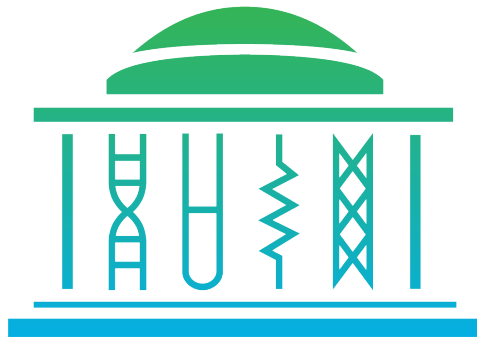


Science Olympiad

MIT Invitational

January 24, 2026

Machines C Answer Key



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Section A [70 points]

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|------------------|---------------------|---------------------|---------------------|---------------------|
| 1. <u> D </u> | 2. <u> B </u> | 3. <u> C </u> | 4. <u> B </u> | 5. <u> A </u> |
| 6. <u> C </u> | 7. <u> B </u> | 8. <u> A </u> | 9. <u> B </u> | 10. <u> C </u> |
| 11. <u> B </u> | 12. <u> A </u> | 13. <u> B </u> | 14. <u> A </u> | 15. <u> B </u> |
| 16. <u> D </u> | 17. <u> C </u> | 18. <u> C </u> | 19. <u> B </u> | 20. <u> D </u> |
| 21. <u> C </u> | 22. <u> C </u> | 23. <u> D </u> | 24. <u> C </u> | 25. <u> B </u> |
| 26. <u> C </u> | 27. <u> E </u> | 28. <u> A, D </u> | 29. <u> C, E </u> | 30. <u> B, E </u> |
| 31. <u> B </u> | 32. <u> B, C </u> | 33. <u> B, C </u> | 34. <u> E </u> | 35. <u> D </u> |

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° [9.47, 9.85]
 (c) [3 pts] 13.8° [13.5, 14.1]
 (d) [4 pts] 0.336 N [0.322, 0.350]
 (e) i. [1 pt] 16.1° [15.8, 16.4]
 ii. [3 pts] 14.7° [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° [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.