Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

THINKING SKILLS **9694/33**

Paper 3 Problem Analysis and Solution **May/June 2016**

MARK SCHEME

Maximum Mark: 50

Published

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1 (a) What are the total distances that Bill needs to travel to make each of the other trips? [2]

Warehouse > Model Solutions > Model Market > Warehouse
5 + 6 + 8 = 19 km
Warehouse > Model Emporium > Model Market > Warehouse
7 + 10 + 8 = 25 km

Award 1 mark for each of the two calculations.

(b) Which store should Bill deliver to first in order to make the total distance travelled as short as possible? What is this shortest distance? [3]

Model Emporium cannot be the first destination, because the boxes for the other two stores will not all fit on the van.

All the routes are:

Store	*First trip*	*Second trip*	*Total*
Model Solutions	10 km	25 km	35 km
Model Emporium	14 km	19 km	33 km
Model Market	16 km	20 km	36 km

Bill should deliver to Model Solutions first.
The shortest distance is 35 km.

Award 1 mark for calculation of total distance of any one set of deliveries.
Award 1 mark for identifying Model Solutions as the store to be delivered to first.
Award 1 mark for correct shortest distance of 35 km for Model Solutions OR 33 km for Model Emporium

SC: award 2 marks for all distances calculated, but wrong judgment made.

(c) (i) If Model Emporium does not require any boxes delivered next week, how much would Bill save by hiring the larger van rather than the smaller one? [2]

If there are no boxes to be delivered to Model Emporium then the total distance would be19 km and the large van could be used to make just one trip.
The cost for hiring the van would be 19 × \$7 = \$133.

With the smaller van, two trips would be needed, so it would be most efficient to do one delivery to each of the stores. The distances for these two trips would be 10 km and 16 km.
The cost for hiring the van would be 26 × \$6 = \$156.

Bill will save \$23 by hiring the larger van.

Award 1 mark for one of the two calculations of the cost for the deliveries.
Award 1 mark for the correct final answer of \$23.

(ii) If Model Emporium does require some boxes delivered next week, what is the smallest number of boxes that could be needed at Model Emporium to make it cheaper for Bill to hire the larger van? [3]

With the larger van the deliveries can be made with a total distance of 33 km since there is enough space for the boxes for Model Market and Model Solutions to go on one trip. Therefore the cost of delivering with the large van will be \$231 for anything up to 25 boxes needed at Model Emporium.

The smaller van can be used for trips as in part **(b)**, provided that the boxes for ME can fit with the boxes for one of the other stores. So with 8 boxes Bill can deliver to both MM and ME in one trip, making a total distance of 35 km, giving a total cost of \$210.

But if there are 9 boxes, the shortest route (MS&MM, MS&ME) has a total distance of 39 km with the smaller van ($39 \times \$6 = \$234$) which makes it cheaper to use the larger one on its shortest route (ME, MS&MM, \$231).

3 marks for 9 boxes AND comparative costs (\$231 v \$234)
2 marks for 9 boxes and either \$231 or \$234 seen
0 marks for 9 boxes with no supporting working.

If 9 boxes is not identified, award marks as follows (max 2):
1 mark for a correct minimum cost for 7 or 8 boxes and van size (e.g. small van, 8 boxes = \$210); 1 mark for a correct cost for the other van size.
1 mark for a comparison of small and large van (non-minimal) costs for 7, 8, or 9 boxes.
1 mark for minimal costs calculated for both vans for a number of boxes greater than 9.
1 mark for comparison of costs for large and small vans for 8 or 9 boxes, with one arithmetic error.

2 (a) How many different keys of this sort can be made? [2]

$5 \times 5 \times 5 \times 5 \times 5 = 3125$ [1 mark]
$3125 - 1 = \underline{3124}$

SC1: $4^5 - 1$ or 1023 seen

(b) Which five locks could be opened by the key 3 0 0 0 0? [1]

[3 0 0 0 0] <u>0 3 0 0 0, 0 0 3 0 0, 0 0 0 3 0, 0 0 0 0 3</u>

(c) Give an example of a key, with a code containing no more than two 0s, that could open more than one lock. List all the locks that this key could open. [2]

2 marks for the full list for any key with no more than two 0s.
1 mark for at least one correct lock – other than the lock with the same code – for any key with no more than two 0s.

e.g. 2 3 2 0 0 could open 2 3 2 0 0, 0 2 3 2 0, 0 0 2 3 2, 0 0 0 2 3 and 0 0 0 0 2.

(d) (i) What is this constraint? [1]

The first digit cannot be 0.

(ii) How many locks are permissible, given this rule? [1]

$4 \times 5 \times 5 \times 5 \times 5 =$ 2500 *(condone 2499)*

(e) How many locks, including low security locks, are permissible given this restriction? [1]

$(5 \times 5 \times 5) - 1 =$ 124 *(condone 125)*

(f) Subject to all the restrictions, how many locks with 7-digit codes are permissible? [2]

$4 \times 5 \times 5 \times 5 =$ 500

Award 1 mark for either 7^4 or 6×7^5 or working which attempts to combine the 7 independent possibilities and abide by one of the two restrictions.

SC1: 499

3 (a) If the Medium coin had a value of 5 and the Large coin had a value of 19, how would the price of an item with a value of 30 be written, in terms of L, M and S? [1]

1L, 2M, 1S

(b) If a price of 2L, 0M, 1S can be paid for precisely with 1 Large, 3 Medium and 4 Small coins, give one example of possible values for the Medium and Large coins. [2]

If L = value of Large, and M = value of Medium then
$2L + 1 = L + 3M + 4$
$L = 3M + 3$ **soi** [1 mark]
$1 < M < 11$ because of restrictions

M	2	3	4	5	6	7	8	9	10
L	9	12	15	18	21	24	27	30	33

(c) The first price found was for a jug priced 3M, 6S. What are the only four possible values for this jug? [2]

Medium could have a value of 7, 8, 9 or 10.
So 3M + 6S could be 36, 33, 30 or 27.

1 mark for appreciation that Medium could have those values OR for 2 of the 4 prices given (and up to 2 erroneous prices)

(d) Some time later, a necklace priced 1L, 6M, 7S was found.

(i) What is the largest possible value for this necklace? [1]

Maximum value of M = 10
Maximum value of L = 100
Largest possible value = 167

(ii) What is the smallest possible value for this necklace? [2]

Minimum value of M = 8
L is greater than $(6 \times 8) + 7 = 55$. Minimum value of L = 56
Smallest value of necklace = 56 + 48 + 7 = 111

1 mark for appreciation that L must be worth at least 6M + 7(S) + 1

SC1: 104 (derived from choosing M = 8 and L = 49 as minimum values)

(iii) Initially, the archaeologist believes the necklace has a value of 118. Deduce what the values of the Medium and Large coins would be if this were the case. [2]

L + 6M + 7 = 118 so L = 111 – 6M
When M = 8, L = 111 – 48 = 63

When M = 9 or 10, L = 57 or 51 respectively, but would enable the price to be expressed as 2L +...
One mark for either of these pairs.

SC1: M = 8 and L = 8M: yields 119

(iv) What is the smallest possible value for the necklace which would not allow the values of the Medium and Large coins to be deduced? [3]

If M = 8 then $56 \leqslant L \leqslant 80$
If M = 9 then $62 \leqslant L \leqslant 90$
If M = 10 then $68 \leqslant L \leqslant 100$

If M = 9 then the minimum value of L = 62 and the value of the necklace would be $62 + (6 \times 9) + 7 = 123$
If M = 8 then L = 68 also gives a value of the necklace of 123.

Award 1 mark for any value (apart from 118) analysed into values of M and L.
Award 1 mark for reference to why a specific value is accepted/rejected
OR for values of M and L for two necklace values between 119 and 130.
Award 1 mark for 123 can be achieved in two ways.

(v) What value for the necklace could still be explained by three different values of the Large coin? [2]

135

The lowest price in the range is given by 12M + 15.
The highest price in the range is given by 16M + 7.
When M is 8, the range is 111–135
When M is 9, the range is 123–151
When M is 10, the range is 135–167

Only 135 is possible for all three values of M; L could be 80, 74 or 68.

1 mark for any two ranges derived from values of M.
OR
1 mark for any value considered and rejected with appropriate explanation.

4 (a) What is the total amount of prize money won every season? [1]

$900 (13 × $50 + $250)

(b) McGann's win last night was their second win of the season. In which week was their previous win? [1]

Week 5

(c) There has only been one tie-break so far this season. Which team won it? Explain your reasoning. [3]

Award 1 mark for identification of Baker as the winners of the tie-break.
Award 1 mark for evidence of appreciation of each of the following:
Baker, Eccleston and Tennant were involved in the tie-break.
Eccleston and Tennant (currently) have an odd-number handicap.

If no other marks can be awarded, award 1 mark for evidence of appreciation that the tie-break occurred in week 6.

(d) Which team has scored 80 points or more four times, but has so far failed to win any prize money? [1]

Pertwee

(e) Hartnell's win last week was achieved with the highest final score by any team this season. They only failed to answer 7 questions correctly.

How many of these 7 questions were picture questions? [2]

2 (they failed to score 2 × 2 points and 5 × 1 point) to achieve 91 points.

If 2 marks cannot be awarded, award 1 mark:
for evidence of appreciation that the team scored 91 question points (because their handicap was still 2 points last week)
OR
for working supporting an appropriate number of picture questions if handicap was forgotten (89 points would be reached by 4 picture questions, and 3 GK questions).

(f) Which week's quiz seems to have been the hardest? Give a reason for your answer. [1]

Week 9

The winning/total/mean/median score/result was the lowest of the season.

(g) (i) List all the teams' league totals as they are now, following last night's quiz. [4]

Eccleston	795
McCoy	787
Troughton	784 (703 + 81)
McGann	783 (701 + 82)
Tennant	776 (768 + 79 – 71)
Baker	769 (759 + 78 – 68)
Hartnell	751 (676 + 75)
Davison	729 (724 + 72 – 67)
Smith	722 (652 + 70)
Pertwee	712 (635 + 77)

Ignore league order.
Award 1 mark for every two correct totals (apart from Eccleston and McCoy).

(ii) Identify one team that cannot win the league, whatever happens in week 13, and explain why not. [2]

Smith's maximum final score in week 13 would be 100, this would knock out 65 from week 9, giving them a total of 722 + 35 = 757.
Davison's maximum final score in week 13 would be 100, this would knock out 68 from week 2, giving them a total of 729 + 32 = 761.
Hartnell's maximum final score in week 13 would be 96 (handicap 4), this would knock out 66 from week 9, giving them a total of 751 + 30 = 781.

Accept calculation for Hartnell with maximum final score of 100.

Award 1 mark for any team's maximum possible score after Week 13 (except Pertwee); award the second mark for a correct inference about a team that cannot win the league.