1. Modern physics began around 1900.
2. The observation of full phases of Venus

3. | Attribute          | Solid | Liquid | Gas | Plasma |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Dense?</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Fluid?</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Compressible?</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Crystalline?</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Elect. Cond.?</td>
<td>some</td>
<td>some</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

4. | Charge | Mass | Common Name                  |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$+2$</td>
<td>He nucleus (He)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>$+1$</td>
<td>electron/positron (e)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0</td>
<td>photon</td>
</tr>
</tbody>
</table>

5. $1\text{ LY} = 365.25\text{ days} \times 24\text{ hours} \times 60\text{ min} \times 60\text{ sec} \times 3.8 \times 10^8 \text{ m/s}$
   $= 9.5 \times 10^{15} \text{ m}$
6. a) \[ a = \frac{\Delta v}{\Delta t} = \frac{15 \text{ m/s}}{8 \text{ s}} = 1.9 \text{ m/s}^2 \]

b) \[ d = \frac{1}{2} at^2 = \frac{1}{2} (1.9 \text{ m/s}^2)(8 \text{ s})^2 = 62 \text{ m} \]

c) remaining distance = 40 m

\[ d = vt \Rightarrow t = \frac{d}{v} = \frac{40 \text{ m}}{15 \text{ m/s}} = 2.7 \text{ s} \]

d) total time = 8.0 s + 2.7 s = 10.7 s ✓ good number

[ Note: VW Women's outdoor record: 11.55 s (2005)
Women's world record: 10.49 s (1988)
10.7 s would be in top 10. ]

7. (Done in class Monday)

- \( F_W = \) wing lift
- \( F_D = \) drag force
- \( F_A = \) air drag
- \( F_{es} = \) engine thrust
- \( W = mg = \) weight

Sum of forces is zero — no acceleration.

8. \( m = 70 \text{ kg} \quad r = 25 \text{ m} \quad v = 30 \text{ m/s} \)

Turn force is \[ F_c = \frac{m v^2}{r} = \frac{(70 \text{ kg})(30 \text{ m/s})^2}{25 \text{ m}} = 2500 \text{ N} \]

Weight is \[ W = mg = (70 \text{ kg})(9.8 \text{ m/s}^2) = 690 \text{ N} \]

Turn force is almost 4x her weight!
Yes, requires powerful thigh guards!
9. If muon neutrinos "oscillate" to/from tau neutrinos, then standard theory says that neutrinos have nonzero mass.

10. \( m = \frac{G m_1 m_2}{r^2} \) (gravity provides centripetal force)

\[ r \omega^2 = \frac{G M}{r^2} \] (m's cancel)

\[ \omega^2 = \frac{G M}{r^2} \] (algebra)

\[ \omega = \frac{2\pi}{24 \text{ hr}} \times \frac{60 \times 60}{24 \times 60} \text{ rad/sec} = 7.3 \times 10^{-5} \text{ rad/sec} \]

\[ r^3 = \frac{4.0 \times 10^{14} \text{ N m}^2/\text{kg}}{(7.3 \times 10^{-5} \text{ rad/sec})^2} = 7.6 \times 10^{22} \text{ m}^3 \]

Cube root: \( r = 4.2 \times 10^7 \text{ m} = 42,000 \text{ km} \)

Note: \( N = \frac{\text{kg m}}{\text{s}^2} \rightarrow \frac{\text{N m}^2}{\text{kg m} \text{ m}^2} = \frac{\text{m}^3}{\text{kg} \text{ s}^2} \)