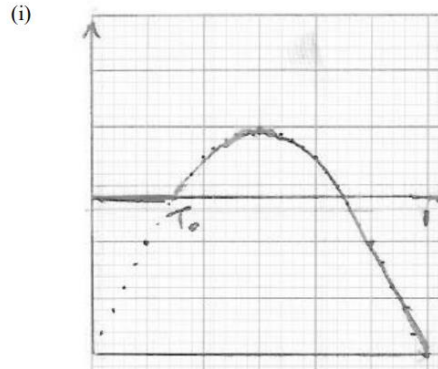


## STEP III, 2008 Q9 MS

9. When the particle starts to move, friction is limiting and so  
 $mg \sin \pi T_0 - \mu mg = 0$   
 i.e.  $\mu = \sin \pi T_0$

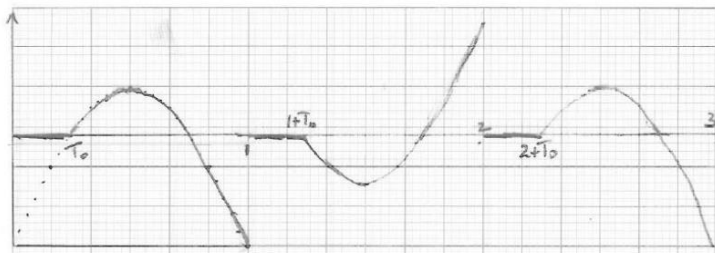


When the particle comes to rest, the area under the acceleration-time graph is zero

$$\text{i.e. } \int_{T_0}^1 g \sin \pi t - \mu_0 g dt = 0$$

Completing the manipulation and eliminating  $T_0$  using the relation at the start of the question renders the required result.

(ii)



In the case  $\mu = \mu_0$ , the motion is periodic with period 2, the particle is stationary in intervals  $(0, T_0), (1, 1 + T_0), (2, 2 + T_0) \dots$ , reversing its direction of motion after times 1, 2, 3, ... , and returning to its starting point at time 2 (and 4, 6, ...)

In the case  $\mu = 0$ , the motion is simple harmonic motion (period 2) superimposed on uniform motion, the particle instantaneously comes to rest at time 2, 4, ... but otherwise always moves in the positive x direction.

$$(x = \frac{g}{\pi^2}(\pi t - \sin \pi t))$$



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