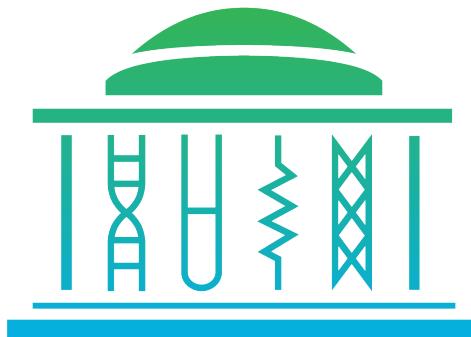


Science Olympiad  
MIT Invitational

January 24, 2026

**Machines C Answer Key**



**ANSWER KEY ANSWER KEY  
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**Section A [70 points]**1. D      2. B      3. C      4. B      5. A6. C      7. B      8. A      9. B      10. C11. B      12. A      13. B      14. A      15. B16. D      17. C      18. C      19. B      20. D21. C      22. C      23. D      24. C      25. B26. C      27. E      28. A, D      29. C, E      30. B, E31. B      32. B, C      33. B, C      34. E      35. D

## Section B [80 points]

For compute questions, half points are given for work shown, and the other half for the correct answer.

1. (a) [2 pts] 4  
 (b) [3 pts] 0.118 [0.112, 0.124]  
 (c) [3 pts] 2210 N [2150, 2270]  
 (d) [2 pts] Remain the same (1); truck's velocity and tension of the cable have a constant product, since increased IMA would increase velocity of table and decrease tension by the same factor (1)
2. (a) [3 pts] 0.224 [0.221, 0.227]  
 (b) [3 pts] 17.9 m/s [17.4, 18.4]  
 (c) [4 pts] 71.3 J [70.6, 72.0] (4) OR 57.0 J [56.3, 57.7] (3)
3. (a) i. [1 pt] Class III  
 ii. [2 pts] 0.124 (Exact)  
 (b) [3 pts]  $9.66^\circ$  [9.47, 9.85]  
 (c) [3 pts]  $13.8^\circ$  [13.5, 14.1]  
 (d) [4 pts] 0.336 N [0.322, 0.350]  
 (e) i. [1 pt]  $16.1^\circ$  [15.8, 16.4]  
 ii. [3 pts]  $14.7^\circ$  [14.4, 15.0]  
 iii. [3 pts] 1.26 m/s [1.21, 1.31]
4. (a) [2 pts]  $M_D = 7/3$  bvr (Exact)  
 (b) [2 pts]  $M_B = 2/3$  bvr (Exact)  
 (c) [3 pts]  $M_B$  can take on any mass (1).  $M_C$  is in equilibrium with  $M_D$ , so  $M_C \leq 1/2$  bvr (1). Then,  $M_E + M_F \leq 1/4$  bvr (0.5) and torque balance means  $2M_E = M_F$  (0.5).  
 (d) i. [5 pts]  $M_{\max/\min} = (19 \pm \sqrt{345})/8$   
 ii. [5 pts]  $a_A = 1.75 \text{ m/s}^2$  (Upwards (0.5); [1.71, 1.79] (2)),  
 $a_E = -6.72 \text{ m/s}^2$  (Downwards (0.5); [6.68, 6.75] (2))  
 iii. [3 pts] 6.86 W [6.79, 6.93]  
 (e) [0 pts] Tim the beaver
5. (a) [1 pt] Left  
 (b) [2 pts]  $Mg/4$   
 (c) [2 pts]  $g\mu/2$   
 (d) [4 pts]  $\tau_{\text{axle}}(\theta) = \kappa\theta \frac{r}{L} \sec\left[\frac{\theta}{2} + \sin^{-1}\left(\frac{r}{2L} \csc\left[\frac{\pi-\theta}{2}\right]\right)\right]$   
 (e) [3 pts]  $148^\circ$  [146, 150]  
 (f) [6 pts]  $\Delta d = 2.00 \text{ m}$  [1.98, 2.02] (6) OR 1.95 m [1.93, 1.97] (3)  
 (g) [2 pts] No (1). Since the angles in part (f) are less than the critical angle from part (c), the vehicle moves without slipping (1). The number of rotations of the right wheels doesn't change and thereby the distance traveled does not as well.