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Mark Scheme (Results)

January 2012

GCE Decision D1 (6689) Paper 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

General Principals for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),\ \text{where} |pq| = |c|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q),\ \text{where} |pq| = |c| \text{ and } |mn| = |a|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for a, b and c), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c, \quad q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

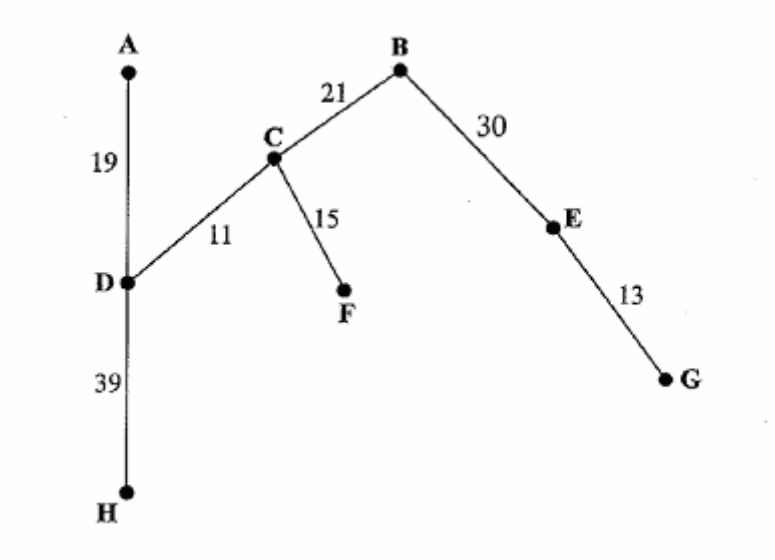
2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

January 2012
6689 Decision Mathematics D1
Mark Scheme

Question Number	Scheme	Marks
Q1 (a)	DC, EG, CF, reject DF; AD, BC, reject AB, BE, reject EF and FG, DH	M1; A1 A1 **3**
(b)	AD, DC, CF, CB; BE; EG, DH	M1;A1; A1 **3**
(c)		B1 **1**
(d)	Weight of tree = 148 (km)	B1 **1** **Total 8**

Notes

a1M1: First three arcs correctly chosen and DF rejected. Accept weights for all 3 marks.
Special case: If all 7 arcs, in correct order, but no rejections seen at all, then award M1 only.
a1A1: All arcs/weights in tree selected correctly at correct time.
a2A1: All rejections correct and at the right time.
b1M1: First four arcs/weights correctly chosen, or first five nodes ADCFB chosen in order.
Special case : If Prim but not starting at A please send to review.
b1A1: First five arcs/weights correctly chosen, or all nodes in order A, D, C, F, B, E, G, H.
b2A1: CSO (must be arcs/weights). E.g no 'reject' arcs
c1B1: CAO mark what you see at (c).
d1B1: CAO mark what you see at (d).

Question Number	Scheme	Marks
Q2		
(a)	BD + EF = 10 + 17 = 27 BE + DF = 15 + 10 = 25 ← BF + DE = 20 + 14 = 34 Repeat **arcs** BC, CE and DF Length of route = 129 + 25 = 154	M1 A1 A1 A1 A1ft B1ft **6**
(b)	We add BF(12) to the network so only have to repeat DE (14) Length of route is therefore 129 + 12 + 14 = 155 155>154 so his route would be increased	M1 A1 **2** Total 8

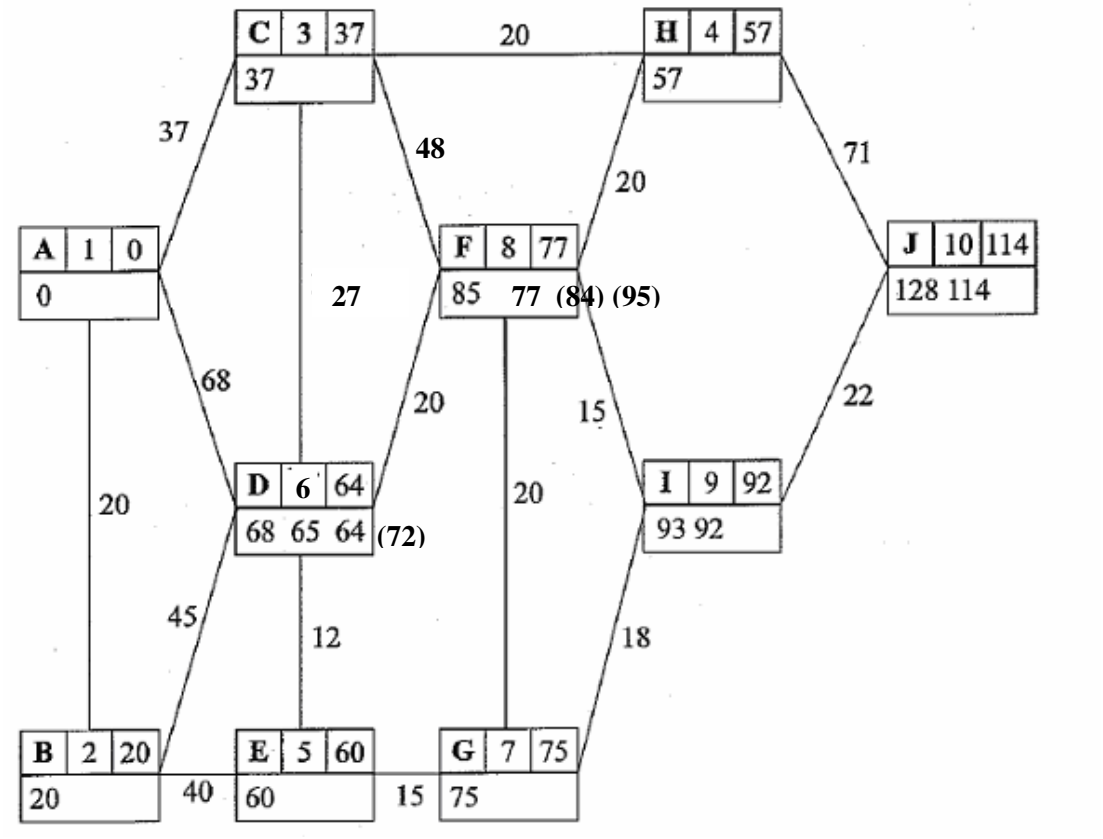
Notes

a1M1: Three pairings of their four odd nodes
a1A1: One row correct including pairing and total
a2A1: Two rows correct including pairing and total
a3A1: Three rows correct including pairing and total
a4A1ft: Their smallest repeated **arcs**, (accept BCE).
a1B1ft: 129 + their least out of a choice of at least two possible, distinct, pairings.
b1M1: DE identified, using/repeating 12 + their DE [ft from (a)]
b1A1: CAO, conclusion, numerical argument e.g. ref to 155 or 26 etc.

Question Number	Scheme	Marks
Q3		
(a)	A bipartite graph consists of two sets of vertices X and Y. The edges only join vertices in X to vertices in Y, not vertices within a set.	B2,1,0 **2**
(b)	A Matching is the pairing of some or all of the elements of one set, X, with elements of a second set, Y.	B2,1,0 **2**
(c)	Alternating path: J – 4 = E – 2 = C – 3 Change status: J = 4 – E = 2 – C = 3 C = 3, E = 2, G = 1, H = 6, J = 4, (S unmatched)	M1 A1 A1 **3**
(d)	Alternating path: S – 6 = H – 3 = C – 2 = E – 5 Change status: S = 6 – H = 3 – C = 2 – E = 5 C = 2, E = 5, G = 1, H = 3, J = 4, S = 6	M1 A1 A1 **3**
		Total 10

Notes

a1B1: 2 sets of vertices
a2B1: arcs must go from one set into the other.
b1B1: pairing or one to one.
b2B1: element(s) from 1 set with element(s) of the other.
c1M1: Path from J to 3 - or vice versa
c1A1: CAO including change status (stated or shown), chosen path clear.
c2A1: CAO unambiguous. Must ft from stated path, diagram ok
d1M1: Path from S to 5 (or vice versa)
d1A1: CAO including change status (stated or shown), but only penalise once per question, chosen path clear.
d2A1: CAO unambiguous. Must ft from stated paths, diagram ok. Must have both M's.

Question Number	Scheme	Marks
Q4 (a)	 ACHFIJ 114 minutes Route: ABEGIJ length 115 (minutes)	M1 A1(BCH) A1ft(DE) A1ft(FG) A1(IJ)
(b)		B1 B1ft **7** B1, B1 **2** **Total 9**

Notes

In (a) Accept any rising sequence for order of labelling. Order of working values is crucial.

a1M1: Big replaced by small in working values at least once at D or F or I or J.

a1A1: A, B, C, H boxes all correct, condone lack of 0 in A's working value

a2A1ft: E and D ft, based on their order of labelling. Penalise order of labelling only once.

a3A1ft: G and F ft, based on their order of labelling. Penalise order of labelling only once.

a4A1: I and J CAO. Penalise order of labelling only once.

a1B1: Route CAO

a2B1ft: 114, or their final value ft.

b1B1: route CAO.

b2B1: length CAO.

Question Number	Scheme	Marks
Q5		
(a)	Bin 1: 5, 1, 8, 5 Bin 2: 13, 2 Bin 3: 16 Bin 4: 8, 12 Bin 5: 15 Bin 6: 10	M1 (1st 6 terms) A1(next 3) A1 **3**
(b)	E.g Bubbling left to right (see alts) 5 1 8 13 16 5 8 2 15 12 10 5 8 13 16 5 8 2 15 12 10 1 8 13 16 5 8 5 15 12 10 2 1 13 16 8 8 5 15 12 10 5 2 1 16 13 8 8 15 12 10 5 5 2 1 16 13 8 15 12 10 8 5 5 2 1 16 13 15 12 10 8 8 5 5 2 1 16 15 13 12 10 8 8 5 5 2 1 + 'sorted'	M1 A1 A1ft A1ft A1 **5**
(c)	Bin 1: 16, 2, 1 Bin 2: 15, 5 Bin 3: 13, 5 Bin 4: 12, 8 Bin 5: 10, 8	M1 (to 8s) A1 (to 5s) A1 **3**
(d)	E. g. $\frac{95}{20} = 4.75$ so a minimum of 5 bins needed.	M1 A1 **2** **Total 13**

Notes

a1M1: Bin 1 correct 13 and 16 in bins 2 and 3.
a1A1: Bin 2 correct 8 in bin 4.
a2A1: CAO
b1M1: End number (greatest/least) in place. Consistent direction throughout.
b1A1: first pass correct.
b2A1ft: 2nd and 3rd passes correct – so end three numbers in place.
b3A1ft: 4th and 5th passes correct – so end five numbers in place.
b4A1: cso including 'sorted', or extra pass (es), ruling off, boxed, ticked etc.
c1M1: Bins 4 and 5 correct, others started.
Special case: If list at end of (b) wrong give M1 only for their 1st 7 terms placed correctly.
c1A1: Bins 2 and 3 correct up to the 5s.
c2A1: cao
d1M1: Numerical argument. E.g. Attempt to find lower bound o.e., consideration of 'spare room'. Etc. (Accept '5 items $\geq$ 10' o.e for M1 only)
d1A1: correct numerical argument; conclusion (the yes/no) may follow from (c).

Alternatives for Question 5(b)

Right to left

5	1	8	13	16	5	8	2	15	12	10	**1M1**
16	5	1	8	13	15	5	8	2	12	10	**1A1**
16	15	5	1	8	13	12	5	8	2	10	
16	15	13	5	1	8	12	10	5	8	2	**2A1ft**
16	15	13	12	5	1	8	10	8	5	2	
16	15	13	12	10	5	1	8	8	5	2	**3A1ft**
16	15	13	12	10	8	5	1	8	5	2	
16	15	13	12	10	8	8	5	1	5	2	
16	15	13	12	10	8	8	5	5	1	2	
16	15	13	12	10	8	8	5	5	2	1 + Stop	**4A1**

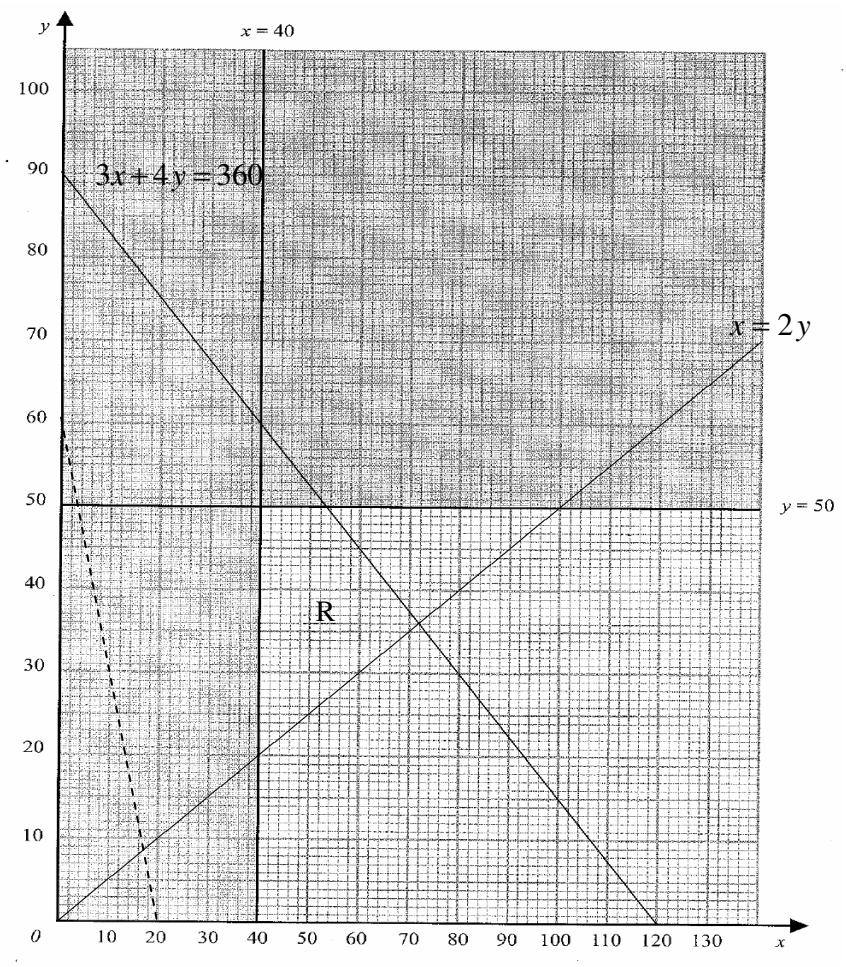
Misreads – allow recovery if list reversed.

Left to right ascending

5	1	8	13	16	5	8	2	15	12	10	**1M1**
1	5	8	13	5	8	2	15	12	10	16	**1A1**
1	5	8	5	8	2	13	12	10	15	16	
1	5	5	8	2	8	12	10	13	15	16	**2A1ft**
1	5	5	2	8	8	10	12	13	15	16	
1	5	2	5	8	8	10	12	13	15	16	**3A1ft**
1	2	5	5	8	8	10	12	13	15	16 + stop	**4A1**

Right to Left ascending

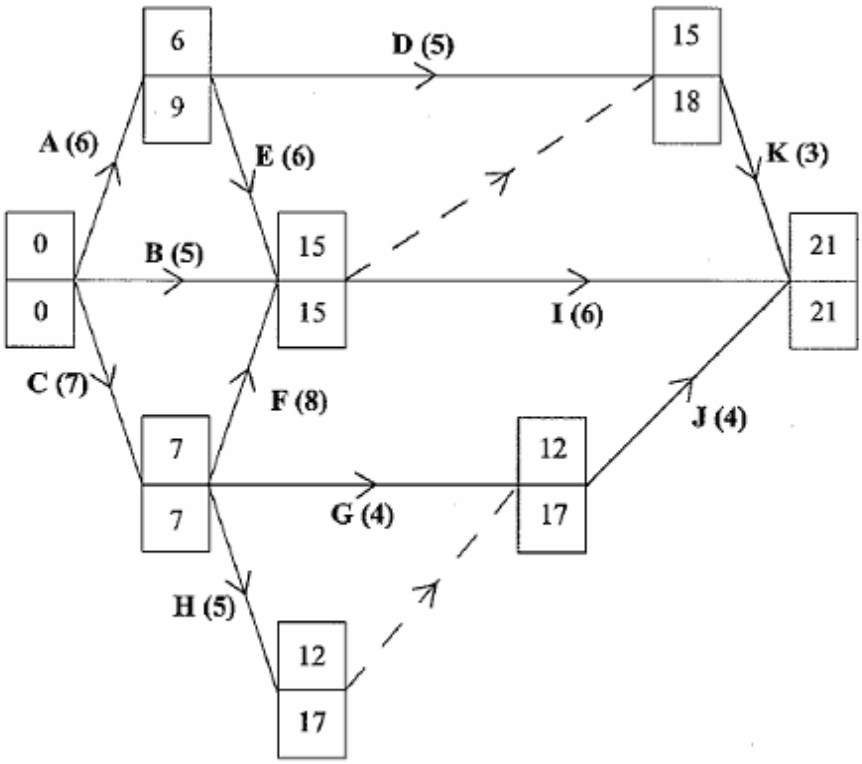
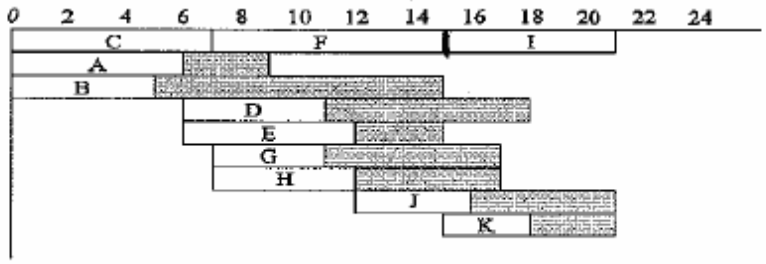
5	1	8	13	16	5	8	2	15	12	10	**1M1**
1	5	2	8	13	16	5	8	10	15	12	**1A1**
1	2	5	5	8	13	16	8	10	12	15	
1	2	5	5	8	8	13	16	10	12	15	**2A1ft**
1	2	5	5	8	8	10	13	16	12	15	
1	2	5	5	8	8	10	12	13	16	15	**3A1ft**
1	2	5	5	8	8	10	12	13	15	16 + stop	**4A1**

Question Number	Scheme	Marks
Q6		
(a)	(Edgar should plant) at least 40 apple trees. (Edgar should plant) at most 50 plum trees.	B1 **1**
(b)	 	B1 B1 B1ft B1 **4**
(c)		B1 **1**
(d)		M1 A1 DM1 A1 **4**
(e)	(P =) $60x + 20y$ Drawing objective line Calculating optimal point (72, 36) (£) 5 040	B1 **1** **Total 11**

Q6 Notes:
a1B1: CAO, both. Must be ≤ and ≥ not < and >.
b1B1: $3x + 4y = 360$ CAO. If extended it must go axis to axis within one small square. Must be long enough to form the correct feasible region. Lines should be drawn with a ruler.
b2B1: $x = 2y$ If extended must go through (0,0) and (120, 60) within one small square. Must be long enough to form the correct feasible region. Lines should be drawn with a ruler.
b3B1ft: ft their lines for correct shading on one of their lines. Implicit if R is correct.
b4B1: Region R correct, CAO. Must be labelled.
c1B1: CAO
d1M1: Drawing objective line or its reciprocal.
d1A1: Correct objective line. Axis to axis (0, 30) to (10, 0) minimum.
d2DM1: Depends on 1st M and correct region. Finding their correct optimal point.
d2A1: CSO
e1B1: CAO

The vertices in R are:

(40, 20) (40, 50) (53$\frac{1}{3}$, 50) (72, 36)

Question Number	Scheme	Marks
Q7		
(a)(i)	I depends on B, E and F only, K depends on B, E, F **and** D	B1 DB1
(ii)	This is so that G and H will not share the same start and end events. So that G and H can be uniquely described in terms of their end events.	B1 **3**
(b)		M1 A1 M1 A1 **4**
(c)		M1 A1ft B1 **3**
(d)		M1 A1cso **2**
(e)	Total float on D = 18 – 5 – 6 = 7 Total float on G = 17 – 4 – 7 = 6	M1 A1 M1 A1 **4**
	Lower bound = $\frac{59}{21} = 3$ workers	**Total 16**
		

Q7 Notes

ai1B1: K, I, D and at least one of B, E, F referred to. Correct statement but maybe incomplete give bod here.
ai2DB1: Clear correct statement. No bod.
aii3B1: correct statement referring to either events or activities. ('unique' alone not enough)
b1M1: All top boxes complete, values generally increasing left to right, condone one rogue
b1A1: CAO
b2M1: All bottom boxes complete, values generally decreasing R to L, condone one rogue
b2A1: CAO
c1M1: Correct calculation seen once, all three numbers correct (ft).
c1A1ft: one float (≥ 0) correct.
c1B1: Both floats correct (independent of working)
d1M1: Attempt to calculate a lower bound. [51-67 / their finish time]. Accept awrt 2.81
d1A1: CSO.
e1M1: At least 7 activities including at least 4 floats. Do not accept scheduling diagram.
e1A1: Critical activities dealt with correctly
e2M1: All 11 activities including at least 8 floats
e2A1: Non-critical activities dealt with correctly

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