Past-paper walk-through

Acid–base titrations ▪ 12.2

eXercise

Questions in this set

- 0620/22 N25 Q39 ▪ 1 mark
- 0620/61 N25 Q2 ▪ 18 marks
- 0620/62 N25 Q2 ▪ 18 marks
- 0620/21 J25 Q38 ▪ 1 mark
- 0620/22 J25 Q38 ▪ 1 mark

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 39

0620/22 N25 ▪ Q39 ▪ 1 mark

39 Which item of apparatus is used to measure 13.7 cm^3 of dilute hydrochloric acid?

A a balance

B a burette

C a conical flask

D a volumetric pipette

Solution 39

Answer: **B**

Why

- 13.7 cm^3 is an awkward volume quoted to one decimal place.
- A volumetric pipette delivers only one fixed volume, so it cannot give 13.7.
- A burette measures any volume to one decimal place, so it is the right choice.

Question 2

0620/61 N25 ▪ Q2 ▪ 18 marks

2 A student investigates the reaction between dilute hydrochloric acid and aqueous sodium hydroxide.

The student does five experiments.

Experiment 1

- Fill a burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use a volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to a conical flask.
- Stand the conical flask on a white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Question 2

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Refill the burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use the volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to the conical flask.
- Add 0.25 g of sodium hydrogencarbonate to the conical flask and swirl the flask.
- Stand the conical flask on the white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Experiment 3

- Repeat Experiment 2 using 0.50 g of sodium hydrogencarbonate instead of 0.25 g.

Question 2

Experiment 4

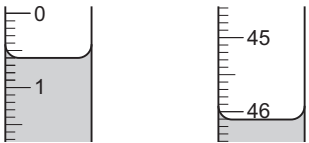
- Repeat Experiment 2 using 1.00 g of sodium hydrogencarbonate instead of 0.25 g.

Experiment 5

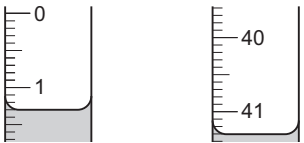
- Repeat Experiment 2 using 1.50 g of sodium hydrogencarbonate instead of 0.25 g.

(a) Use the information in the descriptions of Experiments 1 to 5 and the burette diagrams in Fig. 2.1 and Fig. 2.2 to complete Table 2.1.

Experiment 1



Experiment 2



Question 2

initial burette reading

final burette reading

Fig. 2.1

initial burette reading

final burette reading

Fig. 2.2

Table 2.1

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5
volume of dilute hydrochloric acid / cm^3					

Question 2

Question 2

mass of sodium hydrogencarbonate / g	0.00	0.25	0.50	1.00	1.50
final burette reading / cm^3			36.0	24.1	13.5
initial burette reading / cm^3			1.4	0.3	0.5
volume of aqueous sodium hydroxide added to reach the end-point / cm^3					13.0

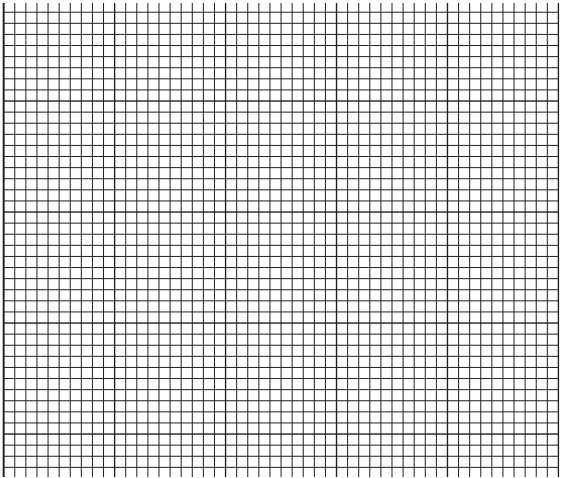
[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 in Table 2.1 on Fig. 2.3. Draw a straight line of best fit.

Question 2

Question 2

volume of aqueous sodium hydroxide added to reach the end-point / cm^3



Question 2

Question 2

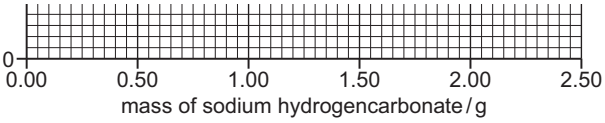


Fig. 2.3

[4]

(c) The sodium hydrogencarbonate added in Experiments 2 to 5 neutralises some of the dilute hydrochloric acid in the conical flask. The sodium hydroxide used in the titration neutralises the remaining dilute hydrochloric acid.

Extrapolate the line on your graph in Fig. 2.3 and deduce the mass of sodium hydrogencarbonate needed to neutralise **all** of the dilute hydrochloric acid in the conical flask.

Show clearly **on Fig. 2.3** how you worked out your answer.

Question 2

Question 2

Question 2

[3]

(d) (i) Explain why a volumetric pipette is used rather than a measuring cylinder to measure the volume of dilute hydrochloric acid used in each experiment.

Question 2

(ii) Explain why it is **not** possible to use a volumetric pipette instead of the burette to measure the volume of aqueous sodium hydroxide added in each experiment.

Question 2

(e) The conical flask is placed on a white tile to make the colour change of the indicator at the end-point more visible.

Explain why universal indicator is **not** a suitable indicator for this titration.

Question 2

(f) Draw a line **on Fig. 2.3** to show the results you would expect if the investigation was repeated using aqueous sodium hydroxide with twice the concentration.

Label your line **F**. [2]

[Total: 18]

Solution 2

(a) Mark scheme

- M1 all five experiments have volume of hydrochloric acid recorded as 25.0 (cm3)
- 1 M2
- final and initial burette readings for experiment 1 correct and recorded the correct way round (46.1, 0.6)
- 1 M3
- final and initial burette readings for experiment 2 correct and recorded the correct way round (41.3, 1.3)
- 1 M4

Solution 2

- all titres calculated correctly (45.5, 40.0, 34.6, 23.8)
- 1 **M5**
- all readings recorded to 1 decimal place
- 1

Solution 2

(b) Mark scheme

- M1 y-axis scale is linear, and the points extend over halfway up the scale
- 1 M2
- AND M3 all points plotted correctly
- 2 M4
- best-fit line correctly drawn
- 1
- 0620/61
- October/November 2025

Solution 2

(c)

Mark scheme

- M1 line is extrapolated to reach x-axis (to the right)
- 1 M2
- correct reading from graph at volume of sodium hydroxide = 0.0 cm3
- 1 M3
- units of g
- 1

Solution 2

(d)(i)

Mark scheme

- (volumetric pipette is) more accurate (than a measuring cylinder)
- 1

(d)(ii)

Mark scheme

- volumetric pipettes measure a fixed volume
- 1

Solution 2

(e)

Mark scheme

- M1 no sharp colour change / keeps changing colour / many colours / more than two colours / gradual colour change / sharp
- colour change is needed
- 1 M2
- so cannot determine end-point / end-point not clear / difficult to tell when to stop adding /
- 1

Solution 2

(f)

Mark scheme

- M1 sketch line is below plotted line at all volumes
- 1 M2
- line is straight, starts on y-axis between 20 and 25 and ends on x-axis between 2.0 and 2.2
- 1

Question 2

0620/62 N25 ▪ Q2 ▪ 18 marks

2 A student investigates the reaction between acidic solution **B** and two different solutions of aqueous sodium hydroxide, solution **C** and solution **D**, using two different indicators.

The student does two experiments.

Experiment 1

- Rinse a burette with distilled water and then with solution **C**.
- Fill the burette with solution **C**. Run some of solution **C** out of the burette so that the level of the solution is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour 25 cm^3 of solution **B** into a conical flask.
- Add five drops of methyl orange indicator **and** five drops of thymolphthalein indicator to the conical flask.
- Stand the conical flask on a white tile.
- Slowly add solution **C** from the burette to the conical flask, while swirling the flask, until the solution changes colour from red to orange. This is the first end-point.
- Record the burette reading at the first end-point.

Question 2

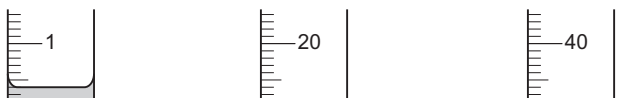
- Continue to add solution **C** from the burette to the conical flask while swirling the flask. The solution changes colour from orange to yellow.
- Continue to add solution **C**, while swirling the flask, until the solution changes colour from yellow to green. This is the second end-point.
- Record the burette reading at the second end-point.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Repeat Experiment 1 using solution **D** instead of solution **C**.

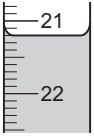
(a) Use the burette diagrams in Fig. 2.1 and Fig. 2.2 to record the readings for Experiment 1 and Experiment 2 in Table 2.1. Complete Table 2.1.

Experiment 1

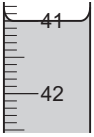


Question 2

initial burette reading



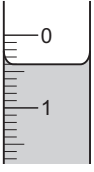
burette reading at first end-point

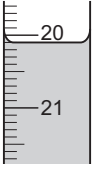


burette reading at second end-point

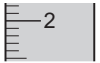
Fig. 2.1

Experiment 2





Question 2



initial burette reading

burette reading at first end-point

burette reading at second end-point

Fig. 2.2

Table 2.1

	Experiment 1 using solution **C**	Experiment 2 using solution **D**
burette reading at first end-point / cm^3		
burette reading at second end-point / cm^3		

Question 2

initial burette reading / cm^3			

Question 2

initial burette reading / cm^3		
volume added from burette to reach first end-point / cm^3		
total volume added from burette to reach second end-point / cm^3		

[5]

(b) (i) Explain why the conical flask is rinsed with distilled water at the start of Experiment 2.

Question 2

(ii) At the start of Experiment 1, the burette is rinsed with distilled water and then with solution **C**.

Explain how the volume added from the burette to reach the first end-point would be different if the burette was **not** rinsed with solution **C**.

Question 2

(iii) Explain why the conical flask is placed on a white tile during the titration.

Question 2

(c) Compare the concentration of solution **C** used in Experiment 1 with the concentration of solution **D** used in Experiment 2.

Explain your answer.

Question 2

(d) **(i)** Deduce the volume of solution **C** required to reach the **first** end-point if Experiment 1 is repeated using 50 cm^3 of solution **B** instead of 25 cm^3.

Question 2

(ii) State why using 50 cm^3 of solution **B** would cause a problem when finding the volume of solution **C** needed to reach the **second** end-point in Experiment 1.

Question 2

(e) A student repeats Experiment 2.

The student warms solution **B** in the conical flask before carrying out the titration.

State the effect, if any, on the volume of solution **D** required to reach the **second** end-point in Experiment 2.

Explain your answer.

Question 2

[2]

(f) State **one** change to the **apparatus** that will improve the accuracy of the results.

Question 2

[Total: 18]

Solution 2

(a)

Mark scheme

- M1 all burette readings correct in experiment 1 (21.2, 41.0, 1.6) M2
- all burette readings correct in experiment 2 (10.2, 20.1, 0.4) M3
- burette readings recorded in correct place in table M4
- all four titres in experiment 1 and 2 calculated correctly (19.6, 39.4, 9.8, 19.7) M5
- all ten readings/volumes given to 1 decimal place or better and a consistent number of decimal places
- 5

Solution 2

(b)(i)

Mark scheme

- to clean / to remove contaminants / to remove impurities
- 1

Solution 2

(b)(ii)

Mark scheme

- M1 (volume (added) is) greater / more / higher / bigger (if not rinsed with C) **M2**
- water left in the burette dilutes solution C / solution C becomes less concentrated
- 2

Solution 2

(b)(iii)

Mark scheme

- colour (changes) easier to see / colour change can be seen easily/clearly/better/accurately
- 1

Solution 2

(c) Mark scheme

- M1 D / experiment 2 is more concentrated (than C/experiment 1)
- OR
- C / experiment 1 is less concentrated (than D/experiment 2) **M2**
- smaller volume of D (required to reach end point/neutralisation) OR larger volume C (required to reach
- end-point/neutralisation) **M3**
- answer is quantitative. Either D is 2 x concentration of C OR the volume of C is 2 x the volume of D
- 3

Solution 2

(d)(i)

Mark scheme

- M1 39.2 M2
- units given as cm3
- 2

Solution 2

(d)(ii)

Mark scheme

- volume would be more than burette can hold
- 1
- 0620/62
- October/November 2025

Solution 2

(e)

Mark scheme

- M1 none / no change / same volume needed **M2**
- (warming) does not change moles / concentration
- 2

Solution 2

(f)

Mark scheme

- use a volumetric pipette instead of a measuring cylinder
- 1

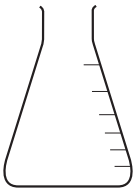
Question 38

0620/21 J25 ▪ Q38 ▪ 1 mark

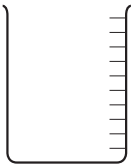
38 Which item of apparatus is used to measure 25.0 cm^3 of aqueous sodium hydroxide?

A

B



C



D

Solution 38

Answer: **D**

Why

- A volume quoted as 25.0 cm^3 needs accurate, not approximate, apparatus.
- A pipette delivers exactly that fixed volume.
- A measuring cylinder or beaker is far too imprecise for one decimal place.

Question 38

0620/22 J25 ▪ Q38 ▪ 1 mark

38 Which item of apparatus is used to measure exactly 26.3 cm^3 of a liquid?

A

B

C

D

Question 38

Solution 38

Answer: **A**

Why

- 26.3 cm^3 is an awkward volume quoted to one decimal place.
- A pipette only delivers one fixed volume, so it cannot give 26.3.
- A burette measures any volume accurately to one decimal place, so it is the right choice.