first law of motion this particle positioned at X will undergo non-accelerated motion in this inertial frame, and since all inertial frames are equivalent, motion in any inertial frame of reference will be non accelerated (8)

iii) From part ii)

$X = m_A x'_A(t) + m_B x'_B(t)$

$m_A + m_B$

$= \frac{1}{2}(2\cos 2t, \frac{1}{2}\sin 2t, t^2) + \frac{1}{2}(0, -\frac{1}{2}\sin 2t, t^2)$

$\frac{1}{2} + \frac{1}{2}$

$= (\cos 2t, \frac{1}{4}\sin 2t, \frac{1}{2}t^2) + (0, -\frac{1}{4}\sin 2t, \frac{1}{2}t^2)$ ✓

1 2

$= (\cos 2t, 0, t^2)$

$\frac{dX}{dt} = (-2\sin 2t, 0, 2t)$

$\frac{d^2X}{dt^2} = (-4\cos 2t, 0, 2) \neq 0$ ✓ 2

Since the acceleration of the centre of mass of the system is not zero, the frame of reference is not an inertial frame of reference. 2 (6)

iv) Yes. A and B comprise an isolated system, and so the centre of mass of the system will undergo unaccelerated motion in a frame of reference centred at the centre of mass. A frame of reference centred on A or B would not be an inertial frame of reference since the particle would not be isolated (from B, or A) and would undergo acceleration (and so would the frame of reference). Any ? (4)