

No Brain Too Small



Level 1 Science Practice Exam 2

90944 Demonstrate understanding of aspects of acids and bases

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of acids and bases.	Demonstrate in-depth understanding of aspects of acids and bases.	Demonstrate comprehensive understanding of aspects of acids and bases

You should attempt all the questions in this booklet.

A table of ions (page 2) and periodic table (page 14) are included.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Table of ions

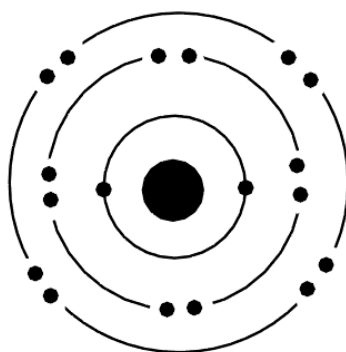
+1	+2	+3	-3	-2	-1
NH_4^+	Ca^{2+}	Al^{3+}		O^{2-}	OH^-
Na^+	Mg^{2+}	Fe^{3+}		S^{2-}	Cl^-
K^+	Cu^{2+}			CO_3^{2-}	NO_3^-
Ag^+	Pb^{2+}			SO_4^{2-}	HCO_3^-
H^+	Fe^{2+}				
Li^+	Ba^{2+}				
	Zn^{2+}				

Question One: Atoms, Ions and Formulae.

(a) Write the formulae for the following ionic compounds. Use the Table of Ions to help you.

- (i) aluminium chloride AlCl_3
(ii) silver sulfate Ag_2SO_4
(iii) lead nitrate $\text{Pb}(\text{NO}_3)_2$

The diagram shows the electron arrangement of an unknown substance.



(b) Discuss the identity of the substance.

In your answer:

- discuss the number of protons there would be
- identify which group and period of the Periodic table the substance would be found
- identify the substance by name

(i) If it was a neutral atom.

Electrons have a negative charge. This substance has 18 electrons so if it was a neutral atom there would be have to be 18 protons (which have a + charge). The element has a full valence shell (8 electrons) so it is in group 18. It has three energy levels of electrons so it is in period 3. From the periodic table the substance is identified as Ar (argon) atom.

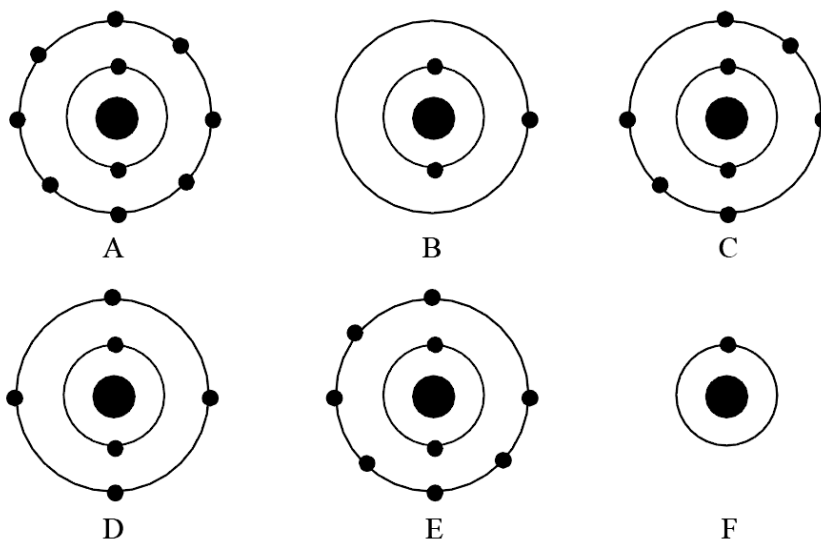
(ii) If it was a 2+ ion

To be a 2+ ion it would have to have 2 more protons (+) than the 18 electrons we can see. The element with 20 protons in its nucleus is Ca, calcium. When calcium loses two valence electrons it achieves a full valence shell. Calcium is in group 2 which means it has 2 valence electrons. The element calcium is in period 4. However the ion only has 3 energy levels now as it has lost its valence shell of 2 electrons. It now has a full valence shell of 8.

(iii) If it was a 1- ion

To be a 1- ion it would have to have 1 less proton (+) than the 18 electrons we can see. The element with 17 protons in its nucleus is Cl, chlorine. When chlorine gains one valence electron it achieves a full valence shell. Chlorine is in group 17 which means it has 7 valence electrons; It gained one electron to achieve a full valence shell. The ion has 3 energy levels as the element is in period 3.

(c) The diagrams below represent the electron arrangement of some different atoms.



Which two letters represent atoms which will form an ionic compound with a formula similar to Na_2S ?

In your answer:

- consider the ratio of ions in the formula Na_2S and explain how the ratio is related to the charge on the ions
- relate the ratio of ions in the formula to the number of electrons lost or gained by each atom.

Na_2S has the sodium ion and sulfide ion in a 2 : 1 ratio.

This is because the sodium ion has a 1+ charge and the sulfide ion has a 2- charge. Therefore to make the compound neutrally charged overall there has to be 2 Na^+ ions for every S^{2-} ion.

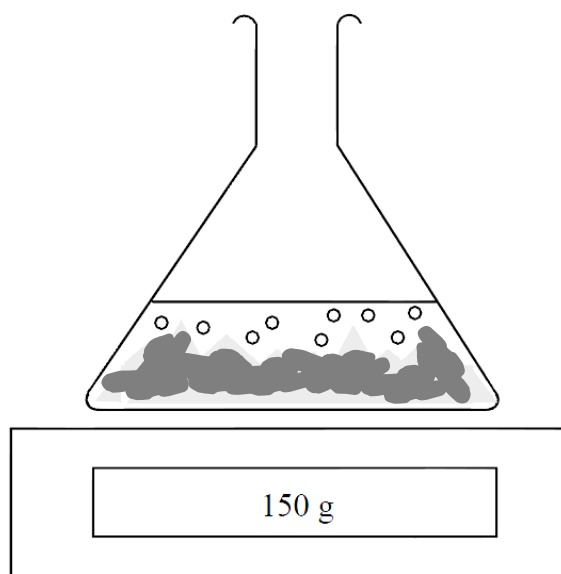
Na forms a Na^+ ion because the atom has an electron configuration of 2.8.1. The sodium atom loses one electron to achieve a full valence shell because this is a stable arrangement. Atom B (with an electron arrangement of 2.1) could also lose its one valence electron to form a 1+ ion.

S forms a S^{2-} ion because the atom has an electron arrangement 2.8.6. The sulfur atom gains two electrons to achieve a full valence shell because this is a stable arrangement. Atom C (with an electron arrangement of 2.6) could also gain two electrons to form a 2- ion.

Therefore the two letters are B (lithium) and C (oxygen).

Question Two: Rates of reaction

The diagram shows a flask of zinc metal reacting with sulfuric acid on a chemical balance.



- (a) Explain how this apparatus could be used to measure the rate of the reaction?

Measure the decrease in mass over time intervals. As the gas escapes the reading on the balance will go down. The amount it goes down equals the mass of gas that escaped.

NOTE TO STUDENT: This is actually not a very good method for this reaction as it involves H_2 gas which is very light indeed and so the change in mass would be very small. It works well for the reaction between $CaCO_3$ and HCl because CO_2 gas is much heavier.

(b) What is the gas being produced and how would you test the gas to identify it?

The gas produced is hydrogen gas. To test for hydrogen collect a sample of the gas and test it with a burning splint. If the gas burns with a squeaky pop, then the gas is hydrogen.

NOTE TO STUDENT: Do not say "do the pop test".... thats 'so year 9...."

(c) Write a word equation AND a balanced symbol equation for the reaction between sulfuric acid and zinc.

Word equation:



Balanced symbol equation:



(d) How would you expect the results to change if the zinc was ground into a fine powder? In your answer you should refer to rates of reaction and particle collisions.

The rate of the reaction would increase. More gas would be released in the same amount of time.

By making the zinc into a powder its surface area is increased. This means there are more zinc particles immediately exposed and therefore there will be more collisions / time between the zinc particles and the acid particles, and so a faster rate of reaction.

(d) Some students repeated the experiment but this time wrapped some copper wire around the pieces of zinc. They discovered that

- The reaction occurred at a much **faster rate**
- The **mass** of the copper wire was unchanged at the end of the experiment



Explain these observations.

The copper (wire) is acting as a catalyst. It makes the reaction occur at a faster rate by lowering the activation energy for the reaction.

We know it is acting as a catalyst as catalysts are not used up in the reactions they speed up. That is why the mass of copper wire was the same at the end of the experiment as it was at the beginning.

Question Three: Indigestion problems

Antacid tablets are used to treat indigestion, which is caused by excess acid in the stomach. Details of four solids, which are used to neutralise stomach acid, are shown in the table below.

Name of solid	Formula	Reaction with acid
Magnesium carbonate	MgCO_3	fizzes
Calcium carbonate	CaCO_3	fizzes
Magnesium hydroxide	Mg(OH)_2	does not fizz
Aluminium hydroxide	Al(OH)_3	does not fizz

(a) Complete the table.

See above

(b) Write a word equation AND a balanced symbol equation for the reaction between magnesium hydroxide and hydrochloric acid.

Word equation:

magnesium hydroxide + hydrochloric acid → magnesium chloride + water

Balanced symbol equation:

$\text{Mg(OH)}_2 + 2\text{HCl} \rightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$

An experiment was done to find out how much solid was needed to neutralise 20 mL of hydrochloric acid. The results are shown below.

Solid	Mass of solid to neutralise 20 mL of acid
Magnesium carbonate	0.75 g
CaCO ₃	1.22 g
Magnesium hydroxide	0.60 g
Aluminium hydroxide	0.39 g

(c) (i) Which solid is the most effective at neutralising the hydrochloric acid?

Aluminium hydroxide was most effective

(ii) How did you decide this?

A smaller mass of aluminium hydroxide neutralised 20 mL of acid.

(d) Describe how you would know that the acid had been neutralised.

In your answer you should:

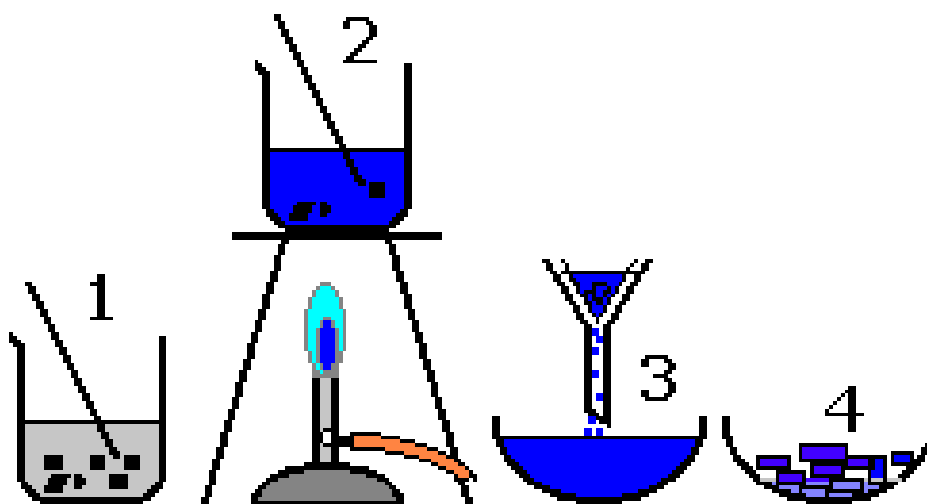
- include details of the indicator you would use
- discuss the observations you would expect to make during the neutralisation
- explain the relationship between the changing pH of the solution and the amount of hydrogen and hydroxide ions as the solid is added to the beaker.

Add some UI to the acid: it would go red. Add the solid a little at a time with stirring. The universal indicator would become orange – then yellow – then green – once enough solid had been added to neutralise the acid completely. Initially the concentration of H⁺ ions were much greater than OH⁻ ions but as more solid was added the H⁺ ions concentration decreased and

(b) Describe how to make a sample of pure copper nitrate crystals in the laboratory.

In your answer you should:

- Identify suitable chemicals you would use.
- Refer to stages 1-4 in the diagram, explaining their purpose
- Write a word equation AND a balanced symbol equation for the reaction you have chosen.



PERIODIC TABLE OF THE ELEMENTS

		Atomic Number		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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