



AS Level Chemistry

STATES OF MATTER

9701-MCQ



Q1 Easy

9701/13/M/J/25/Q9

1 mark

9 In which substance are covalent bonds broken as it melts?

- A silicon(IV) oxide
- B ice
- C iodine
- D ethanol

Q2 Easy

9701/11/M/J/21/Q8

1 mark

8 Which gas would behave most like an ideal gas under room conditions?

- A helium
- B nitrogen
- C ammonia
- D krypton

Q3 Hard

9701/11/13/O/N/21/Q6

1 mark

6 Which substance shows the greatest deviation from the properties of an ideal gas under room conditions?

- A $\text{CO}_2(\text{g})$ B $\text{H}_2(\text{g})$ C $\text{Ne}(\text{g})$ D $\text{NH}_3(\text{g})$

Q4 Hard

9701/12/M/J/22/Q7

1 mark

7 Which gas will behave **least** like an ideal gas at 150 °C and 101 kPa?

- A ammonia
- B fluorine
- C krypton
- D steam

Q5 Easy

9701/12/O/N/22/Q14

1 mark

14 Each of the substances shown is gaseous.

Which substance is most likely to show ideal behaviour in the conditions shown?

	substance	temperature / K	pressure / Pa
A	carbon dioxide	250	1.00×10^5
B	hydrogen chloride	1000	1.00×10^6
C	nitrogen	1000	1.00×10^5
D	oxygen	250	1.00×10^6

Q6 Easy

9701/12/F/M/23/Q9

1 mark

9 Under which conditions will nitrogen behave most like an ideal gas?

	temperature	pressure
A	low	high
B	high	low
C	low	low
D	high	high

Q7 Easy

9701/13/M/J/23/Q7

1 mark

7 Which assumptions are made about ideal gases?

- 1 Ideal gases contain molecules with no mass.
- 2 Ideal gases contain molecules with no volume.
- 3 Ideal gases have no intermolecular forces.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only



Q8 Hard

9701/12/F/M/21/Q6

1 mark

- 6 A solution contains 0.25 g of sulfur dioxide in 1.00 dm³ of water.

Which volume of sulfur dioxide, measured at 50 °C and a pressure of 1×10^5 Pa, must be added to 1.00 dm³ of water to produce this solution?

- A 0.0162 cm³ B 0.105 cm³ C 16.2 cm³ D 105 cm³

Q9 Hard

9701/12/M/J/21/Q5

1 mark

- 5 Flask Q contains 5 dm³ of helium at 12 kPa pressure. Flask R contains 10 dm³ of neon at 6 kPa pressure.

If the flasks are connected at constant temperature, what is the final pressure?

- A 8 kPa B 9 kPa C 10 kPa D 11 kPa

Q10 Easy

9701/12/O/N/21/Q8

1 mark

- 8 The general gas equation can be used to calculate the value of the M_r of a gas.

For a sample of a gas of mass m grams, which expression will give the value of M_r ?

- A $M_r = \frac{mRT}{pV}$ B $M_r = \frac{pVRT}{m}$ C $M_r = \frac{mpV}{RT}$ D $M_r = \frac{pV}{mRT}$

Q11 Hard

9701/11/M/J/22/Q7

1 mark

- 7 'Black powder' is a mixture of potassium nitrate, carbon and sulfur. The mixture reacts as shown.



A sealed tube containing black powder has a volume of 10.0 cm³. When all of the black powder reacts, the reaction causes a pressure of 2×10^6 Pa and a temperature of 2500 K.

The volume of the K₂CO₃ and K₂S produced can be ignored.

How many moles of KNO₃ are contained in the sealed tube?

- A 4.81×10^{-4} B 9.63×10^{-4} C 1.93×10^{-3} D 9.63×10^{-1}

Q12 Hard

9701/12/M/J/22/Q8

1 mark

- 8 When an evacuated glass bulb of volume 200 cm^3 is filled with a gas at 300 K and 101 kPa , the mass of the bulb increases by 0.68 g . The gas obeys the ideal gas equation.

What is the identity of the gas?

- A argon
- B krypton
- C neon
- D nitrogen

Q13 Hard

9701/13/M/J/22/Q8

1 mark

- 8 A student reacts 1 mol of magnesium powder in a sealed 0.030 m^3 container of oxygen at a pressure of $2.0 \times 10^5\text{ Pa}$ and a temperature of 600 K . The magnesium reacts completely to form MgO .

Which percentage of the oxygen will be used up?

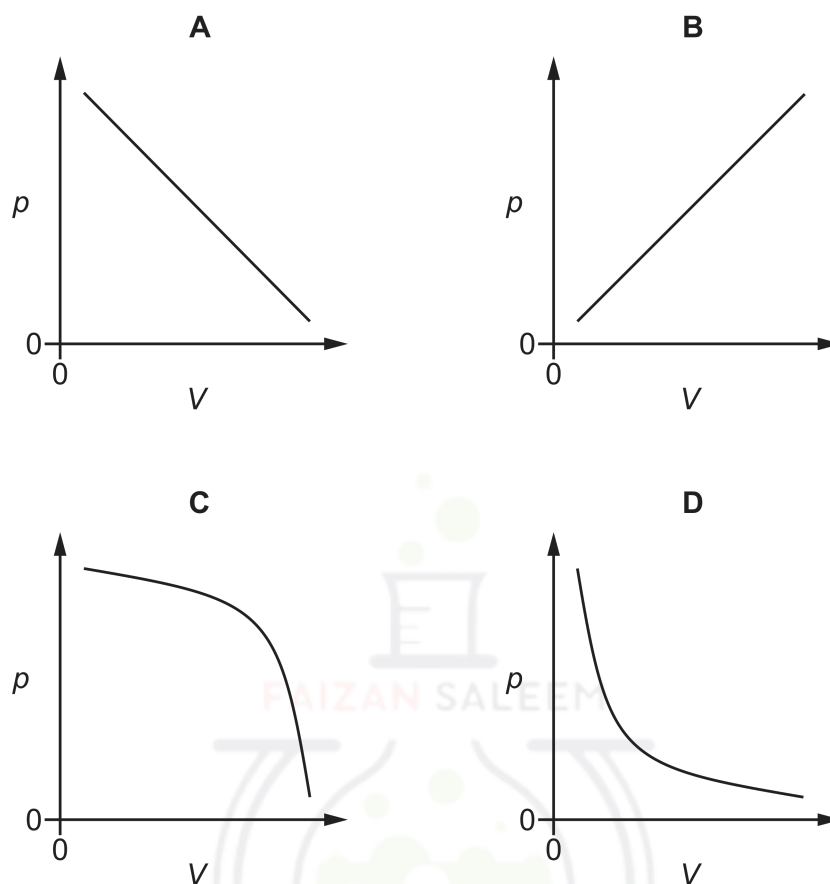
- A 5.0% B 10% C 42% D 83%

Q14 Easy

9701/12/O/N/22/Q15

1 mark

- 15 Which graph represents the variation of pressure p and volume V of a sample of an ideal gas at constant temperature?



Q15 Hard

9701/11/M/J/23/Q13

1 mark

- 13 In this question you should assume that the gas formed behaves as an ideal gas.

A 1.7 g sample of Mg reacts with 50.0 cm^3 of 2.2 mol dm^{-3} HCl at 303 K and 110 400 Pa.

Which volume of gas is produced, measured under these conditions?

- A** 1.3 dm^3 **B** 1.6 dm^3 **C** 2.5 dm^3 **D** 5.0 dm^3

Q16 Easy

9701/12/M/J/23/Q8

1 mark

- 8 The volume of a vessel is $1.20 \times 10^{-3} \text{ m}^3$. It contains pure argon at a pressure of $1.00 \times 10^5 \text{ Pa}$, and at a temperature of 25.0°C . Under these conditions it can be assumed that argon behaves as an ideal gas.

Which mass of argon does it contain?

- A 0.0485 g B 1.93 g C 10.4 g D 23.0 g

Q17 Hard

9701/13/M/J/23/Q8

1 mark

- 8 A 200 cm^3 sample of water has an amount of oxygen gas dissolved in it.

This amount of oxygen gas has a volume of 6.00 cm^3 when measured at $1.00 \times 10^5 \text{ Pa}$ and 35°C .

What is the concentration of oxygen gas in the water? (You should assume that oxygen behaves as an ideal gas.)

- A $2.34 \times 10^{-4} \text{ mol dm}^{-3}$
B $1.17 \times 10^{-3} \text{ mol dm}^{-3}$
C $1.25 \times 10^{-3} \text{ mol dm}^{-3}$
D $1.03 \times 10^{-2} \text{ mol dm}^{-2}$

Q18 Hard

9701/11/13/O/N/23/Q7

1 mark

- 7 When an evacuated tube of volume 400 cm^3 is filled with gas at 300 K and 101 kPa , the mass of the tube increases by 0.65 g .

Assume the gas behaves as an ideal gas.

What is the identity of the gas?

- A argon
B helium
C krypton
D neon

Q19 Hard

9701/12/O/N/23/Q9

1 mark

- 9 At a temperature of 2500 K and a pressure of 1.00×10^{-4} Pa, a sample of 0.321 g of sulfur vapour has a volume of $2.08 \times 10^6 \text{ m}^3$.

What is the molecular formula of sulfur under these conditions?

- A S B S_2 C S_4 D S_8

Q20 Hard

9701/11/M/J/24/Q7

1 mark

- 7 What is the density of a sample of fluorine gas at 32°C and 100 000 Pa? Assume fluorine behaves as an ideal gas under these conditions.

- A 1.4 g dm^{-3} B 1.5 g dm^{-3} C 1.6 g dm^{-3} D 1.7 g dm^{-3}

Q21 Easy

9701/12/M/J/24/Q7

1 mark

- 7 In this question it should be assumed that nitrogen behaves as an ideal gas under the conditions stated.

Which volume is occupied by 1.00 g of nitrogen at 50.0°C and at a pressure of 120 kPa?

- A 0.124 dm^3 B 0.799 dm^3 C 1.60 dm^3 D 22.4 dm^3

Q22 Hard

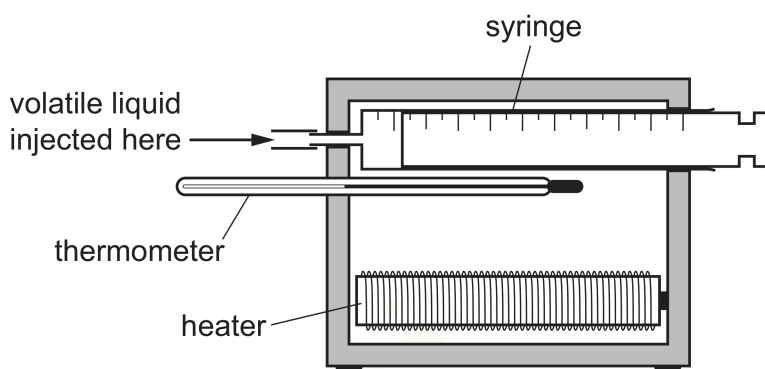
9701/13/M/J/24/Q7

1 mark

- 7 The diagram shows the apparatus used to find the relative molecular mass of a volatile liquid.

When 0.10 g of a volatile liquid is injected into the syringe, all of the volatile liquid evaporates and the volume increases by 85 cm³.

The heater maintains a temperature of 400 K and the experiment is carried out at a pressure of 101 300 Pa.



If the vapour of the volatile liquid behaves as an ideal gas, which expression can be used to calculate the relative molecular mass of the liquid?

- A $M_r = (85 \times 101\,300) \div (0.10 \times 8.31 \times 400)$
- B $M_r = (85 \times 101.3) \div (0.10 \times 8.31 \times 400)$
- C $M_r = (0.10 \times 8.31 \times 400) \div (85 \times 10^{-6} \times 101\,300)$
- D $M_r = (0.10 \times 8.31 \times 400) \div (85 \times 10^{-6} \times 101.3)$

Q23 Easy

9701/12/O/N/24/Q7

1 mark

- 7 In this question you may assume that nitrogen behaves as an ideal gas. One atmosphere pressure = 101 kPa.

Which volume does 1.0 g of nitrogen occupy at 50 °C and a pressure of 2.0 atmospheres?

- A 70 cm³ B 150 cm³ C 470 cm³ D 950 cm³

Q24 Hard

9701/12/F/M/25/Q8

1 mark

- 8 An excess of zinc reacts with $x \text{ cm}^3$ of 2.00 mol dm^{-3} hydrochloric acid.

The gas produced is dried and collected.

The gas occupies 1.534 dm^3 at $101\,000 \text{ Pa}$ and 293 K .

The gas produced behaves as an ideal gas.

What is the value of x ?

- A 31.8 cm^3 B 34.7 cm^3 C 63.6 cm^3 D 69.4 cm^3

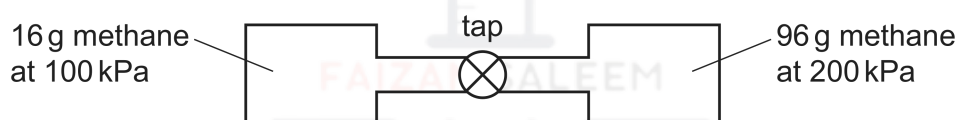
Q25 Hard

9701/11/M/J/25/Q13

1 mark

- 13 The diagram shows two containers of methane connected by a closed tap.

Each container has a volume of 1.00 m^3 .



The tap is opened. The temperature of the system is changed to 800 K .

The system reaches constant pressure.

What is the pressure of methane within the system?

- A 23.3 kPa B 46.6 kPa C 186 kPa D 372 kPa

Q26 Easy

9701/12/M/J/25/Q12

1 mark

- 12 A sample of an ideal gas occupies 240 cm^3 at 37°C and 100 kPa .

How many moles of gas are present in the sample?

- A 9.32×10^{-6} B 9.32×10^{-3} C 0.0781 D 78.1

Q27 Easy

9701/13/M/J/25/Q14

1 mark

- 14 When 0.15 g of an organic compound is vaporised, it occupies a volume of 65.0 cm^3 at 405 K and $1.00 \times 10^5 \text{ Pa}$.

Using the expression $pV = nRT$, which expression should be used to calculate the relative molecular mass, M_r , of the compound?

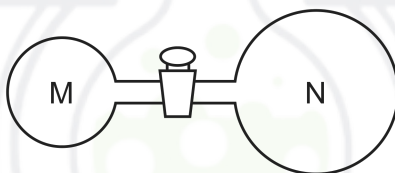
- A $\frac{0.15 \times 65 \times 10^{-6} \times 1 \times 10^5}{8.31 \times 405}$
- B $\frac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-3}}$
- C $\frac{0.15 \times 65 \times 10^{-3} \times 1 \times 10^5}{8.31 \times 405}$
- D $\frac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-6}}$

Q28 Hard

9701/14/M/J/25/Q4

1 mark

- 4 Two glass vessels, M and N, are connected by a closed valve.



M contains helium at 20°C at a pressure of $1 \times 10^5 \text{ Pa}$. N has been evacuated, and has three times the volume of M.

The valve is opened and the temperature of the whole apparatus is raised to 100°C .

What is the final pressure in the system?

- A $3.18 \times 10^4 \text{ Pa}$
- B $4.24 \times 10^4 \text{ Pa}$
- C $1.25 \times 10^5 \text{ Pa}$
- D $5.09 \times 10^5 \text{ Pa}$

Q29 Hard

9701/14/M/J/25/Q10

1 mark

- 10 A 69.0 g sample of nitrogen dioxide is placed in a reaction vessel.

The initial pressure of the nitrogen dioxide is P . An effective catalyst is then added and the nitrogen dioxide begins to decompose into its elements.

After ten minutes, the total pressure is $1.1P$.

What is the mass of oxygen molecules in the reaction vessel after ten minutes?

- A 4.80 g B 9.60 g C 38.4 g D 48.0 g

Q30 Easy

9701/11/13/O/N/25/Q11

1 mark

- 11 1.00 g of nitrogen gas is stored in a 2.00 dm^3 vessel at 40.0°C .

What is the pressure in the vessel?

- A 5940 Pa B 11 900 Pa C 46 400 Pa D 92 900 Pa

Q31 Hard

9701/12/O/N/25/Q8

1 mark

- 8 A pure sample of a gas has a density of 2.62 g dm^{-3} at 101 000 Pa and 25°C . The gas behaves ideally under these conditions.

Which expression gives the M_r of the gas?

- A $\frac{101000 \times 0.001}{2.62 \times 8.31 \times 25}$
- B $\frac{101000 \times 0.001}{2.62 \times 8.31 \times 298}$
- C $\frac{2.62 \times 8.31 \times 25}{101000 \times 0.001}$
- D $\frac{2.62 \times 8.31 \times 298}{101000 \times 0.001}$

Q32 Easy

9701/13/M/J/21/Q36

1 mark

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

No other combination of statements is used as a correct response.

36 Which statements help to explain the increase in melting point from sodium to aluminium?

- 1 The charge on the metal ion increases.
- 2 There are more delocalised electrons per metal ion.
- 3 The radius of the metal ion decreases.

Q33 Easy

9701/12/O/N/22/Q18

1 mark

18 The melting points of the Period 3 elements sodium to aluminium are shown in the table.

element	Na	Mg	Al
melting point/K	371	923	932

Which factor explains the **increase** in melting points from sodium to aluminium?

- A** the change in first ionisation energy from sodium to aluminium
- B** the increase in electronegativity from sodium to aluminium
- C** the increase in the A_r of the elements from sodium to aluminium
- D** the increase in the number of outer electrons in each atom from sodium to aluminium

Q34 Easy

9701/11/M/J/23/Q2

1 mark

- 2 Which statement explains why calcium has a higher melting point than barium?
- A Calcium cations are smaller than barium cations and have a stronger attraction to the delocalised electrons.
 - B The structure of calcium is partly giant molecular.
 - C There are more delocalised electrons in calcium than in barium as it has a lower ionisation energy.
 - D There is greater repulsion between barium atoms as they have more complete electron shells than calcium atoms.

Q35 Easy

9701/11/M/J/23/Q6

1 mark

- 6 In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the coordination number of the sodium ions.

What are the coordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

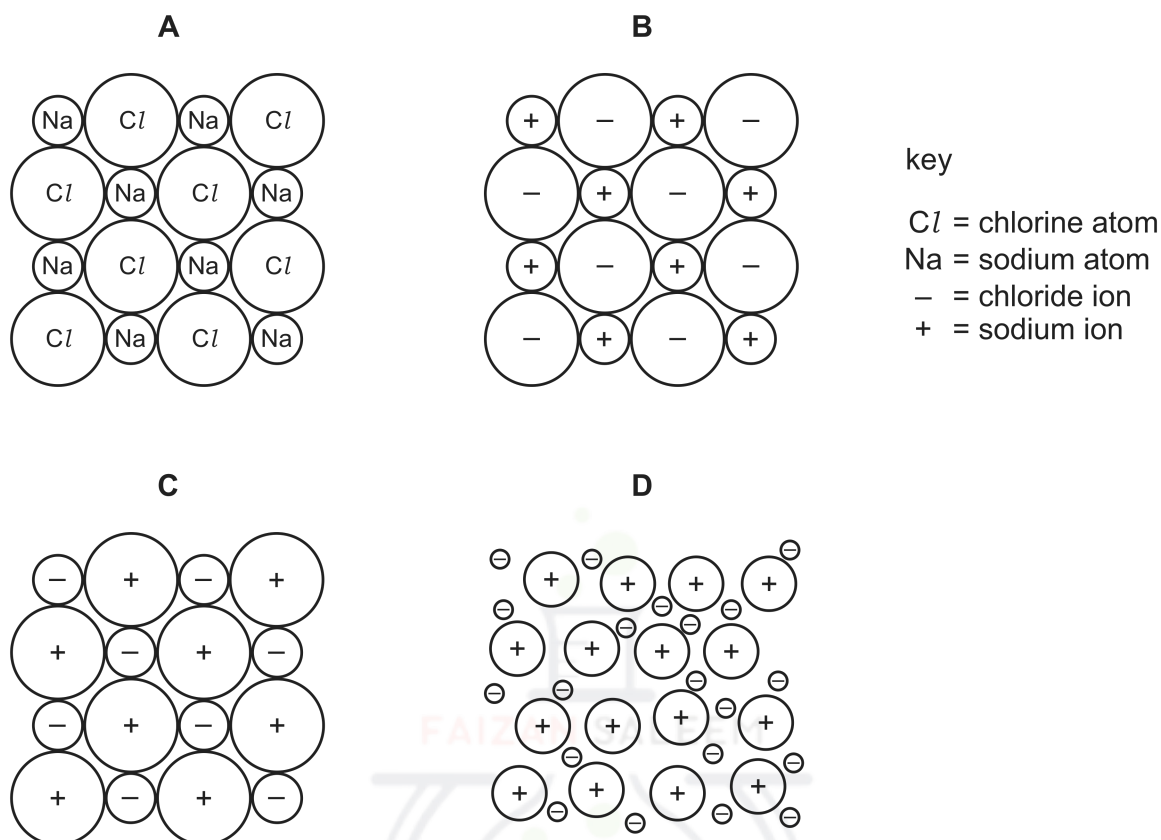
	coordination number of sodium ions	coordination number of chloride ions
A	4	6
B	6	4
C	6	6
D	8	6

Q36 Easy

9701/11/M/J/25/Q8

1 mark

8 Which diagram represents the lattice structure of sodium chloride?



Q37 Easy

9701/11/13/O/N/25/Q5

1 mark

5 Which statement explains why sodium and potassium have different melting points?

- A** The attraction between cations and delocalised electrons is stronger in sodium.
- B** The attraction between cations and anions is stronger in sodium.
- C** The attraction between atoms is stronger in sodium.
- D** The attraction between nuclei and shared electron pairs is stronger in sodium.

Q38 Easy

9701/13/M/J/22/Q7

1 mark

7 This question is about buckminsterfullerene, graphite, iodine and diamond.

How many of these substances have a simple molecular structure?

- A 0 B 1 C 2 D 3

Q39 Easy

9701/12/F/M/23/Q20

1 mark

20 Which row describes the structure and bonding of SiO_2 and SiCl_4 ?

	SiO_2		SiCl_4	
	structure	bonding	structure	bonding
A	giant	covalent	giant	covalent
B	giant	covalent	simple	covalent
C	giant	ionic	giant	covalent
D	giant	ionic	simple	covalent

Q40 Easy

9701/13/M/J/23/Q9

1 mark

9 Which statement explains why buckminsterfullerene has a lower melting point than graphite?

- A Buckminsterfullerene exists as discrete molecules with weak intermolecular bonding.
B Graphite is partly ionic as its structure contains mobile electrons and it conducts electricity.
C The carbon–carbon bonds in buckminsterfullerene are shorter and more strained.
D The mobile electrons in graphite mean it has a metallic structure.

Q41 Easy

9701/12/O/N/23/Q10

1 mark

10 In the structure of solid SiO_2

each silicon atom is bonded to x oxygen atoms

each oxygen atom is bonded to y silicon atoms

each bond is a z type bond.

What is the correct combination of x, y and z in these statements?

	x	y	z
A	2	1	covalent
B	2	1	ionic
C	4	2	covalent
D	4	2	ionic

Q42 Easy

9701/11/13/O/N/24/Q8

1 mark

8 Which solid has a simple molecular lattice?

- A calcium fluoride
- B nickel
- C silicon(IV) oxide
- D sulfur

Question	Answer	Original paper reference
1	A	9701/13/M/J/25/Q9
2	A	9701/11/M/J/21/Q8
3	D	9701/11/13/O/N/21/Q6
4	D	9701/12/M/J/22/Q7
5	C	9701/12/O/N/22/Q14
6	B	9701/12/F/M/23/Q9
7	D	9701/13/M/J/23/Q7
8	D	9701/12/F/M/21/Q6
9	A	9701/12/M/J/21/Q5
10	A	9701/12/O/N/21/Q8
11	A	9701/11/M/J/22/Q7
12	B	9701/12/M/J/22/Q8
13	C	9701/13/M/J/22/Q8
14	D	9701/12/O/N/22/Q15
15	A	9701/11/M/J/23/Q13
16	B	9701/12/M/J/23/Q8
17	B	9701/13/M/J/23/Q8
18	A	9701/11/13/O/N/23/Q7
19	A	9701/12/O/N/23/Q9
20	B	9701/11/M/J/24/Q7
21	B	9701/12/M/J/24/Q7
22	C	9701/13/M/J/24/Q7
23	C	9701/12/O/N/24/Q7
24	C	9701/12/F/M/25/Q8
25	A	9701/11/M/J/25/Q13
26	B	9701/12/M/J/25/Q12
27	D	9701/13/M/J/25/Q14
28	A	9701/14/M/J/25/Q4

Question	Answer	Original paper reference
29	B	9701/14/M/J/25/Q10
30	C	9701/11/13/O/N/25/Q11
31	D	9701/12/O/N/25/Q8
32	A	9701/13/M/J/21/Q36
33	D	9701/12/O/N/22/Q18
34	A	9701/11/M/J/23/Q2
35	C	9701/11/M/J/23/Q6
36	B	9701/11/M/J/25/Q8
37	A	9701/11/13/O/N/25/Q5
38	C	9701/13/M/J/22/Q7
39	B	9701/12/F/M/23/Q20
40	A	9701/13/M/J/23/Q9
41	C	9701/12/O/N/23/Q10
42	D	9701/11/13/O/N/24/Q8