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| MARK SCHEME | نموذج الإجابة وتوزيع الدرجات |
| KINGDOM OF BAHRAIN | مملكة البحرين |
| EDUCATION & TRAINING QUALITY AUTHORITY | هيئة جودة التعليم والتدريب |
| Directorate of National Examinations | إدارة الامتحانات الوطنية |
| Grade 12 National Examinations | الامتحانات الوطنية للصف الثاني عشر |
| March 2017 | مارس 2017 |
| PROBLEM SOLVING | حل المشكلات |
| Paper 2 Problem Analysis and Solution | الورقة 2 تحليل وحل المشكلات |

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the National Examinations. 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 the Examiners' meeting before marking began. All Examiners are instructed that alternative correct answers and unexpected approaches in students' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated, even if they do not appear in this mark scheme. Therefore, the Directorate of National Examinations, BQA will not enter into discussions or correspondence in connection with these mark schemes.

Mark schemes must be read in conjunction with the question papers and the Principal Examiner reports.

1 (a1) If everyone in the family bought a pair of casual shoes, what was the least amount they could have paid in total? [1]
BD 82 ($20 + 24 + 19 \times 2$)
Award 1 mark.

(a2) If the two parents bought athletic shoes for themselves and paid a total of BD 70, what were the possible models they selected? Give all possible combinations. [2]
MA1 and WA4
Award 1 mark.

MA3 and WA5
Award 1 mark.

(b) What was the number of women players within the 15 best players? [2]
6 (Women) (The total cost was BD 468. Because the cost of each MA3 men shoes was BD 34 and the cost of each WA2 women shoes was BD 27, then by systematic search there must be 6 WA2 women shoes and 9 MA3 men shoes).
Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for any solution that shows the total number of shoes is 15 and calculates their total cost **or** for setting the equations $34 M + 27 W = 468$ and $M + W = 15$.

- (c1) The shop's owner decided that the model GS4 had to be among the sale collection but his staff forgot to tag it red. If Mona chose a pair of shoes of each of the models GA3, GC2 and GS4 and her mother paid a total of BD 62.900, in which group should the GS4 model be listed? [2]

(Group) C

(Amount paid for GS4 = $62.900 - (27 + 30 \times 0.8) = \text{BD } 11.900$. Then Mariam paid 70% ($11.900 \div 17$) of the shoes price. Hence, the discount was 30%).

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for **either** of the following:

- Finding the amount paid for GS4 model, which is BD 11.900.
- Calculating the difference in amounts paid before and after sale, which is BD 5.100 ($68 - 62.900$).

- (c2) The shop's owner decided to set a further reduction of 20% on any of the discounted models with a price more than BD 25 after discount. How much did Mariam pay for the purchase of the models WS4 and WC1? [2]

BD 39.470 ($37 \times 0.7 \times 0.8 + 25 \times 0.75$)

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for **either** of the following:

- BD 20.720 (price of WS4 model after further reduction) **and** BD 18.750 (price of WC1 model after sale).
- BD 35.720 (for applying further reduction for both models).
- BD 40.900 (for applying further reduction on the model with a price less than BD 25 after discount).

- (d1) If Hassan sold all of the athletic shoes he purchased for a total of BD 345 and he sold all of the models WC5, BC3 and WS1 that he purchased at the prices BD 22, BD 21 and BD 27 for each pair respectively, how much would be his profit from the sale of these shoes? [3]

BD 117.600

(Cost of the athletic shoes:

$$3 \times ((24 + 23 + 20 + 23) + 1.5 \times 4) = \text{BD } 288$$

Cost of the models WC5, BC3 and WS1:

$$5 \times (16 + 1.2) + 5 \times (15 + 1.2) + 2 \times (20 + 0.7) = \text{BD } 208.400$$

The total cost is $288 + 208.400 = \text{BD } 496.400$.

The total revenue is $345 + 5 \times 22 + 5 \times 21 + 2 \times 27 = \text{BD } 614$

The profit is $614 - 496.400 = \text{BD } 117.600$).

Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for calculating **either** of the following:

- BD 496.400 (the total cost) **and** BD 614 (the total revenue).
- BD 57 (profit for athletic shoes ($345 - 288$)) **and** BD 48 (profit for casual shoes ($215 - 167$)) **and** BD 12.600 (profit for sandals ($54 - 41.400$)).

If 2 marks cannot be awarded, award 1 mark for calculating **either** of the following:

- BD 496.400 (the total cost) **or** BD 614 (the total revenue).
- Mentioning any two of the profits for selling either athletic shoes or casual shoes or sandals.
- Sight of BD 149 (forget to add the shipping cost).

- (d2) List three other possible cases through which Hassan can charge exactly BD 100, showing the price and the quantity of each model. [3]

The six other possible cases are as follows:

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 13 | 2 |
| WS1 | 23 | 1 |
| BS4 | 15 | 1 |
| GS3 | 18 | 2 |

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 13 | 1 |
| WS1 | 23 | 1 |
| BS4 | 14 | 2 |
| GS3 | 18 | 2 |

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 12 | 1 |
| WS1 | 23 | 2 |
| BS4 | 12 | 2 |
| GS3 | 18 | 1 |

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 12 | 2 |
| WS1 | 23 | 2 |
| BS4 | 12 | 1 |
| GS3 | 18 | 1 |

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 12 | 2 |
| WS1 | 24 | 1 |
| BS4 | 14 | 1 |
| GS3 | 19 | 2 |

| Model | Price (BD) | Quantity |
|-------|------------|----------|
| MS3 | 12 | 1 |
| WS1 | 24 | 1 |
| BS4 | 15 | 3 |
| GS3 | 19 | 1 |

Award 1 mark for each correct case (maximum 3 marks).

- 2 (a) A group of 8 school students want to register for a course in the institute. What is the total amount due for payment by the group on the registration day? [1]**

(BD) 72 (BD 9 × 8)

Award 1 mark.

- (b) An employee of the institute finds out that he has accidentally registered a group of students for the wrong level. The total amount he should have received from all the registered students, according to the registers, is BD 657, whereas the actual total amount he has received is BD 639. How many students has he registered incorrectly? [2]**

6 (students) (18 ÷ 3)

(The difference in registration fees between school and university students is BD 3 per student and the difference between the amount according to the registers BD 657 and the actual amount received BD 639 is BD 18).

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for determining the difference in registration fees between school and university students, which is BD 3 per student.

- (c) Approaching the end of the first semester, the maximum number of students in all the institute's classrooms and courses was reached. What is the total amount to be returned to students after the end of the registration period for this month? [3]

(BD) 9792 ($14 \times 20 \times 6 \times 4 + 8 \times 16 \times 4 \times 6$)

Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for **either** of the following:

- Determining the amounts to be returned to school students which is BD 6720 ($14 \times 20 \times 6 \times 4$) **and** the amount to be returned to university students which is BD 3072 ($8 \times 16 \times 4 \times 6$).
- Sight of BD 21264 (the total revenue at the registration) **and** BD 11472 (the total revenue after returning the access money).

If 2 marks cannot be awarded, award 1 mark at maximum for **either** of the following:

- Determining the amount to be returned to school students, which is BD 6720 **or** the amount to be returned to university students, which is BD 3072.
- Sight of BD 21264 (the total revenue at the registration) **or** BD 11472 (the total revenue after returning the excess money).
- Sight of BD 1888 (forgetting number of weekly courses per classroom).

- (d) On the Kingdom of Bahrain National Day, the institute announced an offer to school students, so that for every six students enrolled for the same course, one of them will be free of charge. 252 students registered for 14 different courses. What is the least possible number of students who have been registered for those courses free of charge? [3]
33 (students) (17 students in 9 courses + 20 students in 4 courses + 19 students in 1 course).
Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for providing a distribution of students that distributes the total number of 252 students to 14 courses; and distribution to be having 20, 17, 11 or 5 students in most courses but it does not satisfy the least number of students.

If 2 marks cannot be awarded, award 1 mark for providing a distribution of the total number of 252 students to 14 courses.

- (e1) How many students are registered in each level? [2]
424 (students) in school level
Award 1 mark.

320 (students) in university level.
Award 1 mark.

(Based on the course fee per student in the university level, we notice that BD 12 and BD 10 are greater than BD 9 for the school level. Therefore, the best distribution to generate the highest revenue for the institute would be achieved by allocating 10 students in all university classrooms and courses which are $(8 \times 4 = 32)$ courses, then moving on to the school level classrooms and allocating 5 students in each course if possible. The number of available courses is $(14 \times 6 = 84)$ courses and by allocating 5 students in each course, we get 420 students and the 4 remaining students are added to one of the 84 courses).

- (e2) **How much revenue did the institute make?** [1]
 (BD) 7007
 $(32 \times 10 \times \text{BD } 10 + 83 \times 5 \times \text{BD } 9 + 1 \times 9 \times \text{BD } 8)$
 Award 1 mark.

Accept an incorrect answer in (e1) correctly calculated in (e2).

- (f) **Noora made a suggestion that satisfies all the conditions of the director and generates more revenue than the current system by BD 112 if the maximum number of students in all the institute's classrooms and courses is reached. How many classrooms are allocated to school, university and graphic design students according to Noora's suggestion?** [3]

(Total classrooms are 22 and according to the conditions, there are 6 possible distributions of classrooms as shown in the table below along with the revenue associated with each possibility.

| Level | School | University | Graphic Design | Revenues |
|-----------------------------|--------|------------|----------------|---|
| Number of classrooms | 10 | 6 | 6 | $10 \times 20 \times 6 \times 5 + 6 \times 16 \times 4 \times 6 + 6 \times 14 \times 5 \times 8 = \text{BD } 11664$ |
| | 6 | 10 | 6 | $6 \times 20 \times 6 \times 5 + 10 \times 16 \times 4 \times 6 + 6 \times 14 \times 5 \times 8 = \text{BD } 10800$ |
| | 6 | 6 | 10 | $6 \times 20 \times 6 \times 5 + 6 \times 16 \times 4 \times 6 + 10 \times 14 \times 5 \times 8 = \text{BD } 11504$ |
| | 8 | 8 | 6 | $8 \times 20 \times 6 \times 5 + 8 \times 16 \times 4 \times 6 + 6 \times 14 \times 5 \times 8 = \text{BD } 11232$ |
| | 8 | 6 | 8 | $8 \times 20 \times 6 \times 5 + 6 \times 16 \times 4 \times 6 + 8 \times 14 \times 5 \times 8 = \text{BD } 11584$ |
| | 6 | 8 | 8 | $6 \times 20 \times 6 \times 5 + 8 \times 16 \times 4 \times 6 + 8 \times 14 \times 5 \times 8 = \text{BD } 11152$ |

Revenues under the current system: $14 \times 20 \times 6 \times 5 + 8 \times 16 \times 4 \times 6 = \text{BD } 11472$

Since Noora's suggestion generates BD 112 more in revenue, then revenue would be $\text{BD } 11472 + \text{BD } 112 = \text{BD } 11584$).

(Therefore, the distribution of classrooms should be) 8 classrooms for school level, 6 classrooms for university level and 8 classrooms for graphic design.

Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for work showing all possible distributions of classrooms **or** 3 out of the six possible models along with their respective revenues.

If 2 marks cannot be awarded, award 1 mark for work showing 3 possible distributions of classrooms **or** one of the six possible models along with its respective revenue.

- 3 (a) How long does the trip take from Manama to Holy Mecca by bus number (2) ? [1]**

17 hours and 20 minutes

Award 1 mark.

- (b) When will bus number (1) arrive back in Manama if it makes a trip to Holy Mecca on Tuesday? [2]**

7:05 pm on Wednesday **or** 19:05 on Wednesday

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for determining the time but not the day, **or** sight of 01:05 pm on Wednesday (forgetting to add 6 hours) **or** 01:10 am on Wednesday (only added 6 hours).

- (c) Hossam went to Alhedaya office and booked 3 round-trip air tickets to Jeddah Airport for himself, his wife and his son. He paid BD 270. Which airline did Hossam choose? Explain your answer. [2]**

The second (airline), because the remaining amount is BD 50 ($270 - 2 \times 110$), which is the ticket price for the infant via the same airline.

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for naming the second airline without explaining the answer.

- (d) What is the maximum number of outward trips that bus number (3) can make in a week (from Sunday to Saturday), if it starts a trip on Sunday and has to return to Manama each time before it can make the next trip? [1]**

4 (trips)

(Bus number (3) starts its trip to Holy Mecca at 07:00 am and arrives at 11:55 pm on the same day, and it starts its return trip at 05:55 am to Manama on the next day and arrives at 10:50 pm on the same day. So if the bus starts a trip on Sunday, then it will make trips on Sunday, Tuesday, Thursday and Saturday).

Award 1 mark.

- (e1) What is the total cost for Khalid and his family if he decides to travel on a round trip by bus, leaving Manama after 02:00 am and before 05:00 am? [2]**

(BD) 153 (The cost of the outward trip is BD 85 ($25 \times 2 + 15 \times 2 + 5$) and the cost of the round trip is BD 170 (85×2). Therefore, the total cost after discount is BD 153 (170×0.9)).

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for the sight of BD 170 or BD 85.

(e2) What is the least cost for Khalid and his family if he decides to travel by plane to Holy Mecca on a round trip, if he does not want to wait at any airport for more than 4 hours for their connection? [3]

(BD) 468

(The first airline will cost BD 444 to arrive at Jeddah Airport and the bus will cost BD 24 to travel to and from Holy Mecca with a total of BD 468. The taxi will cost BD 30 to travel to and from Holy Mecca with a total of BD 474.

The second airline, the waiting time at Riyadh Airport is 4 hours and 10 mins.

The third airline will cost BD 439 to arrive at Jeddah Airport and the taxi will cost BD 30 to travel to and from Holy Mecca, with a total of BD 469. If Khalid wanted to use the bus company, he would have to wait until 10:00 am, in which case the waiting time at Jeddah Airport would exceed 4 hours).

Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for calculating the cost of arrival to Holy Mecca via the first and third airlines **and** proving that the second airline is inappropriate **or** determining that the third (airline) (will cost) BD 463 (calculating the cost of arrival to Holy Mecca via the third airline using the bus company).

If 2 marks cannot be awarded, award 1 mark at maximum for **either** of the following:

- Calculating the cost of arrival at Holy Mecca via the first and third airlines.
- Proving that the second airline is inappropriate.
- Determining that the third (airline) (will cost) BD 439 (calculating the cost of arrival at Jeddah Airport).

- (f) **Sami travelled on a round trip by plane with his family, which consists of at least 1 child and 1 infant, to perform Umrah. He paid a total amount of BD 381 to the Alhedaya office. Specify how many members of each age group make up Sami's family. [2]**

2 adults, 1 child and 2 infants

(When Sami chooses the third airline, he will pay BD 106 for himself, BD 95 for 1 child and BD 37 for 1 infant with a total of BD 238. So BD 143 will be left with him and that is the cost of additional adult and infant)

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for the sight of 1 adult, 1 child and 2 infants (excluding Sami).

(g) How long did the first family to arrive in Holy Mecca have to wait for the other family? [3]

20 mins

(Bus number (1) will arrive at 07:10 pm, bus number (2) will arrive at 08:25 pm and bus number (3) will arrive at 11:55 pm.

Whereas the first airline's flight will arrive to Jeddah Airport at 16:00 and Fahad will finish the airport procedures at 04:20 pm. Then, he will arrive at Holy Mecca at 06:40 pm using the taxi and at 07:30 pm using the bus company.

The second airline's flight will arrive to Jeddah Airport at 18:15 and Fahad will finish the airport procedures at 06:35 pm. Then, he will arrive at Holy Mecca at 08:55 pm using the taxi and at 10:00 pm using the bus company.

The third airline's flight will arrive to Jeddah Airport at 20:30 and Fahad will finish the airport procedures at 08:50 pm. Then, he will arrive at Holy Mecca at 11:10 pm using the taxi, but he will not be able to use the bus company because the last trip is at 08:30 pm. Therefore, Fahad will choose the first airline and Jassim will take bus number (1)).

Award 3 marks.

If 3 marks cannot be awarded, award 2 marks for mentioning 10 mins (Fahad will choose the first airline and Jassim will take bus number (1), where student disregarded the fact that Alsaree' Company has a bus trip every 30 minutes or Fahad will choose the second airline and Jassim will take bus number (2), where student disregarded that he should add the 20 minutes needed to finish the airport procedures).

If 2 marks cannot be awarded, award 1 mark at maximum for **either** of the following:

- 5 mins (Fahad will choose the third airline and Jassim will take bus number (3), where student disregarded the fact that the last trip from Jeddah Airport with Alsare' Company is at 08:30 pm).
- Calculating Fahad's arrival times to Holy Mecca via 3 airlines with the use of the taxi or bus.

- (h) Describe two possible changes to Bader's plan to travel by plane rather than by bus, stating in each change which airplane company has replaced which bus number, that has led to an increase in the total cost of BD 150. Explain your answer. [4]**

First change: Bader chose the second airline for a cost of BD 258 and used the bus company for a cost of BD 18, with a total cost of BD 276; rather than using bus number (1) for a cost of BD 126.

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for stating that Bader has chosen the second airline rather than bus number (1).

Second change: Bader chose the first airline for a cost of BD 237 and used the taxi for a cost of BD 30, with a total cost of BD 267; rather than using bus number (2) for a cost of BD 117.

Award 2 marks.

If 2 marks cannot be awarded, award 1 mark for stating that Bader has chosen the first airline rather than bus number (2).