Analysis of Applied Maths Leaving Cert Questions

1983-2015

The following analysis is based on the modified papers with mistakes removed. You can buy a booklet of papers, with answers at the back, 1990-2015 for €10 (which all goes to support schools in Ethiopia and the needy in Ireland).

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It is recommended that students try to solve questions on their own and then, if they get stuck, to look below for guidelines.

Ratings

1 = Easy
2 = Reasonably easy
3 = Regular
4 = Tricky
5 = Very difficult

Q1: Uniform Acceleration

2015	(a) Nice and straightforward: $s(7) - s(6) = 39$	
	(b) Not too difficult for a part (b)	**Rating: 3**
2014	(a) Requires a bit of work but OK	
	(b) The key equation is: Power = Tv	**Rating: 3**
2013	(a) $s = 39.2$ leads to a quadratic with 2 solutions	
	(b) Letters instead of numbers shouldn't mean it's too hard	**Rating: 3**
2012	(a) Not too hard. (b) You end up with a quadratic: use formula if it's too hard to factorise.	**Rating: 3**
2011	(a) Investigate AB then AC	
	(b) Average speed = total distance / total time	**Rating: 3**
2010	(a) Both parts are very manageable	
	(b) This can be solved by equations or graphs.	**Rating: 3**
2009	(a) 'Let fall..' means $u = 0$.	
	(b) Tricky enough with lots of letters	**Rating: 4**
2008	(a) (i) Easy (ii) Note that the distance travelled and the displacement from the ground are two different things.	
	(b) Not too difficult for a part (b)	**Rating: 3**
2007	(a) It is travelling at 29.9 m/s at time $t = 2.5$.	
	(b) Average speed = total distance / total time: Form an equation!	**Rating: 4**
2006	(a) Remember you must give a reason why $t_1 : t_2 = 3 : 1$.	
	(b) They will pass when $S_1 + S_2 = 2(79.5)$	**Rating: 3**
2005	(a) Tricky for a part (a): Can be solved 'relatively'.	
	(b) When in the sand, gravity pulls it down, the resistance is up. Use $F = ma$.	**Rating: 4**
2004	(a) Remember the times are t and $t - 1$.	
	(b) Use $F = ma$ both times. In (ii) $a = 0$, as the car is not accelerating.	**Rating: 2**
2003	(a) Remember you must make equations for p to q and p to r.	
	(b) Tricky! Since the man **just** catches the bus, we can conclude that he and the bus are going at the same speed when he catches it.	**Rating: 4**
2002	(a) If the starting point is the origin, then it hits the ground when $s = -30$.	
	(b) Can be done with equations or with areas in a time-velocity graph.	**Rating: 2**
2001	(a) Draw time-velocity graphs.	
	(b) The times are t and $t - T$.	**Rating: 3**
2000	(a) Two equations: One for t seconds the other for the first $2t$ seconds.	
	(b) Try to synchronise the watches by finding their positions when all acceleration is over. Then proceed.	**Rating: 4**
1999	(a) Ugh! Power = Tv where T = tractive effort, v = velocity.	
	(b) Very difficult to solve!	**Rating: 5**
1998	(a) Very tricky for a part (a). Average speed = Total distance/Total time. Draw a time-velocity graph with times x, y, z for each part.	
	(b) Use $v^2 = u^2 + 2as$ twice! And then use $v = u + at$ twice! YUK!! The numbers here are ugly. Shoot the exam-setter.	**Rating: 5**
1997	(a) Time-velocity graph.	

	(b) (i) They collide when $S_1 + S_2 = d$. (ii) "Before" means one time is less than the other. (iii) It returns to q when $s = 0$. **Rating: 4**
1996	(a) Do equations for [ab] and [ac]. Solve! (b) Tricky but do-able. **Rating: 3**
1995	(a) Let $x = \|pq\| = \|qr\|$ etc. Tricky! (b) Follow one flight (which travels 3 m up and down). **Rating: 4**
1994	(a) Easy. You must give a reason why $t_1 : t_2 = 0.8 : 0.6$ (b) A spring balance measures the REACTION between the object and the floor. **Rating: 3**
1993	(a) You have to show that the three equations are compatible: solve two and show this works in the third. Actually there is a flaw in this question – can you see it? (b) (i) It is best to let t = the time that Q spends in the air and therefore $t + 2$ = the time that P spent in the air (since it took off first) (ii) Can be answered mathematically or logically; just be clear! **Rating: 3**
1992	(a) Very tricky!! The particle is ascending with the balloon when it is let go – it will go up a bit before it starts to fall! (b) (i) Show that $S_1 = S_2$ has two real solutions (ii) Greatest gap occurs when their velocities are equal. **Rating: 5**
1991	(a) (ii) Means to say (but doesn't!) that $v = 2t + 50$ at any time t. So the particle is accelerating: can you find the acceleration? (b) Solve $S_1 = S_2$ **Rating: 3**
1990	(a) Very tricky for a part (a). You want to find the two solutions to $s = h$. Their product can be found using Quadratic theory $\alpha\beta = \frac{c}{a}$. (b) Average speed = Total distance/Total time **Rating: 5**
1989	Be careful! The cars do not decelerate at the same time! They will collide when the gap between the fronts of the cars is 5 metres: $S_B - S_A = 5$ **Rating: 4**
1988	(a) The speed of the particle at time $t = 4.5$ is $v = 23$… (b) Write equations for [ab] and [ac] **Rating: 3**
1987	(a) You have to show why $t_1 : t_2 = 4 : 8 = 1 : 2$. (b) Greatest gap occurs when their velocities are equal. **Rating: 3**
1986	(a) Tricky part (a)! (b) When you find $a = 10$ you know that at time t the velocity is $10t$. **Rating: 4**
1985	(i) OK (ii) The starting speed is u but the finishing speed is half-way between u and v : that is $\frac{1}{2}(u+v)$ **Rating: 4**
1984	(a) You can solve this 'relatively' by looking at the relative initial speed, final speed and 120 m to be covered… (b) Can be done relatively also. **Rating: 4**
1983	They will pass when $S_1 + S_2 = 120 + 80$. You can choose whichever train you want to put its foot on the brakes – the answer will be the same, as the question asks for the **decrease** in the acceleration. **Rating: 4**

Q2: Relative Velocity

2015 (a) (i) Regular. (ii) Start when B reaches the junction. Where is A then? You have to go back in time to find the closest distance.
(b) Let $v_r = x\vec{i} + y\vec{j}$ and form two equations **Rating: 3**

2014 (a) They will collide if $v_{XZ} = -kr_{XZ}$, for positive *k*. But you have to 'synchronise the watches' first: tricky!
(b) (i) OK (ii) requires clever use of chord-length **Rating: 4**

2013 (a) Very tricky for (a): Find shortest distance in terms of θ
(b) The best way is to use the *t*-method in Fundamental Applied Maths **Rating: 4**

2012 (a) Tricky enough to work out the angles
(b) Regular nearest distance and 'within range' question **Rating: 3**

2011 (a) Start when B reaches the junction; where is A?
(b) Examine the cases where she lands at B and at C. **Rating: 3**

2010 (a) They will collide if $v_{BA} = -kr_{BA}$, for positive *k*.
(b) The apparent velocity of the wind means v_{WM} **Rating: 3**

2009 (a) Long! When B reaches the junction, where is A?
(b) Careful, now! Only 20 marks for this part. **Rating: 4**

2008 (a) Regular question.
(b) Let the velocity of the wind $= x\vec{i} - 3\vec{j}$ both cases. And let *v* = the speed of the man. **Rating: 3**

2007 (a) Find the shortest distance between them first.
(b) Let *t* = the time. Good diagram needed. **Rating: 3**

2006 (a) The fact that they are flying horizontally should never have been mentioned – this means that the aeroplanes are not taking off or landing. Draw a clear diagram to show where *A* heads, where the wind brings it, so that the resultant is 200 km/h NW.
(b) Tricky: Draw a very clear diagram on graph paper. **Rating: 5**

2005 (a) Shortest time means she heads straight across.
(b) In vector equations, i = i and j = j. **Rating: 4**

2004 (a) Draw a clear diagram. (b) Use the formula for distance from a point to a line. **Rating: 3**

2003 (a) Let the velocity of the wind $= x\vec{i} + y\vec{j}$ both cases.
(b) OK. Be careful to answer precisely what you were asked. **Rating: 3**

2002 (a) Draw a clear diagram of the "relative path".
(b) Do some general algebra first! **Rating: 3**

2001 (a) Be very careful with directions and signs.
(b) Very tricky! Draw good diagrams. **Rating: 5**

2000 They will intercept if P moves up *u* all the time, to stay level with Q. See where they are at half-time first! **Rating: 4**

1999 (a) Good diagram needed. Use sine rule.
(b) You will need **differentiation** to find the angle which leaves the "relative path's angle" as small as possible. Ugh!! **Rating: 5**

1998 (a) Horrible part (a)! Let *t* = the time and examine the directions they go in (the yacht travelling 5*t* and the speedboat 20*t*). Use the sine rule twice.
(b) Ugh^2!! Use the same method as in part (a) but when you solve the sine rule, you must use both solutions (one in each of the first 2 quadrants) and

proceed to solve both! Whoever set this question should have to listen to Daniel O'Donnell records non-stop for a week. **Rating: 5^+**

1997 Let the velocity of the wind $= x\vec{i} + y\vec{j}$. You will end up with two second degree equations. Subtract them. Then get x in terms of y and solve by 'substitution'. It is interesting to note that solving two second degree equations is not on the Maths course. **Rating: 4**

1996 Let the velocity of the ship C $= x\vec{i} + y\vec{j}$. Its magnitude is 32: so form an equation, then another, and solve! Also a good diagram is essential. **Rating: 4**

1995 (a) Pythagoras comes into play here.
(b) (i) is easy (ii) needs the *t*-method, as in 1998's question. **Rating: 4**

1994 (a) Easy - if you study the situation when B reaches the intersection
(b) Use formulae from Uniform Acceleration. **Rating: 3**

1993 (a) Let the velocity of the wind $= x\vec{i} + y\vec{j}$.
(b) So nice! **Rating: 1**

1992 (i) should read "the directions in which the aeroplane must ***head*** …"
(ii) Two good big diagrams are needed
(iii) A joke! **Rating: 3**

1991 Tricky! If the wind appears to come from the direction $2\vec{i} + 3\vec{j}$, the ratio of the i-component to the j-component is 2 : 3. **Rating: 4**

1990 (a) Fine. (b) The best thing is to wait until A gets to the junction, then proceed. **Rating: 3**

1989 Let the velocity of the wind $= x\vec{i} + y\vec{j}$. (i) Solve simultaneous equations.
(ii) Reasonably easy. **Rating: 2**

1988 (a) Two clear diagrams needed.
(b) Not too challenging **Rating: 2**

1987 (i) Straightforward (ii) If you find the shortest distance between them, you can use Pythagoras' Theorem; if not use the Cosine Rule or Sine Rule. **Rating: 3**

1986 Reject the solution $v = 0$.
(i) Wait until A gets to the junction. (ii) Pythagoras. **Rating: 4**

1985 Q 5 (a) Good diagram of the "relative path" is needed.
(b) is about Power, not relative velocity **Rating: 4**

1984 A good clear diagram of the relative path will see this through. **Rating: 3**

1983 Let the velocity of the wind $= x\vec{i} + y\vec{j}$. Extremely tricky: all algebra and no numbers. **Rating: 5**

Q3: Projectiles

2015 (a) Very long with horrible numbers for a part (a)
(b) Not too difficult for a part (b) **Rating: 4**

2014 (a) Very nasty! Ugly numbers, too. The difference between $\frac{-b+\sqrt{b^2-4ac}}{2a}$ and $\frac{-b-\sqrt{b^2-4ac}}{2a}$ is $\frac{2\sqrt{b^2-4ac}}{2a}=\frac{\sqrt{b^2-4ac}}{a}$ …ugh!!
(b) Use landing angle equal to β **Rating: 5**

2013 (a) Nice projectile on a horizontal plane
(b) Can be done with calculus or as in textbook **Rating: 3**

2012 (a) OK question about range on the horizontal plane
(b) Here the trigonometry might be tricky – but solvable. **Rating: 3**

2011 (a) Regular target practice question.
(b) i-speed stays the same, j-speed will be multiplied by *e*. **Rating: 3**

2010 (a) Find time first.
(b) Landing angle *l* is given by $\tan l = \frac{-v_y}{v_x} = \frac{2}{\sqrt{3}}$ **Rating: 3**

2009 (a) What a nasty part (a)!
(b) Not so bad, to compensate. **Rating: 4**

2008 (a) Be clear what you are given and what you want to find.
(b) The *x*-acceleration is positive; The *y*-acceleration is negative
Rating: 4

2007 (a) Straightforward.
(b) The landing angle is 45 degrees. **Rating: 3**

2006 (a) (i) OK (ii) The direction of the vector $x\vec{i} + y\vec{j}$ is $\tan^{-1}\frac{y}{x}$.
(iii) Use $m_1.m_2 = -1$ or 'dot product'.
(b) Straightforward: find S_x when $S_y = 0$. **Rating: 3**

2005 (a) Tricky for a part (a). When a ball bounces, the i-velocity remains the same, but the j-velocity is multiplied by –*e*.
(b) You need to open Page 9 of the Mathematical Tables, and use product-to-sum formulae, amongst others. **Rating: 5**

2004 (a) Assume the particle just scrapes the ceiling.
(b) You'll need to use a formula for $\tan(\theta-\alpha)$ eventually. **Rating: 4**

2003 (a) You must **derive** formulae for the range and the maximum height – no ready-made formulae allowed! (b) OK. **Rating: 3**

2002 (a) Solve $S_y = 14.7$ (using the quadratic formula).
(b) Fine question. **Rating: 3**

2001 (a) Let the point of projection be the origin. The target is (21, 1).
(b) Yuk! Find speed and velocity vector of particle as it hits the plane for the first time. Then see 2005 above. **Rating: 5**

2000 (a) Classic question if you know your basics.
(b) Again, know your theory! **Rating: 3**

1999 (a) This is about landing angle. In this case, the landing angle is θ.

(b) Very difficult and long! Potential energy and kinetic energy (at landing) have to be calculated. It takes ages. **Rating: 5**

1998 (a) Target : use $\frac{\sin A}{\cos A} = \tan A$ and $\frac{1}{\cos^2 A} = 1 + \tan^2 A$ to get a quadratic in tan A.

(b) (i) OK (ii) Tricky but do-able! **Rating: 4**

1997 (a) Not bad!

(b) 2β is the angle with the **vertical**! Be careful. **Rating: 4**

1996 (a) The numbers in the quadratics are nice (if you divide by 4.9).

(b) Tricky but do-able. **Rating: 3**

1995 (a) (i) Let $\vec{u} = x\vec{i} + y\vec{j}$ etc. (ii) OK (iii) Speed = $\sqrt{{v_x}^2 + {v_y}^2}$

(b) (i) OK (ii) You must prove $\tan l < 0$ (where l = landing angle).

Rating: 4

1994 (a) Let $u_x = p$ and $u_y = q$ …

(b) (i) Let the origin be the point of projection (ii) Speed = $\sqrt{{v_x}^2 + {v_y}^2}$

Rating: 3

1993 (a) Regular.(b) (i) No problem (ii) $\tan l = -\frac{v_y}{v_x}$ when $S_y = 0$ **Rating: 3**

1992 (i) Target : use $\frac{\sin A}{\cos A} = \tan A$ and $\frac{1}{\cos^2 A} = 1 + \tan^2 A$ to get a quadratic in tan A.

(ii) To get maximum clearance, we want the maximum height at $s_x = 18$.
Differentiate s_y with respect to α. **Rating: 4**

1991 (i) Regular.

(ii) Tricky. When a ball bounces, the i-velocity remains the same, but the j-velocity is multiplied by $-e$. **Rating: 4**

1990 (i) Landing angle.

(ii) Lands perpendicularly. **Rating: 4**

1989 (i) Fine (ii) Trigonometry equation (iii) Be careful: is $2H = 5R$ or $2R = 5H$?

Rating: 2

1988 (a) Not difficult. Use $g = 9.8$.

(b) See 1991 (above) for 'bouncing theory'. It will take off at an angle of $45°$ to the hill, and hence at $90°$ to the horizontal. Surely, if it rises vertically then it is bound to strike p again on the second bounce?! **Rating: 4**

1987 (a) Lands perpendicularly. (b) Examine the second half of the journey from the highest point to q. **Rating: 4**

1986 Remember that if you can find that $\tan\alpha = 4$ then you can work out the sine and cosine easily. At t_1 the flight is perpendicular to the original flight. Use $m_1 . m_2 = -1$ **Rating: 4**

1985 Q2: (i) OK (ii) Regular (iii) Use the quadratic formula and simplify!

Rating: 3

1984 Since the particle strikes the plane while moving horizontally, the landing angle is the angle of the inclined plane. **Rating: 4**

1983 Q4: It is not clear, but you may assume that the target is not moving under gravity. It is travelling at a constant speed at a $45°$ angle. Take it to be a bird in flight – not a projectile. **Rating: 3**

Q4: Pulleys & Wedges

2015 (a) Not bad. In (iii) you use conservation of momentum of the whole system, treating the three connected particles as a 'train'
(b) Difficult wedge question, made easier by the fact that the wedge is at rest.
Rating: 4

2014 (a) Unusual apparatus, but when you think about it, it's OK. If A moves 1 metre, B will move 2 m. Hence their accelerations are *a* and 2*a*.
(b) Regular wedge question. **Rating: 4**

2013 (a) In (ii) 6kg has acceleration f+g/8 and 7kg has a = f-g/8
(b) Accelerations are *a*, *b* and (*a* + *b*)/2 **Rating: 2**

2012 (a) After B hits the ground, T = 0
(b) Accelerations are *a*, *b* and (*a* + *b*)/2 **Rating: 3**

2011 (a) It's an inclined plane – not a wedge.
(b) 4 equations with four unknowns. **Rating: 3**

2010 (a) Nice and easy.
(b) Two particles on a wedge. Not bad, though. **Rating: 3**

2009 (a) Nice regular pulley for starters.
(b) The accelerations are: m_1 : *a,* 1 kg: *b* and C: ½(*a* + *b*). **Rating: 4**

2008 (a) The accelerations are *a* and 2*a*. This got 30 marks.
(b) Yuk! But don't be put off. You only needed a force diagram to get half the marks. The tensions in the string act on the wedge also! **Rating: 5**

2007 (a) Not bad: draw a clear force-diagram. (b) The accelerations will be 4 kg: *a,* 6 kg: *b* and B: ½(*a* + *b*). **Rating: 3**

2006 (a) Regular pulley question.
(b) Regular wedge question. **Rating: 3**

2005 (a) OK
(b) The 3 kg falls, then suddenly the 5 kg is picked up – you must use conservation of momentum to find the new speed of the particles.
Rating: 4

2004 (a) Regular pulley question.
(b) Regular wedge question. **Rating: 3**

2003 (a) Regular pulley question.
(b) Inclined plane (not a wedge). **Rating: 2**

2002 (a) SHM!! Doesn't belong here.
(b) Relative accelerations: be careful. **Rating: 3**

2001 Regular pulley question. **Rating: 2**

2000 (a) Regular pulley question.
(b) Regular wedge question. **Rating: 3**

1999 (a) (i) Easy (ii) Each particle is propelled up by a Reaction and down by a weight. Use *F* = *ma* for each particle.
(b) Regular wedge question. **Rating: 3**

1998 (a) OK (b) Ugh! Very tricky question because the friction exerted by A on B has an equal but opposite anti-friction which propels A forward! Should never have been asked. It's a university question. **Rating: 5**

1997 (a) OK (b) Easy enough; the accelerations of C and E are *a* and 2*a*.
Rating: 2

1996 (i) Fine (ii) Answer the question you were asked! (iii) Tricky: *a* = *b*.
Rating: 3

1995 (i) OK (ii) Easy (iii) You must regard the whole apparatus as a "train" of mass 0.9 kg which then becomes a heavier "train" of mass 1.1 kg when the 0.2 kg is picked up. Use conservation of momentum. (iv) OK. **Rating: 4**

1994 (i) Easy (ii) OK (iii) Tricky but do-able. **Rating: 3**

1993 Very hard wedge question. Five equations (2 for each particle and one for the wedge). The strings at the top of the wedge pull on the wedge – don't leave them out! **Rating: 5**

1992 Assume that the accelerations are: $\boldsymbol{m}$: upwards a ; **3*m*** : upwards b ; $\boldsymbol{M}$: downwards $\frac{1}{2}(a+b)$. **Rating: 3**

1991 This question was a bit unclear. The block is a **bus** which is being driven with an acceleration $\frac{g}{3}$ to the right. **Rating: 4**

1990 (i) The accelerations are: $\boldsymbol{A}$: a ; $\boldsymbol{B}$: b ; **2*m*** : $\frac{1}{2}(a+b)$.
(ii) Ignore the statement "If $\mu \prec \frac{3}{4}$" (iii) OK **Rating: 3**

1989 Q 5: Tricky wedge question. **Rating: 4**

1988 (i) Let accelerations be: **6 kg** : a (right) ; **2 kg** : b (up) ; **4 kg** : $\frac{1}{2}(a+b)$ down. **Rating: 3**

1987 That's a funny looking $30°$! This is quite straightforward. **Rating: 2**

1986 What makes this question tricky is the friction at the ground. It will be $\frac{1}{3}$ of the reaction at the ground, not $\frac{1}{3}$ of 4mg. **Rating: 3**

1985 (i) OK (ii) OK (iii) My booklet has a new version – the original was a disgracefully unclear piece of garbled English. **Rating: 4**

1984 (i) If 8 kg goes up with acceleration *a* then C goes down with acceleration 2*a*.
(ii) Answer precisely what is asked! **Rating: 3**

1983 Very nice question! **Rating: 2**

Q5: Collisions

2015 (a) Quite a regular question. Take care with the numbers.
(b) Quite nice for a part (b) **Rating: 2**
2014 (a) Regular direct collision
(b) Regular oblique collision **Rating: 3**
2013 (a) Not bad at all
(b) There's always going to be some question with a new twist: it's only fair. You should be able to think your way through this neat problem **Rating: 3**
2012 (a) OK question on direct collisions
(b) Oblique collisions: not too demanding **Rating: 3**
2011 (a) To 'rebound' means to move in the opposite direction (apparently)
(b) A lot of managing and manipulating equations. **Rating: 4**
2010 (a) Regular direct collision.
(b)You need to remember that $0 \le e \le 1$ **Rating: 2**
2009 (a) This is a reasonable direct collision. (b) Don't be put off by the strange lay-out: turn the page around! **Rating: 4**
2008 (a) Not too bad. Rather a lot of algebra with the letter *e.*
(b) Find the tan of the angle using the formula $\tan\theta = \pm\frac{m_1 - m_2}{1 + m_1 m_2}$ for the angle between two lines. **Rating: 4**
2007 (a) OK. (ii) asks for impulse
(b) OK. Get velocity of A in terms of i and j. **Rating: 3**
2006 (a) Quite long for a part (a). The answer comes out nicely if you can avoid errors in the algebra.
(b) Easier if you turn the page sideways and look at the diagram with the i-axis as the line of centres at impact. **Rating: 3**
2005 (a) Regular direct collision question.
(b) Regular oblique collision question. **Rating: 3**
2004 (a) P goes left, Q goes right (after impact).
(b) Equal speeds gives and extra equation. **Rating: 4**
2003 (a) Rather long and tricky.
(b) Let v = the speed of A after impact. The definition of 'impulse' is on page 40 of the mathematical tables. **Rating: 4**
2002 (a) Needs care with the algebra.
(b) Tricky. Do a large diagram to show all the angles. **Rating: 4**
2001 (a) Ok. (b) The speeds before might be x and $x + u$. **Rating: 3**
2000 (a) Be careful with the signs!
(b) The best way to get the angle of deflection is to use the formula
$\tan\theta = \frac{m_1 - m_2}{1 + m_1 m_2}$ **Rating: 4**
1999 (a) Ugh! What a horror for a part (a). Do 1994 first (similar but easier). The best way is to remember that the ratio of the distances is proportional to the ratio of the speeds.
(b) Not nice numbers! **Rating: 5**
1998 (a) (i) The Conservation of Momentum equation delivers. Note that if $a = b + c$ and if c is positive then $a > b$. (ii) Remember that $0 \le e \le 1$.
(b) Use conservation of energy and then collisions. **Rating: 4**

1997 (a) OK (b) Regular oblique collision. **Rating: 3**

1996 (a) Opposite direction: one velocity is positive, one is negative!
(b) After impact, $\sqrt{v_i^2 + v_j^2} = \frac{u}{2}$ **Rating: 3**

1995 (a) Opposite direction: one velocity is positive, one is negative!
(b) Let the inclined plane be the x –axis. For impacts $u_x = v_x$ and $v_y = -eu_y$.
Rating: 4

1994 Very tricky, so be careful! The best way is to remember that the ratio of the distances is proportional to the ratio of the speeds. **Rating: 5**

1993 Once you get the speeds as i-j vectors, it's an easy question. 2/5 means $\frac{2}{5}$.
Rating: 3

1992 You must make sure that the i-axis is the line of centres at impact. Draw a very accurate diagram showing the spheres at the moment of impact, using coins or a compass. Once you get the speeds as i-j vectors, it's plain sailing!
Rating: 4

1991 (a) Be careful with the algebra!
(b) Use $\tan\theta = \pm\frac{m_1 - m_2}{1 + m_1 m_2}$. You have to solve for both $\pm$ to find the correct answer. The algebra is messy. Long. **Rating: 5**

1990 I've got rid of the original question, which would have had a rating of 10. It took me 1 hr and 25 minutes to get the right answer. This new question is OK once you get the speeds as vectors. **Rating: 3**

1989 Be careful! Make use of the fact that the angle of deflection is a right angle. There are many ways of doing this. **Rating: 4**

1988 Two direct collisions and an impact. Do not be put off by the awkward numbers, surds and fractions. Just keep going, with accuracy! **Rating: 4**

1987 Nice question with nice answers – if you are careful. **Rating: 2**

1986 (a) (i) and (ii) are separate parts with different answers.
(b) One along each axis, as it transpires. **Rating: 3**

1985 Q4: (i) Very tricky (ii) Differentiate or assume $e = 0$ (iii) Long
Rating: 5

1984 (a) Definition of Impulse is on P 40 of Maths tables. Tricky algebra.
(b) One along each axis. **Rating: 4**

1983 Nice question with nice answers – if you are careful and don't mind dealing with fractions. **Rating: 2**

Q6: SHM & Circular Motion

2015 (a) Horrible part (a) in which the hint makes the question harder. Requires knowledge of hydrostatics
(b) Tricky motion in a vertical circle. It leaves when R = 0 **Rating: 5**
2014 (a) Nasty enough!
(b) Very tricky, especially (ii). Ugh! **Rating: 5**
2013 (a) Knowledge of hydrostatics is needed.
(b) OK but (ii) is sort of a trick question: it flies off horizontally and you've to find how long to fall $3l$ under gravity – simple! **Rating: 4**
2012 (a) SHM formulae needed.
(b) Motion in a vertical circle: challenging! **Rating: 4**
2011 (a) Differentiate twice with respect to t.
(b) Good, large, clear diagram will help. **Rating: 3**
2010 (a) Ridiculously difficult for a part (a). In (ii) use conservation of energy to find speed (b) Not as hard as part (a)! **Rating: 5**
2009 (a) Nice classic SHM question.
(b) Max accel = $\omega^2 A$. Max force = $m\omega^2 A$. So, $m\omega^2 A \le \mu R$ **Rating: 4**
2008 (a) Quite challenging for a part (a).
(b) Tricky question of motion in a horizontal circle. **Rating: 4**
2007 (a) Tricky for a part (a). The length is $l_o + d + x$.
(b) Conservation of energy, then conservation of momentum and then conservation of energy again. **Rating: 4**
2006 (a) Just use your formulae.
(b) Difficult. Maximum l will occur when the particle is on the point of sliding **up** the side of the cone; hence friction is **down** the side of the cone.
Remember: The **resultant** force to the centre = $m\omega^2 r$. **Rating: 4**
2005 (a) Regular circular motion question.
(b) The particle does SHM for half the journey and then travels with a constant speed for the rest of the journey. **Rating: 3**
2004 (a) Motion in a vertical circle. Very tricky.
(b) (i) Differentiate twice to get a (ii) OK **Rating: 4**
2003 (a) OK if you know your formulae.
(b) Motion in a vertical circle. Tricky. **Rating: 4**
2002 (i) Motion in a vertical circle. (ii) $\vartheta = 180°$ at this point. **Rating: 4**
2001 (a) SHM formulae needed.
(b) Hooke's Law with SHM. **Rating: 3**
2000 (a) Regular circular motion.
(b) Tricky! There are two strings and gravity. **Rating: 5**
1999 (a) SHM formulae.
(b) SHM with Hooke's Law. **Rating: 3**
1998 (a) (i) Differentiate twice to get acceleration.
(ii) Must know: The amplitude of $a\sin x + b\cos x$ is $\sqrt{a^2+b^2}$.
(b) Tricky: SHM with hanging particle. **Rating: 4**
1997 (a) Very tricky (i) Statics question (ii) The particle now swings with circular motion in a vertical circle. **Rating: 5**
1996 (a) Regular SHM using formulae.

(b) (i) Prove that $a = -\omega^2 x$ (ii) The particle does SHM for half the journey and then travels with a constant speed for the rest of the journey. **Rating: 4**

1995 (a) Circular motion. Periodic time = $\frac{2\pi}{\omega}$.
(b) Motion in a vertical circle. **Rating: 4**

1994 (i) Easy (ii) Gravity and the glue keep the particle down (iii) it will leave when the acceleration has magnitude 9.8 **Rating: 3**

1993 (a) SHM formulae.
(b) Very trick SHM with a vertical string. **Rating: 4**

1992 (a) See 1998 above
(b) (i) Prove that $a = -\omega^2 x$ (ii) The particle does SHM for this part the journey (iii) it then travels with a constant speed for the rest of the journey.
Rating: 3

1991 (a) Tricky enough circular motion question.
(b) SHM of a particle on a vertical string. **Rating: 4**

1990 (a) You need to be careful here – and clear in your thinking. SHM.
(b) Wonderful question about tides. Not plain sailing though! **Rating: 4**

1989 (i) Tricky SHM with Hooke's Law. (ii) OK (iii) OK **Rating: 4**

1988 (i) Circular motion (you may give the answer in terms of v)
(ii) OK (iii) Let x = the distance above the table. Start the whole thing again with new radius, new tension and new angle. Very difficult. **Rating: 3**

1987 SHM with a vertical string. **Rating: 3**

1986 (a) If you can figure out where p and q lie, the rest is OK. You can examine the journey from o to q.
(b) Just Hooke's Law. A statics question. **Rating: 4**

1985 (i) OK (ii) OK (iii) Very tricky (iv) Presumably from a stationary position to a position of slackness. **Rating: 5**

1984 (a) Regular circular motion question.
(b) Examine the forces etc on each particle separately. They go in circles of radius y and $3y$. **Rating: 3**

1983 **Q7**: (i) Friction is up the side of the cone.
(ii) Friction is down the side of the cone. (See 2006) **Rating: 4**
Q8: Excellent but challenging SHM question which requires thought.
(HINT: the centre of oscillation is where $x = 0$.) **Rating: 4**

Q7: Statics

2015 (a) Nice and straightforward: they must want more students to do the statics question because part (b) is a regular double-ladder. **Rating: 2**

2014 (a) It's just a centre of gravity question (as in the textbook). Nice!
(b) The line of action of the normal reaction is towards the centre of the base **Rating: 3**

2013 (a) Trick enough. The magnitude of the 12 and 5 combined is 15.
(b) Not very nice at all! **Rating: 4**

2012 (a) Not too bad but tricky enough.
(b) Rather difficult! **Rating: 4**

2011 (a) Hooke's law states that: $T = k(l - l_o)$
(b) Tricky statics question. **Rating: 4**

2010 (a) Assume it's on point of slipping…
(b) Very large diagrams with distances and forces (drawn using a compass on graph paper) will help you a lot. Only one equation needed each time! **Rating: 4**

2009 (a) Ok (b) Who was mean to the examiner the morning he set this question? Did someone scratch the paintwork on his new car? Ooof! **Rating: 5**

2008 (a) Nice ladder question for starters.
(b) Not bad for a part (b). The best policy is to write down the three equations for each rod. **Rating: 3**

2007 (a) Holy Moly! What a part (a)!! Ugh!
(b) Nicer than part (a). F will be perpendicular to the radius to the kerb. **Rating: 4**

2006 (a) Very easy.
(b) Quite nice for a part (b). Friction = $(\tan\lambda)R$. **Rating: 2**

2005 (a) Assume it is just on the point of moving up the plane.
(b) Get 3 equations for the system and 3 for the lighter rod (as it will be the first to slip). **Rating: 3**

2004 (a) Straightforward ladder question.
(b) Not difficult: just get forces and angles. **Rating: 3**

2003 Reasonably straightforward. The rod is perpendicular to the radius at the point of contact. **Rating: 3**

2002 Clear thinking needed. **Rating: 3**

2001 (a) Too tricky for a part (a)
(b) Off-putting apparatus. **Rating: 4**

2000 (a) Straightforward ladder question.
(b) Not too bad **Rating: 4**

1999 (a) You must know all about angle of friction: $\tan\lambda = \mu$
(b) Not bad. **Rating: 3**

1998 It's easy to get equations but hard to get the answer! **Rating: 5**

1997 (a) (i) Draw good diagrams (ii) Hooke's Law: $F = k(l - l_o)$
(b) Tricky **Rating: 4**

1996 (a) Draw a clear diagram. (b) The worst situation will be when the person is just at the top of one of the ladders: assume the ladder is on the point of slipping at this point. **Rating: 4**

1995 (i) Get 3 equations for the system and three for AB.
(ii) Write the two Reactions as i-j vectors; use dot product or $m_1.m_2 = -1$

Rating: 4

1994 Get 3 equations for the system and 3 for the rod on the point of slipping. **Rating: 3**

1993 (i) Good diagram needed. Be careful with moments.
(ii) New diagram and new equations. **Rating: 4**

1992 (a) Tricky trigonometrical equations here.
(b) (i) OK (ii) Ugh! **Rating: 5**

1991 (i) There will be a normal reaction at the peg and a friction force up. (ii) OK
(iii) Solve for tan θ and show that the quadratic equation has no solution. **Rating: 5**

1990 (a) Be precise!
(b) Straightforward rod question. **Rating: 3**

1989 (i) Simultaneous equations. (ii) OK (iii) You may have to use differentiation to find the least force. **Rating: 4**

1988 (a) Assume there are forces X (horizontal) and Y (vertical) at *b*. There will be a normal reaction at the peg (which is **not** half-way down) (ii) It transpires that Y = 0. (iii) Just find X in terms of *W*. **Rating: 4**

1987 (i) First find the distance from P to the point of contact. The normal reaction at the point of contact will be perpendicular to the rod.
(ii) Just two equations will do for the rod: the moments can't be found as we don't know its length. **Rating: 5**

1986 Definitions and a rather straightforward ladder problem. **Rating: 3**

1985 (i) Don't forget: a metre stick is one metre long! (ii) OK (iii) 3 new equations. **Rating: 4**

1984 (a) Theorem: If three forces act on a body, then their lines of action are concurrent. Hence the line of the string goes through the centre of the sphere.
(b) The above theorem again applies! **Rating: 5**

1983 No statics question!

Q8: Moments of Inertia

2015 (a) Proof of rod
(b) Regular maximum period: nice one too! No need for second derivative to prove answer is a minimum not a maximum. **Rating: 2**

2014 (a) Proof of disc (b) The mass of the disc removed = 0.2M means that the AREA of the hole is 0.2 of the area of the disc. **Rating: 3**

2013 (a) Proof of disc (b) You can work out their distances from P using Pythagoras. **Rating: 3**

2012 (a) Proof of disc (b) You can solve using Conservation of energy or The Principle of Angular Momentum: I prefer the former. **Rating: 3**

2011 (a) Proof for square lamina. (b) (i) Conservation of energy
(ii) Periodic time of compound pendulum **Rating: 3**

2010 (a) Proof for the disc
(b) (i) Just change the limits (ii) Conservation of energy **Rating: 3**

2009 (a) Proof for the rod.
(b) Three nice rods in a triangle. **Rating: 2**

2008 (a) Proof for the disc.
(b) Be careful! This is not Q4 where pulleys are smooth. The tension in the right part of the string is greater than that in the left part. Use conservation of energy: the loss in PE is equal to the gain in KE: the particles speed up and the disc starts to rotate. **Rating: 5**

2007 (a) Learnt off by heart!
(b) Find w when [ac] is vertical. **Rating: 3**

2006 (a) Rod proof (b) (i) Energy equation (ii) Use circular motion theory: $F_c = m\omega^2 r$, where F_c is the resultant force and $r = 0.6$ (the average radius).
Rating: 4

2005 (a) Rod proof. (b) (i) Use the horizontal line through *p* as the 'sea level' and the height will be negative when the centre of gravity is below this line.
(ii) Show it still has speed when it reaches highest point. **Rating: 4**

2004 (a) Disc proof. (b) Principle of conservation of energy: the particle's KE is $\frac{1}{2}mv^2$; the pulley's is $\frac{1}{2}I\omega^2$, where $v = \omega r$. **Rating: 3**

2003 (a) Rod proof. (b) $T = 2\pi\sqrt{\frac{I}{mgh}}$ and $h = \frac{2}{3}(median - length)$.
Rating: 3

2002 (a) Rod proof (b) Find the KE ($\frac{1}{2}I\omega^2$) before and after. The work done is the difference between these. **Rating: 3**

2001 (a) Disc proof. (b) Tricky enough. **Rating: 4**

2000 (a) Disc proof (b) At the bottom of the slope the disc is both moving and rolling, so its KE = $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$. **Rating: 3**

1999 (a) Rod proof. (b) (i) Solve an equation (ii) Let distance = x and solve a quadratic equation. (iii) Differentiate T^2 with respect to x. **Rating: 4**

1998 (a) Rod proof (endpoint) (b) Look up textbook! (c) (i) OK (ii) First find the height which the centre reaches, then the endpoint. **Rating: 4**

1997 (a) Disc proof. (b) (i) First find the moment of inertia about a diameter through C: the formula is $\frac{1}{4}mr^2$. Then use Parallel Axes Theorem.
(ii) Differentiate T^2 with respect to x. **Rating: 4**

1996 (a) Disc proof.
(b) Tricky but do-able. **Rating: 3**

1995 (a) Square lamina proof.
(b) Differentiate T^2 with respect to x. **Rating: 3**

1994 (i) $T = 2\pi\sqrt{\frac{I}{mgh}}$ (ii) Use the horizontal line through p as 'sea level'; h will be negative when the rod is below this line. **Rating: 4**

1993 (a) Rod proof (it should read $\frac{1}{3}ml^2$)
(b) (i) Find the minimum value of ω, then switch to v.
(ii) Regular periodic time question. **Rating: 3**

1992 (a) Disc proof.
(b) When finding h, you can say that the two ms at q and s are equivalent to $2m$ at the centre. **Rating: 4**

1991 (a) Rod proof (b) Regular periodic time question. **Rating: 3**

1990 (a) Square lamina proof. (b) (i) Very good diagram helps. (ii) Let x be the mass. Solve an equation. **Rating: 4**

1989 (a) Disc proof. (b Differentiate T^2 with respect to x. **Rating: 3**

1988 (a) Rod proof.
(b) See 2003 **Rating: 2**

1987 (a) Annulus proof. Be careful! It says 'diameter', not 'radius'.
(b) Straightforward. **Rating: 4**

1986 (a) Disc proof.
(b) Let s = the distance travelled. At the bottom of the slope the disc is both moving and rolling, so its KE = $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$. Find v and then find the acceleration. **Rating: 3**

1985 (i) Use Pythagoras to find all lengths. Tricky! (ii) T formula.
(iii) Differentiate T^2 with respect to x. **Rating: 4**

1984 An elegant question with a clever quadratic equation. Nice factors if you don't make any mistakes. **Rating: 3**

1983 Q6: (i) This question should not have been asked, as triangles are not on the course. You have to divide the triangle into horizontal strips. Use similar triangles to find an expression for their lengths. Then integrate.
(ii) Ugh!! (iii) Horrendous **Rating: 5^+**

Q9: Hydrostatics

2015 (a) Not particularly nice part (a)
(b) Nasty rocks ahoy, mateys! Tricky to understand. It gave a lot of students a sinking feeling. **Rating: 4**

2014 (a) Needs very clear thought. Nasty!
(b) Fiercely tricky **Rating: 5**

2013 (a) Careful now!
(b) Where's the picture, Mr Examiner? **Rating: 4**

2012 (a) Nice easy start.
(b) Classic hydrostatics on a rod in a liquid. **Rating: 3**

2011 (a) When overflowing starts, oil = 24 and water = h.
(b) Needs very clear understanding. **Rating: 4**

2010 (a) A bit yukky for the first part!
(b) Let x = length of immersed part … **Rating: 4**

2009 (a) Not easy: tricky and long.
(b) Regular rod tilted in liquid. OK **Rating: 4**

2008 (a) Not too easy.
(b) Quite tricky. **Rating: 4**

2007 (a) Not bad.
(b) Tricky **Rating: 4**

2006 (a) The fact that it contracts means the volume is less – that's all!
(b) (i) Maximum buoyancy will be if it is all under water. (ii) Tricky
(iii) Nice. **Rating: 4**

2005 (a) Volume, mass, density, etc
(b) Statics problem. OK. **Rating: 3**

2004 (a) U-tube. Pressure at the same level in the same liquid is the same.
(b) Must know where centre of gravity of a triangle is at the centroid, two-thirds of the way along a median. **Rating: 3**

2003 (a) (i) OK (ii) Should not have been asked as the syllabus is limited to "thrust on a horizontal surface". However, thrust = P_c. A, where P_c is the pressure at the centre and A is the area. (iii) Likewise.
(b) Tricky! **Rating: 5**

2002 (a) Very tricky part (a).
(b) Tricky enough. Archimedes' Principle applied. **Rating: 4**

2001 (a) Clear thinking needed.
(b) Let x be the length of the immersed part. **Rating: 4**

2000 (a) Not easy for a part (a).
(b) Rather complicated – hard to get one's head around this problem!
Rating: 5

1999 (a) U-tube problem: OK.
(b) Reasonable Archimedes' Principle problem. **Rating: 3**

1998 (a) Thrust on a vertical surface is not on the course. However, see 2003.
(b) Tricky statics problem. **Rating: 4**

1997 (a) Reasonable weight problem.
(b) Rather complicated problem – hard to solve. **Rating: 4**

1996 (a) Statics problem. OK.
(b) Relative density. OK. **Rating: 3**

1995 (a) OK relative density problem.

	(b) Nice problem about volumes and density. In the third case the object is force under water.	**Rating: 3**
1994	(a) Nice question about density, volume, mass.	
	(b) Tricky problem.	**Rating: 4**
1993	(a) Regular relative density problem.	
	(b) Statics problem: reasonable.	**Rating: 3**
1992	(a) Tricky for part (a).	
	(b) See 2003 about thrust on a vertical surface.	**Rating: 5**
1991	Tricky statics problem.	**Rating: 4**
1990	(a) Very tricky for a part (a).	
	(b) OK, despite error in question.	**Rating: 5**
1989	(a) Tricky problem.	
	(b) Clever problem involving forces.	**Rating: 4**
1988	Reasonable problem of forces.	**Rating: 3**
1987	(a) Tricky – especially part (ii)	
	(b) Reasonable forces problem.	**Rating: 4**
1986	(a) Tricky part (a). It involves thrust on a vertical surface, which is not on the course. See 2003.	
	(b) Clever question of Archimedes' Principle.	**Rating: 4**
1985	(a) Difficult relative density problem. (b) OK question on forces.	**Rating: 4**
1984	(a) Reasonable relative density problem.	
	(b) Must know SHM theory. Tricky. See textbook.	**Rating: 4**
1983	(a) OK. U-tube problem. (b) Archimedes' Principle.	**Rating: 3**

10. Differential Equations

2015 (a) Clever question but manageable. Part (iii) tests your understanding of the relationship between area and integration.
(b) Financial Maths by the back door! Good question, though.
Rating: 3

2014 (a) Use $\frac{dv}{dt}$ in (i) and $v\frac{dv}{ds}$ in (ii)
(b) Not bad at all! **Rating: 3**

2013 (a) Fine! Nice separable differential equation.
(b) No problem!
(c) $\frac{dV}{dt} = -kV$ **Rating: 3**

2012 (a) Very manageable.
(b) Nice problem: not too difficult. **Rating: 2**

2011 (a) Nice separable differential equation
(b) Nowadays you'd be given that $\int \frac{vdv}{v^2+6400} = \frac{1}{2}\ln(v^2+6400)$ and $\int \frac{dv}{v^2+6400} = \frac{1}{80}\tan^{-1}(\frac{v}{80})$ **Rating: 3**

2010 (a) Nowadays you'd be given that $\int \frac{ydy}{y^2+1} = \frac{1}{2}\ln(y^2+1)$
(b) And you'd be given that $\int \frac{vdv}{200-v^2} = -\frac{1}{2}\ln(200-v^2)$ **Rating: 3**

2009 (a) Nowadays you'd be given that $\int \frac{ydy}{y^2+1} = \frac{1}{2}\ln(y^2+1)$
(b) And … $\int \frac{vdv}{kv^2+g} = \frac{1}{2k}\ln(kv^2+g)$ **Rating: 2**

2008 (a) Take out the common factor first.
(b) $P = Tv$ is the key equation here. **Rating: 3**

2007 (a) Perfectly ordinary.
(b) The maximum occurs when the acceleration = 0 **Rating: 2**

2006 (a) Needs care, but OK. (b) (i) OK (ii) You need to find v in terms of x and then change v to $\frac{dx}{dt}$. Then integrate again! **Rating: 4**

2005 (a) Regular.
(b) (i) OK. (ii) OK (iii) Find the energy before and after. **Rating: 3**

2004 (a) Regular.
(b) Gravity and resistance are both negative. OK. **Rating: 3**

2003 (a) OK. Requires substitution.
(b) Power = Tv. **Rating: 4**

2002 (a) Use the Laws of Indices to separate x from y.
(b) Not bad. **Rating: 3**

2001 (a) Disgraceful question! It is not a separable differential equation and is therefore not on the course. It requires you to differentiate an implicit function. You should get (as your answer) the LHS of the next equation.

Then say, "If the differentiation of $\frac{y}{x}$ is $\frac{1}{x}$ then $\frac{y}{x} = \int \frac{1}{x} dx$ and proceed using a constant of integration (not limits). The only person to get it right was the sadistic examiner who set it. He should be punished by being asked to prove Goldbach's Conjecture – and left in solitary confinement until he succeeds.
(b) OK problem. **Rating: 5**

2000 (a) Take a common factor out of the first two terms. Quadratic formula needed. (b) Be careful with the fractions. **Rating: 3**

1999 (a) Nice separable differential equation.
(b) Disgrace. The integration involved is not on the course! You need to look up the Maths tables to find it. Thrust is another name for a force. A high degree of accuracy is needed. **Rating: 5**

1998 (a) Nice. (b) (i) Clever (ii) You can change *v* in the previous equation to $\frac{ds}{dt}$. You have to remember that *k* and *u* are constants. **Rating: 3**

1997 (a) Common factor.
(b) Nice problem. **Rating: 2**

1996 (a) You must know that $\ln e^x = x$.
(b) (i) Draw a diagram for the particle on the way up. Both forces are negative. (ii) On the way down, downwards is positive, so gravity is positive and the resistance is negative. **Rating: 5**

1995 (a) Fine. (b) Gravity is positive, resistance is negative. **Rating: 3**

1994 (a) Common factor. Then let $u = 1 + x$. Tricky.
(b) Power = Tv = 75000. Now get the force equation of motion.
Rating: 4

1993 (a) Substitution. (b) (i) Logic! (ii) Nice integration. **Rating: 3**

1992 (a) Easy! (So long as you know your trigonometrical integrations.)
(b) Use $a = v\frac{dv}{ds}$ and then $a = \frac{dv}{dt}$ **Rating: 4**

1991 (a) Add $\frac{1}{y} + y$ first!
(b) Keep a clear head: it's not that difficult! **Rating: 3**

1990 (a) The amended version is easy – the original integration required partial fractions which are no longer on the course.
(b) (i) Logic! (ii) Requires cleverness to link the two equations. (The second is got by changing *v* to $\frac{dx}{dt}$. **Rating: 4**

1989 (a) Common factor. (b) Use $a = v\frac{dv}{ds}$ and then $a = \frac{dv}{dt}$. Average speed is total distance over total time. **Rating: 4**

1988 (a) Be careful! Either divide out the common factor (4) or let $u = 2x$.
(b) Multiply by 1000. Use radian mode of calculator to find $\tan^{-1} 12$.
Rating: 3

1987 (a) Use substitution. (b) Holy Moly! What a question. The power output (Tv) never changes, as the train heads from the flat to the hill. This question is a monster! If you can solve this one, you can solve any! **Rating: 5**

1986 (a) OK (b) Use $a = v\frac{dv}{ds}$ and then $a = \frac{dv}{dt}$. **Rating: 4**

1985 (a) Use substitution. (b) Average speed is total distance over total time. **Rating: 4**

1984 (a) Let the time be t. Then find the limit of v as t tends to infinity.
(b) Use $a = v\frac{dv}{ds}$ and then $a = \frac{dv}{dt}$. **Rating: 3**

1983 (a) The integration of $\cot x$ is in the Mathematical Tables. You may use substitution also.
(b) Clever question (despite error in original question). Leave the i out of the equation. **Rating: 3**