CHEMISTRY MULTIPLE CHOICE QUESTIONS

D. States of Matter

2002 -2014

1.
Why does copper wire conduct electricity when a potential difference is applied?

A   Bonding electrons in the crystal lattice move.

B   Copper(II) ions move to the cathode.

C   The atoms of copper become ionised.

D   The crystal lattice breaks down.

[2002 M/J (5)]

2.
Flask X contains $1 \, dm^3$ of helium at $2 \, kPa$ pressure and flask Y contains $2 \, dm^3$ of neon at $1 \, kPa$ pressure.

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

A $1\frac{1}{3} \, kPa$ B $1\frac{1}{2} \, kPa$ C $1\frac{2}{3} \, kPa$ D $2 \, kPa$

[2002 M/J (6)]

3.
When heated, solid iodine readily forms iodine vapour.

What does this information suggest about the nature of the particles in these two physical states of iodine?

	solid	vapour
A	ionic	atomic
B	ionic	molecular
C	molecular	atomic
D	molecular	molecular

[2002 M/J (7)]

4.
Which of the following exists in the solid state as a giant covalent lattice?

A   ice

B   iodine

C   silicon(IV) oxide

D   tin(IV) chloride

[2002 O/N (7)]

5.
A $2 \, g$ sample of hydrogen at temperature T and of volume V exerts a pressure p. Deuterium, ^2_1H, is an isotope of hydrogen.

Which of the following would also exert a pressure p at the same temperature T?

A $2 \, g$ of deuterium of volume V

B $4 \, g$ of deuterium of volume $\frac{V}{2}$

C   a mixture of $1 \, g$ of hydrogen and $2 \, g$ of deuterium of total volume V

D   a mixture of $2 \, g$ of hydrogen and $1 \, g$ of deuterium of total volume $2 \, V$

[2002 O/N (8)]

6.
Which of the following are features of the structure of metallic copper?

1   ionic bonds

2   delocalised electrons

3   lattice of ions

[2002 O/N (32)]

7.
Which of the following solids has a simple molecular lattice?

A   magnesium oxide

B   sodium

C   silicon(IV) oxide

D   sulphur

[2003 M/J (5)]

8.

Measured values of the pressure, volume and temperature of a known mass of a gaseous compound are to be substituted into the equation

$$pV = nRT$$

in order to calculate the relative molecular mass, M_r, of the compound.

Which conditions of pressure and temperature would give the most accurate value of M_r?

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

[2003 M/J (6)]

9.

A substance commonly found in the house or garden has the following properties.

- It is combustible.
- It is an electrical insulator.
- It melts over a range of temperature.

What could the substance be?

A   brass

B   paper

C   poly(ethene)

D   silicon(IV) oxide

[2003 O/N (8)]

10.

Use of the Data Booklet is relevant to this question.

In an experiment using a gas syringe, 0.10 g of a gas is found to occupy 83.1 cm³, measured at standard pressure (1.0×10^5 Pa) and 27 °C.
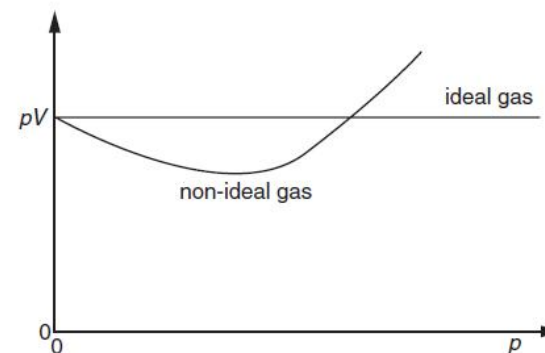
What is the relative molecular mass of the gas?

A $\dfrac{0.10 \times 8.31 \times 27}{1.0 \times 10^5 \times 83.1}$

B $\dfrac{0.10 \times 8.31 \times 300}{1.0 \times 10^5 \times 83.1}$

C $\dfrac{0.10 \times 8.31 \times 27}{1.0 \times 10^5 \times 83.1 \times 10^{-6}}$

D $\dfrac{0.10 \times 8.31 \times 300}{1.0 \times 10^5 \times 83.1 \times 10^{-6}}$

[2003 O/N (9)]

11.

The value of pV is plotted against p for two gases, an ideal gas and a non-ideal gas, where p is the pressure and V is the volume of the gas.
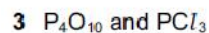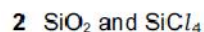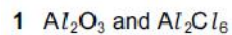

Which of the following gases shows the greatest deviation from ideality?

A   ammonia

B   ethene

C   methane

D   nitrogen

[2003 O/N (10)]

12.

Which pairs of compounds contain one that is giant ionic and one that is simple molecular?

1 Al_2O_3 and Al_2Cl_6

2 SiO_2 and $SiCl_4$

3 P_4O_{10} and PCl_3

[2004 M/J (34)]

13.

Use of the Data Booklet is relevant to this question.

Which expression gives the pressure exerted by 1.6×10^{-3} mol of N_2 in a container of volume $3.0 dm^3$ at $273°C$?

A $\dfrac{1.6 \times 10^{-3} \times 8.31 \times 273}{3.0 \times 10^{-6}}$ Pa

B $\dfrac{1.6 \times 10^{-3} \times 8.31 \times (273 + 273)}{3.0 \times 10^{-6}}$ Pa

C $\dfrac{1.6 \times 10^{-3} \times 8.31 \times 273}{3.0 \times 10^{-3}}$ Pa

D $\dfrac{1.6 \times 10^{-3} \times 8.31 \times (273 + 273)}{3.0 \times 10^{-3}}$ Pa

[2004 O/N (8)]

14.

Three substances, R, S, T, have physical properties as shown.

substance	mp/°C	bp/°C	electrical conductivity	
			of solid	of liquid
R	801	1413	poor	good
S	2852	3600	poor	good
T	3550	4827	good	not known

What could be the identities of R, S and T?

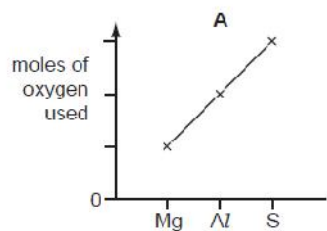|	R	S	T
A	NaF	KCl	Cu
B	NaBr	BaO	SiO$_2$
C	NaCl	MgO	C [graphite]
D	NaBr	CaO	C [diamond]

[2005 M/J (6)]

15.

One mole of magnesium, aluminium and sulphur are each completely burned in an excess of oxygen gas.

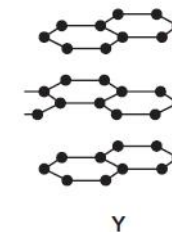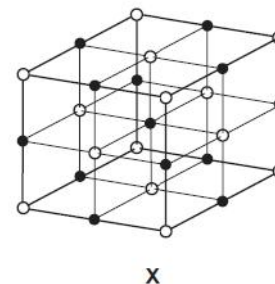Which graph shows the moles of oxygen used in each case?
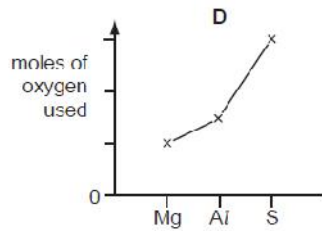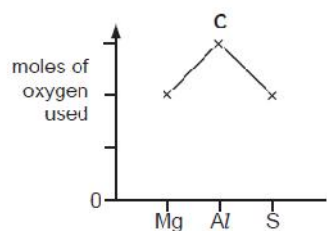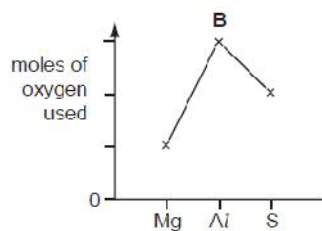
16.

Which of the following least resembles an ideal gas?

A   ammonia

B   helium

C   hydrogen

D   trichloromethane

17.

The diagram shows part of the lattice structures of solids **X** and **Y**. [In **X**, ○ and ● represent particles of different elements.]

What are the types of bonding present in **X** and **Y**?

	X	**Y**
A	covalent	metallic
B	ionic	covalent
C	ionic	metallic
D	metallic	ionic

18.

Compound **X**

- does not conduct electricity when in a liquid state,

- when added to water produces a solution that readily conducts electricity.

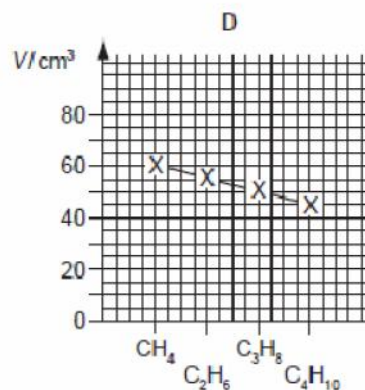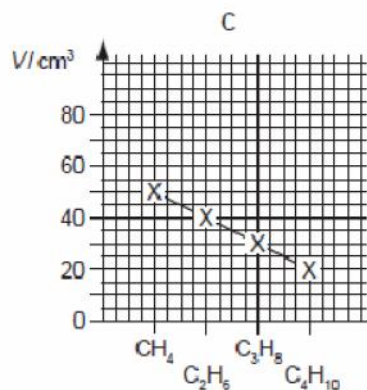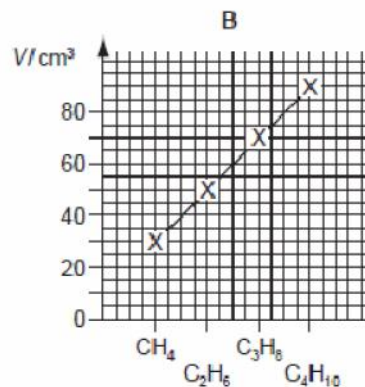What could **X** be?

1 $MgCl_2$

2 $SiCl_4$

3 PCl_3

19.

Samples of 10 cm³ of each of the first four members of the alkane series are separately mixed with 70 cm³ of oxygen. Each is then burned and the total volume, V, of residual gas measured again at room temperature and pressure.

Which graph represents the results that would be obtained?

A

V/cm³
80
60
40
20
0
CH_4 C_2H_6 C_3H_8 C_4H_{10}

B

V/cm³
80
60
40
20
0
CH_4 C_2H_6 C_3H_8 C_4H_{10}

C

V/cm³
80
60
40
20
0
CH_4 C_2H_6 C_3H_8 C_4H_{10}

D

V/cm³
80
60
40
20
0
CH_4 C_2H_6 C_3H_8 C_4H_{10}
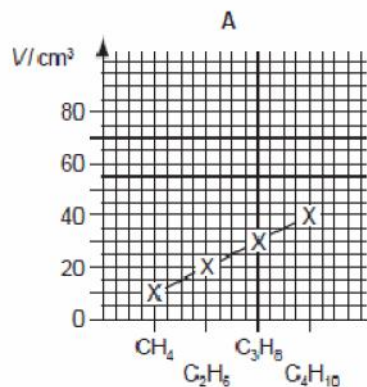
[2006 O/N (4)]

20.

For an ideal gas, the plot of pV against p is a straight line. For a real gas, such a plot shows a deviation from ideal behaviour. The plots of pV against p for three real gases are shown below.

The gases represented are ammonia, hydrogen and nitrogen.
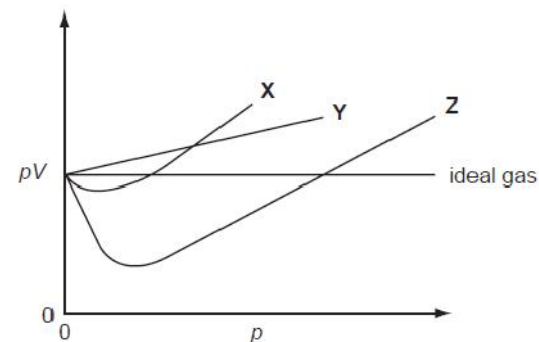
What are the identities of the gases **X**, **Y** and **Z**?

	X	Y	Z
A	ammonia	nitrogen	hydrogen
B	hydrogen	nitrogen	ammonia
C	nitrogen	ammonia	hydrogen
D	nitrogen	hydrogen	ammonia

[2006 O/N (6)]

21.

What are the lattice structures of solid diamond, iodine and silicon(IV) oxide?

	giant molecular	simple molecular
A	diamond, silicon(IV) oxide	iodine
B	diamond, iodine	silicon(IV) oxide
C	iodine	diamond, silicon(IV) oxide
D	silicon(IV) oxide	diamond, iodine

[2007 O/N (7)]

22.

What are assumptions of the kinetic theory of gases and hence of the ideal gas equation, $PV = nRT$?

1 Molecules move without interacting with one another except for collisions.

2 Intermolecular forces are negligible.

3 Intermolecular distances are much greater than the molecular size.

[2007 O/N (31)]

23.

The density of ice is 1.00 g cm^{-3}.

What is the volume of steam produced when 1.00 cm^3 of ice is heated to $323\,^\circ\text{C}$ (596 K) at a pressure of one atmosphere (101 kPa)?
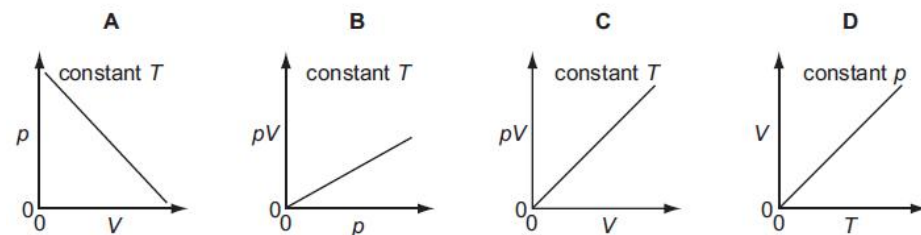
[1 mol of a gas occupies 24.0 dm^3 at $25\,^\circ\text{C}$ (298 K) and one atmosphere.]

A 0.267 dm^3 **B** 1.33 dm^3 **C** 2.67 dm^3 **D** 48.0 dm^3

[2008 M/J (6)]

24.

Which diagram correctly describes the behaviour of a fixed mass of an ideal gas? (*T* is measured in K.)

[2008 M/J (8)]

25.

A substance commonly found in the house or garden has the following properties.

- It is combustible.
- It is an electrical insulator.
- It melts over a range of temperature.

What could the substance be?

A brass

B paper

C poly(ethene)

D silicon(IV) oxide

[2008 O/N (6)]

26.

Which of the following would behave most like an ideal gas at room temperature?

A carbon dioxide

B helium

C hydrogen

D nitrogen

[2008 O/N (7)]

27.

An ideal gas obeys the gas laws under all conditions of temperature and pressure.

Which of the following are true for an ideal gas?

1 The molecules have negligible volume.

2 There are no forces of attraction between molecules.

3 The molecules have an average kinetic energy which is proportional to its absolute temperature.

[2009 M/J (31)]

28.

Which gas closely approaches ideal behaviour at room temperature and pressure?
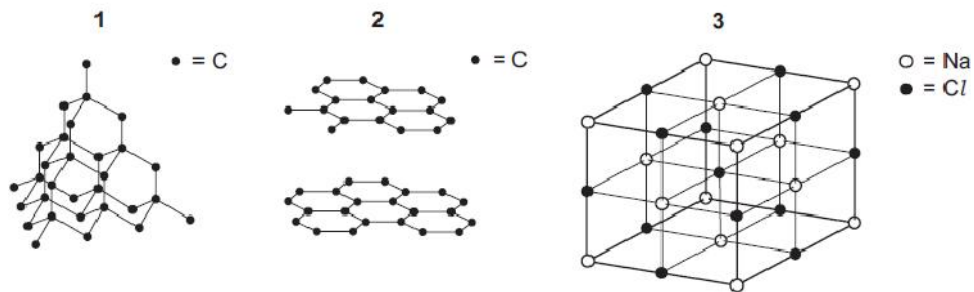
A ammonia

B carbon dioxide

C helium

D oxygen

[2010 M/J-11 (3)]

29.

Which mass of gas would occupy a volume of $3\,dm^3$ at $25\,°C$ and 1 atmosphere pressure?
[1 mol of gas occupies $24\,dm^3$ at $25\,°C$ and 1 atmosphere pressure.]

A $3.2\,g\ O_2$ gas

B $5.6\,g\ N_2$ gas

C $8.0\,g\ SO_2$ gas

D $11.0\,g\ CO_2$ gas

[2010 M/J-11 (9)]

30.

Which diagrams represent part of a giant molecular structure?

[2010 M/J-11 (31)]

31.

The table gives the radii, in pm, of some ions. $[1\,pm = 10^{-12}\,m]$

ion	radii
Na^+	102
Mg^{2+}	72
Cs^+	167
Cl^-	181
O^{2-}	140

Caesium chloride, CsCl, has a different lattice structure from both sodium chloride, NaCl, and magnesium oxide, MgO.
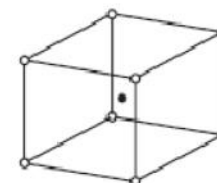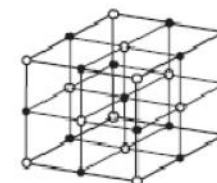
CsCl lattice   NaCl and MgO lattice

Which factor appears to determine the type of lattice for these three compounds?

A the charge on the cation

B the ratio of the ionic charges

C the ratio of the ionic radii

D the sum of the ionic charges

[2010 O/N-12 (3)]

32.

Which solid has a simple molecular lattice?

A calcium fluoride

B nickel

C silicon(IV) oxide

D sulfur

[2010 O/N-12 (5)]

33.

Flask X contains $5\,dm^3$ of helium at $12\,kPa$ pressure and flask Y contains $10\,dm^3$ 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** $11\,kPa$

[2010 O/N-12 (7)]

34.

Three substances, R, S and T, have physical properties as shown.

substance	R	S	T
mp/°C	801	2852	3550
bp/°C	1413	3600	4827
electrical conductivity of solid	poor	poor	good

What could be the identities of R, S and T?

	R	S	T
A	MgO	NaCl	C [graphite]
B	MgO	NaCl	SiO_2
C	NaCl	MgO	C [graphite]
D	NaCl	MgO	SiO_2

[2011 M/J-11 (10)]

35.

Which are features of the structure of metallic copper?

1 a lattice of ions

2 delocalised electrons

3 ionic bonds

[2011 M/J-11 (32)]

36.

When a sample of a gas is compressed at constant temperature from $1500\,kPa$ to $6000\,kPa$, its volume changes from $76.0\,cm^3$ to $20.5\,cm^3$.

Which statements are possible explanations for this behaviour?

1 The gas behaves non-ideally.

2 The gas partially liquefies.

3 Gas is adsorbed on to the vessel walls.

[2011 M/J-12 (32)]

37.

Which equations apply to an ideal gas?
[p = pressure, V = volume, M = molar mass, ρ = density, c = concentration, R = gas constant, T = temperature]

1 $p = \dfrac{\rho RT}{M}$ **2** $pV = MRT$ **3** $pV = \dfrac{cRT}{M}$

[2011 M/J-12 (33)]

38.

At room temperature and pressure chlorine does not behave as an ideal gas.

At which temperature and pressure would the behaviour of chlorine become more ideal?

	pressure /kPa	temperature /K
A	50	200
B	50	400
C	200	200
D	200	400

[2011 O/N-11 (5)]

39.

Three compounds have the physical properties shown in the table.

compound	P	Q	R
melting point/°C	2852	993	−119
boiling point/°C	3600	1695	39
conductivity (solid)	poor	poor	poor
conductivity (liquid)	good	good	poor
conductivity (aqueous)	insoluble	good	insoluble

What might be the identities of **P**, **Q** and **R**?

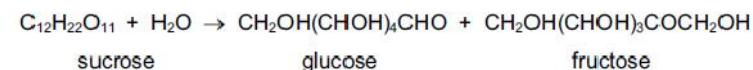|	P	Q	R
A	MgO	KC*l*	NH$_3$
B	MgO	NaF	C$_2$H$_5$Br
C	SiO$_2$	KC*l*	C$_2$H$_5$Br
D	SiO$_2$	NaF	HC*l*

[2011 O/N-12 (6)]

40.

The use of sucrose in food processing depends in part on osmotic pressure, symbol Π.

In dilute solution, Π varies with concentration in a similar way to gas behaviour. The equation $\Pi V = nRT$ can be used, where n is the number of moles of solute molecules contained in volume V at temperature T. The number of moles of solvent molecules should be ignored.

Under aqueous acidic conditions sucrose is hydrolysed.

$$C_{12}H_{22}O_{11} + H_2O \rightarrow CH_2OH(CHOH)_4CHO + CH_2OH(CHOH)_3COCH_2OH$$

sucrose   glucose   fructose

What can be deduced from this hydrolysis equation?

	the osmotic pressure	glucose and fructose are
A	decreases	optical isomers
B	decreases	structural isomers
C	increases	optical isomers
D	increases	structural isomers

[2011 O/N-12 (9)]

41.

Which are assumptions of the kinetic theory of gases and hence of the ideal gas equation, $PV = nRT$?

1 Molecules move without interacting with one another except for collisions.

2 Intermolecular forces are negligible.

3 Intermolecular distances are much greater than the molecular size.

[2011 O/N-12 (33)]

42.

Use of the Data Booklet is relevant to this question.

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.56 g of ethene gas is contained in a vessel at a pressure of 102 kPa and a temperature of 30 °C.

What is the volume of the vessel?

A   49 cm³   B   494 cm³   C   48 900 cm³   D   494 000 cm³

[2012 M/J-11 (6)]

43.

Under which set of conditions is a gas most likely to behave ideally?

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

[2012 M/J-11 (8)]

44.

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

where each symbol has its usual meaning.

Which statements are correct?

1   One mole of an ideal gas occupies the same volume under the same conditions of temperature and pressure.

2   The density of an ideal gas at constant pressure is inversely proportional to the temperature, T.

3   The volume of a given mass of an ideal gas is doubled if its temperature is raised from 25 °C to 50 °C at constant pressure.

[2012 M/J-11 (31)]

45.

Use of the Data Booklet is relevant to this question.

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.96 g of oxygen gas is contained in a glass vessel of volume 7000 cm³ at a temperature of 30 °C.

What is the pressure in the vessel?

A   1.1 kPa   B   2.1 kPa   C   10.8 kPa   D   21.6 kPa

[2012 M/J-12 (6)]

46.

Use of the Data Booklet is relevant to this question.

The volume of a sample of ammonia is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is 5.37×10^{-3} m³.

What is the mass of the sample of ammonia, given to two significant figures?

A   0.00019 g   B   0.0034 g   C   0.19 g   D   3.4 g

[2012 O/N-11 (6)]

47.

Some car paints contain small flakes of silica, SiO_2.

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 this statement?

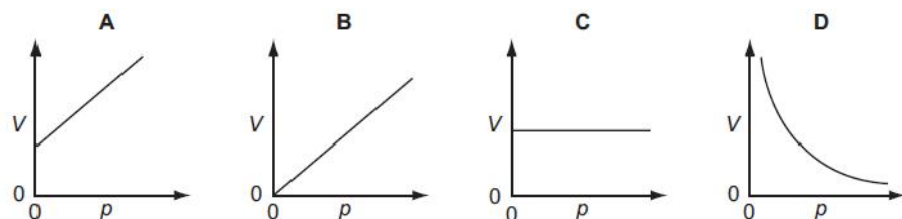|	x	y	z
A	2	1	covalent
B	2	1	ionic
C	4	2	covalent
D	4	2	ionic

[2012 O/N-11 (8)]

48.

Which of these substances have a giant structure?

1   silicon(IV) oxide

2   baked clay found in crockery

3   phosphorus(V) oxide

[2012 O/N-11 (33)]

49.

Which diagram shows the correct graph of V against p for a fixed mass of an ideal gas at constant temperature?

[2012 O/N-13 (1)]

50.

Use of the Data Booklet is relevant to this question.

The volume of a sample of ammonia was measured at a temperature of 40 °C and a pressure of 95 kPa. The volume measured was $4.32 \times 10^{-5} \, m^3$.

What is the mass of the sample of ammonia?

A 2.7×10^{-5} g   B 2.1×10^{-4} g   C 2.7×10^{-2} g   D 2.1×10^{-1} g

[2012 O/N-13 (3)]

51.

Which would behave the **least** like an ideal gas at room temperature?

A   carbon dioxide

B   helium

C   hydrogen

D   nitrogen

[2013 M/J-11 (9)]

52.

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

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

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

[2013 M/J-11 (10)]

53.

Ethanol has a boiling point of 78 °C. At 101 kPa and 79 °C ethanol vapour does not perfectly obey the gas equation $pV = nRT$.

What is the reason for this?

A   Ethanol vapour is in equilibrium with ethanol liquid at 79 °C.

B   There are intermolecular forces between the molecules of ethanol vapour.

C   The vapourisation of ethanol liquid is an endothermic process.

D   Vapours will not obey the gas equation perfectly at such a low pressure.

[2013 M/J-12 (7)]

54.

Which **least** resembles an ideal gas at room temperature and pressure?

A   ammonia

B   helium

C   hydrogen

D   methane

[2013 M/J-13 (6)]

55.

Use of the Data Booklet is relevant to this question.

When 0.15 g of an organic compound is vaporised, it occupies a volume of 65.0 cm^3 at 405 K and 1.00×10^5 N m^{-2}.

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

A $\quad \dfrac{0.15 \times 65 \times 10^{-6} \times 1 \times 10^5}{8.31 \times 405}$

B $\quad \dfrac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-3}}$

C $\quad \dfrac{0.15 \times 65 \times 10^{-3} \times 1 \times 10^5}{8.31 \times 405}$

D $\quad \dfrac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-6}}$
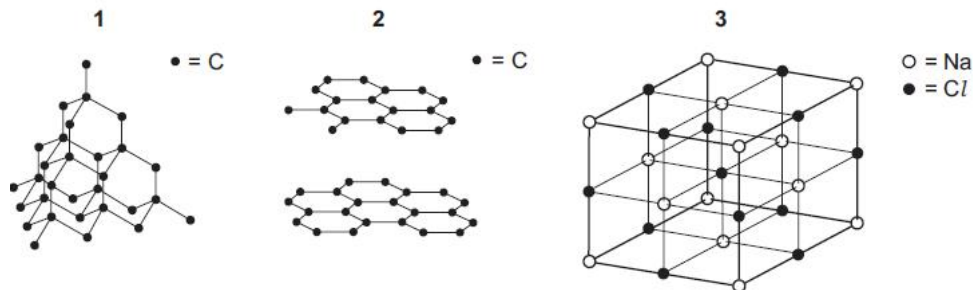
[2013 M/J-13 (7)]

56.

Which compound is the only gas at room temperature and pressure?

A $\quad CH_3CH_2CH_2NH_2 \qquad M_r = 59.0$

B $\quad CH_3CH_2CH_2OH \qquad M_r = 60.0$

C $\quad CH_2OHCH_2OH \qquad M_r = 62.0$

D $\quad CH_3CH_2Cl \qquad M_r = 64.5$

[2013 M/J-13 (8)]

57.

Which diagrams represent part of a giant molecular structure?

[2013 M/J-13 (34)]

58.

Use of the Data Booklet is relevant to this question.

The approximate percentage composition of the atmosphere on four different planets is given in the table below.

The density of a gas may be defined as the mass of 1 dm^3 of the gas measured at s.t.p.

Which mixture of gases has the greatest density?

	planet	major gases/ % by number of molecules
A	Jupiter	H_2 89.8, He 10.2
B	Neptune	H_2 80.0, He 19.0, CH_4 1.0
C	Saturn	H_2 96.3, He 3.25, CH_4 0.45
D	Uranus	H_2 82.5, He 15.2, CH_4 2.3

[2013 O/N-11 (8)]

59.

Measured values of the pressure, volume and temperature of a known mass of a gaseous compound are to be substituted into the equation $pV = nRT$.

The measurements are used to calculate the relative molecular mass, M_r, of a compound.

Which conditions of pressure and temperature would give the most accurate value of M_r?

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

[2013 O/N-13 (7)]

60.

Use of the Data Booklet is relevant to this question.

When an evacuated fluorescent light tube of volume $300 \, cm^3$ is filled with a gas at 300 K and 101 kPa, the mass of the tube increases by 1.02 g. The gas obeys the ideal gas equation $pV = nRT$.

What is the identity of the gas?

A   argon

B   krypton

C   neon

D   nitrogen

[2013 O/N-13 (9)]

61.

Use of the Data Booklet is relevant to this question.

Iodine is a black, shiny, non-metallic solid and a member of Group VII. It sublimes easily on heating to give a purple vapour.

A sample of iodine vapour of mass 6.35 g has a volume of $1.247 \, dm^3$ when maintained at constant temperature and a pressure of $1.00 \times 10^5 \, Pa$.

If iodine vapour acts as an ideal gas, what is the temperature of the iodine vapour?

A   300 K   B   600 K   C   300 000 K   D   600 000 K

[2014 M/J-11 (2)]

62.

The table shows the physical properties of four substances.

Which substance has a giant covalent structure?

	melting point /°C	boiling point /°C	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	−119	39	poor	poor	insoluble
B	−115	−85	poor	poor	good
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

[2014 M/J-11 (4)]

63.

Substances X, Y and Z are all solids. Some of their physical properties are given in the table.

substance	X	Y	Z
melting point/°C	772	114	1610
boiling point/°C	1407	183	2205
electrical conductivity of the liquid state	conducts	does not conduct	does not conduct

What type of lattice could each substance have?

	X	Y	Z
A	giant molecular	simple molecular	ionic
B	ionic	giant molecular	simple molecular
C	ionic	simple molecular	giant molecular
D	simple molecular	ionic	giant molecular

[2014 M/J-12 (2)]

64.

Use of the Data Booklet is relevant to this question.

In an experiment, 12.0 dm³ of oxygen, measured under room conditions, is used to burn completely 0.10 mol of propan-1-ol.

What is the final volume of gas, measured under room conditions?

A 7.20 dm³   B 8.40 dm³   C 16.8 dm³   D 18.00 dm³

[2014 M/J-12 (9)]

65.

A 10.0 cm³ bubble of an ideal gas is formed on the sea bed where it is at a pressure of 2020 kPa.

Just below the sea surface the pressure is 101 kPa and the temperature is the same as the sea bed.

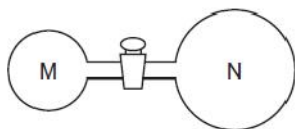What is the volume of the bubble when it rises to just below the sea surface?

A 10.0 cm³   B 20.2 cm³   C 200 cm³   D 2 020 000 cm³

[2014 M/J-13 (7)]

66.

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

M contains helium at 20 °C at a pressure of 1×10^5 Pa. N has been evacuated, and has three times the volume of M. In an experiment, 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 3.18×10^4 Pa

B 4.24×10^4 Pa

C 1.25×10^5 Pa

D 5.09×10^5 Pa

[2014 O/N-11 (4)]

67.

A student borrowed a friend's chemistry notes and copied out the notes in the box below.

Which statements are correct?

A gas behaves **less** like an ideal gas when the gas
1 is at low pressure.
2 is at low temperature.
3 can be easily liquefied.

[2014 O/N-11 (34)]

68.

Which row shows properties of a ceramic material?

	melting point /K	boiling point /K	conductivity of solid
A	156	352	none
B	922	1380	good
C	2130	2943	good
D	3125	3873	none

[2014 O/N-13 (3)]

69.

Use of the Data Booklet is relevant to this question.

When an evacuated glass tube of volume 200 cm³ is filled with a gas at 300 K and 101 kPa, the mass of the tube increases by 1.06 g.

What is the identity of the gas?

A argon

B krypton

C neon

D xenon

[2014 O/N-13 (9)]