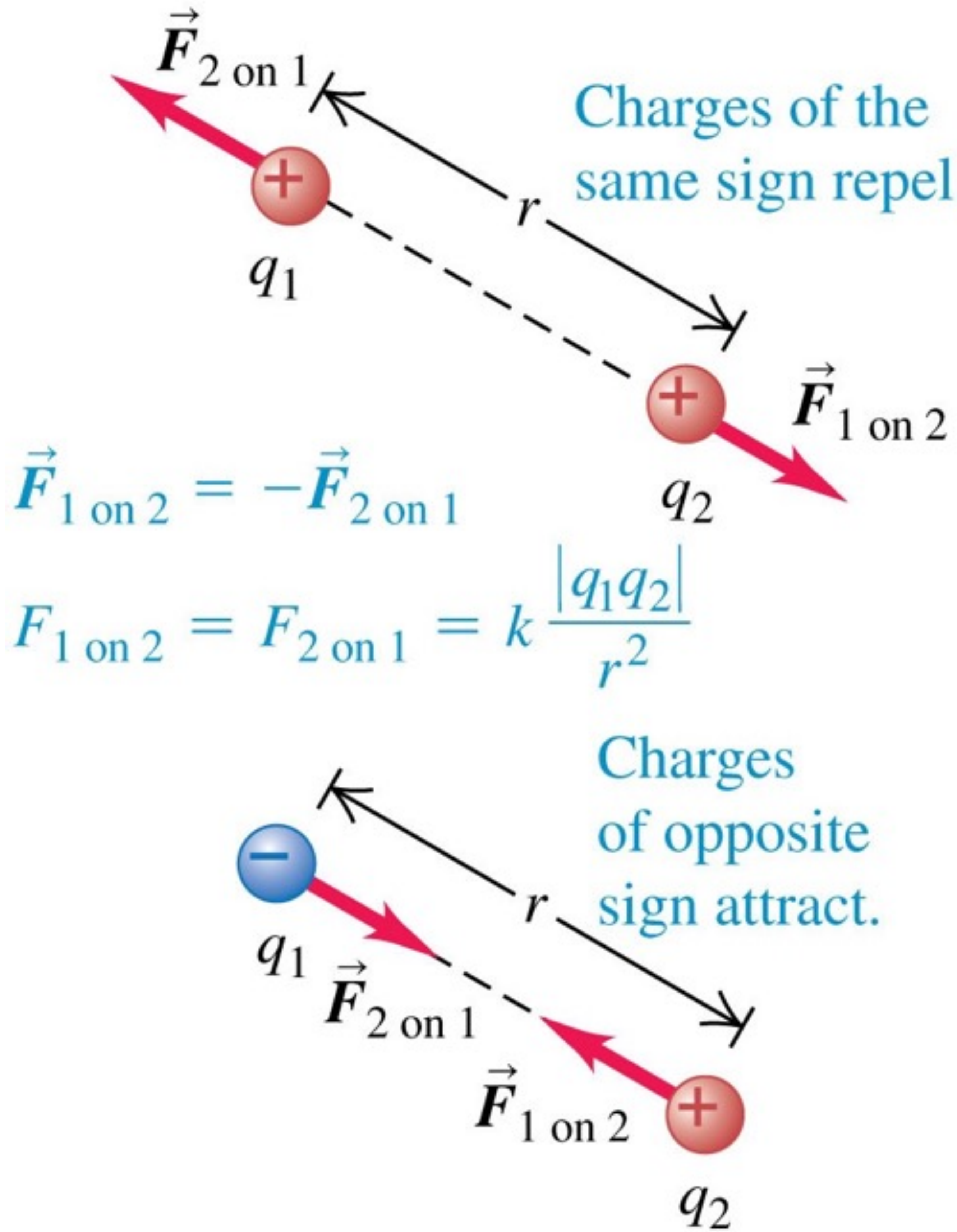
Lecture 9 - Exam 1 Review

PHYC 161 Fall 2016

Coulomb's Law

- **Coulomb's Law**: The magnitude of the electric force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

$$F = k\frac{|q_1 q_2|}{r^2}$$



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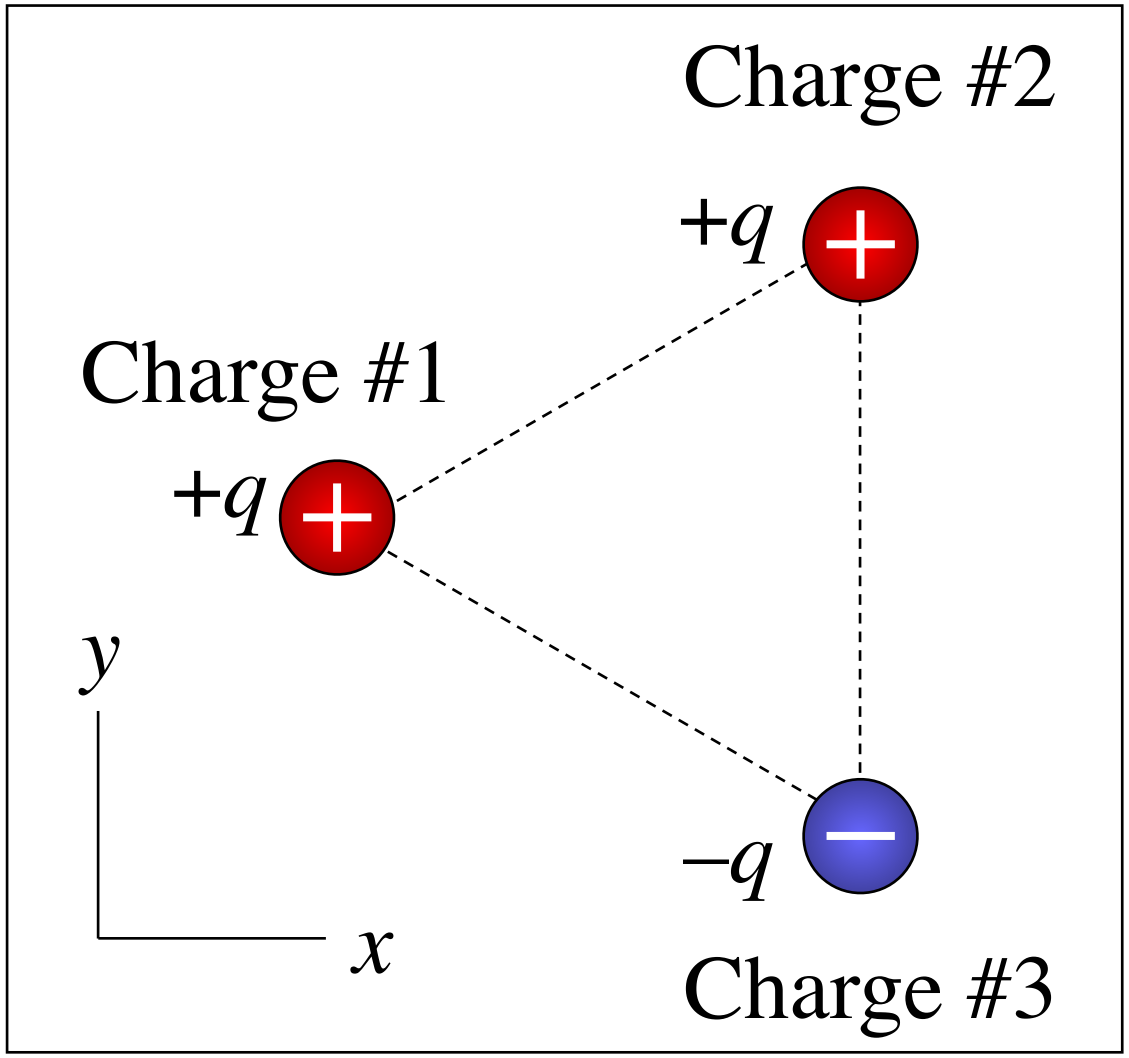
Q21.3

Three point charges lie at the vertices of an equilateral triangle as shown. All three charges have the same magnitude, but charges #1 and #2 are positive ($+q$) and charge #3 is negative ($-q$). The net electric force that charges #2 and #3 exert on charge #1 is in



A. the $+x$-direction.

B. the $-x$-direction.

C. the $+y$-direction.

D. the $-y$-direction.

E. none of the above.

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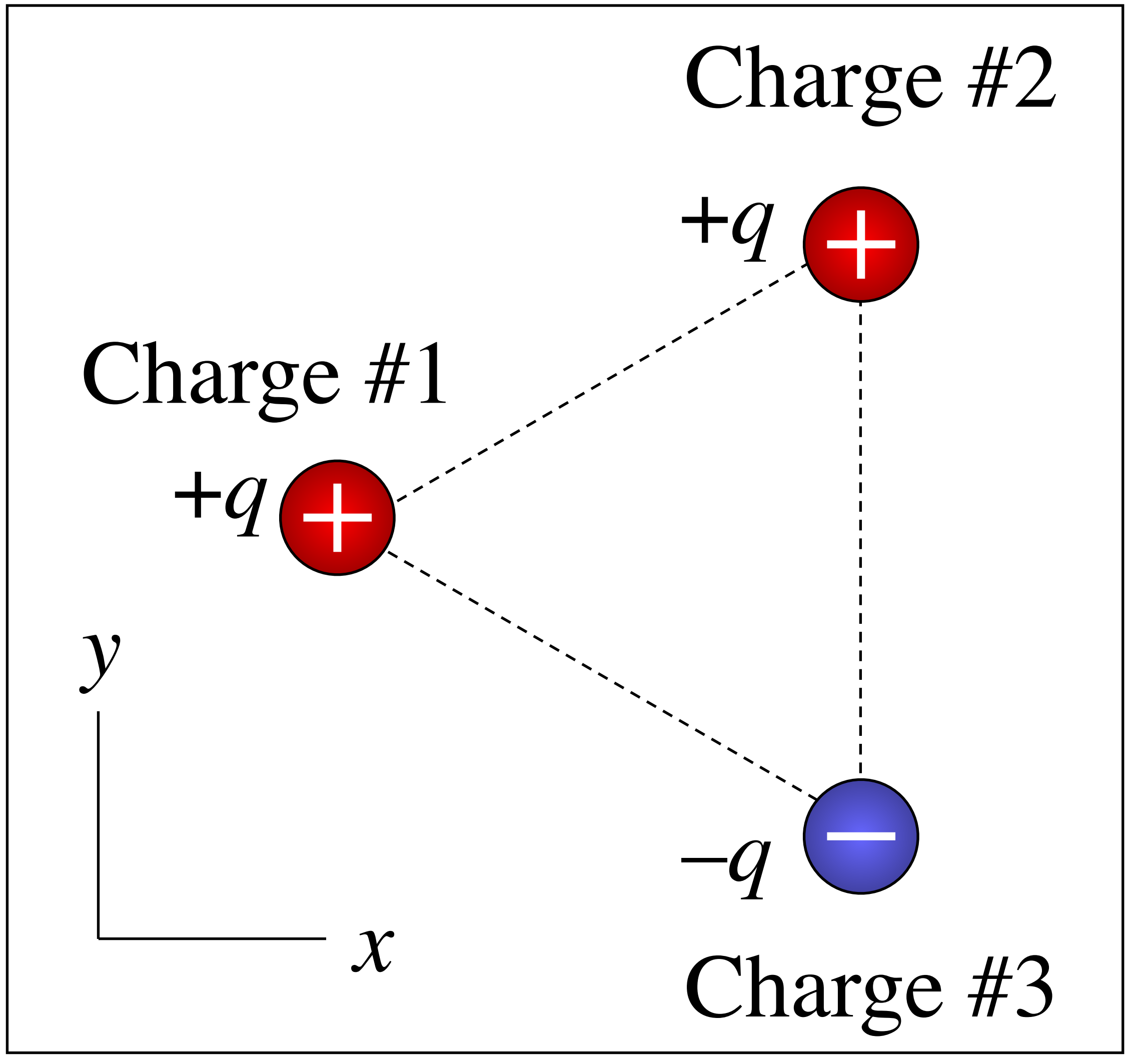
Vector expression for the force on #1?

Three point charges lie at the vertices of an equilateral triangle as shown. All three charges have the same magnitude, but charges #1 and #2 are positive ($+q$) and charge #3 is negative ($-q$). The net electric force that charges #2 and #3 exert on charge #1 is in



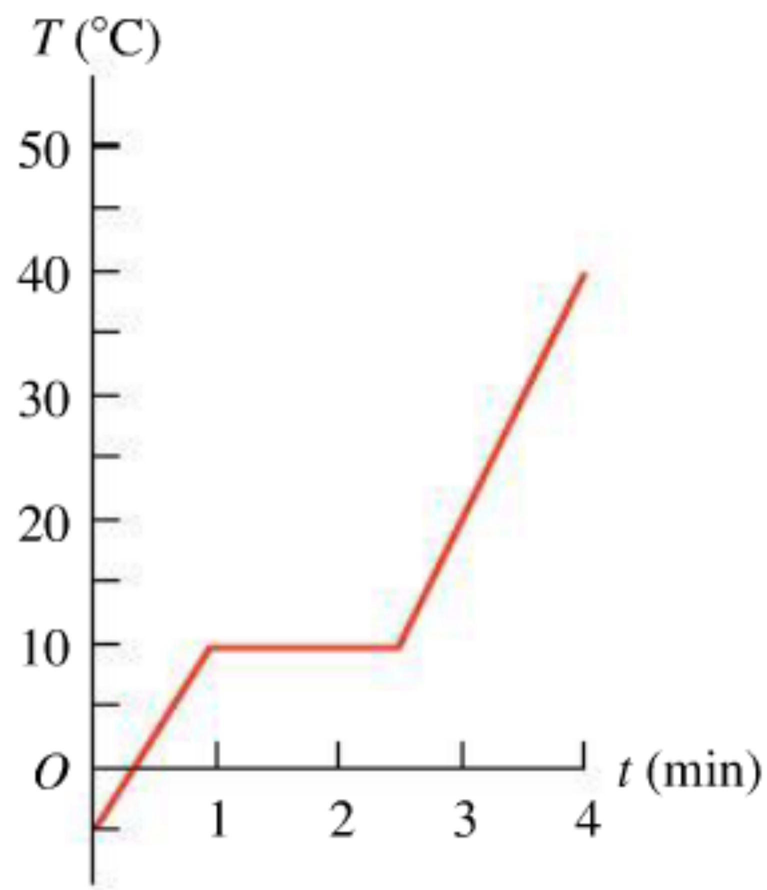
Problems

17.33 •• CP A 15.0-g bullet traveling horizontally at 865 m/s passes through a tank containing 13.5 kg of water and emerges with a speed of 534 m/s. What is the maximum temperature increase that the water could have as a result of this event?

Problems

17.111 •• **DATA** As a physicist, you put heat into a 500.0-g solid sample at the rate of 10.0 kJ/min while recording its temperature as a function of time. You plot your data as shown in **Fig. P17.111**. (a) What is the latent heat of fusion for this solid? (b) What are the specific heats of the liquid and solid states of this material?

Figure **P17.111**



Problems

18.16 • Three moles of an ideal gas are in a rigid cubical box with sides of length 0.300 m. (a) What is the force that the gas exerts on each of the six sides of the box when the gas temperature is 20.0°C? (b) What is the force when the temperature of the gas is increased to 100.0°C?

Problems

19.6 •• A gas undergoes two processes. In the first, the volume remains constant at $0.200\ \mathrm{m}^3$ and the pressure increases from 2.00×10^5 Pa to 5.00×10^5 Pa. The second process is a compression to a volume of $0.120\ \mathrm{m}^3$ at a constant pressure of 5.00×10^5 Pa. (a) In a pV-diagram, show both processes. (b) Find the total work done by the gas during both processes.

Problems

20.15 • A Carnot engine has an efficiency of 66% and performs 2.5×10^4 J of work in each cycle. (a) How much heat does the engine extract from its heat source in each cycle? (b) Suppose the engine exhausts heat at room temperature (20.0°C). What is the temperature of its heat source?

Problems

20.25 • Three moles of an ideal gas undergo a reversible isothermal compression at 20.0°C. During this compression, 1850 J of work is done on the gas. What is the change of entropy of the gas?

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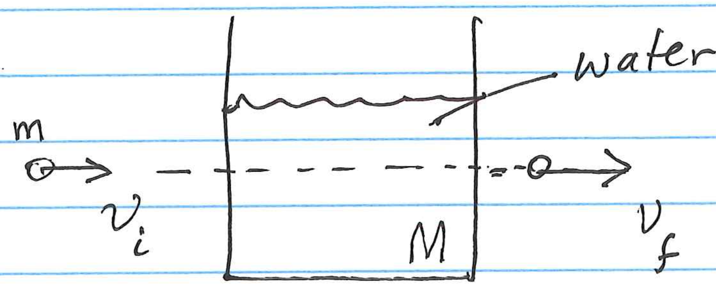
17.33



$$\Delta KE = \frac{1}{2}m\left(v_f^2 - v_i^2\right) \Rightarrow Q = -\Delta KE$$

ΔKE = -Work done on ~~bullet~~ water = (heat gained)
by friction

$$Q = Mc_w \Delta T = -\Delta KE = -\frac{1}{2}m\left(v_f^2 - v_i^2\right)$$

$$\Delta T = \frac{-\frac{1}{2}m\left(v_f^2 - v_i^2\right)}{Mc_w}$$

17.111

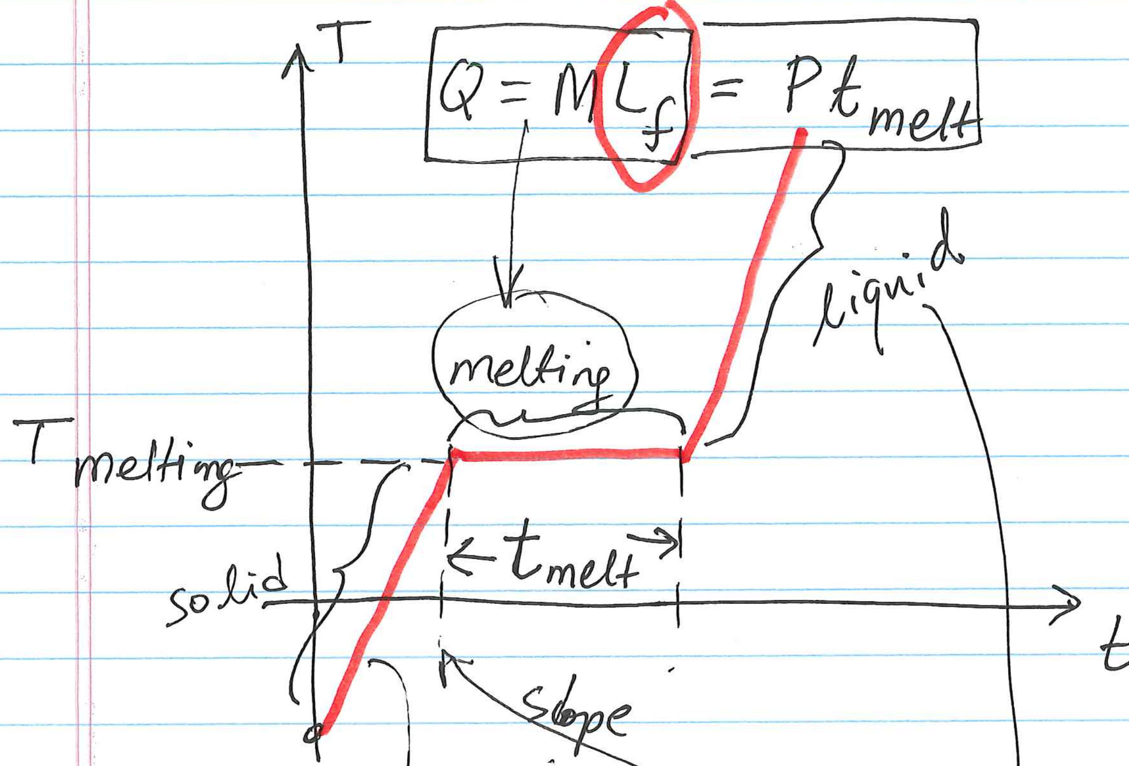
$M = 500\ g$ solid

c_s = solid specific heat cap.

c_ℓ = liquid "

$P = 10\ \frac{kJ}{min} = \frac{\Delta Q}{\Delta t} = ?$

$$\boxed{Q = M L_f = P t_{melt}}$$



$$P = \frac{\Delta Q}{\Delta t} = M c_s \frac{\Delta T}{\Delta t}$$

$$\text{slope} = \frac{\Delta T}{\Delta t} = \frac{P}{M c_\ell}$$

$$\frac{P}{M c_\ell}$$

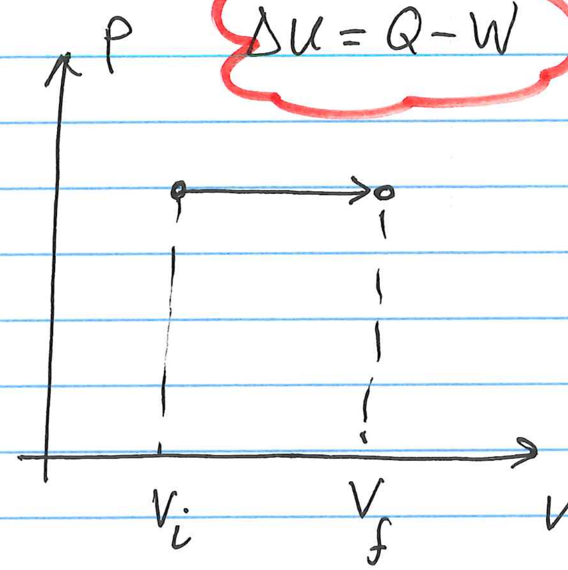
→ Coulomb's Law → Vector addition

→ Heating → with & without phase changes

→ Ideal Gases / Processes

$pV = nRT$

$\boxed{\Delta U = Q - W}$



- isobaric $\quad p = \text{constant}$

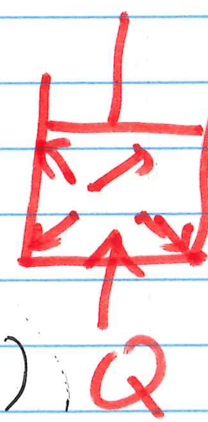
  $\Delta p = 0$

$$W = \int p\,dV = p\int dV$$
$$= p(V_f - V_i)$$

$$Q = nC_p\Delta T$$

$\Delta U = Q - W$ $\qquad$ If ΔT known, $\Delta U = nC_v\Delta T$

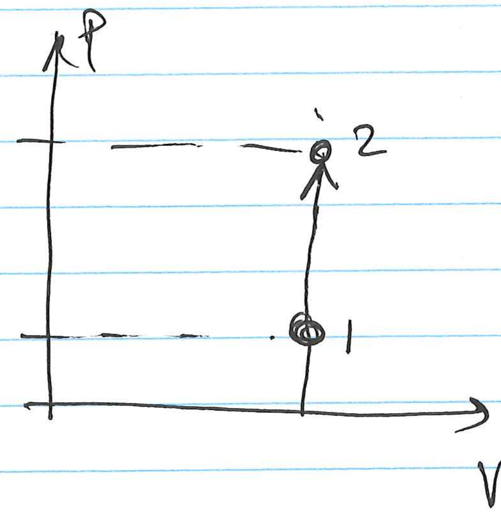
Ideal Gas $\quad U \propto U(T)$



$$\Delta U = Q - W$$

$$nC_v\Delta T = nC_p\Delta T - p(V_f - V_i)$$

isochoric



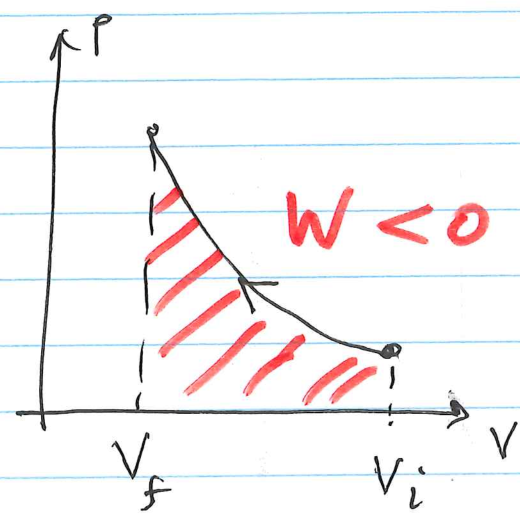
$V = \text{constant}$

$\Delta V = 0$

$$W = \int p \, \cancelto{0}{dV} = 0$$

$$\Delta U = Q = n C_V \Delta T$$

isothermal



$T = \text{constant}$

$\Delta T = 0$

$\Delta U = 0 \Rightarrow Q = W$

$$W = \int p \, dV$$

$$= \int_{V_i}^{V_f} \frac{\overbrace{nRT}^{\text{constant}}}{V} dV = nRT \ln\left(\frac{V_f}{V_i}\right)$$

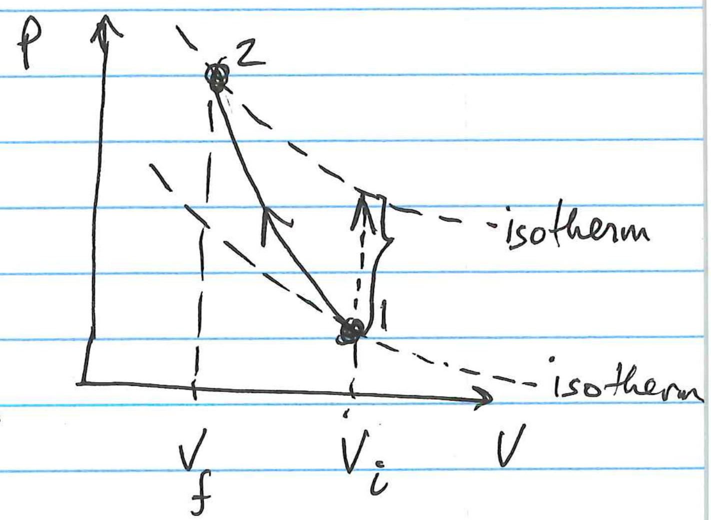
adiabatic $\Rightarrow$ no heat exchanged

- Reversible

$Q = 0$

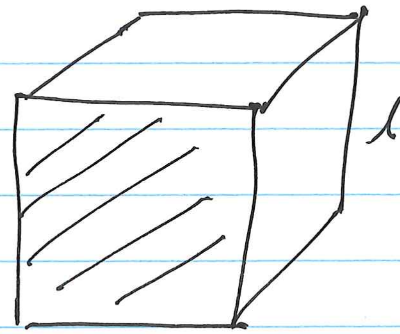
$\Delta U = -W$

$= n C_v \Delta T = -W$



$$\boxed{\begin{aligned} PV^{\gamma} &= \text{constant} \\ TV^{\gamma-1} &= \text{constant} \end{aligned}}$$

18.16



$$pV = nRT$$

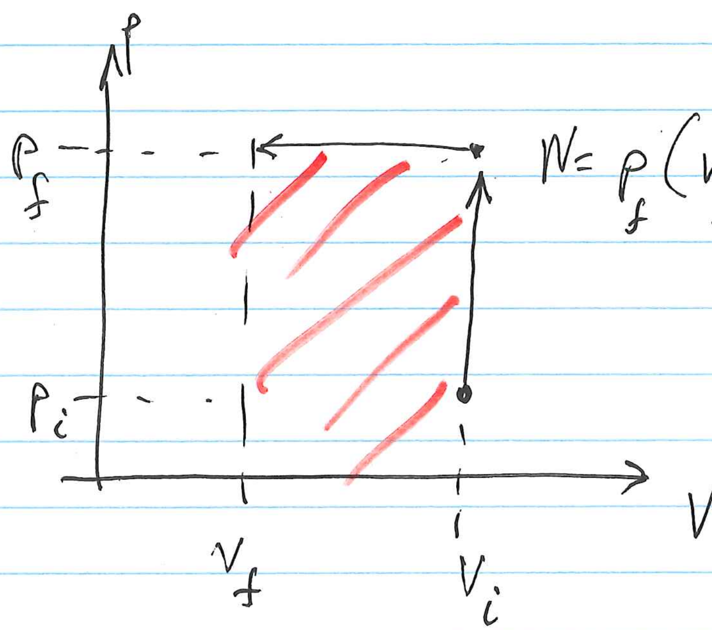
$$p = \frac{nRT}{V}$$

$$V = \ell^3$$

Force = pressure × area

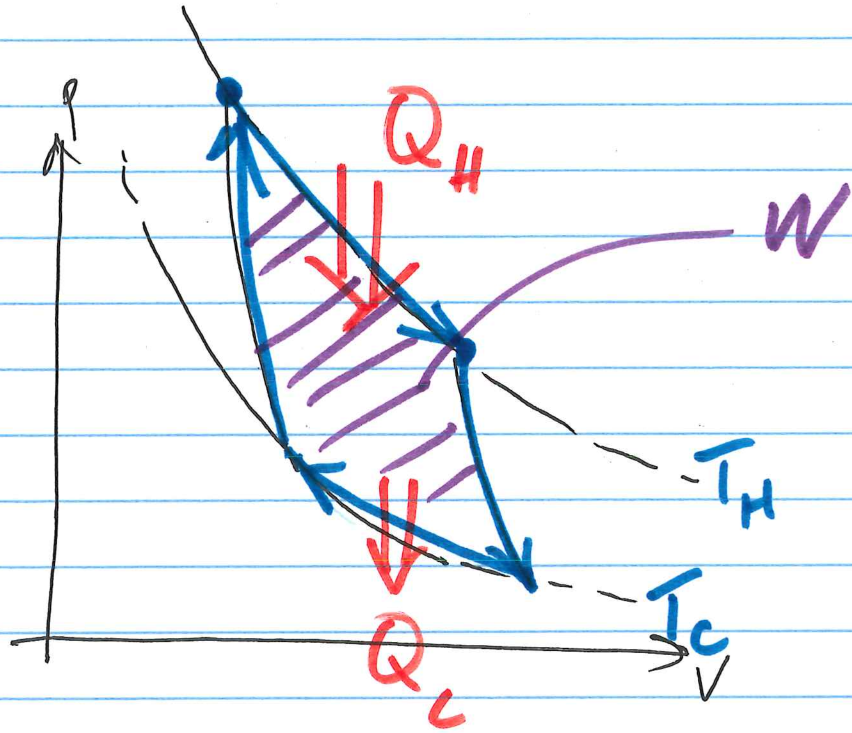
$$= p\,\ell^2 = \frac{nRT\ell^2}{\ell^3} = \frac{nRT}{\ell}$$

19.6



$$W = p_f(V_f - V_i) < 0$$

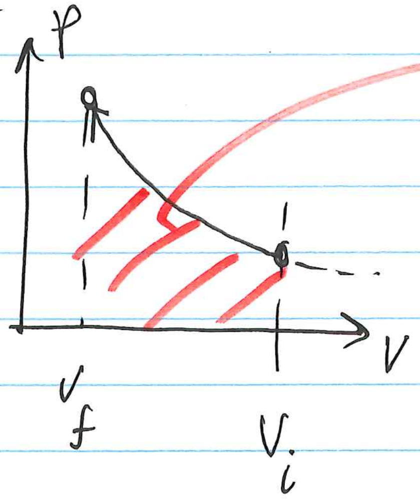
20.15



$$e = \frac{66}{100} = \frac{W}{Q_H} = \boxed{1 - \frac{T_c}{T_H}}$$

Refrigerator: $K \equiv \frac{|Q_c|}{W} \neq \frac{1}{e}$

20.25



$W = -1850\,J$

$T = 20°C = 293\,K$

$\Delta T = 0 = \Delta U$

$Q = W = -1850\,J$

$$\Delta S = \frac{Q}{T} = \frac{-1850\,J}{293\,K}$$

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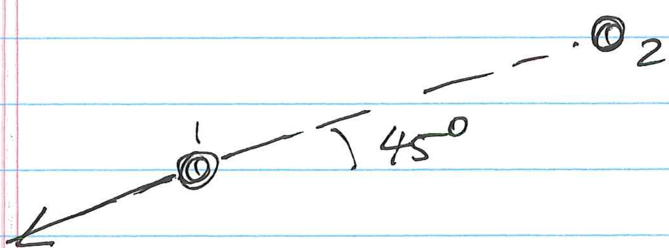
- Coulomb's Law

$$\bar{F}_{12} = \frac{kq^2}{r^2}\left[\cancel{-\cos(45^\circ)\hat{x}} - \sin(45^\circ)\,\hat{y}\right]$$



$$\bar{F}_{13} = \frac{kq^2}{r^2}\left[\cancel{+\cos(45^\circ)\hat{x}} - \sin(45^\circ)\,\hat{y}\right]$$

$$\vec{F}_{NET} = -\frac{2kq^2}{r^2}\sin(45^\circ)\,\hat{y}$$