

2

6678 Mechanics M2 – June 2001

1. $\sqrt{20} \text{ m s}^{-2}$
2. (a) 6 cm (b) 22.6°
3. $k = \frac{6\sqrt{3}-1}{5}$ (1.88)
4. (a) $(-25\mathbf{i} - 5\mathbf{j}) \text{ m s}^{-1}$
(b) 32.9 m
(c) 51 m
5. (a) 1.45 (b) 1.36 m
6. (b) u (c) $e \leq \frac{2}{3}$
7. (a) $t = 4$ (b) $18 - \frac{1}{12}t^3$

3

6678 Mechanics M2 – January 2002

1. $R = 6.25$
2. (a) 0.15 m s^{-2} (b) 36 m s^{-1}
3. (a) 4.02 (b) $(67\mathbf{i} + 28\mathbf{j}) \text{ m}$
4. (b) $k = \frac{3}{55}$
5. (b) $x = \frac{2}{3}a$ (c) $\frac{22}{9}W$
6. (b) $0 \leq e < \frac{1}{2}$ (c) $\frac{5}{16}mu^2$
7. (a) 260 m (b) 7.1 s (d) 140 m

4

6678 Mechanics M2 – June 2002

1. (b) 11.2 m
2. (a) 9 m s^{-1} (b) 13.5 m s^{-1}
3. (a) 2168 N (b) 300 W
4. (a) 6.86 cm (b) 32.1°
5. (b) 21.8 m (c) 2.2 s
6. (a) $\frac{1}{4}(1 + e)u$ (b) $\frac{1}{3} < e < \frac{7}{9}$
7. (b) 68.2° (c) 0.646

5

6678 Mechanics M2 – January 2003

1. (b) $k = -1.1$
2. (a) $f = 0.08$ (b) $d = 81 \frac{2}{3}$ (c) Resistance may vary with speed
3. $\mu \geq \frac{1}{4}$
4. (b) $\lambda = \frac{11}{15}$
5. (a) $v = 2t^2 - 8t + 6$ (b) $2 \frac{2}{3} \text{ m}$
6. (b) $e = \frac{25}{32}$
(c) Q still has velocity and will *bounce back* from all colliding with stationary P .
7. (a) 14.8 N s (b) $v = 22 \text{ m s}^{-1}$ (c) 48°
(d) Air resistance; Wind (problem not 2 dimensional);
Rotation of ball (ball is not a particle)

6

6678 Mechanics M2 – June 2003

1. 9 m
2. (a) 5.8 Ns (b) 31° (c) 35 J
3. (a) $\frac{19a}{15}$ (b) $m = \frac{7M}{45}$
4. (b) 880 N
5. (b) 7 (c) $\frac{7}{4}$
6. (a) 324 W (b) 9.3 m s^{-1} (c) 32 N (d) 0.59 m s^{-2}
7. (a) $v_1 = \frac{u}{3}(1 - 2e)$; $v_2 = \frac{u}{3}(1 + e)$ (b) $e < \frac{1}{2}$

7

6678 Mechanics M2 – January 2004

4. 220
5. (a) 7.5 N (b) $39\mathbf{i} - 42\mathbf{j} \text{ m s}^{-1}$
6. (a) 8.4 m s^{-1} (b) 0.42
4. (a) $\frac{7W}{8}$
5. (b) 15 (c) 180 m
6. (b) $\left| \frac{u}{4}(1 - 3e) \right|$ (c) $\frac{1}{3}$
7. (b) $0.7a$ (c) 20° (e) $\frac{5mg\sqrt{65}}{4}$

8

6678 Mechanics M2 – June 2004

1. (a) 0.7 m s^{-2} (b) 44 400 kW
2. (a) $10\mathbf{i} + 20\mathbf{j} \text{ m s}^{-1}$ (b) 63.4° (c) 40 J
3. (a) $\frac{5}{6}$ (b) 14.6°
4. (a) $(2t^2 - 7t + 3)\mathbf{i} + (5 - 5t)\mathbf{j}$
5. (c) $f > \frac{1}{9}$
6. (b) $0.4 \text{ mg} \leq P \leq 13.6 \text{ mg}$
7. (a) $R = 52 \text{ N}$ (b) $t = 3 \text{ s}$ (c) 48 m (d) 24 m s^{-1}

9

6678 Mechanics M2 – January 2005

1. (b) $\frac{2}{3} \text{ W}$
2. (a) 10.7 cm (b) $\theta = 25^\circ$
3. (a) 41.0 J (b) 0.67
4. (a) 5.0 (b) 78 m
5. (b) 1.4 m s^{-2} (c) 850 N (d) 335 kJ (e) Resistances vary with speeds
6. (b) $\frac{2}{3} < e \leq 1$ (c) $e = \frac{7}{9}$
7. (a) 4.77 s (b) 122 m (c) 33.2 m s^{-1} (d) 39.6°

10

6678 Mechanics M2 – June 2005

1. (a) 35 m s^{-1} (b) 14.6 m s^{-1}
2. (a) 3 cm (b) $\frac{1}{7}$
3. (a) 4 (b) $-36\mathbf{i} + 8\mathbf{j}$
4. (a) 1.8 m (b) 6.75 m s^{-1}
5. (a) $\frac{2}{3}$
6. (a) 1020 N (b) 778 N
7. (a) 118 J (b) 10 N (c) 0.39 (d) 5.39 m s^{-1}

11

6678 Mechanics M2 – January 2006

1. (a) 96 J (b) 0.272
2. (a) 26 m s^{-1} (b) $\mathbf{v} = 30\mathbf{i} - 54\mathbf{j} \text{ m s}^{-1}$
3. (b) 20
4. (a) $\frac{2}{5}$ (c) $\frac{3}{4}$
5. (a) $\frac{2}{3}$ (c) $\frac{4}{9}$ (d) 83.7°
6. (b) $\frac{10}{7}$
7. (a) 1.05 s (c) 12

12

6678 Mechanics M2 – June 2006

1. 6 s
2. (a) 14.4 kW (b) 0.4 m s^{-2}
3. (a) 25.1 Ns (b) 18.9 m s^{-1}
4. (a) (i) $\frac{5}{2}a$ (ii) $\frac{4}{3}a$ (b) $\uparrow = 14.9^\circ$
5. (b) 3.5 s
7. (a) 22.4 J (b) 6.4 m s^{-1} (c) 4.27 m s^{-1}
8. (a) $\left(\frac{1+e}{5}\right)u, \left(\frac{4e-1}{5}\right)u$ (c) $\frac{3}{10}mu^2$

13

6678 Mechanics M2 – January 2007

1. (a) 50 J (b) $\mu \approx 0.32$
2. (a) 8.6 kW (b) $T \approx 21$
3. (a) $AG = 25 \text{ cm}$ (b) $\frac{3}{11}m$
4. (a) $8v$ (b) $k = 3$
5. (a) $32.7m$ (c) $\mu = \frac{3}{8}$
6. (a) $\mathbf{a} = (3t^2 - 6)\mathbf{i} + 4t\mathbf{j}$ (c) 6.5 (d) 157°
7. (b) 55.2° (c) 60 m

14

6678 Mechanics M2 – June 2007

1. $R = 3$
2. (a) $\mathbf{a} = 6\mathbf{i} - 4\mathbf{j}$ (b) $F \approx 6.3$
3. (a) $\frac{5a}{6}$ (b) $q \approx 35.5^\circ$
4. (a) PE lost = $\frac{7mgh}{5}$ (b) $v^2 = \frac{3}{5}gh$ (c) $\uparrow = 14.9^\circ$
5. (a) $AB = 45$ cm (b) $R \approx 55.9$ N
6. (a) $h = 40$ m (b) $A = 89.6$ m (c) $v = 54.6$ ms⁻¹
7. (c) No second collision
8. (a) $v = \frac{32}{3}$ m/s (b) 32 m (c) 8 s
(d) 52 m

19

6678 Mechanics M2 – January 2008

1. (a) 80 J (b) $R = 4$
2. (a) $(6t - 6)\mathbf{i} + (9t^2 - 4)\mathbf{j}$ m s⁻¹ (b) $t = \frac{2}{3}$
(c) $4\mathbf{i} - 7\mathbf{j}$ m s⁻¹
3. (b) $y = 102$
4. (a) (i) 7.58 (ii) 3.71 (b) 15°
5. $\mu = \frac{5}{16\sqrt{3}}$
6. (b) $u = 3$ (c) 34.5 m s⁻¹
7. (b) $\frac{9}{20}mu^2$ (c) $e > \frac{1}{4}$

16

6678 Mechanics M2 – June 2008

1. 11 kW
2. (b) $0.375mu^2$
3. (a) 304 (b) $\mu \approx 0.674$
4. (a) $\mathbf{v} = (6t^2 - 10t + 1)\mathbf{i} + \left(\frac{2}{3}t^3 - 2t^2 - 4\right)\mathbf{j}$ (b) 25 m s^{-1}
5. (b) $\mu = \frac{\sqrt{5}}{4}$
6. (b) $\bar{x} = \frac{16}{3}$, $\bar{y} = \frac{70}{27}$ (c) 26°
7. (a) 0.743 s (b) 1.1 m (c) 29 m s^{-1}

6678 Mechanics M2 – January 2009

1. 0.2 m s^{-1}
2. (a) 44g (b) $\beta = 56^\circ$
3. (a) 2800 J (b) 12 m s^{-1}
4. (a) 3.6 m (b) 7.2 m
5. (a) 4.69 cm (b) 3.06 cm (c) $\theta = 23^\circ$
6. (a) $p = 19.2$ (b) $q = 14.4$ (c) 24 m s^{-1}
(d) $\frac{3}{4}$ (e) 2.47 or 2.5
7. (d) $\frac{1}{5}d$

6678 Mechanics M2 – June 2009

1. (a) 23.5
2. (a) 16 (b) 12 seconds
3. (a) 1200 W (b) 3.6 m s^{-1}
4. (a) 62.4 N (b) 46.5 N at angle $\tan^{-1} \frac{1}{3} = 18.4^\circ$
5. (a) 50 cm (b) 50.2° (0.876 rads)
6. (b) 9.1 m s^{-1}
7. (b) 8.9 m s^{-1}
8. (b) $k = 3$

6678 Mechanics M2 – January 2010

1. $\frac{38}{27} \text{ m}$
2. (i) $u(1 - e)$ (ii) $u(1 + 2e)$
3. $R = 5.1$
4. (i) 9.01 N s (b) 106°
5. $R = 140 \text{ N}$ (b) $U = 1.6$
6. $R = 157 \text{ N}$
8. (b) (i) $R = 10c$ (ii) $H = 2.5c^2$ (c) $x = 5 \left(c + \frac{1}{c} \right)$

20

6678 Mechanics M2 – June 2010

1. (a) $T = \frac{2}{3}$
2. (a) 30.5 J (b) 0.50
3. (a) 2.5 cm (b) 11.8°
4. (a) $a = 0.2$
5. (a) 13 N s (b) 67.4° (c) 69 J
7. (a) 22.5° (b) 173 m (d) 48 m s^{-1}
8. (a) (i) $v = \frac{1}{4}u$ (ii) $w = \frac{5}{4}u$ (b) $V = \frac{1}{2}u$

21

6678 Mechanics M2 – January 2011

1. (a) $v = 12 \text{ m s}^{-1}$ (b) $a = 0.089 \text{ m s}^{-2}$
2. 29 J
3. (a) $v = t^4 - 6t^2 + 8 \text{ m s}^{-1}$ (b) $s = \frac{t^5}{5} - 2t^3 + 8t$
(c) $t = \sqrt{2}, t = 2$
4. (a) 8480 J (b) 10.2 m s^{-1}
5. (a) (i) 11 cm (ii) 11 cm (b) 24°
6. (b) $T = 2.03 \text{ s}$ (c) $v = 3\mathbf{i} + (5 - 9.8t)\mathbf{j} \text{ m s}^{-1}$ (d) $t = 0.82$
(e) $v = 4.24 \text{ m s}^{-1}$
7. 0.514

22

6678 Mechanics M2 – June 2011

1. (a) $V = 15$
3. (a) 14.6 m s^{-1} (b) 74° (c) 17 J
4. (a) $\frac{61}{27}a$ (b) 24°
5. (a) 6.7 m s^{-1} (b) 0.40
6. (a) $v = \frac{1}{2}t^2 - 4t + 6$ (b) $t = 6, t = 2$ (c) $5\frac{1}{3} \text{ m}$
7. (c) $\frac{9}{20}$
8. (b) 8.9 m (b) 6.4 m s^{-1}

23

6678 Mechanics M2 – January 2012

1. $10\mathbf{i} - 40\mathbf{j}$
2. (a) 48.7 m s^{-1} (b) $2\mathbf{i} - 24\mathbf{j} \text{ m s}^{-1}$ (c) $11\mathbf{i} - 62\mathbf{j}$
3. (a) 829 W (b) 28.6 m
4. (b) 43.9°
5. (a) 18.4 N (b) 0.29
6. (a) (i) $\frac{5u}{6}, \frac{u}{6}$ (c) $\frac{25}{36}u$
7. (a) $\frac{18}{g}$ (b) $6\sqrt{2} \text{ m s}^{-1}$ (c) $\frac{6}{g} \text{ s}$

24

6678 Mechanics M2 – June 2012

1. (a) 6.32 m s^{-2} (b) $25\mathbf{i} + 9\mathbf{j} \text{ m}$
2. (a) $\frac{u(2+9e)}{7}$ (b) $1 \geq e > \frac{1}{6}$
3. (a) $F = 35$ (b) 40, up
4. (b) $k = 6$
5. (i) 40 m s^{-1} (ii) perpendicular to original direction
6. (a) 2.3 m s^{-2} (b) 1400 (c) 60 m
7. (b) 17.2 m s^{-1} (c) 2.5 s

25

6678 Mechanics M2 – January 2013

1. (a) 0.1 (b) $\theta = 56.3^\circ$
2. (a) $R = 780$ (b) 45 000 W
3. $\mu = 0.43$
4. (a) $t = \frac{5}{4}$ (b) $(2t^2 - 5t + 2)\mathbf{i} + (3t + 5)\mathbf{j}$
(c) (i) $c = 4$ (ii) $d = 5$
5. (a) 3.4 J (b) $U = 5.6$ (c) 5.0 m s^{-1}
6. (b) $u = 9.7$ (c) $T = 2.3$ (d) $a = 74^\circ$
7. (a) (i) $v = \frac{u}{4}(3e - 1)$ (ii) $w = \frac{u}{4}(1 + e)$ (b) $\frac{3}{8} < e \leq \frac{1}{2}$
(c) no second collision

26

6678 Mechanics M2 – June 2013

1. 2.69 m s^{-1}
2. (a) 166 J (b) 13.7 m s^{-1}
3. (a) $t = 2$ or $t = 5$ (b) 20 m s^{-1} (c) 24 m
4. (a) 0.5 m (b) 10.9°
5. (b) $2mg - \frac{3amg \cos \theta}{b} \times \cos \theta$ (c) $\frac{a}{b} = \frac{2}{3}$
6. (a) $u = 7.2$ (b) $\theta = 53.3^\circ$ (c) 4.3 m s^{-1}
7. (b) $\frac{21}{40}u$ (c) $\frac{23u}{40}$

27

6678 Mechanics M2 – June 2013 (R)

1. (a) $15\,000 \text{ watts}$ (b) $T = 270 \text{ N}$
2. $v = 12$
3. (a) $t = 2 \text{ s}$ or $t = 4 \text{ s}$ (b) 4 m
4. (b) $\mu = \frac{\sqrt{3}}{5}$
5. (a) $v_Q = u$ (b) $e = \frac{1}{2}$
6. (b) $\frac{11h}{81}$ (c) $\tan \alpha = \frac{8h}{27a}$
7. (b) $\tan \theta_1 = 5, \tan \theta_2 = 1$ (d) $v = \sqrt{15ag}$