Section A (80 points)

1. D	9. B	17. B	25. C	33. D
2. B	10. C	18. C	26. A	34. B
3. C	11. B	19. B	27. D	35. A
4. B	12. B	20. B	28. A	36. C
5. C	13. C	21. B/C	29. D	37. C
6. D	14. C	22. A	30. C	38. C
7. D	15. C	23. A	31. D	39. X
8. A	16. D	24. A	32. B	40. D

Section B (120 points)

1. (a)   i. <u>12.4</u> N

        ii. <u>112</u> J

   (b)   i. <u>1.77</u>

        ii. <u>Friction, sound, etc.</u>

       iii. <u>The block can be raised slower, since air resistance depends on velocity.</u>

   (c)   i. <u>The block begins to slide down the plane to the left due to gravity and the plane begins to slide to the right due to the normal force from the block. Once the block reaches the floor, they move away from each other.</u>

        ii. <u>0.664</u> $\mathrm{m\,s^{-2}}$

       iii. <u>8.14</u> $\mathrm{m\,s^{-1}}$

2. (a)   i. <u>79.3</u> g

        ii. <u>463</u> g

   (b)   i. <u>±0.01</u> g

        ii. <u>Various answers accepted: decrease the total weight on the lever (by lengthening the lever, moving the zero point towards the fulcrum, etc.), decrease the contact area at the fulcrum, change the fulcrum and lever material with lower μ, etc.</u>

3. (a) <u>8.91</u> kg

   (b) <u>≥ 0.403</u>

   (c) <u>39.5</u> $\mathrm{cm\,s^{-1}}$ <u>upwards</u>

   (d) <u>17.8</u> cm

4. (a) <u>857</u> kg

     <u>The cables should connect the cab to the axle and the counterweight to the wheel.</u>

   (b)   i. <u>It moves upwards with constant acceleration. Then after 10 seconds, it coasts at a constant velocity. Finally after 30 more seconds, it comes to a stop with constant deceleration.</u>

        ii. <u>0.35</u> $\mathrm{m\,s^{-1}}$

       iii. <u>2.5</u> m

(c)   i. <u>63.3 N</u>

       ii. <u>0.126 rad/s</u>

      iii. <u>2350 N</u>

5. (a)   i. <u>2810</u> N m

       ii. <u>80</u> %

      iii. <u>Water leaks from the blades before it reaches the bottom, waterwheel diameter less than the height of the flume, friction, etc.</u>

   (b)   i. <u>Advantage: [gears run smoother and quieter]; Disadvantage: [causes a thrust along the axis of the gear, greater sliding friction between the teeth, harder to manufacture/more expensive]</u>

       ii. <u>1.67</u>

      iii. <u>0.956</u> m

      iv. <u>770</u> W

6. (a) <u>7.2 (0.139 accepted)</u>

   (b) <u>Left: 102, right: 366</u> N

   (c) <u>$M = 360$</u> kg

     <u>$\mu = 180$</u> kg

   (d) <u>Downwards, 8.59</u> $\mathrm{m\,s^{-2}}$

7. (a)   i. <u>$4\csc(\theta)$</u> lbf

         <u>$90° - \theta$ from the horizontal, towards the door</u>

       ii. <u>Wood: 21.8°; plastic: 36.9°; rubber: 43.5°</u>

      iii. <u>Wood: 2.5; plastic: 1.33; rubber: 1.05</u>

   (b)   i. <u>5.60</u> s

       ii. <u>12.2</u> °

      iii. <u>-20.5</u> N