## peture

(a) Two neutrons each of rest mass  $M_0$  have velocities equal in magnitude  $v = \beta c$  but opposite in direction as measured in their centreof-mass frame. Show that in the rest frame of one of the neutrons, the other neutron has energy  $E' = M_0 c^2 (1 + \beta^2)/(1 - \beta^2)$ .

[3]

(b) A photon rocket works by converting a portion of its mass into photons. If the photon rocket starts at rest with respect to some observer with a rest mass  $m_i$ , and subsequently is observed moving with some velocity  $v = \beta c$  with respect to the same observer, and having a rest mass  $m_f$  having converted some of its rest mass into photons, show that

$$\frac{m_f}{m_i} = \sqrt{\frac{1-\beta}{1+\beta}}.$$

You may wish to assume something particularly simple about the emission of the photons, in particular about the number of photons that is actually emitted.

[4]

(c) A photon of energy E collides with a stationary particle of rest mass  $m_0$  and is absorbed. Express the velocity of the resulting composite particle in terms of  $m_0$ , E and c.

[3]

1(a)

leutron A Neutron B In the 1ab Grame 
$$V=Bc$$
  $V=-Bc$ 

Boost to the rest frame of neutron A using a loventy transformation  $ct' = 8 (ct - \beta x)$   $x' = 8 (x - \beta ct)$   $\gamma = \sqrt{1 - \beta^2}$ 

or, 
$$\begin{pmatrix} ct \\ x \end{pmatrix} = \begin{pmatrix} x \\ -\beta x \end{pmatrix} \begin{pmatrix} ct \\ x \end{pmatrix}$$

Apply to every & momentum of newtron B

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$$\begin{pmatrix} b,c \\ E \\ 1 \end{pmatrix} = \begin{pmatrix} -\beta & \lambda \\ \lambda & -\beta & \ell \end{pmatrix} \begin{pmatrix} b \\ E \\ \ell \end{pmatrix}$$

$$E = \chi_{\text{MoC}^2}$$

$$PC = -\chi_{\text{MoV}C} = -\beta \chi_{\text{MoC}^2}$$

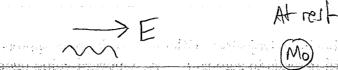
$$P^2 = -\chi_{\text{MoV}C} = -\beta \chi_{\text{MoC}^2}$$

$$= (\chi_{\text{MoC}^2} + \chi_{\text{MoC}^2}) + (\chi_{\text{MoC}^2} + \chi_{\text{MoC}^$$

CONTINUED = 
$$\left(\frac{1+\beta^2}{1-\beta^2}\right)$$
 m<sub>o</sub> c<sup>2</sup>

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to elimination	) ma) s Ey Ymf	$c^2(1+\beta)$	$=M_i^2$	បាយាណ៍ អាចស្វីទ ។ ម៉ែល » អសិបាល « សូវ៉ា សំពាញ់ប ទសាស៊ី មាន ១ ភាព សំបាន	deb respond pediri gover Mesediri g
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$$\beta = \frac{E}{E + m_0 c^2}$$

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