MONASH University

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INFORMATION
TECHNOLOGY

SQL Intermediate

GROUP OF EIGHT AUSTRALIA

Aggregate Functions

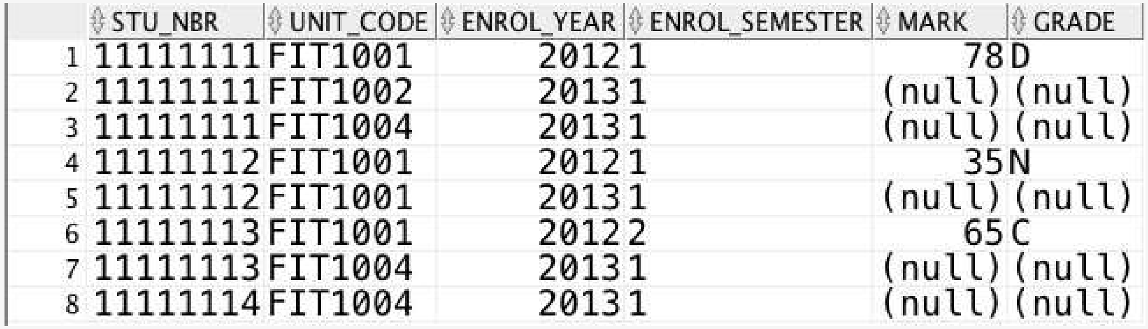
- COUNT, MAX, MIN, SUM, AVG
- Example:

```
SELECT max(mark)
FROM enrolment;
```

```
SELECT min(mark)
FROM enrolment;
```

```
SELECT avg(mark)
FROM enrolment;
```

```
SELECT count(stu_nbr)
FROM enrolment
WHERE mark >= 50;
```



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	(null)	(null)
3	11111111	FIT1004	2013	1	(null)	(null)
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	(null)	(null)
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	(null)	(null)
8	11111114	FIT1004	2013	1	(null)	(null)

Q1. What will be displayed by the following SQL statement?

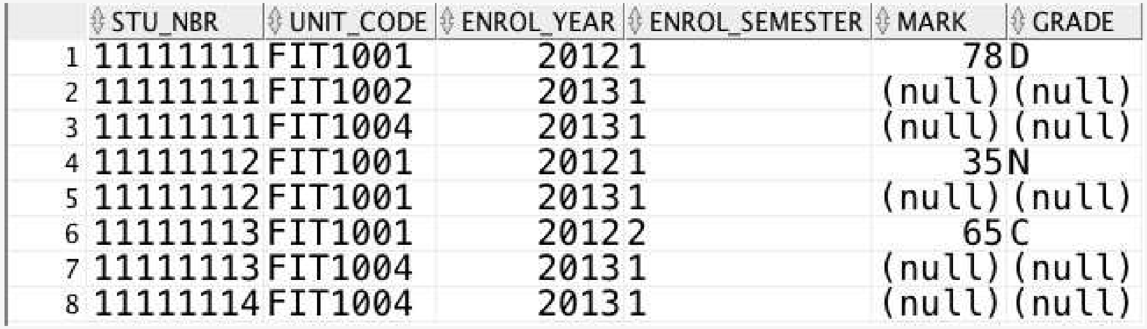
```
SELECT count(*), count(mark)
FROM enrolment;
```

A. 8, 8

[✓ B.] 8, 3

C. 3, 3

D. 3, 8



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	(null)	(null)
3	11111111	FIT1004	2013	1	(null)	(null)
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	(null)	(null)
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	(null)	(null)
8	11111114	FIT1004	2013	1	(null)	(null)

Q2. What will be displayed by the following SQL statement?

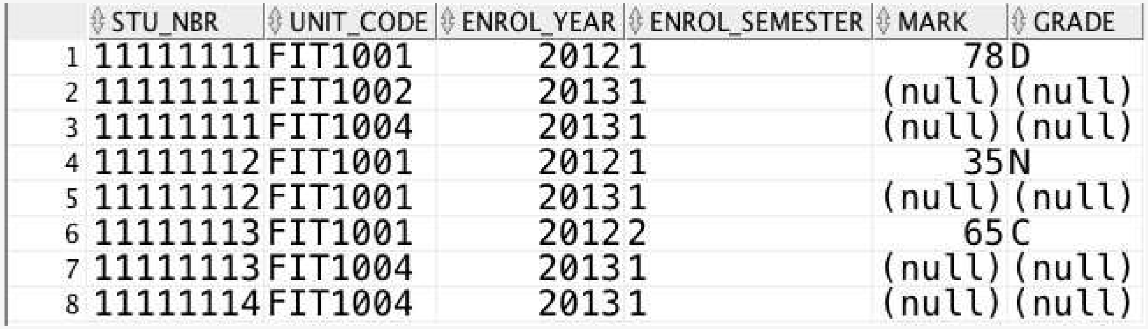
```
SELECT count(*), count(stu_nbr), count(distinct stu_nbr)
FROM enrolment;
```

[✓ A.] 8, 8, 4

B. 8, 8, 8

C. 8, 4, 8

D. 8, 4, 4



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	(null)	(null)
3	11111111	FIT1004	2013	1	(null)	(null)
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	(null)	(null)
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	(null)	(null)
8	11111114	FIT1004	2013	1	(null)	(null)

Q3. We want to calculate the *average mark of the 8 rows* in the above table. What SQL statement should we use?
Note: We want to calculate (78+35+65)/8=22.25

A. SELECT avg(mark) FROM enrolment; ✗

B. SELECT sum(mark)/count(mark) FROM enrolment; ✗

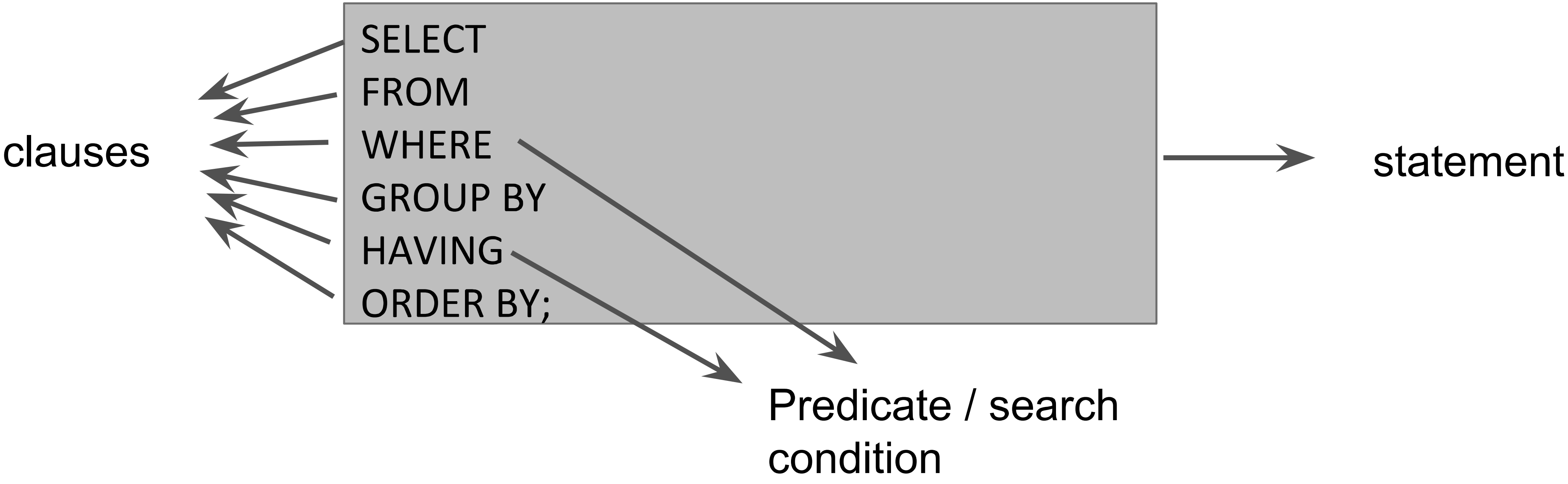
C. SELECT sum(mark)/count(*) FROM enrolment; ✓

D. SELECT avg(NVL(mark,0)) FROM enrolment; ✓

E. None of the above.

[✓ F.] More than one option is correct.

Anatomy of an SQL Statement - Revisited



```
SELECT
FROM
WHERE
GROUP BY
HAVING
ORDER BY;
```

clauses

statement

Predicate / search condition

GROUP BY

- If a GROUP BY clause is used with aggregate function, the DBMS will apply the aggregate function to the different groups defined in the clause rather than all rows.

```
SELECT avg(mark)
FROM enrolment;
```

```
SELECT unit_code, avg(mark)
FROM enrolment
GROUP BY unit_code
ORDER BY unit_code;
```

```
SQL>
SQL> SELECT avg(mark)
  2  FROM enrolment;

 AVG(MARK)
----------
59.3333333

SQL>
SQL> SELECT unit_code, avg(mark)
  2  FROM enrolment
  3  GROUP BY unit_code
  4  ORDER BY unit_code;

UNIT_CO  AVG(MARK)
------- ----------
FIT1001 59.3333333
FIT1002
FIT1004
```

What output is produced?

```
SELECT avg(mark)
FROM enrolmentA;
```

```
SELECT unit_code, avg(mark)
FROM enrolmentA
GROUP BY unit_code
ORDER BY unit_code;
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code
ORDER BY unit_code;
```

```
SQL> SELECT avg(mark)
  2  FROM enrolmentA;

 AVG(MARK)
----------
        56

SQL>
SQL> SELECT unit_code, avg(mark)
  2  FROM enrolmentA
  3  GROUP BY unit_code
  4  ORDER BY unit_code;

UNIT_CO  AVG(MARK)
------- ----------
FIT2004         60
FIT2094         50

SQL>
SQL> SELECT unit_code, avg(mark), count(*)
  2  FROM enrolmentA
  3  GROUP BY unit_code
  4  ORDER BY unit_code;

UNIT_CO  AVG(MARK)   COUNT(*)
------- ---------- ----------
FIT2004         60          3
FIT2094         50          2
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

What output is produced?

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code, year
ORDER BY unit_code, year;
```

```
SQL> SELECT unit_code, avg(mark), count(*)
  2  FROM enrolmentA
  3  GROUP BY unit_code, year
  4  ORDER BY unit_code, year;

UNIT_CO  AVG(MARK)   COUNT(*)
------- ---------- ----------
FIT2004         40          2
FIT2004        100          1
FIT2094         20          1
FIT2094         80          1
```

Note: attributes in the GROUP BY clause do not have to appear in the select list

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SQL> SELECT unit_code, year, avg(mark), count(*)
  2  FROM enrolmentA
  3  GROUP BY unit_code, year
  4  ORDER BY unit_code, year;

UNIT_CO       YEAR  AVG(MARK)   COUNT(*)
------- ---------- ---------- ----------
FIT2004       2015         40          2
FIT2004       2016        100          1
FIT2094       2015         20          1
FIT2094       2016         80          1
```

HAVING clause

- It is used to put a condition or conditions on the groups defined by GROUP BY clause.

```
SELECT unit_code, count(*)
FROM enrolment
GROUP BY unit_code
HAVING count(*) > 2;
```

What output is produced?

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code
HAVING count(*) > 2
ORDER BY unit_code;
```

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code
HAVING avg(mark) > 55
ORDER BY unit_code;
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SQL> SELECT unit_code, avg(mark), count(*)
  2  FROM enrolmentA
  3  GROUP BY unit_code
  4  HAVING count(*) > 2
  5  ORDER BY unit_code;

UNIT_CO  AVG(MARK)   COUNT(*)
------- ---------- ----------
FIT2004         60          3


SQL>
SQL> SELECT unit_code, avg(mark), count(*)
  2  FROM enrolmentA
  3  GROUP BY unit_code
  4  HAVING avg(mark) > 55
  5  ORDER BY unit_code;

UNIT_CO  AVG(MARK)   COUNT(*)
------- ---------- ----------
FIT2004         60          3
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

HAVING and WHERE clauses

```
SELECT unit_code, count(*)
FROM enrolment
WHERE mark IS NULL
GROUP BY unit_code
HAVING count(*) > 1;
```

- The WHERE clause is applied to ALL rows in the table.
- The HAVING clause is applied to the groups defined by the GROUP BY clause.
- The order of operations performed is FROM, WHERE, GROUP BY, HAVING and then ORDER BY.
- On the above example, the logic of the process will be:
  - All rows where mark is NULL are retrieved. (due to the WHERE clause)
  - The retrieved rows then are grouped into different unit_code.
  - If the number of rows in a group is greater than 1, the unit_code and the total is displayed. (due to the HAVING clause)

What output is produced?

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
WHERE year = 2015
GROUP BY unit_code
HAVING avg(mark) > 30
ORDER BY avg(mark) DESC;
```

```
SQL> SELECT unit_code, avg(mark), count(*)
  2  FROM enrolmentA
  3  WHERE year = 2015
  4  GROUP BY unit_code
  5  HAVING avg(mark) > 30
  6  ORDER BY avg(mark) DESC;

UNIT_CO  AVG(MARK)   COUNT(*)
------- ---------- ----------
FIT2004         40          2
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

Q4. What is the output for:

```
SELECT unit_code, studid, avg(mark)
FROM enrolmentA
GROUP BY unit_code
HAVING avg(mark) > 55
ORDER BY unit_code, studid;
```

A. FIT2094, 111, 50

B. FIT2004, 111, 60

C. FIT2004, 111, 60, 222, 333

D. FIT2004, 111, 100

E. Will print three rows

F. Error

```
SQL> SELECT unit_code, studid, avg(mark)
  2  FROM enrolmentA
  3  GROUP BY unit_code
  4  HAVING avg(mark) > 55
  5  ORDER BY unit_code, studid;

Error starting at line : 1 in command -
SELECT unit_code, studid, avg(mark)
FROM enrolmentA
GROUP BY unit_code
HAVING avg(mark) > 55
ORDER BY unit_code, studid
Error at Command Line : 1 Column : 19
Error report -
SQL Error: ORA-00979: not a GROUP BY expression
00979. 00000 -  "not a GROUP BY expression"
*Cause:
*Action:
```

Unit_code	Mark	Studid	Year
FIT2094	80	111	2016
FIT2094	20	111	2015
FIT2004	100	111	2016
FIT2004	40	222	2015
FIT2004	40	333	2015

```
SELECT stu_lname, stu_fname, avg(mark)
FROM enrolment e JOIN student s
        ON s.stu_nbr = e.stu_nbr
GROUP BY s.stu_nbr;
```

The above SQL generates error message

```
SQL Error: ORA-00979: not a GROUP BY expression
00979. 00000 -  "not a GROUP BY expression"
```

Why and how to fix this?

- Why? Because the grouping is based on the stu_nbr, whereas the display is based on stu_lname and stu_fname. The two groups may not have the same members.
- How to fix this?
  - Include the stu_lname,stu_fname as part of the GROUP BY condition.
- Attributes that are used in the SELECT, HAVING and ORDER BY must be included in the GROUP BY clause.

Subqueries

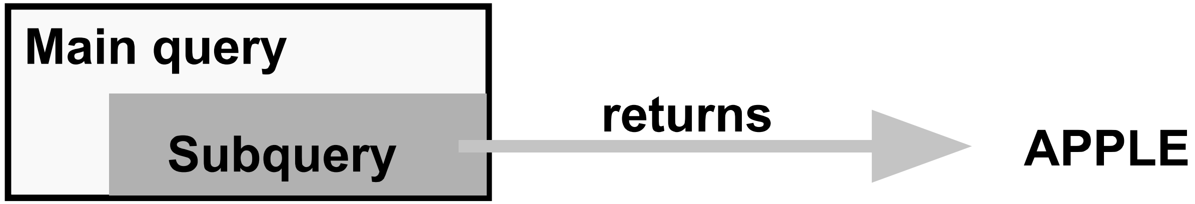
- Query within a query.

"Find all students whose mark is higher than the average mark of all enrolled students"

```
SELECT *
FROM enrolment
WHERE mark > (SELECT avg (mark)
                          FROM enrolment );
```

Types of Subqueries

Single-value



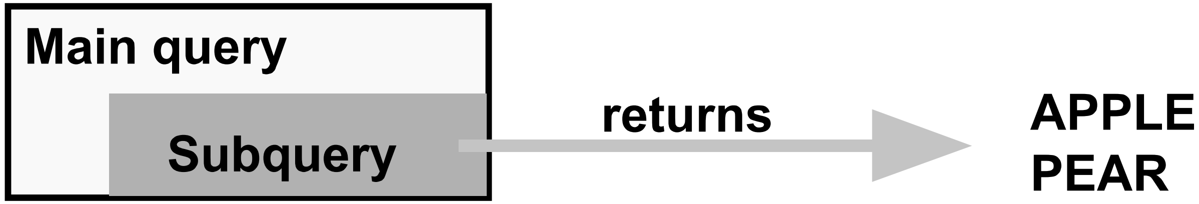
Main query

Subquery

returns

APPLE

Multiple-row subquery (a list of values – many rows, one column)



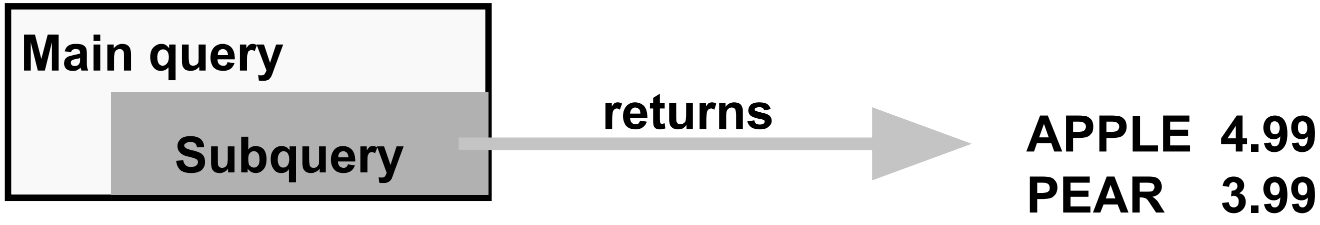
Main query

Subquery

returns

APPLE
PEAR

Multiple-column subquery (many rows, many columns)



Main query

Subquery

returns

APPLE 4.99
PEAR 3.99

Q5. What will be returned by the *inner query*?

```
SELECT *
FROM enrolment
WHERE mark > (SELECT avg(mark)
              FROM enrolment
              GROUP BY unit_code);
```

A. A value (a single column, single row).

[✓ B.] A list of values.

C. Multiple columns, multiple rows.

D. None of the above.

```
SQL> SELECT *
  2  FROM enrolment
  3  WHERE mark > (SELECT avg(mark)
  4           FROM enrolment
  5           GROUP BY unit_code);

Error starting at line : 1 in command -
SELECT *
FROM enrolment
WHERE mark > (SELECT avg(mark)
              FROM enrolment
              GROUP BY unit_code)
Error report -
ORA-01427: single-row subquery returns more than one
row
```

Q6. What will be returned by the *inner query*?

```
SELECT unit_code, stu_lname, stu_fname, mark
FROM  enrolment e join student s
          on e.stu_nbr = s.stu_nbr
WHERE (unit_code, mark) IN (SELECT unit_code, max(mark)
                            FROM enrolment
                            GROUP BY unit_code);
```

A. A value (a single column, single row).

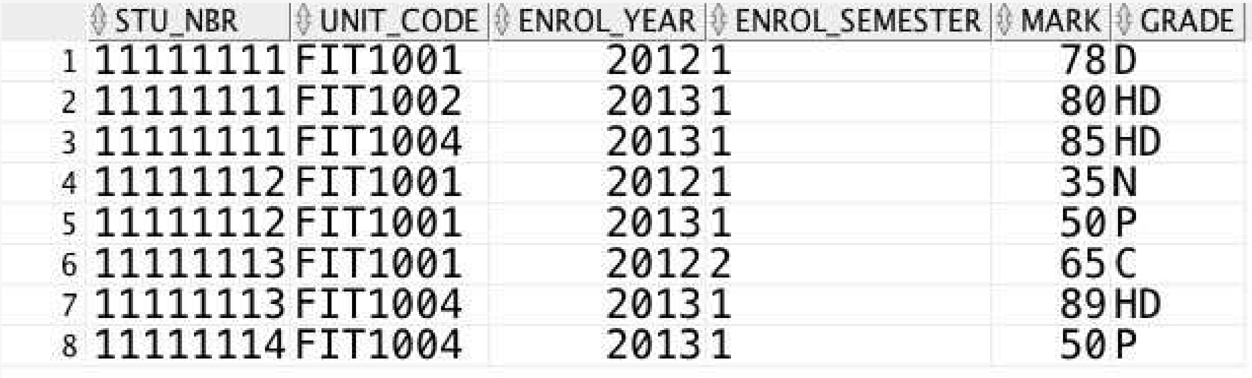
B. A list of values.

[✓ C.] Multiple columns, multiple rows.

D. None of the above.

Comparison Operators for Subquery

- Operator for single value comparison.
  =, <, >
- Operator for multiple rows or a list comparison.
  - –equality
    - IN
  - –inequality
    - •ALL, ANY combined with <, >



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P

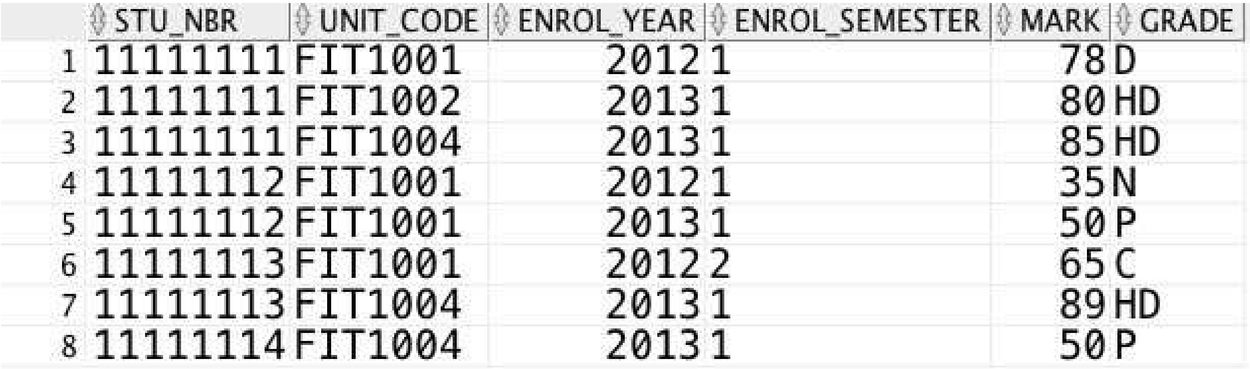
Q7. Which row(s) in ENROL2 table will be retrieved by the following SQL statement?

```
SELECT * FROM enrol2
WHERE mark IN (SELECT max(mark)
                              FROM enrol2
                             GROUP BY unit_code);
```

[✓ A.] 1, 2, 7

B. 7

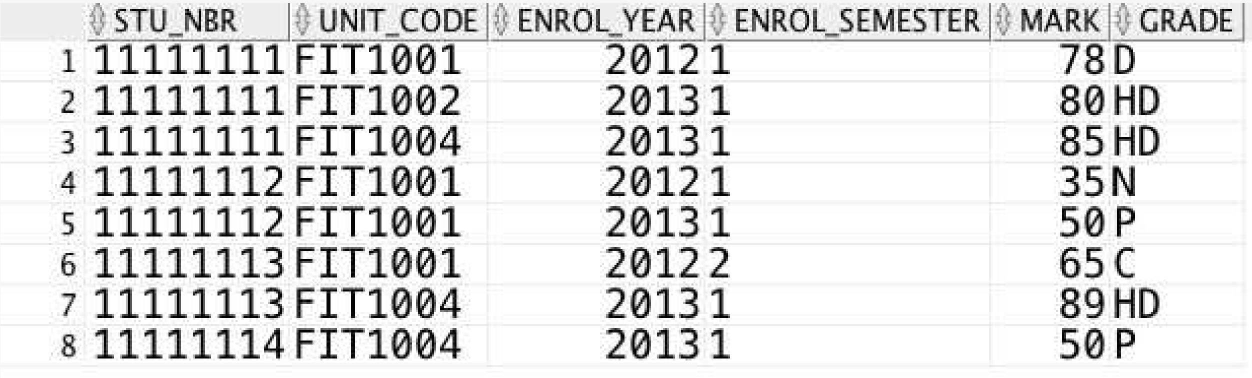
C. 2, 3, 7



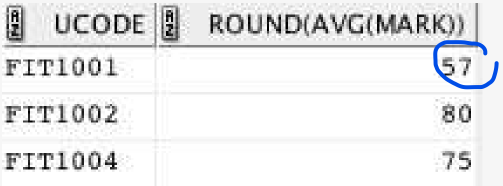
	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P

```
SQL> SELECT * FROM enrol2
  2  WHERE mark IN (SELECT max(mark)
  3                 FROM enrol2
  4                 GROUP BY unit_code)
  5  ORDER BY stu_nbr, unit_code, enrol_year;

   STU_NBR UNIT_CO ENROL_YEAR E       MARK GRA
---------- ------- ---------- - ---------- ---
  11111111 FIT1001       2012 1         78 D
  11111111 FIT1002       2013 1         80 HD
  11111113 FIT1004       2013 1         89 HD
```



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P



UCODE	ROUND(AVG(MARK))
FIT1001	57
FIT1002	80
FIT1004	75

Q8. Which row/s in ENROL2 will be retrieved by the following SQL statement?

```
SELECT * FROM enrol2
WHERE mark > ANY (SELECT avg(mark)
                  FROM enrol2
                        GROUP BY unit_code);
```

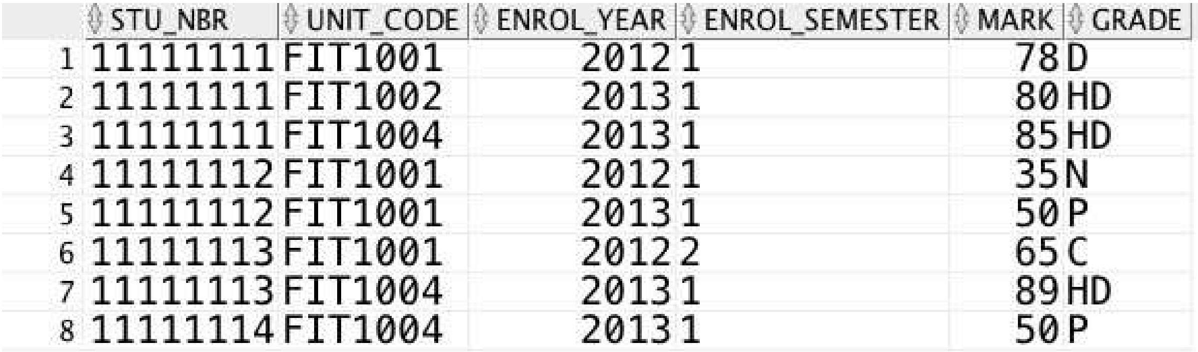
see smallest

[✓ A.] 1, 2, 3, 6, 7

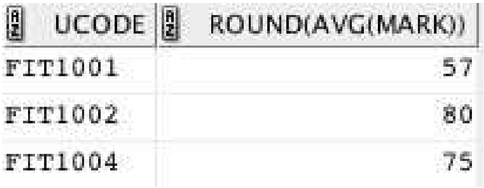
B. 2, 3, 7

C. 3, 7

D. No rows will be returned



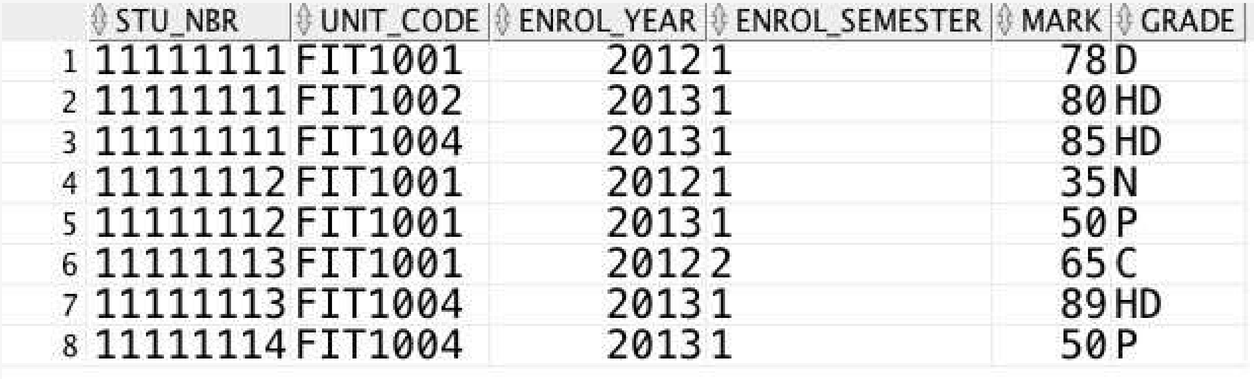
	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P



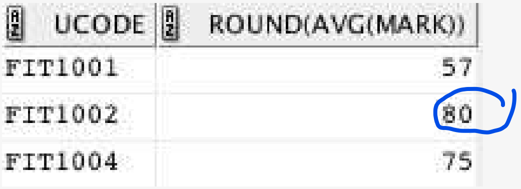
UCODE	ROUND(AVG(MARK))
FIT1001	57
FIT1002	80
FIT1004	75

```
SQL> SELECT * FROM enrol2
  2  WHERE mark > ANY (SELECT avg(mark)
  3                    FROM enrol2
  4                    GROUP BY unit_code)
  5  ORDER BY stu_nbr, unit_code, enrol_year, enrol_semester;

   STU_NBR UNIT_CO ENROL_YEAR E       MARK GRA
---------- ------- ---------- - ---------- ---
  11111111 FIT1001       2012 1         78 D
  11111111 FIT1002       2013 1         80 HD
  11111111 FIT1004       2013 1         85 HD
  11111113 FIT1001       2012 2         65 C
  11111113 FIT1004       2013 1         89 HD
```



	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P



UCODE	ROUND(AVG(MARK))
FIT1001	57
FIT1002	80
FIT1004	75

Q9. Which row/s in ENROL2 will be retrieved by the following SQL statement?

```
SELECT * FROM enrol2
WHERE mark > ALL (SELECT avg(mark)
                  FROM enrol2
                       GROUP BY unit_code);
```

see largest

A. 1, 2, 3, 6, 7

B. 2, 3, 7

C. 3, 7

D. No rows will be returned

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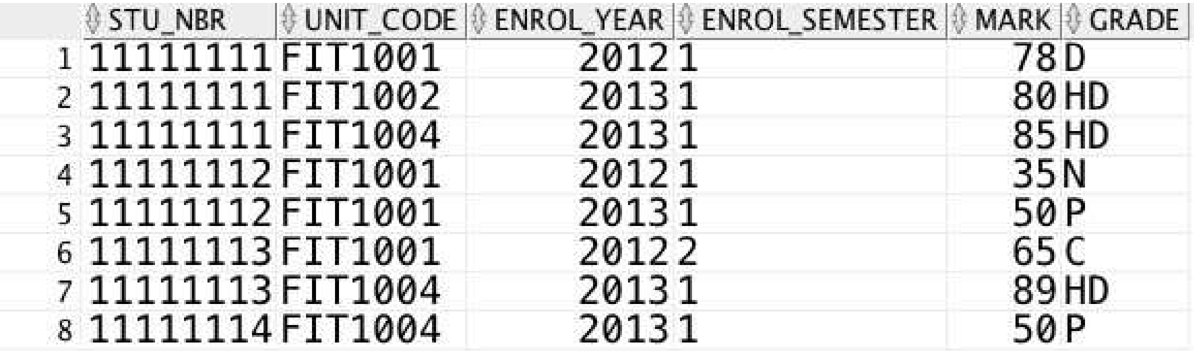
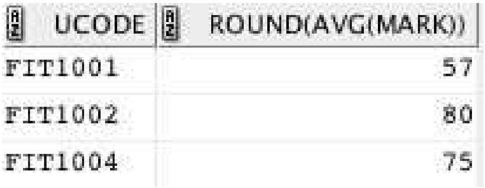


	STU_NBR	UNIT_CODE	ENROL_YEAR	ENROL_SEMESTER	MARK	GRADE
1	11111111	FIT1001	2012	1	78	D
2	11111111	FIT1002	2013	1	80	HD
3	11111111	FIT1004	2013	1	85	HD
4	11111112	FIT1001	2012	1	35	N
5	11111112	FIT1001	2013	1	50	P
6	11111113	FIT1001	2012	2	65	C
7	11111113	FIT1004	2013	1	89	HD
8	11111114	FIT1004	2013	1	50	P



UCODE	ROUND(AVG(MARK))
FIT1001	57
FIT1002	80
FIT1004	75

```
SQL> SELECT * FROM enrol2
  2  WHERE mark > ALL (SELECT avg(mark)
  3                    FROM enrol2
  4                    GROUP BY unit_code)
  5  ORDER BY stu_nbr, unit_code, enrol_year, enrol_semester;

   STU_NBR UNIT_CO ENROL_YEAR E       MARK GRA
---------- ------- ---------- - ---------- ---
  11111111 FIT1004       2013 1         85 HD
  11111113 FIT1004       2013 1         89 HD
```

Q10. Find all students whose mark in any enrolled unit is lower than Wendy Wheat's lowest mark for all units she is enrolled in. What would be a possible inner query statement for the above query (assume Wendy Wheat's name is unique)?

A.
```
SELECT min(mark)
        FROM enrol2
        WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```
✗

[✓ B.]
```
SELECT min(mark)
        FROM enrol2 e JOIN student s on e.studid = s.studid
        WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```
✓

C.
```
SELECT min(mark) FROM enrol2;
```
✗

D.
```
SELECT mark
        FROM enrol2 e JOIN student s on e.studid = s.studid
        WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```
✗

Summary

- Aggregate Functions
  - –count, min, max, avg, sum
- GROUP BY and HAVING clauses.
- Subquery
  - –Inner vs outer query
  - –comparison operators (IN, ANY, ALL)