

# 2012 F=ma Exam: Problem 23

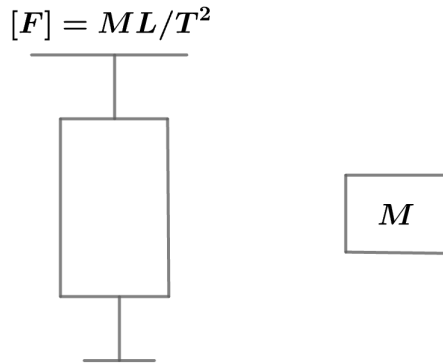
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The dimensions of  $g$  are

$$[g] = \frac{L}{T^2}$$

so it is necessary (though not sufficient) to have equipment that can measure quantities with length dimensions and quantities with time dimensions.

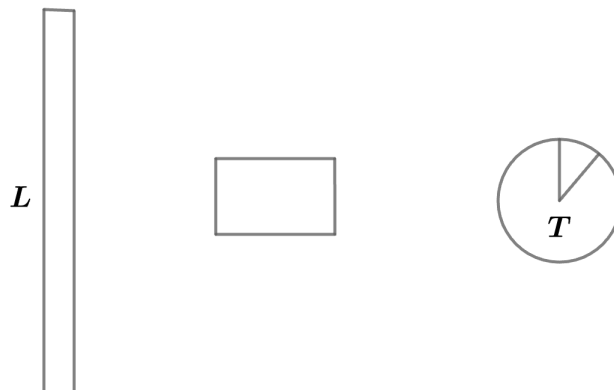
- A) The mass  $M$  can be hung on the spring scale which reads force  $F = Mg$  so  $g = F/M$ .



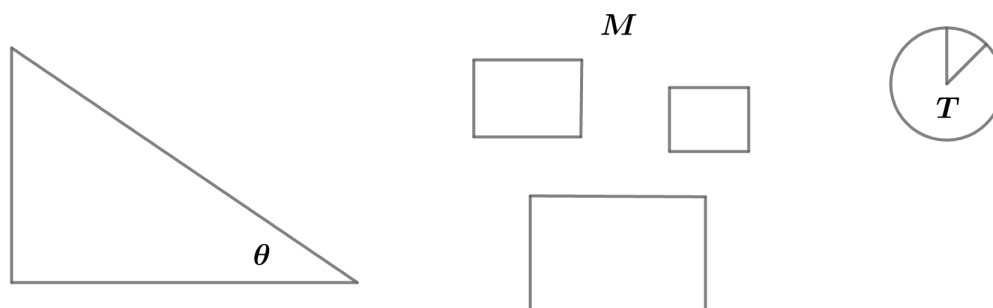
- B) The mass can be dropped while we measure the time  $T$  it takes the mass to travel across the length  $L$  of the rod. Then since

$$L = \frac{1}{2}gT^2$$

we have  $g = 2L/T^2$ .



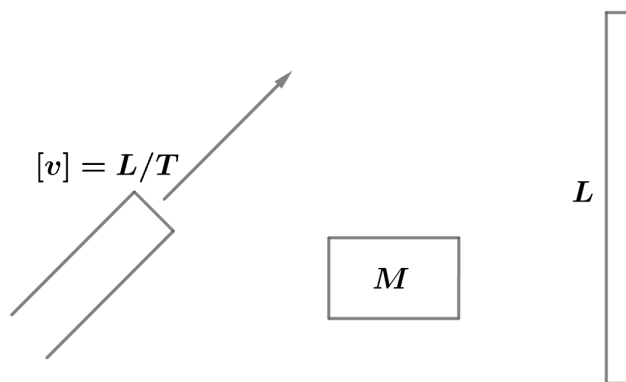
- C) None of the equipment measure quantities which contain dimensions of length, so it is not possible to measure  $g$ .



- D) The mass  $M$  can be launched upward with velocity  $v$  and the height  $h$  reached can be measured with the meter stick. Then since

$$\frac{1}{2}Mv^2 = Mgh$$

we have  $g = v^2/2h$ .



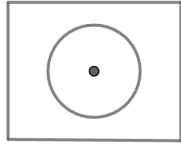
- E) The motor of power  $P$  can act on the mass  $M$  for time  $T$ , accelerating it to speed  $v$ . By energy conservation,

$$PT = \frac{1}{2}Mv^2$$

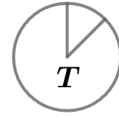
$$v = \sqrt{\frac{2PT}{M}}$$

We then measure the time  $T_2$  it takes the mass to move across the string and determine the string length via  $L = vT_2$ . Knowing  $L$ , we can use the method described in choice B to measure  $g$ .

$$[P] = ML^2/T^3$$



$M$



Thus, the answer is  $C$ .