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Problems

1.1

(a) picosecond : ps ; femtosecond : fs.

$1ps = 10^{-12}s$ $\quad$ $1fs = 1\times10^{-15}s$

$\Rightarrow 1ps = 1\times10^{3}fs$, the order of time interval is 3

(b) $1nm = 10^{-3}\mu m = 10^{-6}mm = 10^{-7}cm = 10^{-8}dm = 10^{-9}m = 10^{-12}km$.

(c) Electron volt (eV) is a unit of energy

$1MeV = 1\times10^{6}eV$ $\quad$ M : million

$1GeV = 1\times10^{9}eV$ $\quad$ G : gillion

1.3 $m = 5.98\times10^{24}kg = 5.98\times10^{25}mol$?

1.8. Use parameters (M, R) of a spherically symmetric distribution of mass and gravitational constant G to construct a quantity of dimension of speed.

$\sqrt{\frac{GM}{R}}$

$\Rightarrow v_1 = \sqrt{\frac{GM}{R}}$, and it has the dimension of speed.

1.12 $C_V = \alpha T^3 + \gamma T$

$\varepsilon_{n_i} = (n_i + \frac{1}{2})\hbar\omega_i$

$C_V = \left(\frac{\partial \bar{E}}{\partial T}\right)_V = k\sum_{i=1}^{3N}\left(\frac{\hbar\omega_i}{kT}\right)^2 \frac{e^{\hbar\omega/kT}}{(e^{\hbar\omega/kT}-1)^2}$

When the temperature is extreme low, $T \ll \frac{\hbar\omega_i}{k}$

$C_{Vi} = k\left(\frac{\hbar\omega}{kT}\right)^2 e^{-\frac{\hbar\omega_i}{kT}}$

$3N$: $C_V = 3Nk\left(\frac{\Theta_E}{T}\right)^2 e^{-\frac{\Theta_E}{T}}$, have the same order of magnitude with.

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1.14 $\vec{A}, \vec{B}, \vec{C}$ are polar vectors

$(\vec{B} \times \vec{C})$ is axial vector

$\Rightarrow \vec{A} \times (\vec{B} \times \vec{C})$ is (polar vector) × (axial vector)

= a polar vector

1.17

$b_1 \cdot a_1 = 2\pi$

$b_1 \cdot a_2 = 2\pi \frac{a_2}{a_1}$

$b_1 \cdot a_3 = 2\pi \frac{a_3}{a_1}$

...

$b_i \cdot a_j = 2\pi \frac{a_j}{a_i}$

1.22 $\vec{A}(2,1,1)$ $\vec{B} = (5,2,0)$, $\vec{C} = (1,1,1)$

(a) $\vec{A} \cdot \vec{B}$

$= 10 + 2 = 12$

(b) $\vec{A} \times \vec{B}$

$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 1 & 1 \\ 5 & 2 & 0 \end{vmatrix}$

$= -2\vec{i} + 5\vec{j} - \vec{k}$

$= (-2, 5, -1)$

(c) $\vec{B} \times \vec{C}$

$= (2, -5, 3)$

$\vec{A} \cdot (\vec{B} \times \vec{C})$

$= 4 - 5 + 3 = 2$

(d) $\vec{A} \times (\vec{B} \times \vec{C})$

$= (2,1,1) \times (2,-5,3)$

$= (8, -4, -12)$

(e) $\vec{A} \times (\vec{A} + \vec{B} \times \vec{C})$

$= (2,1,1) \times (4,-4,4)$

$= (8, -4, -12)$

(f) $\vec{A}(\vec{B} \times \vec{C} - \vec{A} \times \vec{B})$

$= \vec{A} \cdot (4, -10, 4)$

$= 8 - 10 + 4 = 2$