phase changes?
1 = YES, 0 = NO: 1

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #1

1 for YES, 0 for NO

Changes from

Solid to Liquid: 0

Liquid to Solid: 0

Freezing Point=: 0

Lat. Heat of Fusion=: 100

<Enter=OK >ESC=CANCEL

MAIN DEGAUTO FUNC 0/30

Substance #1

0 for YES, 1 for NO

Changes from

Liquid to Vapor: 0

Vapor to Liquid: 1

Boiling Point=: 100

Lat. Heat of Vapor.=: 2000

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Enter any needed values

Specific Heat of

Solid=: c1

Liquid=: 4186

Vapor=: 2010

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #2 begins as a

1: Solid
2: Liquid
3: Vapor

MAIN DEGAUTO FUNC 0/30

Substance #2

Mass=: 2

Init. Temp.=: 20

Final Temp.=: 50

Any phase changes?
1 = YES, 0 = NO: 0

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Enter any needed values

Specific Heat of

Solid=: c2

Liquid=: 4186

Vapor=: c2

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #3 begins as a

1: Solid
2: Liquid
3: Vapor

TYPE OR USE \leftarrow + \rightarrow + \rightarrow + \rightarrow [ENTER] OR [ESC]

Substance #3

Mass=: 1

Init. Temp.=: 20

Final Temp.=: 50

Any phase changes?
1 = YES, 0 = NO: 0

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Enter any needed values

Specific Heat of

Solid=: 837

Liquid=: c1

Vapor=: c2

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

27627. - 2.5296e6 * m1 = 0

$$m1 = .010921$$

MAIN DEGAUTO FUNC 12/30

Same example, but symbolic solution.

1: Numerical solution
2: Symbolic solution

MAIN DEGAUTO FUNC 0/30

CALORIMETRY

Enter # of substances which under30 either a temperature change or a phase change

N=: 3

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

Substance #1 begins as a

1: Solid
2: Liquid
3: Vapor

MAIN DEGAUTO FUNC 0/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #1

Mass: $m1$

Init. Temp.: $to1$

Final Temp.: t

Any phase changes?
1 = YES, 0 = NO: 1

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #1

SU 1 for YES, 0 for NO

Changes from:

Solid to Liquid: 0

Liquid to Solid: 0

Freezing Point: $tf1$

Lat. Heat of Fusion: $lf1$

<Enter=OK >ESC=CANCEL

MAIN DEGAUTO FUNC 0/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #1

SU 0 for YES, 1 for NO

Changes from:

Liquid to Vapor: 0

Vapor to Liquid: 1

Boiling Point: $tb1$

Lat. Heat of Vapor: $lv1$

<Enter=OK >ESC=CANCEL

MAIN DEGAUTO FUNC 1/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Enter any needed values

Specific Heat of:

Solid: $cs1$

Liquid: $cl1$

Vapor: $cv1$

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #2 begins as a

1:Solid

2:Liquid

3:Vapor

MAIN DEGAUTO FUNC 0/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #2

Mass: $m2$

Init. Temp.: to

Final Temp.: t

Any phase changes?
1 = YES, 0 = NO: 0

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Enter any needed values

Specific Heat of:

Solid: $cs2$

Liquid: $cl2$

Vapor: $cv2$

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #3 begins as a

1:Solid

2:Liquid

3:Vapor

TYPE OR USE \leftrightarrow +1 + [ENTER] OR [ESC]

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Substance #3

Mass: $m3$

Init. Temp.: to

Final Temp.: t

Any phase changes?
1 = YES, 0 = NO: 0

<Enter=OK >ESC=CANCEL

TYPE + [ENTER]=OK AND [ESC]=CANCEL

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

Enter any needed values

Specific Heat of:

Solid: $cs3$

Liquid: $cl3$

Vapor: $cv3$

<Enter=OK >ESC=CANCEL

MAIN DEGAUTO FUNC 0/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

$(cl1 \cdot m1 + cl2 \cdot m2 + cs3 \cdot m3) \cdot t \blacktriangleright$

Variable to solve for=
 $m1$

MAIN DEGAUTO FUNC 0/30

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

$(cl1 \cdot m1 + cl2 \cdot m2 + cs3 \cdot m3) \cdot t \blacktriangleright$

Variable to solve for=
 $m1$

$(cl1 \cdot m1 + cl2 \cdot m2 + cs3 \cdot m3) \cdot t \blacktriangleright$

MAIN DEGAUTO FUNC 12/144

When doing a symbolic solution, for some reason I don't understand, sometimes it actually solves for the variable and sometimes, as in this case, just rewrites the equation. If it doesn't solve, just Quit, and at the home screen, enter solve(xx=0,m1) (or whichever variable you want to solve for).

F1	F2	F3	F4	F5	F6
Tools	Algebra	Calc	Other	Pr3mID	Clean Up

$(cl1 \cdot m1 + cl2 \cdot m2 + cs3 \cdot m3) \cdot t \blacktriangleright$

■ main\calrmtry() Done

■ solve(xx = 0, m1)

$m1 = \frac{-(cl2 \cdot m2 + cs3 \cdot r}{cl1 \cdot t - cl1 \cdot tb1 + cv1}$

solve(xx=0,m1)

MAIN DEGAUTO FUNC 3/30