**Question 7**
**7.A**

Let the query Q3 be :
select distinct r1.a

from R r1, R r2, R r3

where r1.b = r2.a and r2.b = r3.a;

We can see that the translated RA SQL query Q4 can be written as follows:

```
select distinct a

from R natural

join (select distinct a as b

    from R natural join (select distinct a as b

                                from R) q1 ) q2

order by 1;
```

**7.B**

| makerandomR | Q3 (ms) | Q4 (ms) |
|---|---|---|
| (100,100,1000) | 62.131 | 1.477 |
| (150,150,4000) | 2185.853 | 6.957 |
| (200,200,10000) | 10523.178 | 16.669 |
| (250,250,20000) | 23968.634 | 29.887 |

**Question 8**

**8.A**

Let the given query Q5 be:

```
select ra.a

from Ra ra

where not exists (select r.b

from R r

where r.a = ra.a and

r.b not in (select s.b from S s));
```

We can write the translated query Q6 as follows:

```
(select distinct a
from Ra)
except
(select a
from (select a, b
        from R
        except
        select a, b
        from R natural join S) subquery );
```

**8.B**

| makerandomR | makerandomS | Q5 (ms) | Q6 (ms) |
|---|---|---|---|
| (100,100,1000) | (100, 1500) | 0.664 | 1.774 |
| (150,150,4000) | (150, 2500) | 3.013 | 6.563 |
| (250,250,10000) | (250, 5000) | 6.792 | 17.812 |
| (500,500,20000) | (500, 10000) | 6.517 | 42.357 |

**Question 9**

**9.A**

Let the query Q7 be:

```
select ra.a
from Ra ra
where not exists (select s.b
from S s
where s.b not in (select r.b
from R r
where r.a = ra.a));
```

We can define the translated query Q8 as follows:

```
select distinct a
```

```
from Ra
except
select a
from (select a, b
        from Ra cross join S
        except
        select a, b
        from R) subquery;
```

**9.B**

| makerandomR | makerandomS | Q7 (ms) | Q8 (ms) |
|---|---|---|---|
| (100,100,1000) | (100, 1500) | 30.742 | 11.494 |
| (150,150,4000) | (150, 2500) | 148.010 | 28.864 |
| (250,250,10000) | (250, 5000) | 757.113 | 102.284 |
| (500,500,20000) | (500, 10000) | 2129.636 | 454.571 |