2015 F=ma Exam: Problem 12

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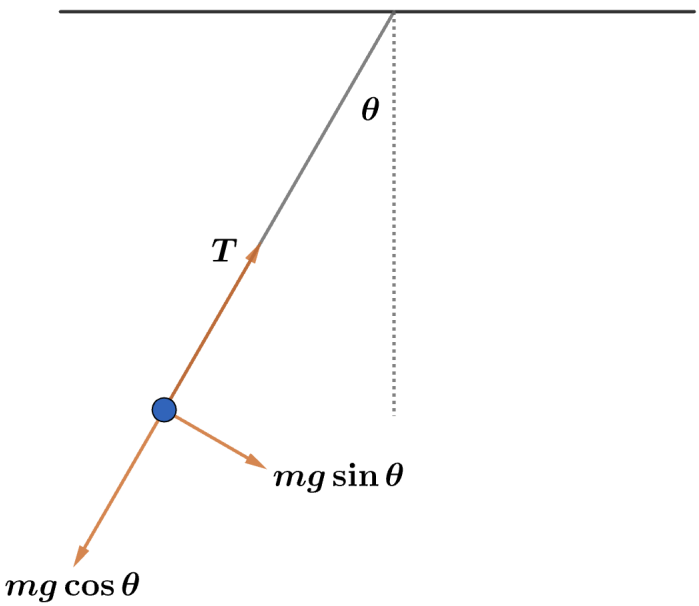

The pendulum feels the forces of tension and gravity. Applying Newton's 2nd law in the tangential direction,

$$ma_t = mg\sin\theta$$
$$a_t = g\sin\theta$$

Since the pendulum is undergoing circular motion, the radial acceleration is given by

$$a_r = \frac{v^2}{L}$$

The magnitude of the total acceleration is

$$a = \sqrt{a_t^2 + a_r^2} = \sqrt{(g\sin\theta)^2 + (v^2/L)^2}$$

Now we go through the possible answer choices.

- A) Not correct since the magnitude of the acceleration depends on θ and v which are both changing.
- B) Not correct since the magnitude of the acceleration at the lowest point $\theta = 0$ is

$$a = v^2/L$$

and we have from energy conservation,

$$\frac{1}{2}mv^2 = mgL(1 - \cos\theta_{\max})$$

$$v^2/L = 2g(1 - \cos\theta_{\max})$$

which is not (in general) equal to g.

- C) Not correct since $v = 0$ (no radial acceleration) only at $\theta = \theta_{\max}$ (where there is a tangential acceleration) so $a \neq 0$ at any point.
- D) Not correct since the mass has a tangential acceleration $a_t = g\sin\theta$.
- E) Correct since at the lowest point $\theta = 0$ there is no tangential acceleration $a_t = 0$.

Thus, the answer is $\boxed{\text{E}}$.