Kinetics of acid reactions: making sense of associated concepts

Kim Chwee Daniel Tan, David F. Treagust, A. L. Chandrasegaran and Mauro Mocerino

Supplementary data

Items in second version of the Acid Reactions Instrument
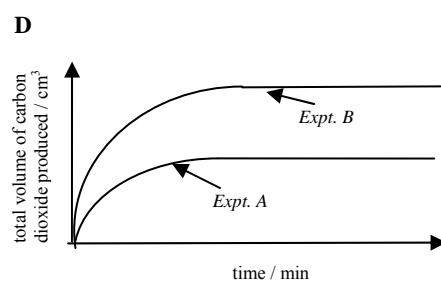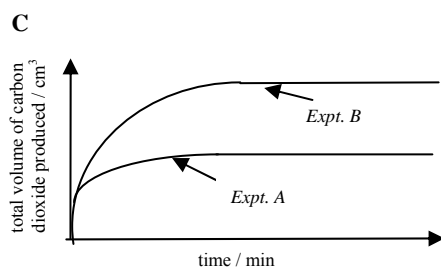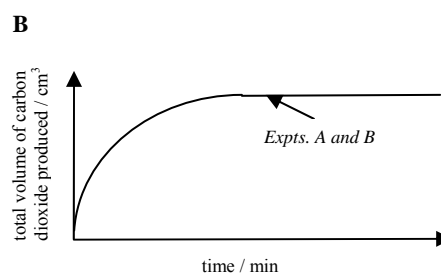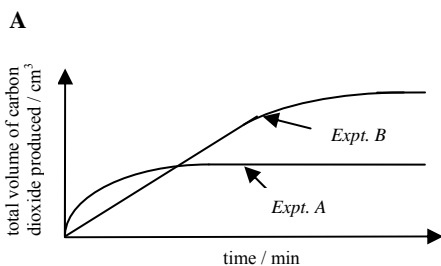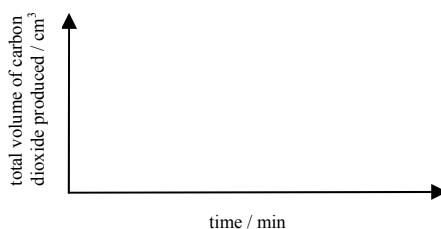
Rates of reactions involving reactions of acids

1 In Experiment A, <u>**excess**</u> 1 mol dm^{-3} hydrochloric acid (HCl) was added to a flask containing some powdered copper(II) carbonate.

   In Experiment B, the same volume of <u>**excess**</u> 1 mol dm^{-3} sulfuric acid (H$_2$SO$_4$) was added to a flask containing the same amount of powdered copper(II) carbonate as in Experiment A.

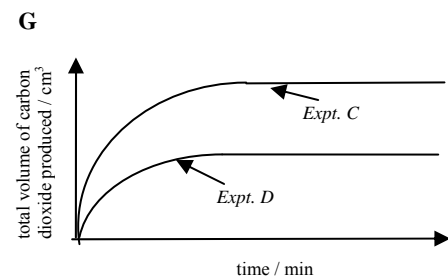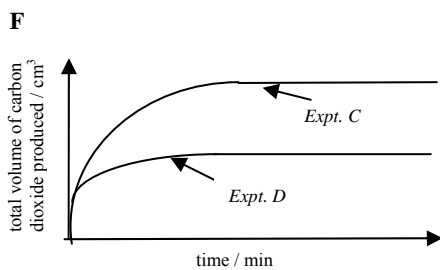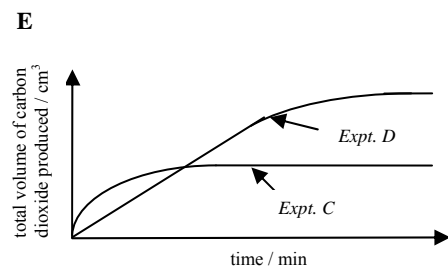   Which of the graphs indicates the total volume of carbon dioxide produced as the reactions progressed in Experiments A and B?

A

B

C

D

E

F

G
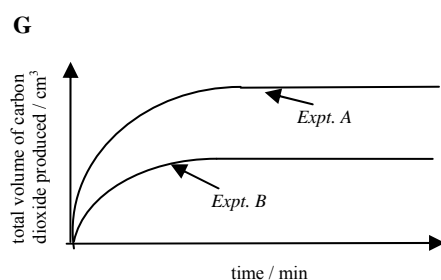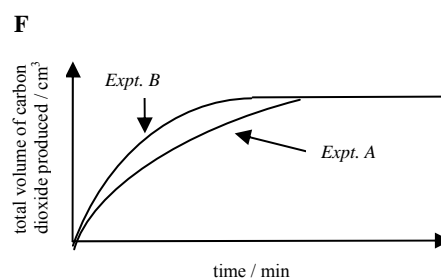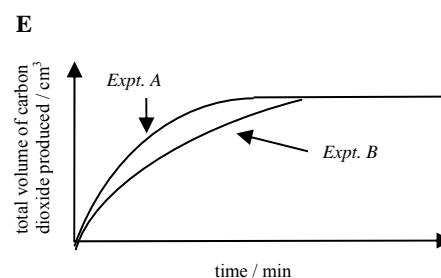
H None of the above. (Please draw your answer)

2   In Experiment C, **excess** 1 mol dm^{-3} hydrochloric acid (HCl) was added to a flask containing some powdered marble (calcium carbonate).
In Experiment D, the same volume of **excess** 0.5 mol dm^{-3} hydrochloric acid was added to a flask containing the same amount of powdered marble as in Experiment C.
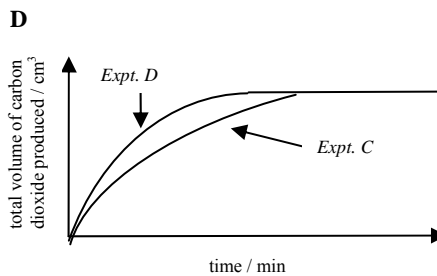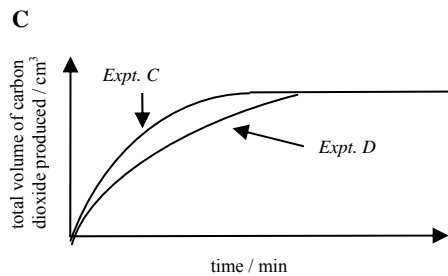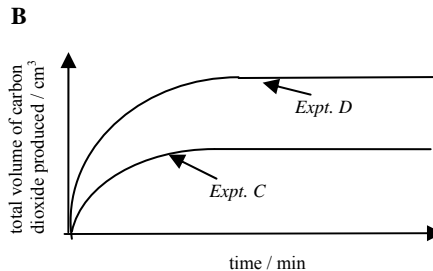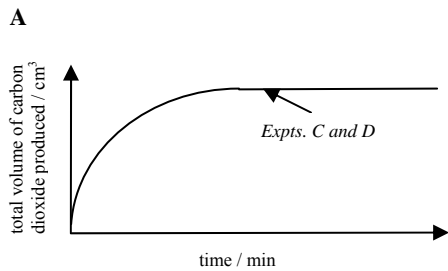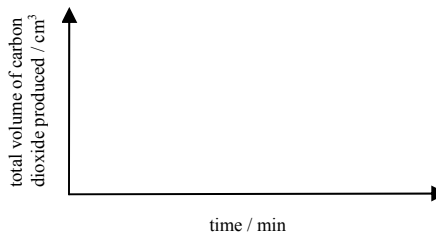Which of the graphs indicates the total volume of carbon dioxide produced as the reactions progressed in Experiments C and D?
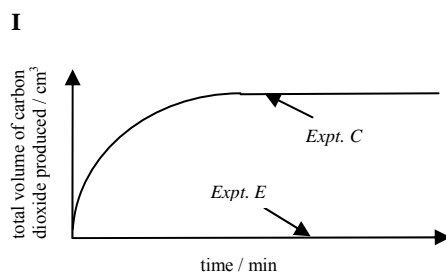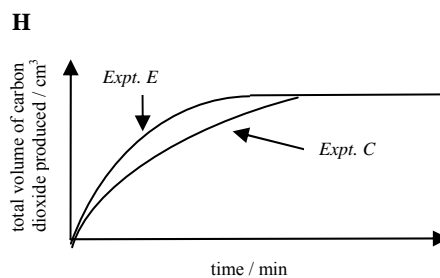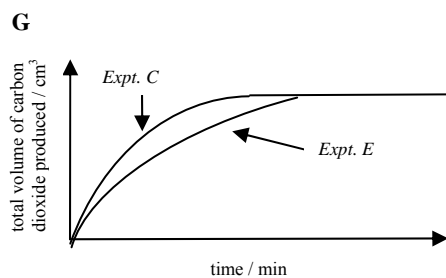
A

Expts. C and D

B

Expt. D

Expt. C

C

Expt. C

Expt. D

D

Expt. D

Expt. C

E

Expt. D

Expt. C

F

Expt. C

Expt. D

G

Expt. C

Expt. D

H   None of the above. (Please draw your answer)

3 In Experiment E, the same volume of **excess** 1 mol dm^{-3} acetic acid (a weak acid) was added to a flask containing the same amount of powdered marble (calcium carbonate) as in Experiment C (excess 1 mol dm^{-3} HCl was used).
Which of the graphs indicates the total volume of carbon dioxide produced as the reactions progressed in Experiments C and E?
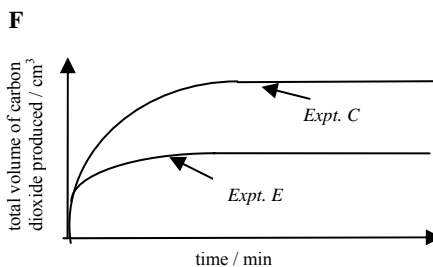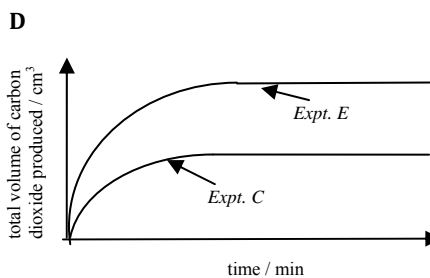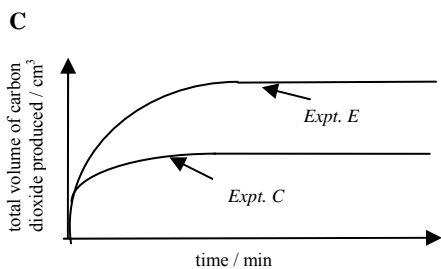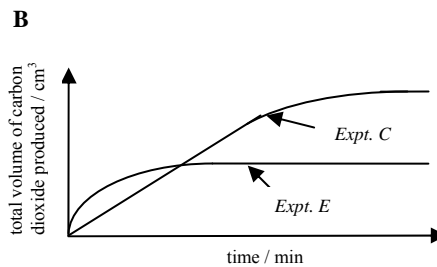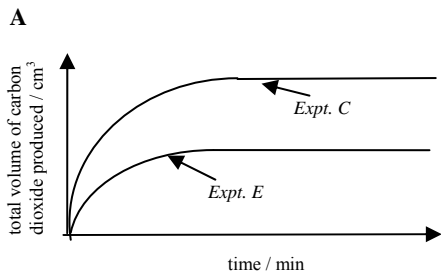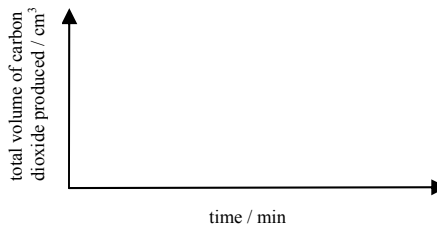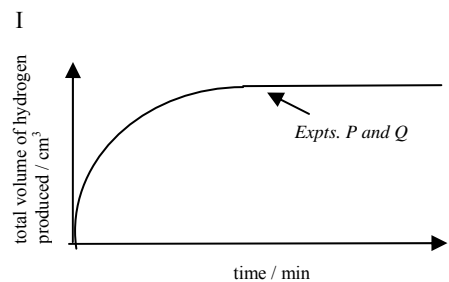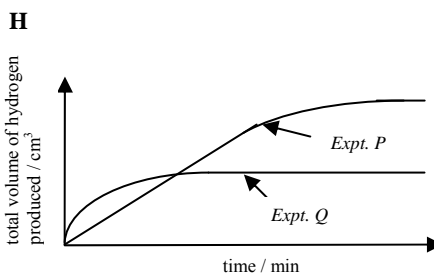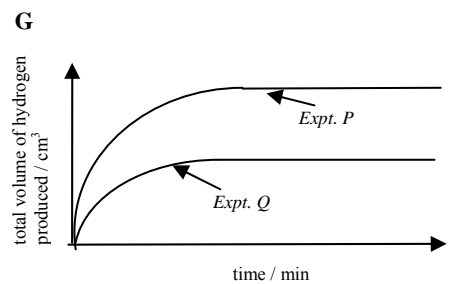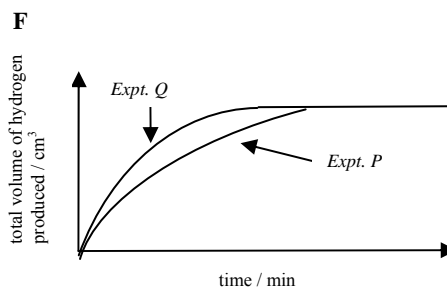
A

total volume of carbon dioxide produced / cm^3 — time / min

Expt. C
Expt. E

B

total volume of carbon dioxide produced / cm^3 — time / min

Expt. C
Expt. E

C

total volume of carbon dioxide produced / cm^3 — time / min

Expt. E
Expt. C

D

total volume of carbon dioxide produced / cm^3 — time / min

Expt. E
Expt. C

E

total volume of carbon dioxide produced / cm^3 — time / min

Expts. C and E

F

total volume of carbon dioxide produced / cm^3 — time / min

Expt. C
Expt. E

G

total volume of carbon dioxide produced / cm^3 — time / min

Expt. C
Expt. E

H

total volume of carbon dioxide produced / cm^3 — time / min

Expt. E
Expt. C

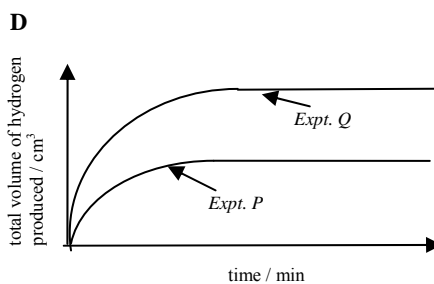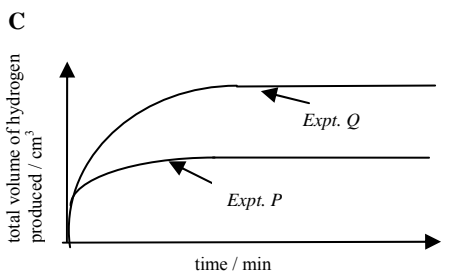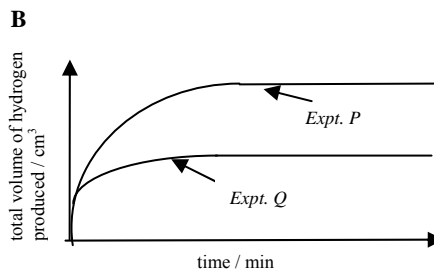**I**

total volume of carbon dioxide produced / cm^3 — time / min

Expt. C
Expt. E

J None of the above. (Please draw your answer)

total volume of carbon dioxide produced / cm^3 — time / min

4 In Experiment P, **excess** magnesium powder was added to a flask containing some 1 mol dm^{-3} hydrochloric acid (HCl).
   In Experiment Q, the same amount of **excess** magnesium powder was added to a flask containing the same volume of 1 mol dm^{-3} sulfuric acid (H$_2$SO$_4$) as in Experiment P.
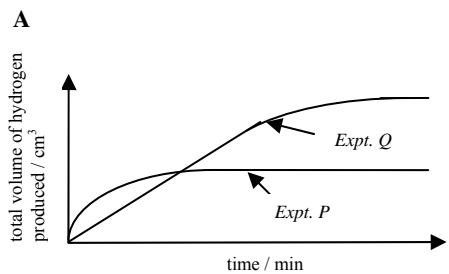   Which of the graphs indicates the total volume of hydrogen produced as the reactions progressed in Experiments P and Q?

A

total volume of hydrogen produced / cm^3

Expt. Q

Expt. P

time / min

B

total volume of hydrogen produced / cm^3

Expt. P

Expt. Q

time / min

C

total volume of hydrogen produced / cm^3

Expt. Q

Expt. P

time / min

D

total volume of hydrogen produced / cm^3

Expt. Q

Expt. P

time / min

E

total volume of hydrogen produced / cm^3

Expt. P

Expt. Q

time / min

F

total volume of hydrogen produced / cm^3

Expt. Q

Expt. P

time / min

G

total volume of hydrogen produced / cm^3

Expt. P

Expt. Q

time / min

H

total volume of hydrogen produced / cm^3

Expt. P

Expt. Q

time / min

J None of the above. (Please draw your answer)

I

total volume of hydrogen produced / cm^3

Expts. P and Q

time / min

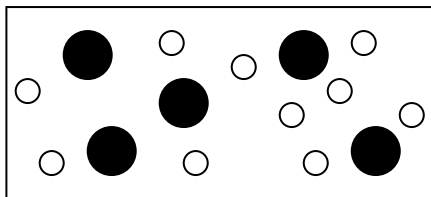total volume of hydrogen produced / cm^3

time / min

5 Which of the following diagrams best represents the relative number of particles in an aqueous solution of dilute sulfuric acid? Ignore the particles that are present in water.
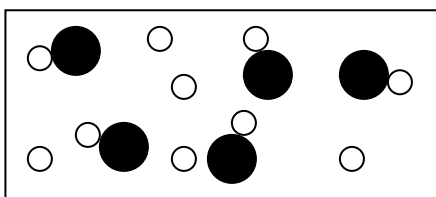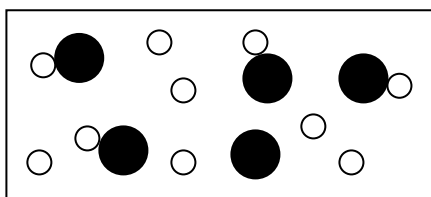
H_2SO_4 HSO_4^- SO_4^{2-} H^+
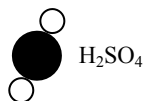
A
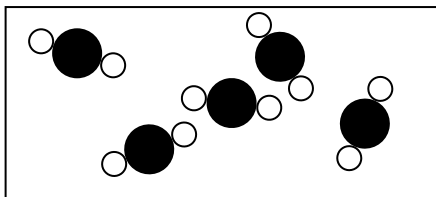
B

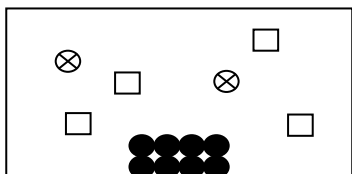**C**

D

E None of the above. (Please draw your answer)

6 **Excess** magnesium ribbon was added to a beaker containing some 1 mol dm^{-3} of a dilute acid, HY. There was a reaction and bubbles of gas were produced.

The chemical reaction that occurred is represented by the chemical equation: $2HY(aq) + Mg(s) \rightarrow MgY_2(aq) + H_2(g)$.

Choose the particulate diagram that represents the relative number of particles left in the beaker after no more gas is produced.

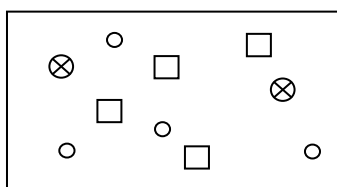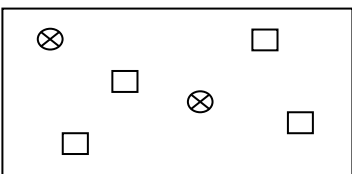Ignore the water molecules and the ions produced by water molecules.

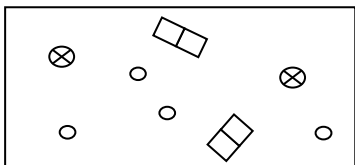○ H$^+$ ● Mg   ⊗ Mg^{2+} ☐ Y$^-$ ☐☐ Y$_2{}^{2-}$ ☐⊗☐ MgY$_2$
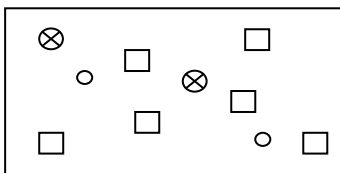
A

B
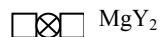
C

D

E

F

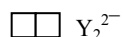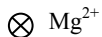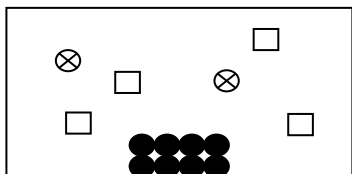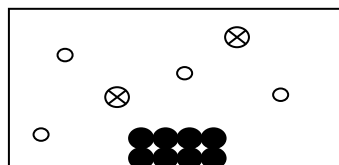**G**

H

I

J

K
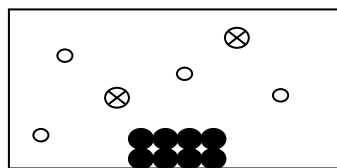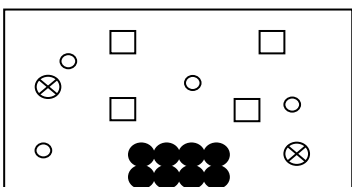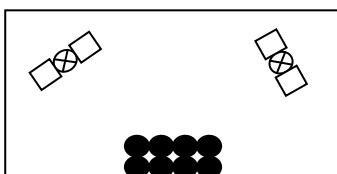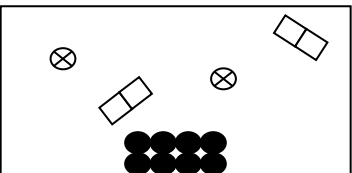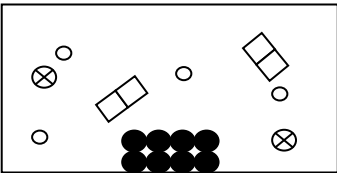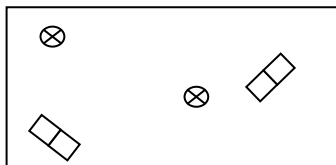
L None of the above. Draw your answer

7 **Excess** 1 mol dm^{-3} of the dilute acid, HY was added to a beaker containing a piece of magnesium ribbon. There was a reaction and bubbles of gas were produced.

The chemical reaction that occurred is represented by the chemical equation: $2HY(aq) + Mg(s) \rightarrow MgY_2(aq) + H_2(g)$.

Choose the particulate diagram that represents the relative number of particles left in the beaker after no more gas is produced.

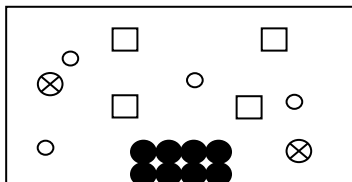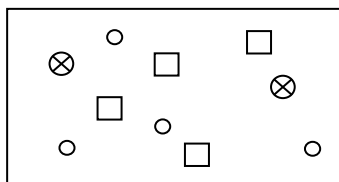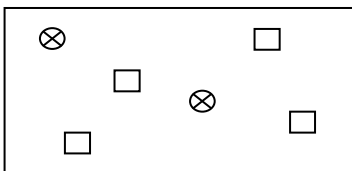Ignore the water molecules and the ions produced by water molecules.

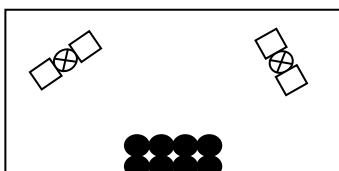○ H$^+$ ● Mg   ⊗ Mg^{2+} ☐ Y$^-$ ☐☐ Y$_2$$^{2-}$ ☐⊗☐ MgY$_2$
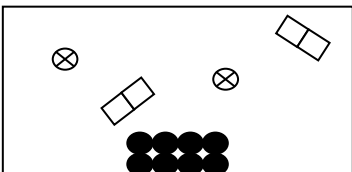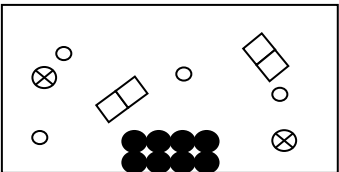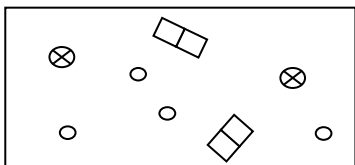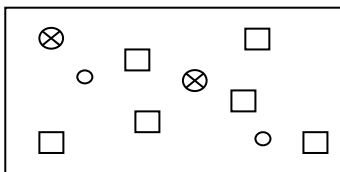
A

B

C

D

E

F

G

H

I

J

K

L None of the above. Draw your answer