CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9694 THINKING SKILLS

9694/32 Paper 2 (Problem Analysis and Solution), maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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CAMBRIDGE
International Examinations

1 (a) Show that it is possible to finish 3rd in each of the first three races, and yet be ranked 4th so far, by listing possible positions for the crews ahead of you. [2]

2 marks for three correct triplets: for example (1, 2, 4), (4, 1, 2), (2, 4, 1) or (1, 2, 5), (5, 1, 2), (2, 5, 1) or (1, 2, 5), (1, 1, 5), (2, 2, 4).

1 mark for a triplet which sums to less than 9, but involves a single repeated position: for example (1, 2, 5), (2, 4, 2), (2, 1, 4).

OR

1 mark for a triplet which involves no repeats, but which includes a (single) total greater than 9: for example (1, 4, 5), (2, 5, 1), (4, 1, 2).

(b) What is the best ranking you could have after two races, if you finished 6th in both of them? [2]

(1, 1), (2, 10), (3, 9), (4, 8) etc.

2nd (equal)

1 mark for explicitly considering outcomes for the winner of a race.

(c) If you finish 4th in every race in a five-race regatta, what is the worst final ranking you can have? Suggest positions for the crews who beat you. [3]

The worst final ranking would be 6th. A list of five quintuplets are needed to demonstrate this is possible: for example (1, 2, 3, 5, 6), (6, 1, 2, 3, 5), (5, 6, 1, 2, 3), (3, 5, 6, 1, 2) and (2, 3, 5, 6, 1).

3 marks for possible crew positions unambiguously described, and the final ranking of 6th given.

If 3 marks cannot be awarded, award 2 marks for a complete demonstration that the ranking of 5th is possible.

OR award 2 marks for a demonstration that 6th is possible with at most one error in the quintuplets.

If 2 marks cannot be awarded, award 1 mark for the correct final ranking (6^{th}), but with insufficient working OR any viable collection of five quintuplets OR list including (1, 2, 3, 5, 6) seen.

(d) What is the lowest position you could finish in the first three races, if you finished in the same position each time (e.g. 2nd, 2nd, 2nd), and still be able to be ranked 1st before the fourth race? [3]

Lowest position is 5th. This is possible: other crew positions could be (1, 6, 8), (2, 4, 9) and (3, 5, 8) each permuted appropriately. 6th not possible because (total other positions = 3 × (1 + 2 + 3 + 4 + 5 + 7 + 8 + 9 + 10) = 147. averaged over the other 9 crews = 147/9 = 16.3 (1d.p.). So it is not possible to arrange the other crews so that they all have a total over 18.

1 mark for the correct minimum (5th);
and 1 mark for each of the following elements (max 2): an argument for its possibility [e.g. (165 – 15)/9 > 15]; a convincing appeal to the impossibility of any higher position [e.g. (165 – 18)/9 < 18]; a demonstration of how the other boats are placed (supporting an answer of 5^{th}, or 4^{th}).

2 (a) (i) Which entry in the table enables us to deduce that there were no crimes reported in April 2010? [1]

The July 2010 figure of zero means that reported crime is zero in April.

(ii) How many crimes were reported in 2011? [1]

25

(iii) How many crimes were reported in September 2010? [1]

5

(iv) How many crimes were reported in November 2009? [2]

2

Unzipping from July backwards:
Jul, Jun, May, Apr 0
Mar was 1
Feb was 3
Jan was 4
Dec 2009 was 0
November 2009 was 2

1 mark for Dec 2009 figure OR 1 mark for method with a single arithmetic mistake.

(b) Assuming that all crimes have been reported immediately, approximately what length of time did Carradine spend in prison last time? [1]

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                    4 2 0
4 3 1 0 0 0 0 5 5 4 3 3
4 0 0 0 0 0 5 2 6 4 4 0   around 6 months
0 0 0 0 0 6 4 4 4 5 4 5

J F M A M J J A S O N D
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(c) Give two plausible but distinct reasons to explain this inconsistency. [2]

e.g. there's a new form of crime (or a second burglar).
The burglar doesn't visit the type of homes of those who say they wouldn't report crimes.
Small figures are not statistically significant.
People don't do as they say.
The people who said they would no longer report crime may have moved out – new tenants.

1 mark each for any 2 independent reasons.

(d) How can the detective use the data in the table to support his claim that Carradine cannot be telling the truth? [2]

1 mark for one of the problematic months identified, and 1 mark for a clear justification of why it is problematic.
Dec 2010 (too few incidents, given Nov 2010 only has 3), Oct 2012, Dec 2012 (both of which have too many, given the 6 incidents in June 2012).
1 mark for an argument based on June 2012.

3 (a) Will the cartwheel appear to be going backwards or forwards if the camera takes 36 frames per second? Justify your answer. [1]

360° ÷ 36 = 10 < 45° therefore forwards.

(b) At what number of frames per second will a 4-spoke cartwheel's direction of motion be ambiguous? [1]

Turning 45° will make the wheel's motion ambiguous. This is done by taking 8 frames per second.

(c) What is the minimum number of frames per second to make the cartwheel's motion appear backwards? Justify your answer. [2]

1 & 2 frames per second obviously make the wheel appear static.
3 frames per second: 120° = nearer to 90° (clockwise) than 180° (anticlockwise). So forwards.
4 frames per second obviously makes the wheel appear static.
5 frames per second: 72° = nearer to 90° (anticlockwise) than 0° (clockwise). So backwards.
6 and 7 will also make the wheel's motion appear backwards.

Award 2 marks for the answer (5) with adequate justification (minimum justification is the calculation showing that 5 produces backwards motion while 3 produces forwards).
If 2 marks cannot be awarded, award 1 mark for EITHER the answer 5 with no justification OR evidence that 3 produces forwards motion, or that 6 or 7 produce backwards motion.

(d) A particular cartwheel has 12 spokes. My camera takes 25 frames per second.

What is the slowest that this cartwheel can be turning (measured in revolutions per second) for its direction of motion to be ambiguous when filmed by my camera? [3]

12 spokes: 30° in between spokes; 15° (or 1/24 of a turn) will make it appear ambiguous; the frames are taken every 1/25 of a second.
1/24 of a revolution in 1/25 of a second
25/24 of a revolution in one second (1.04166…)

3 marks for the correct answer (allow the 'inverted' compound unit: 24/25 seconds per revolution).
If 3 marks cannot be awarded, award 1 mark for a solution in which a candidate states the angle/proportion of a circle needed to achieve ambiguity (15°) and 1 mark for the time between frames (0.04 seconds).
OR 1 mark for 25/12 revolutions per second (2.0833…)

(e) Two differently-sized cartwheels, both with 12 spokes, appeared to be turning in different directions when filmed by my camera (25 frames per second).

Suggest a possible speed of rotation (measured in revolutions per second) for each of the two wheels. Justify your answer. [3]

Wheels will appear forward-turning when they do less than 1/24 of a turn in 1/25 of a second, OR between 2/24 and 3/24 of a turn (in 1/25 of a second), OR and between 4/24 and 5/24…

The most obvious answer will be to use the boundary found in **(d)** and choose a speed just above and below e.g. 1 revolution per second & 26/24 of a revolution per second.
The following table shows the appropriate intervals.

Forwards	Backwards
0 – 1.0417 rev/sec	1.0417 – 2.083 rev/sec
2.083 – 3.125 rev/sec	3.125 – 4.1667 rev/sec
4.1667 – 5.2083 rev/sec	5.2083 – 6.25 rev/sec

Award 3 marks if two speeds are given, with correct directions of motion. If 3 marks cannot be awarded, award 2 marks if the directions are wrong; award 1 mark for a speed not given in part **(d)** AND a clear indication of which direction it will turn.

(f) A cartwheel was filmed with an old camera which took 14 frames per second. The cartwheel appeared to go backwards when revolving at 1 revolution per second.

How many spokes could the cartwheel have? List all the possibilities. (You may assume that no cartwheel has more than 25 spokes.) [5]

14 frames per second: 360 ÷ 14 = 25.7° per frame. If this appeared backwards then the angle between the wheel's spokes must have been less than double this, i.e. less than 51.4°. i.e. more than 7 spokes. But at 14 spokes the motion appears static; and at 15 spokes it appears forward moving again. This effect would continue as the number of spokes increases, until the 21 spoke cartwheel induces ambiguity again, and then perceived backward motion at 22.

So the cartwheel could have 8, 9, 10, 11, 12, 13, 22, 23, 24 or 25 spokes.

If 5 marks cannot be awarded:

Award 4 marks if the candidate offers a full solution, with up to two arithmetic errors.
SC – if a candidate offers the set of spokes which lead to forward motion (15, 16, 17, 18, 19, 20), award 3 marks.

Award 3 marks if the 22, 23, 24, 25 are identified, OR 8, 9, 10, 11, 12 are identified.

Award 1 mark for any number of spokes with a correct identification of the direction of motion, and 2 marks if three are correctly identified – considering any wrongly identified number of spokes as cancelling out a correctly identified one.
OR award 1 mark for each of the spoke numbers inducing ambiguous motion identified as such (7, 14 & 21).

4 (a) How many tours each day begin between 12:00 and 14:00? [1]

7 (at 12:30, 12:40, 12:50, 13:15, 13:30, 13:40 and 13:50)

(b) At what time yesterday did Jojo

(i) begin his second tour? [1]

12:40 (13^{th} tour of the day)

(ii) get back to the Information Centre at the end of his last tour? [2]

18:10

If 2 marks cannot be awarded, award 1 mark for an answer of 16:50, or evidence of recognition that his last tour began at 16:50.

(c) (i) At what times did Penny's second, third and fourth tours begin, and who led each of them? [4]

(second tour) 11:30 (led by) Lucy

(third tour) 13:15 (led by) Maxwell

(fourth tour) 15:40 (led by) Lucy

1 mark for all three correct times above. 1 mark for each tour guide correctly identified.

Allow FT for wrongly chosen guide: e.g. if Martha given as guide for 11:30 (0 marks) then award marks for Lucy and Martha for 13:15 and 15:40 respectively (see appended table).

(ii) How much did the four tours cost Penny altogether? [2]

$47.24 (12.50 + 11.60 + 14.50 + 8.64)

If 2 marks cannot be awarded, award 1 mark for evidence of recognition that only the 15:40 tour (Paul = $10.80) qualifies for 20% off (even though she has 2 vouchers).

Credit answers that correctly correspond to incorrect tour times given in **(i)**.

(d) Had she arrived in time to join the 09:40 Paul tour, how much

(i) earlier or later would she have completed her fourth tour? [1]

15 minutes later

Originally finishing at [15:40 + 75 =] 16:55
If she arrives in time she finishes at 17:10
[09:40 (Paul) 11:30 (John) 13:15 (Ringo) 15:50 (George)]

(ii) more or less would she have paid overall? [1]

16 cents less

(e) Suggest a timetable for her that will allow her to go on the four tours for the lowest possible total cost. [3]

Paul and George tours (the cheapest two) must begin before 12:00 (to get the 20% off vouchers) and John and Ringo tours must begin after 14:00 (to qualify for 20% off).

- any four non-overlapping tours (involving all the caverns) with two that begin before 12:00 and two that begin after 14:00 OR in which Ringo's tour is after 14:00 [1 mark]
- 09:40 (Paul) and 11:50 (George) OR 09:50 (George) and 11:40 (Paul) [1 mark]
- 14:30 (John) and 16:15 (Ringo) OR 14:45 (Ringo) and 17:30 (John) [1 mark]

Tour	Time	Cavern	Guide
1	09:30	John	Martha
2	09:40	Paul	Bill
3	09:50	George	Jude
4	10:15	Ringo	Michelle
5	10:30	John	Jojo
6	10:40	Paul	Sadie
7	10:50	George	Maxwell
8	11:30	John	Lucy
9	11:40	Paul	Martha
10	11:45	Ringo	Bill
11	11:50	George	Jude
12	12:30	John	Michelle
13	12:40	Paul	Jojo
14	12:50	George	Sadie
15	13:15	Ringo	Maxwell
16	13:30	John	Lucy
17	13:40	Paul	Martha
18	13:50	George	Bill
19	14:30	John	Jude
20	14:40	Paul	Michelle
21	14:45	Ringo	Jojo
22	14:50	George	Sadie
23	15:30	John	Maxwell
24	15:40	Paul	Lucy
25	15:50	George	Martha
26	16:15	Ringo	Bill
27	16:30	John	Jude
28	16:40	Paul	Michelle
29	16:50	George	Jojo
30	17:30	John	Sadie
31	17:40	Paul	Maxwell
32	17:50	George	Lucy

All other timetables that are possible within the same day, following the conclusion of the George tour at 11:10:

2nd tour		3rd tour		4th tour	
11:30	Lucy	13:15	Maxwell	15:40	Lucy
11:30	Lucy	13:15	Maxwell	16:40	Michelle
11:30	Lucy	13:15	Maxwell	17:40	Maxwell
11:30	Lucy	14:45	Jojo	16:40	Michelle
11:30	Lucy	14:45	Jojo	17:40	Maxwell
11:30	Lucy	13:40	Martha	16:15	Bill
11:40	Martha	13:15	Maxwell	15:30	Maxwell
11:40	Martha	13:15	Maxwell	16:30	Jude
11:40	Martha	13:15	Maxwell	17:30	Sadie
11:40	Martha	14:45	Jojo	17:30	Sadie
11:40	Martha	13:30	Lucy	16:15	Bill
11:40	Martha	14:30	Jude	16:15	Bill
11:45	Bill	13:40	Martha	15:30	Maxwell
11:45	Bill	13:40	Martha	16:30	Jude
11:45	Bill	13:40	Martha	17:30	Sadie
11:45	Bill	14:40	Michelle	16:30	Jude
11:45	Bill	14:40	Michelle	17:30	Sadie
11:45	Bill	15:40	Lucy	17:30	Sadie
11:45	Bill	14:30	Jude	16:40	Michelle
11:45	Bill	14:30	Jude	17:40	Maxwell
11:45	Bill	15:30	Maxwell	17:40	Maxwell
12:30	Michelle	14:40	Michelle	16:15	Bill
12:30	Michelle	14:45	Jojo	16:40	Michelle
12:30	Michelle	14:45	Jojo	17:40	Maxwell
12:40	Jojo	14:30	Jude	16:15	Bill
12:40	Jojo	14:45	Jojo	17:30	Sadie
12:45	Maxwell	15:30	Maxwell	17:40	Maxwell
12:45	Maxwell	15:40	Lucy	17:30	Sadie