1. a) $A^{\alpha}B_{\alpha} = \sum_{0}^{3} A^{a}B_{\alpha} = 0 + 0 - 4 + 0$

$= -4$

b) $\beta = 0 : \quad 5 + 6 + (-4) + 6 = 7$

$\beta = 1 : \quad 1$

$\beta = 2 : \quad 26$

$\beta = 3 : \quad 17$

c) same above

2) F ≡ free d ≡ dummy noe : number of eqn

a) 0 1 1

b) 1 1 4

c) 2 2 16

d) 2 0 16

5.

a) for any numbers a_β, the linear comb $= 0$ only $a_\beta = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$.

$a_0\vec{e}_0 + a_1\vec{e}_1 + a_2\vec{e}_2 + a_3\vec{e}_3$

b) No

7.

a) eqn 2.10 : $(\vec{e}_\alpha)^\beta = \delta_\alpha{}^\beta$

write $(\vec{e}_\alpha)^\beta$ as matrix $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

b) $A^0\vec{e}_0 = A^0(1,0,0,0) = (A^0, 0, 0, 0)$

↓

....

9. ~

10.

$$A^{\alpha}\left(\Lambda^{\bar{\beta}}{}_{\alpha}\,\vec{e}_{\bar{\beta}} - \vec{e}_{\alpha}\right) = 0$$

2.13 :: $\bar{e}_{\alpha} = \Lambda^{\bar{\beta}}{}_{\alpha}\,\vec{e}_{\bar{\beta}}$

(11)

$$\begin{pmatrix} \gamma & -v\gamma & 0 & 0 \\ -v\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \Lambda^{\nu}{}_{\bar{\mu}}(-v)$$

$$= \Lambda^{\bar{\mu}}{}_{\nu}(v)$$

$A^{\nu} = (A^0, A^1, A^2, A^3)$

$A^{\bar{\alpha}} = \Lambda^{\bar{\alpha}}{}_{\nu}\,A^{\nu}$

$$A^{\bar{0}} = \Lambda^{\bar{0}}{}_{0}A^{0} + \Lambda^{\bar{0}}{}_{1}A^{1} + \cdots$$
$$= \gamma A^0 - v\gamma A^1$$
$$A^{\bar{1}} = -v\gamma A^0 + \gamma A^1$$
$$A^{\bar{2}} = A^2$$
$$A^{\bar{3}} = A^3$$

(c)

$$\Lambda^{\nu}{}_{\beta}(-v)\,\Lambda^{\beta}{}_{\alpha}(v) = \delta^{\nu}{}_{\alpha}$$

$$\Lambda^{0}{}_{\beta}(-v)A^{\beta}{}_{0}(v) = \Lambda^{0}{}_{0}(-v)\Lambda^{0}{}_{0}(v) + A^{0}{}_{1}(-v)\Lambda^{1}{}_{0}(v) + \cdots$$
$$= \gamma^2 + (v\gamma)(-v\gamma) + 0$$
$$= \frac{1}{1-v^2} + \frac{-v^2}{1-v^2}$$
$$= 1$$

(22)

(a)

$4 = E$

$\left(\frac{1}{4}, \frac{1}{4}, 0\right) = V \qquad \gamma = \frac{4}{\sqrt{14}}$

$m = \sqrt{14}$

(b)

$\vec{P}_f \rightarrow (3, -\frac{1}{2}, 1, 0)\ kg$

$\vec{P}_I = (5, 0, 1, 0)\ kg$

$V_{cm} \rightarrow (0, \frac{1}{5}, 0)$