3D Time:
From Transportation to Physics
Part 4: Kinematics II

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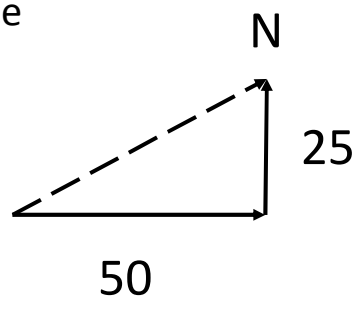
What is displacement?

- Difference between two places in space
- 3D vector difference, **r**
- Example:
  - a car travels east 50 km,
  - then travels north 25 km;
  - displacement is dashed arrow.
- Length of the direct motion



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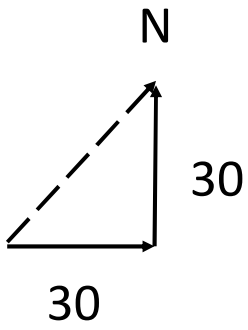
What is distimement?

- Difference between two places in time
- 3D vector difference, **w**
- Example:
  - a car travels east for 30 min
  - then travels north for 30 min;
  - distimement is dashed arrow.
- Time of the direct motion



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What is velocity?

- Speed with space direction
  - Δdisplacement / Δtime, Δ**r**/Δ*t*
- Velocity is a 3D vector
  - magnitude and direction
  - e.g., speed 80 kph north
  - represented by boldface **v**
  - instantaneous velocity, **v** = d**r**/d*t*
- What is pace with direction?

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What is legerity?

- Legerity – "lightness in movement"
- Pace with time direction
  - Δdistimement / Δlength, Δ**w**/Δ*s*
- Legerity is a 3D vector
  - magnitude and direction
  - e.g., 12 min/km north
  - represented by boldface **u**
  - instantaneous legerity, **u** = d**w**/d*s*
- Boldface **w** means 3D time

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Example

- Car travels east 50 km for 30 min
  - velocity is (50/30) km/min * 60 min/hr = 100 kph east
  - legerity is (30/50) min/km * 60 sec/min = 36 sec/km east
- Then it travels north 25 km for 30 min
  - velocity is (25/30) km/min * 60 min/hr = 50 kph north
  - legerity is (30/25) min/km * 60 sec/min = 72 sec/km north

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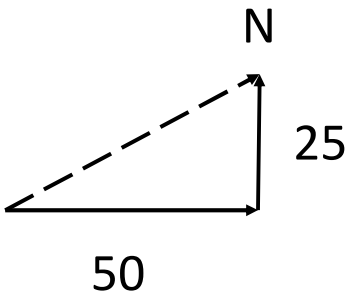
Comparison

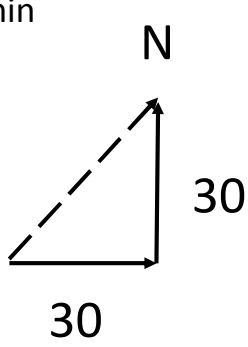
3D Space

- Units in km



3D Time

- Units in min



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What is acceleration?

- Greater (or less) distance per time
- Change in velocity per unit time
  - average acceleration, $\mathbf{a} = \Delta\mathbf{v}/\Delta t$
  - instantaneous acceleration, $\mathbf{a} = d\mathbf{v}/dt$
- Acceleration is a 3D vector
- Units: (m/s)/s = m/s²

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What is expedience?

- Expedite – to make something happen in less time
- Change in legerity per unit length
  - average expedience, **b** = Δ**u**/Δ*s*
  - instantaneous expedience, **b** = d**u**/d*s*
- Expedience is a 3D vector
  - faster is negative
  - direction opposite to motion
- Units: (s/m)/m = s/m²

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Equations of motion

3D Space	**3D Time**
1. $v = s_0 + at$	1. $u = u_0 + bs$
2. $s = s_0 + v_0t + \frac{1}{2}at^2$	2. $t = t_0 + u_0s + \frac{1}{2}bs^2$
3. $2a = (v^2 - v_0^2)/(s - s_0)$	3. $2b = (u^2 - u_0^2)/(t - t_0)$

Similar but not equal

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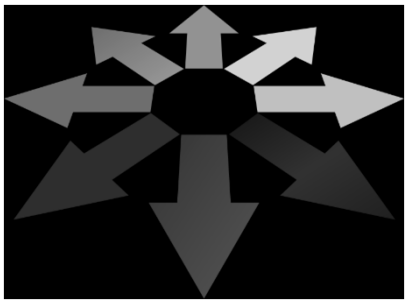
Kinematics II conclusion

- Defined velocity and legerity
- Defined displacement and distimement
- Defined acceleration and expedience
- Different way to look at motion



- 3D time does kinematics!

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