THINKING SKILLS   **9694/03**

Paper 3 Problem Solving and Critical Thinking (Advanced)   **For Examination from 2009**
SPECIMEN MARK SCHEME

1 hour and 15 minutes

MAXIMUM MARK: 40

This document consists of **19** printed pages and **1** blank page.

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

Question Number	Key		Question Number	Key
1	**B, E**		11	**A, E**
2	**B, E**		12	**A, C**
3	**C, D**		13	**E, B**
4	**B, C**		14	**A, E**
5	**B, E**		15	**C, E**
6	**A, D**		16	**E, B**
7	**B, C**		17	**E, D**
8	**E, A**		18	**D, C**
9	**C, D**		19	**C, B**
10	**B, C**		20	**D, A**

If the candidate chooses three or more answers then award zero marks.

1   Energy Sources

The correct answer is **B** (1 mark) **+ E** (1 mark).

Justification

B is an argument that can be rewritten as follows:

Nuclear power stations discharge radioactive material into the oceans.
+
This will inevitably damage marine life and is likely to adversely affect human health in the long term.

Therefore: Nuclear power is not a safe, pollution-free source of energy.

E is an argument that can be rewritten as follows:

Countries that have the technology for nuclear power can more easily produce nuclear weapons.
+
The more countries there are with the capacity for producing nuclear weapons, the greater the threat of global conflict.

Therefore: International organisations must urge countries to tackle global warming without using nuclear power.

Distractors

A, **C** and **D** cannot be rewritten in this way, since none of them contains one claim that is supported by the other two sentences.

2   Olympics in Africa

The correct answer is **B** (1 mark) **+ E** (1 mark).

Justification

B is a correct response because the conjunction of claims that (i) Africa has never hosted the Games and (ii) other continents have (many times), strongly suggests that it is time Africa had a turn.

E is a correct response because Africa is cited as an example of a country that has missed out on hosting the Games and hence it is an example of why London was a wrong choice.

Distractors

The statement is not stated explicitly at all.

It cannot therefore be either the conclusion or a stated reason. This rules out **A** and **C**. Nor is it contrary to the conclusion: the conclusion is that London was the wrong choice, and the claim that Africa should have a turn is perfectly compatible with this.

3 Hydrogen Power

The correct answer is **C** (1 mark) + **D** (1 mark).

Justification

The argument structure is as follows:

R1 Climate change is the most serious environmental issue facing the modern world.

R2 Nuclear & hydrogen power production do not involve the burning of fossil fuels, and hence do not increase the levels of carbon dioxide in the atmosphere.

R3 (Counter assertion) Some fossil fuels are in fact required in pre-production of both nuclear and hydrogen power.

R4 (Counter-Counter assertion) No solution … will ever be perfect.

Therefore (intermediate conclusion), these objections should be discounted.

Therefore (conclusion), in the absence of better alternatives, we must convert as much power generation as possible to nuclear and hydrogen cell methods.

The only positive support for the conclusion is contained in R1 & R2 (R3, R4 and the intermediate conclusion merely dismiss a possible counter-argument). Without the assumption that increased carbon dioxide levels is a major cause of climate change, the conclusion cannot be drawn.

Candidates may be deterred from choosing it on the grounds that it is commonly taken to be a fact rather than a theoretical causal link. Either way, it is unstated in the passage and therefore an assumption.

D is also needed in order for the conclusion to follow. Without this assumption, and following the logic of the argument's own first two reasons, R3 would be a devastating objection, and the conclusion would not follow.

Distractors

A. The argument is perfectly consistent with the notion that better solutions will perhaps arise. It only concludes that '*In the absence of better solutions…*' Therefore it does not rest on the assumption that **A** is true.

B is a tempting distractor, but its truth or otherwise does not directly affect the reasoning in the argument, which moves from the general acceptance of the real dangers of climate change to one important way in which we should respond. The claim that climate change is too complex a phenomenon to measure accurately could form the basis of a very different argument, but not necessarily one leading to an alternative conclusion. It could be *true* that climate change is too complex for us to measure accurately and yet still *true*, based on the reasons given in the argument, that we should take the steps recommended. Hence the argument does not rest on its being false (i.e. statement **B**).

If **E** is not true, then the argument would actually be strengthened; hence it is not an assumption on which the argument rests. (It is also too close too the meaning of R3 to be an assumption by the definition as provided in the subject specifications).

4   **Physics**

The correct answer is **B** (1 mark) + **C** (1 mark).

Justification

B This statement <u>does</u> follow. The pass rate has actually remained the same. As fewer students took Physics *A Level* in 2005, then a fewer number of students passed than in 2000.

C This statement <u>does</u> follow. As the reduction in class sizes is <u>directly proportional</u> to the reduction of the number of students taking Physics *A Level* – <u>and</u> as the number of teachers has <u>decreased</u> somewhat, then it must follow that some teachers are required to teach more class groups over the academic year.

Distractors

A This statement does <u>not</u> follow. The reduction in class sizes is <u>directly proportional</u> to (and due to) the reduction of the number of students taking Physics *A Level*.

D This statement does <u>not</u> follow. Although some particular teachers tend to be responsible for more class groups, the pass rate remains the same. This statement <u>could</u> (logically) be true of particular teachers, but this can only be speculated upon because this does not actually <u>follow</u> from the data provided.

E This statement does <u>not</u> follow. The class size reduction thus far has not produced a better pass rate, so there is no justification for this statement.

5   Evolution

The correct answer is **B** (1 mark) + **E** (1 mark).

Justification for Part (i)

B   This rephrases the main conclusion.

Distractors for Part (i)

A   This is an intermediate conclusion - a conclusion but one which supports the main conclusion.

C   This is in contradiction to the argument.

D   This is the conclusion of the counter argument, and therefore precisely what is being argued against.

E   This is another intermediate conclusion.

Justification for Part (ii)

E   This can clearly be drawn from the reasoning - if evolution is a process of trial and error, there are still trials to be made and new combinations to develop. Some of these will be desirable.

Distractors for Part (ii)

A   This is assumed by the intelligent design argument, but is opposed to the evolution argument which is saying precisely that things which occur by chance can be as good as designed products.

B   This is not a conclusion that can be drawn from the above reasoning.

C   This is in contradiction to the argument.

D   Although the argument says that a chance occurrence can be as good as a designed product, it does not require that a designed product could not be better.

6   Exam retakes

The correct answer is **A** (1 mark) + **D** (1 mark).

Justification

A   Most points lie above the 45 degree line which would indicate the same score in both sessions, so this is correct.

D   The slope of the best line through the points is less than 45 degrees, this shows a larger increase in marks at the lower end, so this is correct.

Distractors

B   This cannot be concluded. The marks may have improved because the students have studied for a further six months.

C   This cannot be concluded. The November paper might have been easier. The answer is too general and cannot be concluded from a single case.

E   Once again comparing with the 45 degree line, all the weaker students lie above it while a few of the stronger students lie below it. This is not correct.

7   WHO

The correct answers are **B** (1 mark) + **C** (1 mark).

Justification

B Follows from the example set by Sweden, where action resulted in a 'drastic drop in … traffic deaths'.

C 65% of 1.2million = 780,000 / 15 years = 52,000

Distractors:

A The Swedish figures, if not representative, would make very little difference to the European totals, or to the trend, and anyway may have been factored in. There is no information to suggest that they were not.

D 420 every three days is approximately 51240 per annum. 51240 / 1,200,000 x 100 = 4.25 so it is not more than 5%.

E A fall from 631 to 480 over 10 years is 151 or 24%, but an annual decrease of 2.4% would not give the same result.

8   Car Sales

The correct answer is **E** (1 mark) + **A** (1 mark).

Justification

In order to answer this question correctly, the candidate must be able to think clearly about what the scatterplot actually conveys/represents. Firstly the candidate needs to identify which data points represent the appointed sales staff. These were the 7 interviewees who claimed to have made an average of 16.5 sales per month, plus three who claimed to have made 18, 19 and 20 respectively.

Then the candidate must scan the scatterplot correctly in order to identify those interviewees who had a higher 'true sales' score, but were rejected.

Distractors

These are incorrect, although similar in magnitude.

9   Coins

The correct answer is **C** (1 mark) + **D** (1 mark).

Justification

Boris has either two 5m coins (1+5+5+6) or two 6m coins (2+3+6+6).

If we look at the ways of partitioning 13 into 4 integers with two the same (the contents of Ayesha's purse) we have the following possibilities:

| 1129 | 1138 | 1147 | 1156 | 1228 | 1336 | 2236 | 2245 | 2335 | 1255 | 2344 |

This gives the following as the denominations they both have:

| 129 | 138 | 147 | 156 | 128 | 136 | 236 | 245 | 235 | 125 | 234 |

We need to find which of these, with a single repeated coin, could add up to 17. There are only two possibilities

236: 2+3+6+6 = 17   and   156: 1+5+5+6 = 17.

In the first case, Boris has two 5m coins and in the second he has two 6m coins.

Distractors

The distractors are other coins which (with others) can make up either 13m or 17m.

10   **Phonological Deficits**

The correct answer is **B** (1 mark) + **C** (1 mark).

Justification for Part (i)

According to the theory, the cause of dyslexia is (lack of/ reduced) phonological awareness. While other factors can exacerbate the condition, there are no grounds for inferring that they can themselves cause it. The root cause is therefore a phonological deficit.

Distractors for Part (i)

A confuses a necessary with a sufficient condition, as the theory neither states nor implies that everyone with a phonological deficit will be dyslexic. The statement 'If X is dyslexic, then X will have a phonological deficit' does not imply the converse 'If X has a phonological deficit, X will be dyslexic'.

The theory only tells us that other factors *can* exacerbate the condition. They are therefore not necessary conditions and therefore should not be stated as part of the overall definition, as they are in **C**.

As with **A**, **D** entails the assumption that a phonological deficit is a sufficient condition for dyslexia, when the theory only implies that it is necessary. The theory is therefore consistent with the claims 'X has a phonological awareness' *and* 'X does not have dyslexia'.

E cannot be derived from the theory as it stands. It could be postulated but would require further experimental evidence to determine. (In fact it *is* often the case that there is a correlation, but this is in no way derivable from the theory.)

Justification for Part (ii)

The theory predicts that all dyslexic pupils will have a phonological deficit but not that all pupils with a phonological deficit will be dyslexic. Short term memory is irrelevant. Additionally, no pupils will be dyslexic without a phonological deficit. Only **C** shows this.

Distractors for Part (ii)

A   shows all pupils with a phonological deficit as dyslexic.

B   shows some pupils with no phonological deficit as dyslexic.

D   is similar to **B**.

E   shows all pupils with a phonological deficit and poor short term memory as dyslexic.

11 Organic Crops

The correct answer is **A** (1 mark) + **E** (1 mark).

Justification

The argument gives the following reasons for the conclusion that our food crops should be grown mainly by conventional methods, using manufactured pesticides and fertilisers:

- These methods have produced a massive increase in food production over the last 50 years.
- This has greatly reduced the price of food, and increased food availability worldwide, despite a doubling of the world's population.
- Organic agriculture is much less efficient than conventional methods, thus organically produced food costs more.
- Organic crops are grown without the use of manufactured pesticides and fertilisers.
- But this does not make organic food healthier, because all plants contain natural pesticides.
- 99.99% of the pesticides we consume are these natural pesticides.
- What is important for health is to eat several portions of fruit and vegetables each day, because these contain nutrients and vitamins that provide protection against a number of serious diseases.

The first three points above focus on the benefit of conventional methods of crop production, in that they have enabled more food to be available to a growing population, something which, it is suggested, organic agriculture cannot match. **A** strengthens this part of the reasoning, since if the world population continues to grow, it is important to use methods of food production which will produce high yields.

The last three points concern the effects of the different methods of farming on health. **E** strengthens this part of the argument, because if food became more expensive due to increased use of organic methods, many people may be unable to consume enough vitamins from fruit and vegetables to help them resist the ill effects of any pesticide residues in food, including natural pesticides, which, according to the passage, could be present in organically produced food as well as in conventionally produced food.

Distractors

Neither **B** nor **D** strengthens the argument because neither identifies a difference between organically produced food and conventionally produced food, since these natural pesticides will be present in both. **C** does not strengthen the argument because it mentions an adverse effect of conventional agriculture, i.e. the damage it can cause to wildlife.

12 Cats and the Paranormal

The correct answer is **A** (1 mark) + **C** (1 mark).

Justification

A This <u>would</u> explain the correlation. The more basic / 'real' associations are:
(1) gender is associated with cat ownership (2) gender is also associated with belief in the paranormal. These two <u>real</u> associations 'create' the illusion that cat ownership is associated with belief in the paranormal.

C This <u>would</u> explain the conclusion. When stating that two variables are <u>significantly</u> associated, a researcher would also state what the *probability level* is. In other words, s/he would state how probable it is statistically that the association observed could have simply been due to random / chance factors (in sampling, etc.). The researcher would normally state (for example) that $p = 0.05$ – this meaning that there <u>is</u> an observed association, BUT that there is a 5% chance that this (empirically) observed association simply happened by chance. Hence, if a researcher looked for 20 possible associations in his/her data, then (approx.) one of these associations should be found to be significant (at $p = 0.05$) simply by chance / due to random sampling.

Distractors

B This would <u>NOT</u> explain the conclusion. If this statement were true, then the only effect of this on the research data would be that more believers than non-believers (in the paranormal) would be represented in the survey's sample. Logically, this sampling bias would not (in itself) produce a link between cat ownership and belief in the paranormal. If the link/association <u>were</u> actually there, then this would be revealed with or without this sampling bias.

D If it were the case that believers in the paranormal answer questions in an unpredictable manner, then this would <u>NOT</u> explain the conclusion. All that this would mean would be that they would be just as likely to answer *'no'* (unpredictably) to the questions as they would be to answer *'yes'* (unpredictably). An association / correlation would, however, be generated if it were true that people who believe in the paranormal tend to answer *'yes'* to questions posed in survey questionnaires.

E This would <u>NOT</u> explain the conclusion. If this statement were true, then cat lovers would enjoy answering *'no'* as much as they would enjoy answering *'yes'*: they would simply <u>enjoy</u> answering the questions.

13 Artificial Selection

The correct answer is **E** (1 mark) + **B** (1 mark).

Justification

The argument makes a comparison between the observed effects of (e.g.) hunting elephants, and protecting weaker humans by means of medicine. It draws an intermediate conclusion that artificial interference in this way will quite quickly alter the proportion of strong members of a species. It then draws a further, provisional conclusion that 'if so…' we may well face a future of medical dependency.

The analogy could be challenged because in the first case the strongest are being killed, and in the second the weak are being preserved *as well as* the strong. There is no suggestion that medicine 'selects out' the fit. The cases are sufficiently unalike to weaken the argument, and **E** points out the difference.

The argument also omits to explain why a change in the proportion of weaker individuals might affect the species adversely. **B** provides a plausible explanation and thus strengthens the argument.

Distractors

A This is largely irrelevant. There is no reason why effects seen in a small, localised population may not be replicated in a larger or more dispersed one.

C This neither strengthens nor weakens the argument. The fact that evolutionary changes can also occur naturally does not affect the argument concerning artificially caused changes.

D This seems like a challenge, but it misses the limited point the argument is making. The argument is entirely about the possibility of certain evolutionary changes taking place as a result of improved medical care, and neither makes nor implies any moral or action-guiding judgements. **D** and the argument's conclusion could both be accepted as true without contradiction.

14 Children reading

The correct answer is **A** (1 mark) + **E** (1 mark).

Justification for Part (i)

This argument consists of an explanation: It is thought that stories help children to understand and structure the world around them. Explains research evidence that (1) research indicates that children who read fiction prolifically are more likely to be successful academically than those who do not; (2) this success extends beyond the areas of literature, language and history, in which the link between stories and academic (school) work can clearly be seen; (3) children who read are also more likely to be good at maths and science. Note that (3) is a significant logical part of the argument because it confirms that reading supports areas of academic endeavour not previously thought to be linked to stories. The explanation particularly focuses on evidence (3). The conclusion is: if this is true, parents with their children's happiness at heart, should do all they can to encourage a love of stories. The blank space is most logically completed by **A**.

Distractors for Part (i)

B Possibly commonly held opinion, but does not fit logically into the gap because we have been told that the success extends beyond the areas you would expect, so logically we need to expect a success story.

C Possibly also commonly held opinion, but does not fit logically into the gap - we are waiting for success story.

D Ditto.

E This may count as a success, but does not logically fit into the gap.

Justification for Part (ii)

E This must be assumed if parents are to encourage their children to love stories on the basis of the explanation that this will promote academic success. If academic success did not influence a child's happiness, then parents who had their children's happiness at heart could ignore the evidence.

Distractors for Part (ii)

A This is far too strong.

B This may be the case but the argument does not assume it. The argument links academic success and happiness.

C This is almost certainly true, but it is not assumed by the argument.

D This is not assumed by the argument and is far too strong. We are told that children who do not read prolifically are likely to be less successful than their reading peers. This does not mean that they cannot be successful.

15 Smoking

The correct answer is **C** (1 mark) **+ E** (1 mark).

Justification

The conclusion is based on the facts that the figure quoted in statistics included deaths from at least one disease (heart disease) which can have other causes besides smoking; and that it had not been recorded whether all those who died from diseases that can be caused by smoking had ever been smokers. These facts support a conclusion that some of those who were said to have died from 'smoking-related illness' may have died from an illness caused by something other than smoking. By claiming in the conclusion that some of those who were said to have died from 'smoking-related illness' may not have died from smoking-related illness, the author must be interpreting the term as meaning an illness that the individual would not have had if he or she had not been a smoker. Both **C** and **E** capture this meaning.

Distractors

A is not the correct answer, because the conclusion implies that an illness can be 'smoking-related' only if it is caused by smoking. Moreover, it is not crucial to the author's meaning of 'smoking-related illness' that all such illness must be fatal.

B is not the correct answer, since the conclusion only requires the assumption that one must have smoked in order to suffer a particular illness. It does not follow from this that all those who smoke suffer from a particular disease.

D is not the correct answer, because this is the definition of 'smoking-related illness' upon which the statistics that the author is disputing are based.

16 Around the World

The correct answer is **E** (1 mark) + **B** (1 mark).

Justification for Part (i)

Passport	$480
Sydney to Hong Kong	$60
Hong Kong to Johannesburg	$75
Johannesburg to Montreal	$85
Montreal to San Francisco	$40
San Francisco to Sydney	$80
	$820

Distractors for Part (ii)

A Considers the supplementary charges for Sydney to Hong Kong ($60), Johannesburg to Montreal ($85) and San Francisco to Sydney ($80) only, then adds these to the passport cost of $480.

B Forgets the flight home from San Francisco to Sydney.

C Forgets the flight from Sydney to Hong Kong.

D Considers the supplementary charges for Sydney to Hong Kong ($60), Sydney to Johannesburg ($75), Sydney to Montreal ($100) and Sydney to San Francisco ($80) then adds these to the Passport cost of $480.

Justification for Part (ii)

Candidates may opt to re-cost the whole trip. Alternatively:

Extra cost of Passport	$150
Johannesburg to Cairo	$50
Cairo to Paris	$35
Paris to Montreal	$50
minus Johannesburg to Montreal	-$85
	$200

Distractors for Part (ii)

A Confuses flights and stopovers, buying a 6-flighty passport.

C Flies to Paris first and then Cairo.

D Forgets to subtract $85 for the Johannesburg to Montreal flight.

E Considers the three extra flights as well as Johannesburg to Montreal flight so buys an 8-flight passport.

 [Turn over

17 Sunningdale Savings

The correct answer is **E** (1 mark) + **D** (1 mark).

Justification for Part (i)

The backlog is 800 applications. 120 can be processed in a day. The net processing is 70 per day as 50 new ones are received. 800/70 is 12 days (rounded up).

Distractors for Part (i)

A 7: 800/120 rounded up (forgets new applications).

B 8: As for A but discounts Monday (thinking it is used for training).

C 10: It takes nearly 7 days to process those already there. In this time a further 350 have been received. These would take just over 3 days to clear: 7 + 3 = 10.

D 11: Correct method but fails to round up.

Justification for Part (ii)

If up to six temporary staff are employed, 1 trainer will be needed. This means that 110 applications will be processed on Monday, a net gain of 60, leaving a backlog of 740. Subsequently, 10 (12 + n) - 50 will be removed from the backlog each day. If n is 6, this is 130 and the backlog could not be cleared in 5 days.

Similarly, if 6-12 temporary staff are employed, 2 trainers will be needed and 100 applications will be processed on Monday, a net gain of 50, leaving a backlog of 750.
Subsequently, 10(12+n) -50 will be removed each day.

If n is 7 this is 140 and it will take 5+ days.
If n is 8 this is 150 and it will take exactly 5 days.

Distractors for Part (ii)

A 4: Fails to allow for new applications and training. To clear 800 in 5 days, 160 a day must be processed, this needs 16 staff or 4 extra.

B 5: fails to note that the number must be rounded up.

C 6: As for **B** but allows for one member of staff training. 110 in first day, leaving 690, this will need 175 a day, 6 extra needed.

E 12: 800 / 120 would take 7 days. There would be 350 more. We need extra temporary staff to do 2 days worth in five days (240/5 is 5) and 7 more to do 350 in 5 days: 12 in total.

18   Hospital Waiting Lists

The correct answer is **D** (1 mark) + **C** (1 mark).

Justification for Part (i)

The waiting time for any new case can be determined by determining the time needed to clear the number of people on the waiting list when the new case was added. As the current waiting list is reduced at a rate of 3 x 7 = 21 per week, the student needs to determine how many people must be on the waiting list such that it takes more than 26 (and less than 27) weeks to clear it. To just clear the waiting list in 26 weeks, 21 x 26 = 546 patients must be treated. The current list is 440, so by the time 106 more are added, the waiting time will be just 26 weeks, and one further addition (to 107, totalling a waiting list of 547 patients) will then exceed the 26 weeks waiting time.

There are 29 new cases and 21 current cases (ie. already on the waiting list) treated per week, leaving a net gain to the list of 8 cases per week. In 13 (i.e. 107 / 8, ignoring remainder) weeks, the waiting list will have increased by 104 new cases, so in 14 weeks it will have increased by 112, resulting in a list of 552, so in 14 weeks the waiting time will have exceeded 26 weeks.

Distractors for Part (i)

The distractors are incorrect but are of plausible magnitude.

Justification for Part (ii)

This is a different application of a similar principle, requiring a different procedure and careful data processing. Each two weeks, the list reduces by 14 (one the first week and thirteen the second). We need to reduce the list by 141 (440-299). It will take 10 lots of two weeks or 20 weeks to reduce by 140 (10 x 14), to 300 exactly. Hence it will take 21 weeks to reduce the number to less than 300.

Distractors for Part (ii)

Due to the fact that calculating the reduction is more straightforward in two week slots, it is easy to make an error by giving the answer in fortnights (11), or forgetting to calculate the last two weeks separately (22). If the student calculates to 300, rather than less than 300, the same errors would give answers of 10 and 20. Hence the four distractors were chosen accordingly.
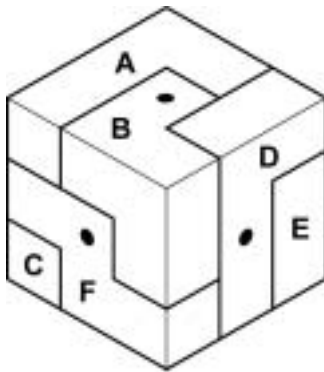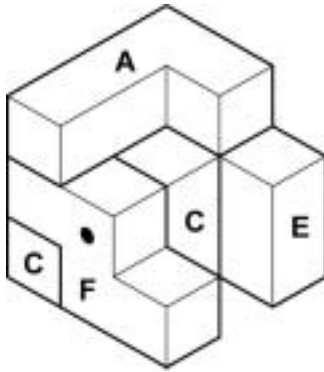
The question involves both data processing and finding a procedure to establish the required solution.

19 Three Dimensional Puzzle

The correct answer is **C** (1 mark) + **B** (1 mark).

Justifications for Parts (i) and (ii)

Careful consideration of the information reveals that the partial assembly and the completed cube have been constructed as follows:

Distractors for Parts (i) and (ii)

These are other pieces in the puzzle.

20 Rose Bushes

The correct answer is **D** (1 mark) and **A** (1 mark).

Justification

From the diagram it should be clear that, as well as red in hole 8, orange must be planted in hole 9 and yellow in hole 17. When these are in place it can be seen that pink must be planted in hole 12 and white in hole 22, then yellow in hole 7 and white in hole 13, then red in holes 6 and 19, then white in hole 24. The last yellow has to be planted in hole 5 and the two oranges in holes 20 and 21, leaving holes 1 and 15 for the remaining two pinks.

Distractors

The distractors are incorrect combinations.

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