شركة تدريب هندسي

E.CAMP

PHYSICS 1

Final - Revision 2

2021 - 2022 No.19

الطريق الدائري بجوار المدرسة المعمارية

01064763583

The First Law of Thermodynamics

Quiz No.

Student Name: Group No.:

Please Choose the Correct Answer

1. Heat is: أستخدآ

A) energy transferred by virtue of a temperature difference B) energy transferred by macroscopic work C) energy content of an object D) a temperature difference E) a property objects have by virtue of their temperatures

2. Heat has the same units as:

A) temperature B) work C) energy/time D) heat capacity

E) energy/volume

3. A calorie is about:

A) 0.24J B) 8.3J C) 250J D) 4.2J E) 4200J

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4. In an isothermal process

A) P is constant. B) V is constant. C) $\frac{P}{T}$ is constant. D) PV is constant.

E) $\frac{V}{n}$ is constant.

CH.7

5. The specific heat of an ideal gas at constant pressure is greater than the specific heat of an ideal gas at constant volume because

A) work is done by a gas at constant pressure. B) work is done by a gas at constant volume. C) no work is done by a gas at constant pressure.

D) the temperature remains constant for a gas at constant pressure. E) the temperature remains constant for a gas at constant.

6. We are able to define a mechanical equivalent for heat because

A) some thermal energy can be converted into mechanical energy. B) mechanical energy can be converted into thermal energy. C) work can be converted into thermal energy. D) some thermal energy can be converted into work.

E) all of the above can occur.

7. Determine the heat capacity (in calories/°C) of a lake containing one million gallons (approximately 4 million kilograms) of water at 15°C. $c = 1\ cal/g$, $m = 4 \times 10^6 \times 10^3\ g$

A) 4×10^6 B) 4×10^9 C) 4×10^3 D) 1×10^3 E) 4×10^2 $C = mc$

2. How many calories of heat are required to raise the temperature of 4 kg of water from 50°F تتحول → °C to the boiling point?

A) 6.5×10^5 B) 3.6×10^5 C) 15×10^5 D) 360 E) 4×10^4 $Q = mc\Delta T$

8) How much heat (in kilocalories) is needed to convert 1.00 kg of ice at 0°C into steam at 100°C?

A) 23.9 B) 79.6 C) 564 D) 643 E) 720

9. If 25 kg of ice at 0°C is combined with 4 kg of steam at 100°C, what will be the final equilibrium temperature (in °C) of the system?

A) 40 B) 20 C) 60 D) 100 E) 8

10. When a gas undergoes an isothermal process, there is
A) no change in the pressure of the gas.
B) no change in the temperature of the gas.
C) no change in the volume of the gas.
D) no work done by (or on) the gas.
E) no heat added to the gas.

11. An ideal gas is compressed in a well-insulated chamber using a well-insulated piston. This process is
A) isochoric. B) isothermal. C) adiabatic. D) isobaric.

12. An 8 000-kg aluminum flagpole 100-m long is heated by the sun from a temperature of 10°C to 20°C. Find the heat transferred (in J) to the aluminum if the specific heat of aluminum is 0.215 cal/g °C.

A) 7.2×10^5 B) 7.2×10^7 C) 7.2×10^3 D) 7.2×10^1 E) 7.2×10^2

13. Two kilograms of water at 100°C is converted to steam at 1 atm. Find the change in internal energy (in J). ($L_v = 2.26 \times 10^6$ J/kg.) $\Delta E_{int} = mL_v = 2 \times 2.26 \times 10^6$

A) 2.1×10^4 B) 4.5×10^6 C) 3.4×10^5 D) 4.2×10^6 E) 2.1×10^6

14. If an object feels cold to the touch, the only statement that you can make that must be correct is that
A) the object has a smaller coefficient of thermal conductivity than your hand.
B) the volume of the object will increase while it is in contact with your hand.
C) the object contains less thermal energy than your hand.
D) the object is at a lower temperature than your hand.
E) the object cannot be a liquid.

Chapter 6:The First Law of Thermodynamics

15. Which of the following statements is correct?

A) You only need to know the amount of thermal energy a body contains to calculate its temperature.
B) The temperature of a body is directly proportional to the amount of work the body has performed.
C) The quantity of thermal energy exchanged by two bodies in contact is inversely proportional to the difference in their temperatures.
D) The quantity of thermal energy exchanged by two bodies in contact is directly proportional to the difference in their temperatures.
E) Different amounts of thermal energy are transferred between two bodies in contact if different temperature scales are used to measure the temperature difference between the bodies.

16. In which process will the internal energy of the system *NOT* change?

A) An adiabatic expansion of an ideal gas.
B) An isothermal compression of an ideal gas.
C) An isobaric expansion of an ideal gas.
D) The freezing of a quantity of liquid at its melting point.
E) The evaporation of a quantity of a liquid at its boiling point.

17 How much heat, in joules, is required to convert 1.00 kg of ice at 0°C into steam at 100°C? ($L_{ice} = 333\ J/g$; $L_{steam} = 2.26 \times 10^3\ J/g$.)

A) 3.35×10^5 B) 4.19×10^5 C) 2.36×10^6 D) 2.69×10^6
E) 3.01×10^6

"QUIZ"

7 $C = ??\ cal/^{\circ}C$ $c_w = 1\ cal/g\cdot{}^{\circ}C$

$m = 4\times10^{6}\ kg$ $= 10^{3}\ cal/kg\cdot{}^{\circ}C$

~answer~

$$C = mc = (4\times10^{6})\times10^{3}$$

$$= \boxed{4\times10^{9}\ cal/^{\circ}C}$$

---

8 $Q = ??$ KiLocaLories $m = 1\ kg$

ice $0^{\circ}C \longrightarrow$ steam $100^{\circ}C$

$L_F = 80\ cal/g$ $L_v = 540\ cal/g$

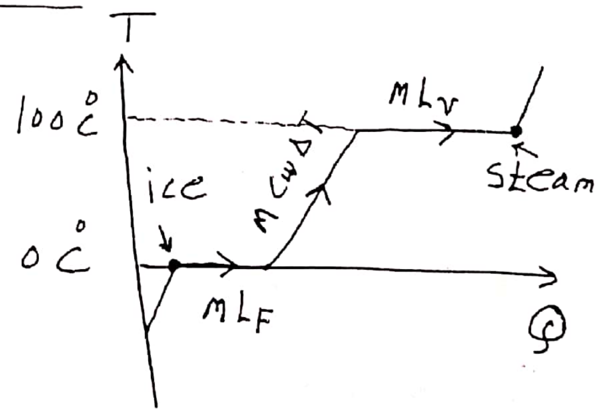
~answer~

$$Q = mL_F + mc_w\Delta T + mL_v$$

$$= 10^{3}[80 + 1*100 + 540]$$

$$= 720\times10^{3}\ cal$$

$$= 720\ Cal$$



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8 $Q = ??\ Cal$ $m = 4\ Kg$

$C_w = 1\ Cal/g.°C$ $T_1 = 50\ °F$

$T_2 = 100\ °C$

"answer"

$\because T_F = \frac{9}{5} T_c + 32$

$50 = \frac{9}{5} T_c + 32$

$\therefore T_c = \frac{5}{9}(50-32) = 10\ °C$

$\therefore \Delta T = 100 - 10 = 90\ °C$

$Q = mC\Delta T = 4 \times 10^3 \times 1 \times 90$

$= \boxed{3.6 \times 10^5\ Cal}$

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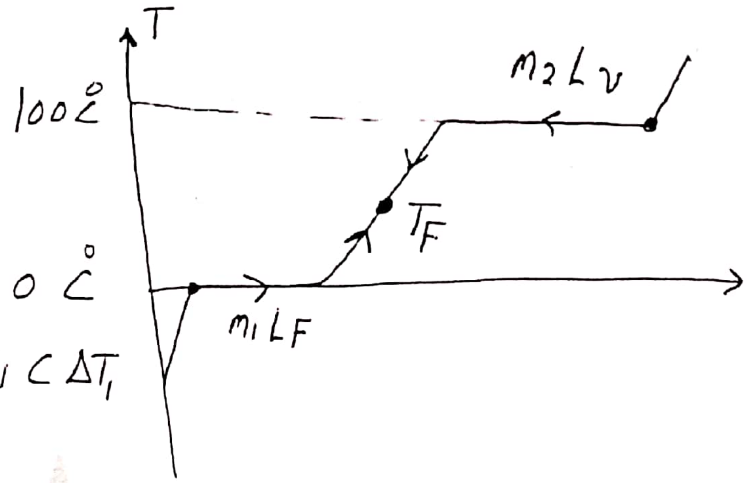
9 $m_1 = 25\ Kg$, ice $0\ °C$

$m_2 = 4\ Kg$, steam $100\ °C$

$T_F = ??$ $L_F = 80\ Cal/g$

$L_V = 540\ Cal/g$

$$Q|_{Lost} = -Q|_{gained}$$



$$m_2 L_v + m_2 C \Delta T_2 = m_1 L_F + m_1 C \Delta T_1$$

$$4\times10^3 \times 540 + 4\times10^3 \times 1 * (100 - T_F) = 25\times10^3 \times 80 + 25\times10^3 \times 1 \times (T_F - 0)$$

$$\boxed{\therefore T_F = 19.31\ C° \simeq 20\ C°}$$

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[12] $m = 8000\ kg$ $\quad l = 100\ m$

$\Delta T = 20 - 10 = 10\ C°$ $\quad Q = ??\ J$

$C = 0.215\ Cal/g.C° = 0.215\times4.186\ J/g.C°$

answer

$$Q = mC\Delta T = 8000\times10^3 \times 0.215\times4.186\times10$$

$$= 7.1992\times10^7 \simeq \boxed{7.2\times10^7\ J}$$

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[13] $m = 2\ kg$ $\quad C_w = 4186\ J/kg.C°$ $\quad T = 100\ C°$

$L_v = 2.26\times10^6\ J/kg$

$$Q = mL_v = 2 \times 2.26 \times 10^6$$
$$= 4.52 \times 10^6 \text{ J}$$

---

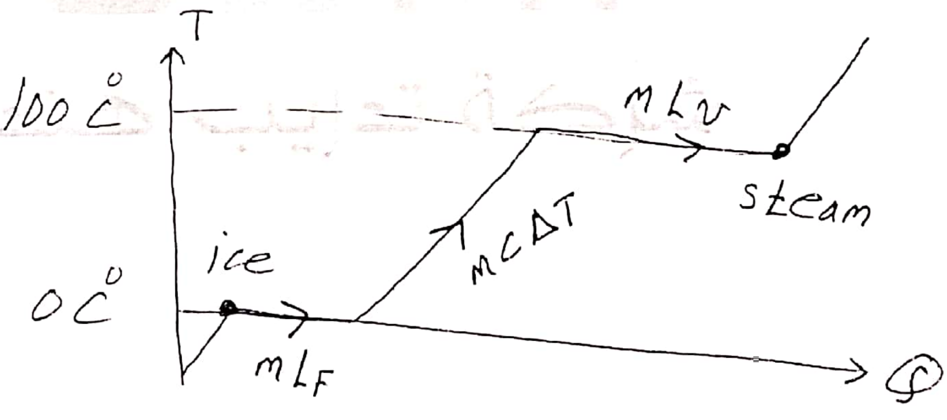
17 $Q = ??$ J $m = 1$ kg

ice $0°C \Longrightarrow$ steam $100°C$

$L_{ice} = 333$ J/g $L_{steam} = 2.26 \times 10^3$ J/g

"answer"

$C_w = 4.186$ J/g.°C



$$Q = mL_F + mC_w\Delta T + mL_v$$
$$= 10^3 [333 + (4.186 \times 100) + 2.26 \times 10^3]$$
$$= 3.0116 \times 10^6 = \boxed{3.01 \times 10^6 \text{ J}}$$

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1. A 75.0 g piece of lead (specific heat = 0.130 J/g°C), initially at 435°C, is set into 125.0 g of water, initially at 23.0°C. What is the final temperature of the mixture?

$q = m \times C \times \Delta T$ for both cases, although specific values differ

Plug in known information for each side

$$q_{water} = -q_{Pb}$$

$$m_{water}\, C_{water}\, \Delta T_{water} = -m_{Pb}\, C_{Pb}\, \Delta T_{Pb}$$

$$125\,(4.18)\,(T_f - 23) = -75\,(0.13)\,(T_f - 435)$$

$$522.5\, T_f - \cancel{12017.5} = -9.75\, \cancel{T_f} + 4241.25$$

$$+9.75\, T_f \quad \cancel{+12017.5} \qquad \cancel{+9.75\, T_f} \quad +12017.5$$

$$532.25\, T_f = 16258.75$$

$$\boxed{T_f = 30.5°C}$$

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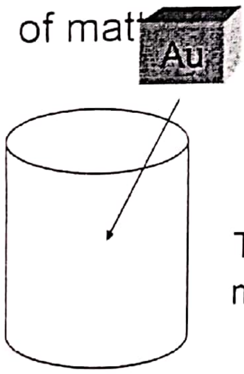
2. A 97.0 g sample of gold at 785°C is dropped into 323 g of water, which has an initial temperature of 15.0°C. If gold has a specific heat of 0.129 J/g°C, what is the final temperature of the mixture? Assume that the gold experiences no change in state of mat



T = 785°C
mass = 97.0 g

T = 15.0 °C
mass = 323 g

$$-\text{LOSE heat} = \text{GAIN heat}$$

$$-[(C\ Au)\,(\text{mass})\,(\Delta T)] = (C\ H_2O)\,(\text{mass})\,(\Delta T)$$

$$-[(0.129\ J/g°C)\,(97\ g)\,(T_f - 785°C)] = (4.184\ J/g°C)\,(323\ g)\,(T_f - 15°C)]$$

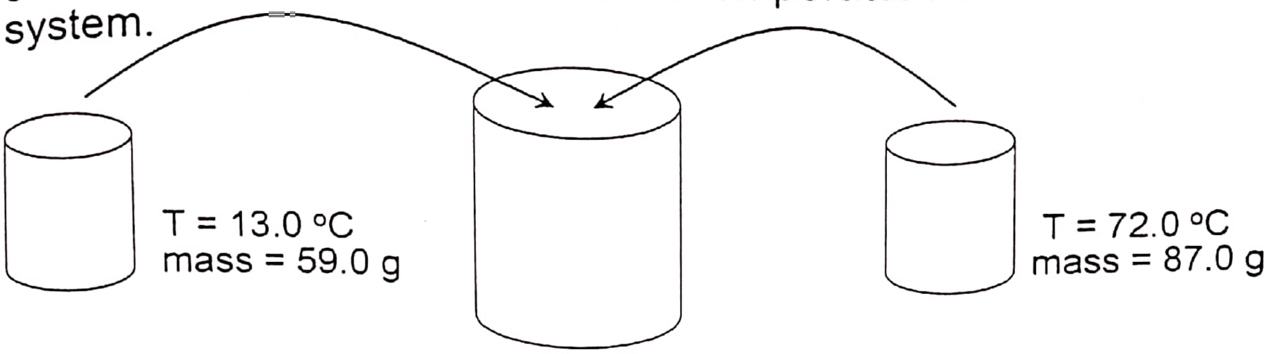
$$-[(12.5)\,(T_f - 785°C)] = (1.35 \times 10^3)\,(T_f - 15°C)]$$

$$-12.5\, T_f + 9.82 \times 10^3 = 1.35 \times 10^3\, T_f - 2.02 \times 10^4$$

$$3 \times 10^4 = 1.36 \times 10^3\, T_f$$

$$T_f = 22.1°C$$

HW #2. If 59.0 g of water at 13.0 °C are mixed with 87.0 g of water at 72.0 °C, find the final temperature of the system.



$$- \text{LOSE heat} = \text{GAIN heat}$$

$$-[(\text{mass})(C\ H_2O)(\Delta T)] = (\text{mass})(C\ H_2O)(\Delta T)$$

$$-[(59\text{ g})(4.184\text{ J/g°C})(T_f - 13°C)] = (87\text{ g})(4.184\text{ J/g°C})(T_f - 72°C)]$$

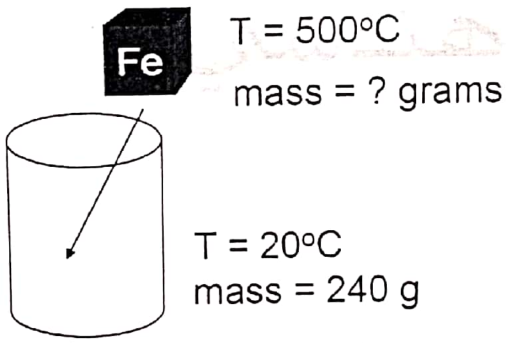
$$-[(246.8)(T_f - 13°C)] = (364.0)(T_f - 72°C)]$$

$$-246.8\ T_f + 3208 = 364\ T_f - 26208$$

$$29416 = 610.8\ T_f$$

$$T_f = 48.2°C$$

HW #4. 240. g of water (initially at 20.0°C) are mixed with an unknown mass of iron initially at 500.0°C (C_{Fe} = 0.4495 J/g°C). When thermal equilibrium is reached, the mixture has a temperature of 42.0°C. Find the mass of the iron.



$$- \text{LOSE heat} = \text{GAIN heat}$$

$$-q_1 = q_2$$

$$-[(\text{mass})(C_{Fe})(\Delta T)] = (\text{mass})(C_{H2O})(\Delta T)$$

$$-[(X\text{ g})(0.4495\text{ J/g°C})(42°C - 500°C)] = (240\text{ g})(4.184\text{ J/g°C})(42°C - 20°C)]$$

$$-[(X)(0.4495)(-458)] = (240\text{ g})(4.184)(22)$$

$$205.9\ X = 22091$$

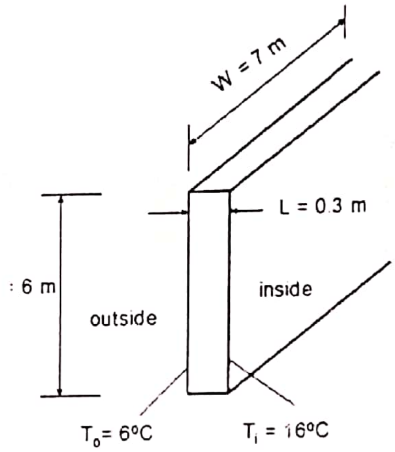
$$X = 107\text{ g Fe}$$

The wall of a house, 7 m wide and 6 m high is made from 0.3 m thick brick with $k = 0.6\ W/mK$. The surface temperature on the inside of the wall is 16°C and that on the outside is 6°C. Find the heat flux through the wall and the total heat loss through it.

heat flux

$$q = \frac{Power}{Area}$$

Solution:



For one-dimensional steady state conduction:

$$q = -k\frac{dT}{dx} = -\frac{k}{L}(T_i - T_o)$$

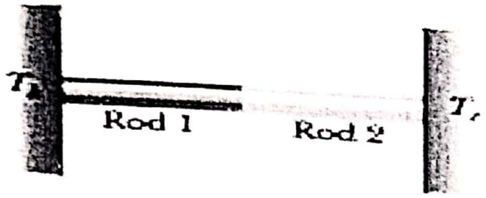
$$q = -\frac{0.6}{0.3}(16-6) = -20\ W/m^2$$

Power $\cancel{Q} = qA = -20 \times (6 \times 7) = -840\ W$

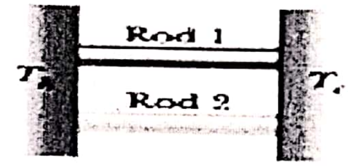
The minus sign indicates heat flux from inside to outside.

Example. Two rods from different materials with ***the same length*** and ***diameter*** are connecting two regions of different temperatures. In which case is the ***rate of energy transfer by heat larger?***

Series



Parallel



Answer (qualitative explanation):

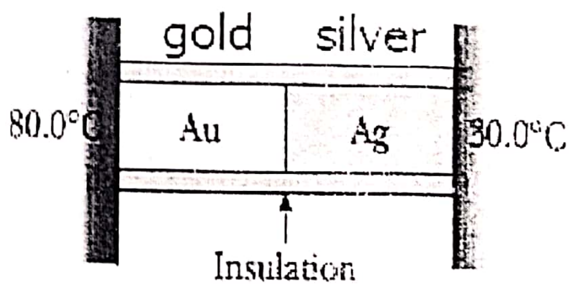
In parallel. The rods arranged in parallel present a ***larger area A*** (more contact) and a ***smaller length L*** (shorter distance) through which the energy can transfer.

Example. A bar of gold is in thermal contact with a bar of silver of the same length and area. One end of the compound bar is maintained at 80.0°C while the opposite end is at 30.0°C. When the energy transfer reaches steady state, what is the temperature at the junction?

Answer:

In the steady state condition, $P_{Au} = P_{Ag}$

$$k_{Au}\cancel{A_{Au}}\left(\frac{\Delta T}{\Delta x}\right)_{Au} = k_{Ag}\cancel{A_{Ag}}\left(\frac{\Delta T}{\Delta x}\right)_{Ag}$$



In this case (lengths and areas)

$\Delta x_{Au} = \Delta x_{Ag}$ $\qquad A_{Au} = A_{Ag}$

$\Delta T_{Au} = (80.0 - T)$

$\Delta T_{Ag} = (T - 30.0)$ where T is the temperature of the junction.

$$k_{Au}(80.0 - T) = k_{Ag}(T - 30.0)$$

314 W/m°C $\qquad \boxed{T = 51.2°C} \qquad$ 427 W/m°C

A 23.6 g ice cube at −31.0°C is dropped into 98.2 g of water at 84.7°C. Find the equilibrium temperature.

Key: Assume that the ice melts and the final product is a liquid.

$$q_{ice} = -q_{water}$$

$$q_{water} = -98.2\ (4.18)\ (T_f - 84.7) = -410.48\ T_f + 34767.32$$

$$q_{ice} = 23.6\ (2.077)\ (0 - -31) + 23.6\ (333) + 23.6\ (4.18)\ (T_f - 0)$$

$$= 1519.53 + 7858.8 + 98.65\ T_f$$

$$= 9378.33 + 98.65\ T_f$$

$$509.13\ T_f = 25388.99$$

$$\boxed{T_f = 49.9°C}$$

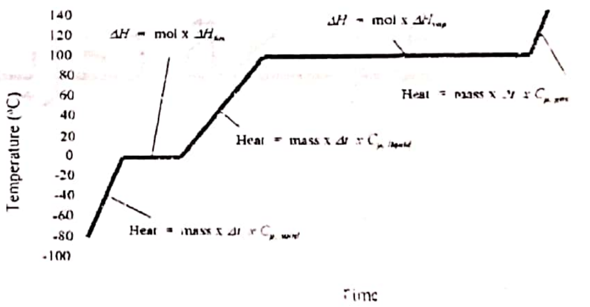
$L_f = 333$

$C_w = 4.18$

$C_{ice} = 2.077$

Heating Curve Challenge Problems

1. A sample of ice at -25°C is placed into 75 g of water initally at 85°C. If the final temperature of the mixture is 15°C, what was the mass of the ice? « 52.8 g ice »



2. A 38 g sample of ice at -5°C is placed into 250 g of water at 65°C. Find the final temperature of the mixture assuming that the ice sample completely melts.

« 45.6 °C »

3. A 35 g sample of steam at 116°C are bubbled into 300 g water at 10°C. Find the final temperature of the system, assuming that the steam condenses into liquid water.

« 76.6 °C »

$\boxed{1}$ $T_{ice} = -25^\circ C$ $\qquad M_{ice} = ??$

$T_w = 85^\circ C$ $\qquad M_w = 75\,g$ $\qquad T_F = 15^\circ C$

answer:

$C_w = 1\,cal/g\cdot{}^\circ C$

$C_{ice} = 0.5\,cal/g\cdot{}^\circ C$

$L_F = 80\,cal/g$

$$Q|_{lost} = -Q|_{gain}$$

$$m_w C_w \Delta T_w = M_{ice} C_{ice} \Delta T_{ice} + M_{ice} L_F + M_{ice} C_w \Delta T_w$$

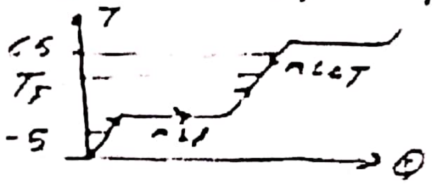
$$(75)(1)(85-15) = M_{ice}\left[(0.5)(25) + 80 + (1)(15)\right]$$

$$\therefore M_{ice} = \frac{(75)(85-15)}{(0.5)(25)+80+15} \approx \boxed{49\ g}$$

$\boxed{2}$ $M_{ice} = 38\,g$ $\qquad T_{ice} = -5^\circ C$

$m_w = 250\,g$ $\qquad C_w = 65^\circ C$ $\qquad T_F = ??$

answer:



$$m_w C_w \Delta T_w = M_{ice} C_{ice} \Delta T_{ice} + M_{ice} L_F + M_{ice} C_w \Delta T$$

$$(250)(1)(65 - T_F) = 38\left[(0.5)(5) + 80 + (1)(T_F - 0)\right]$$

$$(250)(65) - 250\,T_F = 38[(0.5)(5) + 80] + 38\,T_F$$

$$\therefore T_F = \frac{(250)(65) - 38[(0.5)(5) + 80]}{38 + 250} = \boxed{45.6^\circ C}$$ ✓

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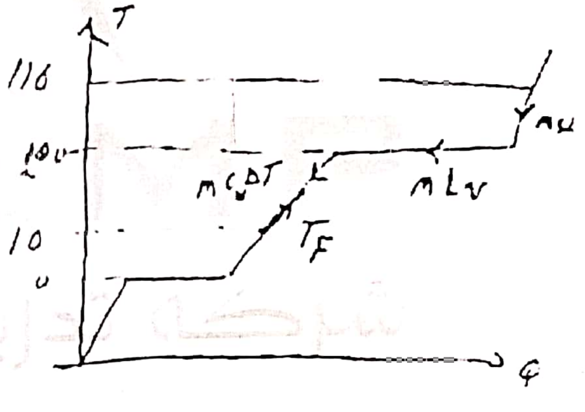
3 $M_{stem} = 35\,g$ $\quad T_s = 116^\circ C$

$M_w = 300\,g$ $\quad T_w = 10^\circ C$ $\quad T_F = ??$

$C_{stem} = 2.042\ J/g.^\circ C$ $\quad C_w = 4.184$

$L_v = 2256\ J/g$

~ answer



$$Q|_{lost} = -Q|_{gain}$$

$$M_{stem} C_{stem} \Delta T_{stem} + M_{stem} L_v + M_{stem} C_w \Delta T = M_w C_w \Delta T_w$$

$$(35)(2.042)(116-100) + (35)(2256) + (35)(4.184)(100 - T_F) = 300(T_F - 10) \Rightarrow \boxed{T_F = 76.5^\circ C}$$ ✓

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Example 5: How many grams of ice at 0°C must be mixed with four grams of steam in order to produce water at 60°C?

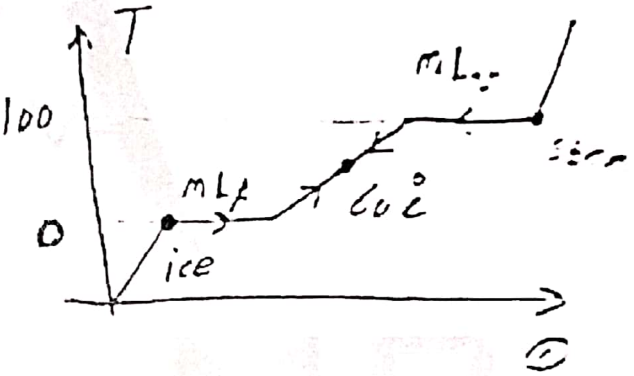
answer

*: ice at 0 °C

*: steam at (100 °C) لم يتكثف

$m_{ice} = ??$

$m_s = 4\ g$



$$\underset{lost}{Q|} = -\underset{gained}{Q|}$$

$$m_s L_v + m_s C_w \Delta T = m_{ice} L_f + m_{ice} C_w \Delta T$$

$$(4 \times 540) + 4 \times 1 \times (100 - 60) = m_{ice} [80 + 1 (60 - 0)]$$

$$\therefore m_{ice} = \frac{(5 \times 540) + 4 (100 - 60)}{80 + 60}$$

$$= \boxed{16.6\ g}$$

EX: A 1.0 mol of an ideal gas is kept at 0°C during an expansion from 3L to 10L.

(a) Find the work done on the gas.

(b) How much energy transfer.

~answer~

$T = 0°C = 273K$ "Isothermal"

(a) $W = nRT \ln\left(\frac{V_i}{V_f}\right)$

$= 1 \times (8.31) \times (273) \ln\left(\frac{3L}{10L}\right) = \boxed{-2.7 \times 10^{3}\ J}$

(b) $\Delta E_{int} = Q + W \Rightarrow Q = -W = \boxed{2.7 \times 10^{3}\ J}$

$\Delta E_{int} \to 0$

(c) If the gas returned to the original volume using isobaric process, Find the work done?

~answer~

$W = -P(V_f - V_i)$, $P = \frac{nRT_i}{V_i}$

$\therefore W = -\left(\frac{nRT_i}{V_i}\right)(V_f - V_i)$

$= -\left(\frac{1 \times 8.31 \times 273}{10 \times 10^{-3}}\right)(3 \times 10^{-3} - 10 \times 10^{-3}) = \boxed{1.6 \times 10^{3}\ J}$

EX: A 1 kg bar of copper is heated at atmospheric pressure so that the tempreure increase from $20\,^{\circ}C$ to $50\,^{\circ}C$

(a) What is the work done by surrounding.
(b) How much energy transfer to the bar.
(c) what is the increase in internal energy.

$\rho_{cu} = 8920\ kg/m^3$ $\quad \alpha_{cu} = 7\times10^{-6}\ ^{\circ}C^{-1}$
$C_{cu} = 387\ J/kg\cdot{}^{\circ}C$

"answer"

$\Rightarrow P = 1\ atm = 1.013\times10^{5}\ Pa$ "Isobaric"

(a) $W = -P(V_f - V_i) = -P\,\Delta V$

$$\Delta V = 3\alpha V_i \Delta T = 3\alpha \frac{m}{\rho_{cu}} \Delta T$$

$$= 3\times(7\times10^{-6})\,\frac{1\ kg}{8920}\times(50-20) = 1.7\times10^{-7}\ m^3$$

$$\therefore W = -1.013\times10^{5}\times(1.7\times10^{-7}) = \boxed{-1.7\times10^{-2}\ J}$$

(B) $Q = mC\Delta T = 1\times387\times(50-20)$
$= \boxed{1.2\times10^{4}\ J}$

(C) $\Delta E_{int} = Q + W = 1.2\times10^{4} - 1.7\times10^{-2} = \boxed{1.2\times10^{4}\ J}$

EX. energy from the sun reaches the earth $1000\ W/m^2$, if a person on the beach exposed to the sun at angle 30°, $e = 0.7$, $A = 0.8\ m^2$, Find the rate of heat energy absorbs (تمتص) by the body.

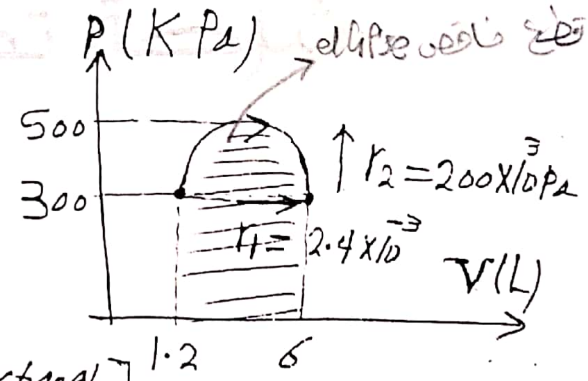
~answer~

$$P = 1000 \times e A \cos\theta$$

$$= 1000 \times 0.7 \times 0.8 \cos 30^\circ = \boxed{485\ W}$$

EX: If the heat added to the system is $5.79\ KJ$, work shown in P–V curve

⇒ Find the change in internal energy



4.8×10^{-3}

"answer"

$$W = -[\text{area half circle} + \text{rectangle}]$$

$$= -[\tfrac{1}{2}\pi r_1 \times r_2 + LW]$$

$$= -[\tfrac{1}{2}\pi \times (2.4 \times 10^{-3}) \times (200 \times 10^{3}) + (4.8 \times 10^{-3}) \times (300 \times 10^{3})]$$

$$= \boxed{-2190\ J}, \quad \Delta E_{in} = Q + W = 5790 - 2190$$

$$= \boxed{3600\ J}$$

EX: The surface of the sun has tempreture 5800 K, the radius of the sun $R = 6.96 \times 10^{8}\ m$, $e = 0.965$. Find energy radiated by the sun in each second. $\sigma = 5.67 \times 10^{-8}$

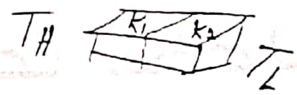
~answer~

$$P = \sigma e A T^{4} = 5.67 \times 10^{-8} \times 0.965 \times 4\pi (6.96 \times 10^{8})^{2} \times (5800)^{4}$$

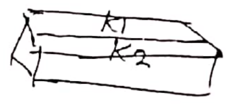
$$\boxed{A = 4\pi R^{2}}$$

$$= \boxed{3.77 \times 10^{26}\ W}$$

EX: Which case the energy transfer high (a) series



(b) Parallel



answer: Parallel ~ High area, small length