

# Leaving Certificate Applied Maths Higher Level Answers

## 2019

- 1) (a) (ii) 2.46 m, (iii) 1.88 m s<sup>-1</sup>. (b) (i) 7200 m, (ii) 2931.75 m, (iii) 0.54 m s<sup>-2</sup>. 2) (a) 6.08 km h<sup>-1</sup>, 65° S of W.  
 2) (b) (i) 48 mins, (ii) 15 mins. 3) (a) (i) 22.5°, (ii) 166 m, (iii) 46.8 m s<sup>-1</sup>. (b) (i) 3.06 s, (ii) 10.4 m s<sup>-1</sup>.  
 4) (a) (i) 3.36 N, (ii) 1.4 m s<sup>-1</sup>. (b) (ii) 7.92, 1.4. 5) (a) (i)  $\frac{u}{4}$ ,  $\frac{5u}{4}$ , (ii)  $\frac{14}{15}$ . (b) (i)  $\sqrt{17}u$ ,  $5u$ , (ii) 67.2°.  
 6) (a) (ii) 36.9°. (b) (iii) 2.1 m s<sup>-1</sup>. 7) (a) 46.5 N, 18.4°. (b) (i) 0.38, (ii)  $\frac{W}{\sqrt{3}}$ ,  $\frac{W}{2}$ .  
 8) (b) (i) 1.55m, (ii) 1.97 s, (iii) 0.97 m. 9) (a) 0.4, 1.2. 10) (a) (i) 2, -10, 15, (ii) 6 m s<sup>-2</sup>, (iii) 2.67 m. (b) (ii) 39.8 m.

## 2018

- 1) (b) (ii)  $\frac{3u^2}{2a}$ . 2) (a) (i) 6.1° E of N, (ii) 118.4 km. (b) (i) 60 s, (ii) 240 m. 3) (a) (ii) 62.5 m.  
 3) (b) (i)  $\frac{4u \sin \theta}{\sqrt{3}g}$ ,  $\frac{4u \sin \alpha}{\sqrt{3}g}$ , (ii)  $\frac{2u^2}{3g}(\sqrt{3}-1)$ . 4) (a) (i)  $\frac{g}{m+3}$  m s<sup>-2</sup>, (ii) 2 kg. (b) (ii)  $\frac{8mg}{8+m}$ , (iii) 8 kg.  
 5) (a) (i)  $\frac{u}{2}(3-7e)$ ,  $\frac{u}{2}(3+7e)$ . (b) (i)  $\frac{u}{5}\sqrt{4\cos^2 \alpha + 400\sin^2 \alpha}$ ,  $\frac{u}{5}\sqrt{49\cos^2 \alpha + 25\sin^2 \alpha}$ , (ii) 38.7°.  
 6) (a) (i) 3.7 m. (b) (ii) 7. 7) (a) 60°. 8) (b) (ii)  $\frac{55mr^2}{96}$ , (iii) 2.52. 9) (a) 68.375%. (b)  $\frac{1}{2}$ .  
 10) (a) 0.63. (b) (i)  $40n + (P-40n)e^{40}$ , (ii) 5 years.

## 2017

- 1) (a) 2. (b) (i)  $\sqrt{2gr}$ , (ii)  $\frac{d}{\mu}$ , (iii) 5 m. 2) (a) 4.07 m s<sup>-1</sup>, 79.4° N of E.  
 2) (b) (i) 15 km h<sup>-1</sup>, 30° S of E, (ii) 35.7°, (iii) 9.04 km. 3) (a) (i) 0°, 71.6°, (ii)  $\sqrt{\frac{2h}{g}}$  s,  $\sqrt{\frac{20h}{g}}$  s.  
 4) (a) (i)  $\frac{8mg}{5}$  N, (ii) 0.0136 m, (iii)  $\frac{6mg}{5}$  N. (b) (ii)  $\frac{1}{5}$ . 5) (a) (i)  $\frac{12}{7}$  m s<sup>-1</sup>, (ii)  $\frac{6}{7}$ . (b) (i)  $\frac{70v}{27\cos \alpha}$ , (ii) 50.2°.  
 6) (a) 1:  $\sqrt{2}$ . (b) (ii)  $\frac{mg}{2}$ ,  $2mg$ . 7) (a)  $\sqrt{39}$  N @ 73.9°,  $\sqrt{3}$  N →. 8) (b) (i)  $69ma^2$ , (iii) 120°.  
 9) (a) 19.5 cm<sup>3</sup>. (b) (i) 0.0574 m, (ii) 997 cm<sup>3</sup>. 10) (a) (i)  $\frac{5}{2}(1-e^{-10t})$ , (ii) 0.23 s, 0.35 m. (b) (ii)  $\sqrt{\frac{8gR}{5}}$ .

## 2016

- 1) (a) (ii) 5 m s<sup>-1</sup>, (iii) 107.5 m. 2) (a) (i) 11.5 km h<sup>-1</sup>, (ii) 17.1° E of N, 72.9° E of N. (b) (i) 150 s, (ii) 187.5 s.  
 3) (a) (i) 1 s, (ii) 0.65 m, (iii) 30.9 m s<sup>-1</sup>. (b) 0.5. 4) (a) (i) 1.92 m s<sup>-2</sup>, 3.84 m s<sup>-2</sup>, (ii) 1.07 m s<sup>-1</sup>.  
 4) (b) (i) 62.4 N, (ii) 0.90 s. 5) (a) (ii) 0.22 m s<sup>-1</sup>, 3.10 m s<sup>-1</sup>, (iii) 41°. (b) (i)  $3\vec{i} + 2\vec{j}$ ,  $2\vec{i} - 2\vec{j}$ , (ii) 52°.  
 6) (a) (i) 9.90 m s<sup>-1</sup>, (ii) 80.4°. (b) (ii) 2.42 m s<sup>-1</sup>, (iii) 0.55 s. 8) (b) (i) 1.488 kg m<sup>2</sup>, (ii) 117.9 J, (iii) 11.35 m.  
 9) (a)  $h = \frac{4M}{\rho\pi d^2}$ . (b)  $1 - \sqrt{1-s}$ . 10) (a) (ii) 40.7 m. (b) (i)  $v = \omega\sqrt{A^2 - x^2}$ , (ii)  $x = A\sin\left(\omega t + \frac{\pi}{2}\right)$ .

## 2015

- 1) (a) 57 m. (b) (i) 3.5 s, (ii) 48.86 m. 2) (a) (i) 97.2 km h<sup>-1</sup>, 19.1° N of W, (ii) 655 m. (b) (i) 8.20 m s<sup>-1</sup>, 19.5°.  
 3) (a) (i) 27.7 or -0.125, (ii) 10.1 s or 0.373 s, (iii) 0.21 m. 4) (a) (i) 2.94 m s<sup>-2</sup>, (ii) 4.2 m s<sup>-1</sup>, (iii) 3 m s<sup>-1</sup>.  
 4) (b) (i) 2.00 m s<sup>-2</sup>, (ii) 220.5 N. 5) (a) (ii)  $\frac{19}{80u}$ . 6) (a) (i)  $\frac{mg}{d}$ , (ii)  $2\pi\sqrt{\frac{d}{g}}$ . (b) 21.6°.  
 7) (a) (i)  $\frac{3W\sqrt{c^2 + l^2}}{2c}$ , (ii)  $\frac{W}{2c}\sqrt{9l^2 + c^2}$ . (b) (i)  $\frac{7W}{4}$ ,  $\frac{5W}{4}$ , (iii) 0.6. 8) (b) (i)  $x + \frac{1}{12x}$ , (ii)  $\frac{1}{2\sqrt{3}}$  m, (iii) 1.53 s.  
 9) (a) 8676 kg m<sup>-3</sup>. (b) (i) 482.8125, (ii) 0.1627 m.  
 10) (a) (i) 16 m s<sup>-1</sup>, (ii) 16 m. (b) (i)  $F + 74x + 0.55x^2 + 0.01x^3$ , (ii) 32,800, (iii) 2,695.

**2014**

- 1) (a) (i)  $24 - \frac{1}{2}t^2$ , (ii) 18.375 m. (b) (i)  $0.527 \text{ m s}^{-2}$ , (ii)  $23.74 \text{ m s}^{-1}$ . 2) (a) (i) 18:00, (ii) 18:51.  
 2) (b) (i)  $25 \text{ km hr}^{-1}$ ,  $73.74^\circ$ , (ii) 91 km. 3) (a)  $28.15 \text{ m s}^{-1}$ . 4) (a) (i)  $3.91 \text{ m s}^{-2}$ , (ii) 140.96 N. (b) (ii)  $\sqrt{\frac{7}{10g}}$  s, 0.22 m.  
 5) (a) (ii)  $\frac{7}{8}mu^2$ . (b) (i) 0.484, (ii) 6.93. 6) (a) (i)  $3158.27 \text{ N m}^{-1}$ , (ii) 47.4 N. (b) (i)  $4.233\sqrt{d}$ , (ii)  $4.06m$ .  
 7) (a) (i) 12.75 cm, 14.75 cm, (ii)  $26.79^\circ$ . (b) (ii) 0.62, (iii)  $73.4 \text{ N}$ ,  $10.0^\circ$ . 8) (b) (i)  $2\pi\sqrt{\frac{3r}{2g}}$ , (ii) 15.  
 9) (a)  $3200 \text{ kg m}^{-3}$ ,  $4800 \text{ kg m}^{-3}$ . (b) (i) 45.2, (ii) 160 N, (iii)  $428.6 \text{ kg m}^{-3}$ .  
 10) (a) (i)  $4.225 \text{ m s}^{-1}$ , (ii) 0.33 m. (b) (i) 1 s, 2 s, (ii)  $\frac{1}{3}t^3 - \frac{3}{2}t^2 + 2t + 1$ , (iii) 1 m.

**2013**

- 1) (a) 7 s. 2) (a) (i) 36 m, (ii)  $53.13^\circ$ . (b) W  $60^\circ$  S. 3) (a) (ii)  $30^\circ$ . (b)  $31.7^\circ$ .  
 4) (a) (i)  $\frac{84g}{13} \text{ N}$ , (ii)  $\frac{189g}{26} \text{ N}$ . (b)  $\frac{4m_1m_2m_3g}{m_1m_3 + m_2m_3 + 4m_1m_2}$ . 5) (a) (i)  $\frac{u}{8}(3-5e)$ ,  $\frac{3u}{8}(1+e)$ , (ii)  $\frac{1}{15}$ .  
 5) (b) (i)  $\frac{1}{2}$ , (ii)  $\frac{1}{3}$ , (iii) 3.33 cm. 6) (a) (i) 0.49, (ii)  $\frac{\pi}{\sqrt{5}}$  s. (b) (i)  $m(l\omega^2 + g)$ ,  $m(l\omega^2 - g)$ , (ii)  $\sqrt{\frac{6l}{g}}$ .  
 7) (a)  $62.18^\circ$ . (b) (i)  $\frac{W(4-b)}{2}$ ,  $\frac{W(2+b)}{2}$ . 8) (b) (i)  $2\pi\sqrt{\frac{5r}{3g}}$ , (ii)  $\frac{5r}{3}$ .  
 9) (a)  $0.0001 \text{ m}^3$ ,  $0.0004 \text{ m}^3$ . (b) 400. 10) (a) 1.5, (b) (i)  $60 \text{ m s}^{-1}$ , 36 m, (ii)  $\frac{10}{3}$  s. (c) 79.3 mins.

**2012**

- 1) (a) 44.1 m. (b) (i) 40 s, (ii) 352 m. 2) (a)  $82.55^\circ$ . (b) (i)  $25 \text{ km hr}^{-1}$  at  $16.3^\circ$  E of N, (ii) 13:21, (iii) 1 hr 9 min.  
 3) (a) (i)  $36.9^\circ$  &  $53.1^\circ$ , (ii) 4 s. (b) (i)  $60^\circ$ , (ii)  $70 \text{ m s}^{-1}$ . 4) (a) (i)  $\sqrt{\frac{2g}{13}}$ , (ii)  $\frac{1}{11}$  m. (b) (i)  $\frac{4mg(1+\mu)}{5}$ , (ii)  $3f - 2g$ .  
 6) (a) (i)  $\frac{\pi^2}{5} \text{ m s}^{-1}$ , (ii) 5.9 N. (b) (i)  $1.4 \text{ m s}^{-1}$ , (ii) 0.93. 7) (a) 1.316. 8) (b) (i)  $\frac{mgl}{I + mr^2}$ , (ii)  $8m$ .  
 9) (a) 7.79. (b) (i) 1.2 m, (ii)  $60^\circ$ . 10) (a) (i) 0.0405, (ii)  $41.8^\circ$ .

**2011**

- 1) (a)  $\frac{7}{8}$  s. (b) (ii)  $t_1 + t_2 = t$ , (iii)  $\frac{31}{12}t$ . 2) (a) (i)  $\sqrt{65} \text{ m s}^{-1}$  at  $82.9^\circ$  S of W, (ii) 49.6 m. (b)  $28.955^\circ \leq \theta \leq 60^\circ$ .  
 3) (a) (i) 50, (ii)  $71.6^\circ$ . (b) (i)  $56.3^\circ$ , (ii)  $\frac{1}{\sqrt{2}}$ . 4) (a)  $2.15 \text{ m s}^{-2}$ . (b) 73 N, 21.9 N, 24 N.  
 5) (a) (ii)  $\frac{1}{4} < e < 1$ . (b) (i)  $\frac{1-e}{2}$ , (ii)  $\frac{3}{4}$ . 6) (a) (ii) 2.6 m,  $4 \text{ rad s}^{-1}$ , 0.395 rad. (b)  $7 \text{ rad s}^{-1}$ . 7) (a) (ii)  $2800 \text{ N m}^{-1}$ .  
 8) (b) (i)  $3.19 \text{ rad s}^{-1}$ , (ii) 1.74 s, 0.75 m. 9) (a)  $2.88 \times 10^{-6} \text{ m}^3$ . (b)  $\frac{3}{7}$ . 10) (a) 66.23. (b) (i) 44.63 m, (ii)  $19.24 \text{ m s}^{-1}$ .

**2010**

- 1) (a) (i)  $-1 \text{ m s}^{-2}$ , (ii)  $-\frac{7}{6} \text{ m s}^{-2}$ . (b) 300 m. 2) (a) (i)  $\sqrt{17} \text{ m s}^{-1}$  at  $75.58^\circ$  S of E. (b)  $12.5 \text{ m s}^{-1}$  from East.  
 3) (a)  $4.9\sqrt{5} \text{ m}$ . (b) (i)  $23.4^\circ$ , (ii)  $20\sqrt{7} \text{ m s}^{-1}$ . 4) (a) (i) 2.4 N, (ii)  $0.8 \text{ m s}^{-1}$ . (b) (ii)  $\frac{3}{11} \text{ g m s}^{-2}$ .  
 5) (a) (i)  $\frac{u(1-3e)}{4}$ ,  $\frac{u(1+e)}{4}$ , (ii) 70.3%. (b) (i)  $\frac{3+k}{2+4k}$ . 6) (a) (i)  $\sqrt{\frac{4g}{3}}$   $\text{m s}^{-1}$ , (ii)  $\sqrt{8g} \text{ m s}^{-1}$ .  
 6) (b) (i)  $\frac{3\pi}{8} \text{ m s}^{-1}$ , (ii)  $\frac{2}{3}$  s. 7) (b) (ii)  $\frac{5}{4}W$ , (iii)  $2W$ . 8) (b) (ii)  $\sqrt{\frac{ga}{3a^2+b^2}}$ . 9) (a)  $1250 \text{ kg m}^{-3}$ .  
 9) (b) (i)  $\frac{5}{9}$ , (ii)  $\frac{2}{5}W$ . 10) (a)  $y = \sqrt{e^{x^2} - 1}$ . (b) (i)  $5.18 \text{ m s}^{-1}$ , (ii) 45.3 s.

**2009**

- 1) (b) (ii) 1.                      2) (a) (i) 160 m, (ii) 128 m, 96 m. (b)  $\frac{uT}{\sqrt{u^2 - 16} + 4}$ .                      3) (a) (i)  $\frac{10\sqrt{10}}{7\cos\alpha}$  s.
- 4) (a) (i)  $\sqrt{\frac{2g}{3}}$  m/s, (ii)  $\frac{4}{3}$  m. (b) (i)  $\frac{3m_1m_2g}{4m_1 + m_2 + m_1m_2}$  N, (ii) 1.                      5) (a) (i)  $\frac{u(4-2e)}{3}$ ,  $\frac{u(4+e)}{3}$ , (iii)  $\frac{1}{3}$ .
- 5) (b) (ii) N,  $80.1^\circ$  W of N, (iii) 13.5%.                      6) (a) (ii) 3.03 cm/s. (b)  $\frac{900\mu g}{\pi^2 N^2}$ .                      7) (a) 15 cm. (b)  $\frac{W}{2}$ .
- 8) (b) (i)  $6ml^2$ , (ii)  $\sqrt{\frac{g}{3l}}$ . 9) (a) 8 cm. (b) (i)  $1 - \sqrt{1-s}$ , (ii)  $\frac{W}{3}$ . 10) (a)  $y = \sqrt{4x^2 - 1}$ . (b) (i)  $\sqrt{\frac{3g}{k}}$ , (ii)  $\frac{1}{g}$ .

**2008**

- 1) (a) (i) 4 s, (ii) 83.3 m. (b) (i)  $\frac{5}{24}$  m/s<sup>2</sup>,  $\frac{1}{2}$  m/s<sup>2</sup>, (ii) 48 m/s, (iii) 525 m.
- 2) (a) (i) 2.5 m/s  $53.13^\circ$  S of E, (ii) 64 m. (b) from  $71.6^\circ$  W of N.                      3) (b) 4.                      4) (b) (ii)  $\frac{\sqrt{3}g}{19}$ .
- 5) (a) (i)  $1-e$ ,  $\frac{1}{2}(1-e^2)$ ,  $\frac{1}{2}(1+e)^2$ .                      6) (a) (ii) 1.68 m/s, 10.8 m/s<sup>2</sup>. (b)  $\sqrt{\frac{3g}{2}}$ .                      7) (a)  $\frac{7}{4}$ . (b)  $\frac{2}{3}$ .
- 8) (b) (i)  $\frac{g}{6}$ , (ii) 49 N, 45.7 N.                      9) (a) 1.06 m. (b) (i) 0.8, (ii) 0.147 N, (iii) 2.18 cm.
- 10) (a) 1. (b) (i) 3200, (ii) 15.0 m/s.

**2007**

- 1) (a) (i) 5.4 m/s, (ii) 100 m. (b) (ii) 1.                      2) (a) (i) 40 km/hr  $53.13^\circ$  N of E, (ii) 24 mins. (b) 48.04 m.                      3) (a)  $15^\circ$ ,  $75^\circ$ .
- 4) (a) 2.15 s. (b) (ii)  $T = \frac{48mg}{5m+48}$ .                      5) (a) (i)  $v_1 = 6-3e$ ,  $v_2 = 6+2e$ . (b) (i)  $u \sin \alpha$ ,  $\frac{1}{2}u \cos \alpha$ , (ii)  $90-\alpha$ ,
- 5) (b) (iii)  $u^2 \cos^2 \alpha$ .                      6) (a) (ii)  $2\pi \sqrt{\frac{d}{g}}$ .                      7) (a)  $\frac{7W}{10\sqrt{3}}$ . (b) (ii) 80g N.                      8) (b) (i)  $\sqrt{2}$ , (ii) 5.87 m/s.
- 9) (a) 27.2 cm. (b) (i) 1.075, (ii) 0.032 kg.                      10) (a)  $y = \frac{1}{1+\cos x}$ . (b) (i) 44.12 m/s, (ii) 56.57 m s<sup>-1</sup>.

**2006**

- 1) (a) (ii)  $d = \frac{3}{8}ft^2$ . (b) (i)  $15t + 0.15t^2$ ,  $10t + 0.1t^2$ , (ii) 6 s, (iii) 3.1 s.
- 2) (a) (i) 163.2 km/hr, (ii) 282.84 km/hr West. (b) (i) 8 m, 4 m, (ii)  $41.41^\circ$ , (iii) 5.3 m.
- 3) (a) (i)  $\vec{r} = (9.8t)\vec{i} + (29.4t - \frac{1}{2}gt^2)\vec{j}$ ,  $\vec{v} = (9.8)\vec{i} + (29.4t - gt)\vec{j}$ , (ii)  $\theta = \tan^{-1}(3-t)$ , (iii) 4 s, 5 s. (b)  $\frac{2u^2}{3g}$ .
- 4) (a) (i)  $\frac{g}{9}$  m/s<sup>2</sup>, (ii) 0.30 s. (b) (iii)  $30^\circ$ .                      5) (a) (i)  $\frac{7-5e}{2}$ ,  $\frac{7+3e}{2}$ , (ii) 15. (b) (i)  $\frac{u}{2}(1-e)$ ,  $\frac{u}{2}\sqrt{e^2+2e+5}$
- 6) (a) (i) 3.78 m/s<sup>2</sup>, (ii) 3.24 s. (b) 0.43 m.                      7) (a) (i) 163.3 N, (ii) 163.3 N,  $36.87^\circ$ . (b)  $2\lambda$ .
- 8) (b) (i) 3.5 rad/s, (ii) 5.25mg N.
- 9) (a) (i)  $0.65 \text{ cm}^3$ , (ii) 1.6. (b) (i)  $\frac{4000\pi a^3 g}{3}$ .                      10) (a)  $y = \frac{e^{x+1}}{1+x}$ . (b) (i) 0.66 m/s, (ii) 1.73 s.

**2005**

- 1) (a) (i) 33.3 m, (ii) 43.3 m. (b) (i) 39278.4 N, (ii) 0.245 m.                      2) (a)  $\frac{10u}{\sqrt{u^2 - v^2}}$ . (b) (i)  $10\sqrt{2}$  m/s, (ii) 11 m.
- 3) (a)  $\frac{3}{4}$ . (b) (i)  $\frac{u^2}{g \cos \beta} \sin 2\alpha - \frac{2u^2 \sin \beta}{g \cos^2 \beta} \sin^2 \alpha$ .                      4) (a) (i)  $\frac{10g}{3}$  N, (ii) 46.2 N.
- 5) (b) (i)  $\frac{u}{\sqrt{2}}\sqrt{1+e^2}$ ,  $\frac{u}{\sqrt{2}}\sqrt{1+e^2}$ .                      6) (a)  $2\pi\sqrt{\frac{h}{g}}$ .                      7) (a) 180.1 N. (b)  $\frac{3}{5} \tan \theta$
- 9) (a) (i)  $45 \text{ cm}^3$ , (ii) 0.081 kg.                      10) (a)  $y = xe^{x-1}$ . (b) (ii) 11.76 m/s, (iii) 1945.5 J.

**2004**1) (a) (ii) 25 m, 16 m. (b) (i) 1.1 m/s<sup>2</sup>, (ii) 6°.

2) (a) (i) 35° E of N, (ii) 8.16 s. (b) (i) 8.06 m/s 82.87° S of E, (ii) 25 m, (iii) 4.6 s.

3) (a) 40 m 4) (a) (i)  $\frac{1}{3}g$  m/s<sup>2</sup>, (ii)  $\frac{3v^2}{g}$ . (b) (ii)  $\frac{14g}{11\sqrt{2}}$  m/s<sup>2</sup>, (iii) 0.3 m.5) (a) (i)  $\frac{u}{8}(3-5e)$ ,  $\frac{3u}{8}(1+e)$ , (ii)  $e > \frac{3}{5}$ . (b) (i) 60°, (ii)  $\frac{1}{3}$ . 6) (a)  $\frac{8r}{15}$ . (b) (ii) 13,  $\frac{\pi}{8}$ , 1.176.7) (a)  $\frac{1}{2}l$ , (b) (i)  $\frac{W\sqrt{3}}{4}$ , (ii) 0.84W. 8) (b) (i) 1.08 J, (ii) 0.62 m.9) (a) 8 cm. (b) (i)  $\frac{1}{3}$ , (ii)  $\frac{W}{2}$ . 10) (a)  $y = e^{-\frac{1}{x}+1} + 4$ . (b) (ii)  $\frac{2}{g}$ .**2003**1) (a) (ii) 51 m. (b) (i) 4 m/s. 2) (a)  $10\sqrt{5}$  km/h, W26.6°S. (b) (i) 9.01 m/s, 73.9° S of E, (ii) 288 m, 115 m.3) (a) 38.7°. (b)  $\frac{u^2}{g \cos^2 \beta} \{ \sin(2\alpha - \beta) - \sin \beta \}$ . 4) (a)  $\frac{g}{2}$  m/s<sup>2</sup>. (b) (ii) 1.65 m.5) (a) (i)  $\frac{u}{16}(3-13e)$ ,  $\frac{3u}{16}(1+e)$ , (ii)  $0 \leq e < \frac{1}{3}$ . (b) (ii)  $\frac{1}{2}$ . 6) (a) (i) 4 cm, (ii)  $2\sqrt{7}$  cm/s. (b) (ii) 63.6°.7) (a) (iii)  $\frac{3}{5}$ . 8) (b) (i)  $2\pi\sqrt{\frac{3l}{g}}$ , (ii)  $\sqrt{3}l$ . 9) (a) (iii)  $150\sqrt{10}g$  N. (b) 12 cm.10) (a)  $y = (2x^2 - 3)^{\frac{1}{4}}$ . (b) (ii) 1.65 s.**2002**

1) (a) (i) 18.5 m/s, (ii) 30.5 m/s. 2) (a) (i) 8660 m, (ii) 1960 s. (b) 26 km/hr, 61° N of E.

3) (a) (ii) 45°. 4) (a) 7 cm. (b) (i)  $\frac{3g}{4}$ , (ii) 3 N. 5) (a) 0.58. 8) (b) (ii)  $14960\pi^2$  J.9) (a)  $\frac{8}{17}$ . (b)  $\frac{8}{25}$ . 10) (a)  $y = \ln(e^x + 3)$ . (b) (i)  $\ln 3$  s or 1.1 s, (ii) 63.63 m, (iii) 100 m/s.**2001**1) (a) 75 s, 60 s. 2) (b) 388 km. 3) (a) 14.7 m/s. (b)  $\frac{3h}{2}$ .4) (ii)  $\frac{7g}{13}$  m/s<sup>2</sup>,  $\frac{3g}{13}$  m/s<sup>2</sup>,  $\frac{2g}{13}$  m/s<sup>2</sup>,  $\frac{2g}{13}$  m/s<sup>2</sup>, (iii)  $\frac{2}{3}$  m. 5) (a) (i)  $\frac{u}{5\sqrt{2}}\sqrt{29-12e+9e^2}$ ,  $\frac{\sqrt{2}u}{5}(1+e)$ .6) (a) (i)  $A = \sqrt{\frac{52}{3}}$  cm,  $T = \frac{2\pi}{\sqrt{3}}$ , (ii)  $2\sqrt{13}$  cm/s. (b) (i)  $\frac{5l}{4}$ , (ii)  $\frac{\pi}{3}\sqrt{\frac{l}{g}}$ . 7) (b) 4W.8) (b)  $\frac{5}{4}mr^2$ ,  $\omega = \sqrt{\frac{8g \sin \theta}{5r}}$ ,  $\omega_{\max} = \sqrt{\frac{8g}{5r}}$ . 9) (a) 0.0014 m<sup>3</sup>, 0.0002 m<sup>3</sup>.10) (a)  $\frac{d}{dx}\left(\frac{y}{x}\right) = \frac{1}{x} \frac{dy}{dx} - \frac{y}{x^2}$ ,  $y = x(1 + \ln x)$ .**2000**1) (a) 56 m/s. (b) (i) 215 s, 4875 m, 5125 m, (ii)  $q$ , 10 s. 2)  $30^\circ$ ,  $\frac{4a}{u\sqrt{3}}$ , (i)  $a$ , (ii)  $\frac{7a}{\sqrt{3}}$ ,  $\frac{5a}{\sqrt{3}}$ .3) (a) 45°. (b) 26.6° or 45°. 4) (a) 4.9 m. (b) (iii)  $3\sqrt{2}$  m/s.6) (a)  $2\sqrt{g}$  rad/s. (b) (i)  $\frac{k+0.3g}{2k}$ ,  $\frac{k-0.3g}{2k}$ , (ii) 0.3g, (iii)  $\pi\sqrt{\frac{0.6}{k}}$ .7) (a) (ii)  $\frac{3l}{2}$ . (b) (ii)  $\frac{W}{2\cos \alpha}(16\cos^2 \alpha - 15)$ . 8) (b) (i) 14 m/s, (ii) 4.29 s. 9) (a) 0.4 cm.10) (a) 2.32. (b) (i)  $\frac{3}{2}\left(\frac{1}{\sqrt{e}} - \frac{1}{e}\right)$ , (ii)  $\frac{3}{2}\left(1 - \frac{1}{e}\right)$ .

**1999**

- 1) (a) (i) 744 N (ii) 14880 W (b)  $4/t$  (ii) 75.76 m  
 2) (a) 50.8 m/s (b) (i)  $53.13^\circ$  S of W (ii) 18 km 3) (a) (i)  $\tan^{-1} \frac{1}{2}$  or  $45^\circ$  (b) (i) 4g  
 4) (a) (i)  $g/8$  (ii) 0.225g and 0.35g (b) (iii) 10g/17  
 5) (a) (ii) Both collisions occur at the same spot (b)  $4.324 \text{ m/s}$ ,  $\tan^{-1} \frac{29}{39\sqrt{3}} = 23.23^\circ$   
 6) (a)  $x = \sqrt{66} \sin(4t + 1.4)$  or  $x = \sqrt{66} \cos(4t + 0.175)$  (b) (i) 0.48 m from p (ii)  $a = -250x$   
 7) (b)  $\tan^{-1} 6$  8) (b) (i) 0.83 m (ii) 0.18 (iii) 0.24 m from centre  
 9) (a) 1.15 (b) 0.01408 kg 10) (a)  $v = \tan\left(\frac{\ln x}{7}\right)$  (b) (i) 138.65 m/s (ii) 12.7%

**1998**

- 1) (a)  $\frac{4}{5}$  (b) (i)  $u = 0.1$ ,  $b = 1$ , (ii) 94.5 m.  
 2) (a) (i)  $59.4^\circ$  N of W, (ii) 264.1 s. (b) (i)  $39.5^\circ$  or  $18.6^\circ$  N of E, (ii) 22 s or 44 s.  
 3) (a) (i)  $\tan^{-1} 3$  or  $45^\circ$ . (b) (i)  $44.4^\circ$ , (ii)  $45^\circ$ . 4) (a) (i)  $2.57 \text{ m/s}^2$ , (ii) 15.9 N. (b) 35.75g.  
 5) (a) (ii)  $e = \frac{3m_1 - m_2}{4m_2}$ . (b)  $\frac{7\sqrt{g}}{11}$ . 6) (a) (ii) 25. (b) (ii) 0.5 m. 8) (c) (ii) 2.8l.  
 9) (a) (i) 0.1875g N, (ii)  $\frac{1}{7}$ . 10) (a)  $v = 18/5e$ .

**1997**

- 1) (a) (i) 6.5, (ii) 21 m. 2) (ii)  $0.84\vec{i} + 1.12\vec{j}$  3) (a) (i)  $\sqrt{30g}$ , (ii)  $\sqrt{300g}$ ,  $\tan^{-1} \frac{1}{3}$ . (b) (ii) 15.31 m.  
 4) (a) (i)  $\frac{2g}{m+2}$ , (ii)  $m = 3$ . (b) (i)  $2T - kmg = kma$ ,  $mg - T = m(2a)$ , (iii)  $T = \frac{1}{3}mg$ .  
 5) (a) (i)  $2u$ . (b) (i)  $\frac{\sqrt{3}u}{4}(1-e)\vec{i} + \frac{u}{2}\vec{j}$ ,  $\frac{\sqrt{3}u}{4}(1+e)\vec{i} + 0\vec{j}$ , (ii)  $e = \frac{1}{3}$ . 6) (i)  $T = \frac{mg}{2\sin\beta}$ , (iii)  $\beta = 30^\circ$   
 7) (a) (i)  $T = \frac{13}{10}W$ , (ii)  $k = \frac{125}{6}W$ . (b) (i)  $T = \frac{\sqrt{7}}{2}W$ , (ii) 75 cm. 9) (a)  $2.36 \text{ m}^2$ . (b) (i) 7.5 kg, (ii) 0.5.  
 10) (a) 0.82. (b) (i) 0.5 m/s, (ii)  $\frac{8}{225} \text{ s}$ .

**1996**

- 1) (a) (i)  $3.5 \text{ m/s}^2$ , (ii)  $|oa| = 7 \text{ m}$ . 2) (i)  $79.45^\circ$  S of E, (ii) 44.5 km/hr, (iii) 12 km, (iv) 0.54 hr.  
 4) (ii) 7 kg:  $\frac{g}{29}$ , 5 kg:  $\frac{8g}{29}$ , 3 kg:  $\frac{6g}{29}$ , (iii)  $m = \frac{35}{9}$ . 6) (a) (i) 0.8, (ii) 0.9 m, (iii)  $22.36 \text{ m/s}^2$ . 7) (a)  $\frac{4W}{3}$   
 8) (b) (i)  $\sqrt{\frac{16rg + 3p^2}{12r^2}}$ , (ii)  $\sqrt{\frac{16rg}{3}}$ . 9) (b) 2 and 3. 10) (a)  $y = e^{4\sin x}$

**1995**

- 1) (a) (i)  $5u$ . (b) (i)  $\sqrt{6g}$ , (ii)  $\sqrt{\frac{2}{3g}}$ , (iii)  $\frac{5}{3}$ ,  $\frac{8}{3}$ , 3 m.  
 2) (a) (i)  $64 - 6t$ ,  $62 - 8t$ , (ii) 4, 13.6 (b) (i)  $p = 0.6$ ,  $q = 0.45$ , (ii) 357.14 s.  
 3) (a) (i) 14.7 m and 9 m, (ii) 7.056 m, (iii) 12.6 m/s. (b) (i)  $40.9^\circ$ , (ii)  $\tan\beta < 0$ ,  $\beta$  is obtuse.  
 4) (i)  $\frac{g}{9}$ , (ii)  $\frac{g}{9}$ , (iii)  $\frac{g}{11}$ , (iv)  $\frac{g}{22}$ . 5) (a) (i)  $v_1 = u(1-3e)$ ,  $v_2 = u(1+2e)$ , (ii)  $e > \frac{1}{3}$ ,  $\Rightarrow v_1 < 0$  and  $v_2 > 0$   
 9) (a) 0.5 litres. (b) (i)  $\frac{2}{3}$ , (ii) 0.098 N, (iii)  $128 \text{ cm}^3$ . 10) (a)  $y = \sqrt{8\tan^{-1}x + 1}$

**1994**

- 1) (a) 33.6 m. (b) (i)  $9g$ , (ii)  $2f = \frac{98}{45} \text{ m/s}^2$ .  
 2) (a) (i)  $-3\vec{i} + 4\vec{j}$ , (ii) 32 m, 24 m. (b) (i)  $-(3+0.1t)\vec{i} + (4-qt)\vec{j}$ , (ii) 0.2.  
 3) (a) (i) 10.5, 21, (ii) 30 m. (b) (i) 12.12 m/s, (ii) 12.36 m/s. 4) (ii)  $\frac{11mg}{13}$ , (iii)  $\frac{44g}{117}$ .  
 6) (i) 3.6 m/s, (ii) 6.68 N, (iii) 1.132 m. 7) (i)  $W$ ,  $\frac{1}{2}W \tan \phi$ . 8) (i)  $2\pi \sqrt{\frac{72r}{19g}}$ .  
 9) (a) (i)  $194.175 \text{ m}^3$ , (ii) 57,085 N. 10) (a)  $y = \frac{(1+x)^2}{e^x}$ . (b) (ii) 6.44 s.

**1993**

- 1) (a) (i)  $a = 3 \text{ m/s}^2$ ,  $u = 1.5 \text{ m/s}$ . (b) (i) 2 s, (ii) 109.6 m.  
 2) (a) 15.556 m/s, SW. (b) (i) straight across, (ii) 90 s, (iii) 75 m.  
 3) (b) (i)  $\vec{v} = \left(\frac{\sqrt{3}u - gt}{2}\right)\vec{i} + \left(\frac{u - \sqrt{3}gt}{2}\right)\vec{j}$ ,  $\vec{r} = \left(\frac{\sqrt{3}ut - gt^2}{2}\right)\vec{i} + \left(\frac{ut - \sqrt{3}gt^2}{4}\right)\vec{j}$ , (ii)  $60^\circ$ . 5)  $\frac{3mu^2}{20}$ .  
 6) (a) (i)  $\frac{16\pi}{\sqrt{7}}$ , (ii) 0.9354 m/s. (b) (ii)  $\frac{l}{24}$ . 8) (b) (ii) 2.54 s. 9) (a) 15 cm. (b) (ii)  $\frac{2l}{5}$ .  
 10) (a)  $y = \sqrt{18} - 1$ . (b) (ii) 20 m.

**1992**

- 1) (a) 176.4 m. (b) (i) after 3 s and 17 s, (ii) 24.5 m. 2) (i)  $9^\circ \text{ E of N}$ , (ii) 6.125 hours, (iii) 6 hours.  
 3) (i)  $\tan^{-1}\left(\frac{2}{3}\right)$ ,  $\tan^{-1}\left(\frac{10}{3}\right)$ . 5) (ii)  $-\frac{\sqrt{3}u}{6}\vec{i} + \frac{u}{2}\vec{j}$ ,  $\frac{\sqrt{3}u}{6}\vec{i} - \frac{u}{2}\vec{j}$ , (iii)  $\frac{2}{3}$ .  
 6) (a) (ii) 13. (b) (ii)  $\frac{\sqrt{7}\pi}{14} \text{ s}$ , (iii)  $\frac{4\sqrt{7}}{7} \text{ s}$ . 7) (b) (ii)  $\frac{W(2\mu \tan \alpha - 1)}{1 - \mu \tan \alpha}$ . 8) (b)  $2\pi \sqrt{\frac{5r}{3g}}$ .  
 9) (a) 0.03 m. (b) (i) 2066g, (ii) 2200g. 10) (a) 2. (b) (i)  $\ln 9$ , (ii)  $\frac{70}{\ln 3}$ .

**1991**

- 1) (a) (i) 3600 m, (ii) 40 s. (b)  $\frac{2u - 19.6}{0.5u + 19.6}$ . 2) (ii)  $0.3u$ ,  $56.3^\circ \text{ S of W}$ . 3) (i)  $\frac{2u^2}{g}$ , (ii) 1.  
 4) (i)  $\frac{2mg}{3} \text{ E}$ ,  $\frac{\sqrt{2}mg}{3} \text{ E}$ , (ii)  $\frac{1}{2}$ . 5) (b) (i)  $(3-e)\vec{i} + 5\vec{j}$ ,  $(3+e)\vec{i} + 3\vec{j}$ , (ii)  $\frac{17}{24}$ . 6) (a)  $\frac{1.2\omega^2}{5g - \omega^2}$ . (b)  $\frac{2\pi}{7}$ .  
 7) (i)  $\frac{1}{2}W \tan \theta$ . 8) (b) (i) 1.88 s, (ii) 0.88 m. 9) (ii)  $\frac{9}{16}$ . 10) (a)  $y = \sqrt{2x^2 - 1}$ .

**1990**

- 1) (b) (ii)  $\frac{13t}{4} \text{ s}$ . 2) (a)  $-28\vec{i} - 8\sqrt{3}\vec{j} \text{ m/s}$ . (b) (i) 6.25 s, (ii) 6.94 s. 6) (b) 9:11 pm. 7) (b)  $\frac{1}{\sqrt{3}}$ .  
 8) (b) (i)  $\sqrt{\frac{3\sqrt{2}g}{4a}}$ , (ii)  $(1 + \sqrt{2}) \text{ m}$ . 9) (a)  $110 \text{ cm}^3$ . (b) (i) 5 cm, (ii)  $60g \text{ N/m}^2$ . 10) (a)  $y = \frac{x}{2-x}$ .

**1989**

- 1) (ii) 43.875 m. 2) (i) 23.1 m/s from  $60^\circ \text{ S of W}$ , (ii)  $40.9^\circ \text{ S of W}$ . 3) (ii)  $15^\circ$  or  $75^\circ$ , (iii)  $58.0^\circ$ .  
 4) (i)  $\tan^{-1}\frac{1}{3}$ , (ii)  $\frac{2}{3}$ . 6) (ii) 0.6953 s, (iii) 0.3615 m/s. 7) (i)  $36.9^\circ$ , (iii)  $4\sqrt{5}g \text{ N}$ .  
 8)  $\frac{r}{\sqrt{2}}$ . 9) (a)  $\left(1 - \frac{\sqrt{5}}{3}\right) \text{ m}$ . (b)  $T = 0.072\pi g \text{ N}$ ,  $R = 0.288\pi g \text{ N}$ . 10) (a)  $y = xe^{x-1}$ .

**1988**

- 1) (a) 5 m/s. (b) 15g m. 2) (b)  $\frac{800\sqrt{3}}{u}$  s. 3) (a)  $18.4^\circ$  or  $71.6^\circ$ .  
 4) (ii)  $\frac{3g}{20}$  m/s<sup>2</sup>,  $\frac{g}{20}$  m/s<sup>2</sup>,  $\frac{g}{20}$  m/s<sup>2</sup>,  $\frac{19g}{10}$  N. 5) (i)  $\frac{2}{7}$ , (ii)  $\frac{u}{14}$ , (iii)  $\frac{195u^2}{98}$ . 6) (i)  $3v^2$ , (iii) 0.1 m.  
 7) (iii)  $\frac{\sqrt{5W}}{2}$  horizontally. 8)  $2\pi\sqrt{\frac{\sqrt{3}l}{g}}$  s. 9) (i)  $\frac{l}{2}$ . 10) (a)  $x = 5\sin\left(2t + \frac{\pi}{2}\right)$ . (b) 1.518 s.

**1987**

- 1) (a) 30 s. 2) (i) 17.88 km/hr,  $8.61^\circ$  N of W, (ii) 1 hr, 2 hrs & 9 mins. 4) (ii)  $\frac{3g}{35}$  m/s<sup>2</sup>.  
 5) (i)  $\vec{v}_A = -4\vec{i} + 4\vec{j}$ ,  $\vec{v}_B = -\vec{i} - p\vec{j}$ , (iii) 1. 6) (ii)  $\frac{2\pi\sqrt{d}}{21}$  s. 7) (iii) 28 N.  
 8) (i)  $2\pi\sqrt{\frac{22p}{3g}}$  s. 9) (a) (i) 0.2 kg, (ii)  $\frac{14}{45}$  kg. (b) (ii) 2. 10) (a)  $x = \sqrt{3y-5}$ . (b) 44.16 s.

**1986**

- 1) (a) (ii) 21.25 s. (b) 15 s. 2) (i) 61.44 m, (ii) 69 m. 3) 4.25 s. 4) (ii)  $\frac{3g}{11}$ .  
 5) (a) (i)  $\frac{3}{5}$ . 6) (a) 12 s, 0.849 m. 9) (a)  $\frac{d}{\sqrt{2}}$ . (b) 0.8. 10) (a)  $y = 3xe^{1-x}$ .

**1985**

- 1) (i)  $\frac{25}{u+v}$ , (ii)  $\frac{3u+v}{4(u+v)}$ . 2) (i)  $\vec{v} = \left(u\cos\theta - \frac{\sqrt{3}gt}{2}\right)\vec{i} + \left(u\sin\theta - \frac{gt}{2}\right)\vec{j}$ ,  
 2) (i)  $\vec{r} = \left(u\cos\theta t - \frac{\sqrt{3}gt^2}{4}\right)\vec{i} + \left(u\sin\theta t - \frac{gt^2}{4}\right)\vec{j}$ , (ii)  $\frac{u^2\sin^2\theta}{g}$ , (iii)  $\frac{2u\sin 2\theta}{g}$ .  
 3) (ii)  $\frac{g(4+x)}{5(2+x)}$ , (iii)  $\frac{8+22x}{16-x}$ . 4) (iii)  $\frac{1}{3}$ . 5) (a) 7.2 s. (b) (i)  $\frac{2600g}{3}$  W, (ii) 29.6 m/s.  
 6) (i)  $0.1\pi$  m/s, (ii) 0.128 s, (iii)  $\frac{\pi^2}{4}$ , (iv)  $\frac{g}{\pi^2}$ . 8) (ii)  $2\pi\sqrt{\frac{3+5x^2}{5gx}}$ , (iii)  $\sqrt{\frac{3}{5}}$ .  
 9) (a) (i)  $\frac{49}{13}$ , (ii) 4kg, 6kg, (iii)  $\frac{1}{13}$ . (b) 1.6 m. 10) (a)  $y = \sqrt[3]{x-2}$ . (b) (ii)  $\frac{u}{\sqrt{3}}$ .

**1984**

- 1) (a) 0.6 m/s<sup>2</sup>, (b) (i) 6 s, (ii) 48 m.. 2) (i) 25.0 m/s at  $77.9^\circ$  N of W, (ii) 2933 m, (iii) 50.4 s.  
 3)  $t = \frac{\sqrt{5}u\sin\theta}{g}$ ,  $R = \frac{\sqrt{5}u^2}{4g}$ . 4) (ii)  $\frac{g}{11}$ ,  $\frac{2g}{11}$ ,  $\frac{g}{11}$ ,  $\frac{5g}{11}$ . 5) (b) 7. 6) (a)  $\sqrt{g}$ . (b) (ii)  $\frac{\sqrt{g}}{2}$ .  
 7) (a)  $\frac{15g}{4}$  N. (b) 7 : 5. 9) (a) (i)  $\frac{6}{7}$ , (ii) 0.9, (iii) 125 ml. (b)  $\frac{2\pi\sqrt{d}}{7}$ . 10) (a)  $v = \frac{1}{k}(g - e^{-k(t+c)})$ . (b)  $\frac{5}{\ln 2}$ .

**1983**

- 1) 4 s, 3 m/s<sup>2</sup>. 2)  $\frac{d\sqrt{4x^2-2v^2}}{x^2-v^2}$ . 3) (i)  $\frac{7g}{32}$  m/s<sup>2</sup>, (ii)  $\frac{15g}{16}$  N,  $\frac{75g}{32}$  N. 4)  $\frac{5}{7}$  s, 30 m.  
 5) (i)  $-\frac{1}{3}\vec{i} + 4\vec{j}$  m/s, (ii)  $\frac{2}{3}\vec{i} - 3\vec{j}$  m/s;  $\frac{24}{23}$ . 6) (iii)  $2\sqrt{3\sqrt{2}g}$ . 7) (i)  $mg$ ,  $\frac{2}{15}$  m, (ii)  $5mg$ ,  $\frac{22}{15}$  m.  
 8) 2.35 m, 0.65 m, 0.404 s. 9) (a) 801.6 kg/m<sup>3</sup>, 507 mm. (b) (i)  $\pi\rho r^3 g$ , (ii)  $2\pi\rho r^3 g$ .  
 10) (a)  $y = 4\sin x$ . (b)  $\sqrt{500}$  m/s, 400 m.