



- 1 Which ion has the same electronic configuration as Cl^- ?

A F^-

☒ B Sc^{3+}

C P^+

D Si^{4+}

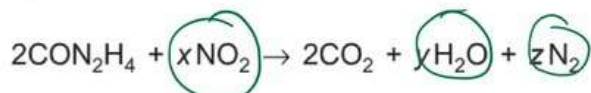
- 2 Four elements from Period 2 are B, C, N and Ne.

Which element has the largest fifth ionisation energy and which element has the smallest fifth ionisation energy?

	largest fifth ionisation energy	smallest fifth ionisation energy
A	C	B
☒ B	C	N
C	Ne	B
D	Ne	N

IE₅ of H . He . Li . C

- 3 An equation is shown.



What are the values of x, y and z in a balanced equation?

	x	y	z
A	1.5	2	1.25
B	2	4	3
☒ C	3	4	3.5
D	3	4	3

$$\text{N: } x + 4 = 2z$$

$$\text{O: } 2 + 2x = 4 + y$$

$$\text{H: } 8 = 2y$$

- 4 14.9 g of sodium chlorate(I), NaOCl , is dissolved in 500 cm^3 of water. An equilibrium is established.



At equilibrium, 20% of the NaOCl(aq) remains.

What is the concentration of HOCl at equilibrium?

- A $0.032 \text{ mol dm}^{-3}$
 B 0.16 mol dm^{-3}
 C 0.32 mol dm^{-3}
 D 1.6 mol dm^{-3}

$2.6 \times 2.2 = 5.72$ 抖音神题来了.

$$[\text{HOCl}]_{\text{E}} = 80\% \cdot [\text{NaOCl}]_{\text{I}} = 0.8 \cdot \frac{14.9}{500} \times 1000 = 0.32$$

- 5 Three statements about hybridisation are listed.

- 1 In ethane, both carbon atoms are sp^3 hybridised.
- 2 In propene, two carbon atoms are sp^2 hybridised and the third carbon atom is sp^3 hybridised.
- 3 In methanenitrile, the carbon atom is sp hybridised.



Which statements are correct?

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

- 6 VSEPR should be used to answer this question.

Element E forms two chlorides. ECl_3 is pyramidal in shape. ECl_5 is trigonal bipyramidal in shape. Both compounds are simple molecular. All bonds are single covalent bonds. Neither compound has coordinate bonding.

What is element E?

- A arsenic
 B gallium
 C germanium
 D selenium

- 7 A container has a volume of 25.0 dm^3 . It is filled with argon gas at a temperature of 25°C and a pressure of 210 kPa . Argon behaves as an ideal gas under these conditions.

Which mass of argon gas is used?

- A 84.6 g B 169 g C 1010 g D 84600 g

$$pV = nRT \Rightarrow n = \frac{pV}{RT} = \frac{210 \times 10^3 \times 25 \times 10^{-3}}{8.314 \times 298} = 2.19 \text{ mol}$$

$$m = n \cdot M = 2.19 \times 39.9 = 87.4 \text{ g}$$

⑦ $n = \frac{V}{V_m} = \frac{25.0}{24.0/2.1} = 2.19 \text{ mol}$ Turn over

$m = n \cdot M = 87.4 \text{ g}$ 👍

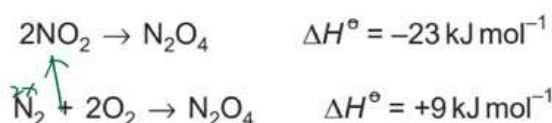
- 8 The boiling points of the hydrogen halides increase from HCl to HBr to HI.

Which factor is most responsible for this increase in boiling point?

id-id ↑ ✓
pd-pd ↓ ×

- A an increase in strength of hydrogen bonding
 B an increase in the number of electrons in the hydrogen halide molecule
 C an increase in strength of permanent dipole–permanent dipole attractions
 D an increase in the polarity of the hydrogen–halogen bond

- 9 The enthalpy changes for two reactions are shown.



$23 - 9 = 14$

What is the enthalpy change of formation, ΔH_f° , of NO_2 ?

- A -14 kJ mol^{-1} B -7 kJ mol^{-1} C $+16 \text{ kJ mol}^{-1}$ D $+32 \text{ kJ mol}^{-1}$

- 10 A butane burner is used to heat water.

- The M_r of butane is 58.
- ΔH_c of butane is $-2877 \text{ kJ mol}^{-1}$.
- 250 g of water is heated from 12°C to 100°C .
- The burner transfers 47% of the heat released from the burning fuel to the water.

$\frac{1.05}{0.47} = 2.234$...

Assume that the butane undergoes complete combustion and none of the water evaporates.

What is the minimum mass of butane that must be burnt?

- A 0.068 g B 1.85 g C 3.94 g D 4.48 g

- 11 In acidic solution, $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ can be reduced to $\text{Cr}^{3+}(\text{aq})$.

How many moles of $\text{Fe}^{2+}(\text{aq})$ can be oxidised to $\text{Fe}^{3+}(\text{aq})$ by 1 mol of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ in acidic solution?

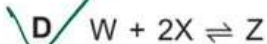
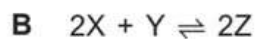
- A 2 B 3 C 4 D 6

2 ...

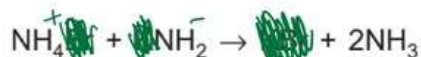
12 Four reversible reactions are shown.

W, X, Y and Z represent different compounds, all of which are present in aqueous solution.

In which reaction does K_c have units $\text{mol}^{-2} \text{dm}^6$? C⁻²



13 KNH_2 is an ionic compound. It contains K^+ ions and a single species of anion. Under appropriate conditions, NH_4Br and KNH_2 react as follows. NH₄⁺



How can the reaction be classified?

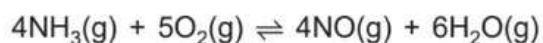
☒ A acid–base

B condensation

C disproportionation

D oxidation–reduction

14 The reaction shown is exothermic in the forward direction.



Which statement about the reaction is correct? ΔH < 0

A Increasing the pressure reduces the rate of reaction.

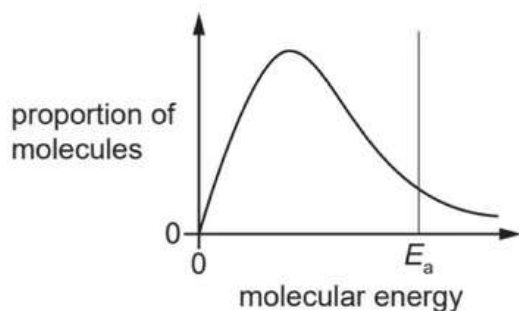
B A higher temperature increases the percentage yield of the products at equilibrium.

☒ C A higher temperature increases the collision frequency between molecules.

D A catalyst increases the percentage yield of the products at equilibrium.

体列的题 45 46.00
当成 Haber process 做即可

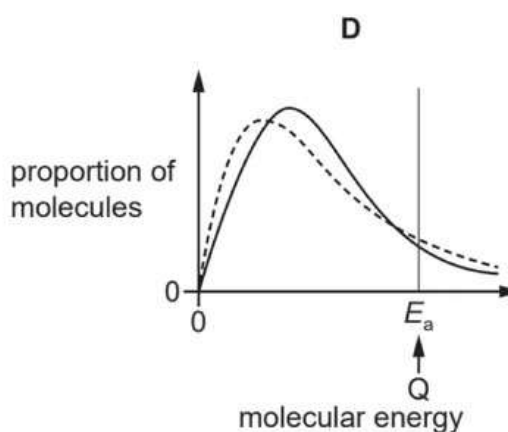
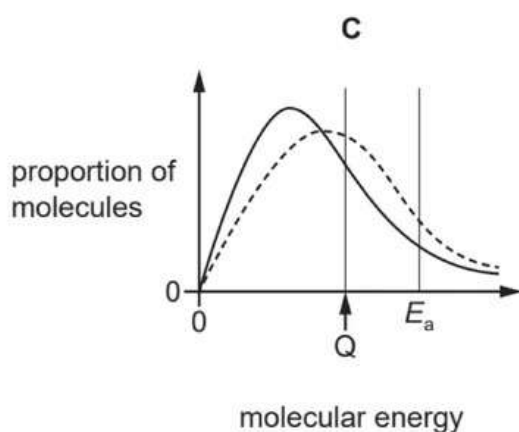
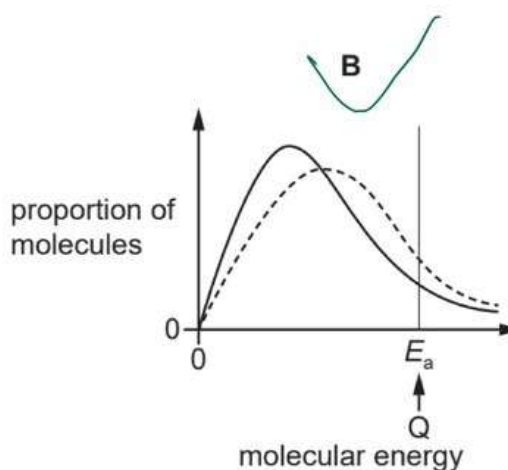
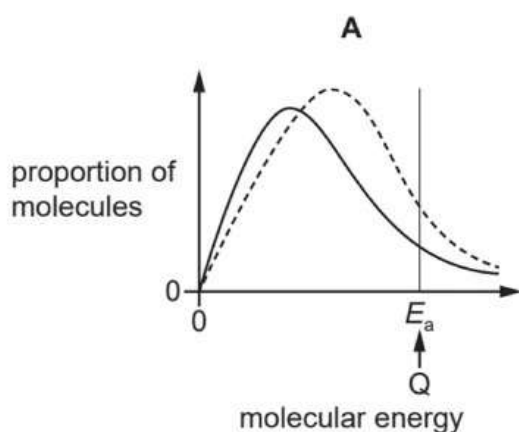
- 15 The diagram represents, for a given temperature, the Boltzmann distribution of the kinetic energies of the molecules in a mixture of two gases that react together. The activation energy for the reaction, E_a , is marked.



此题今年学生解答的题目...

The dotted curves below show the Boltzmann distribution for the same reaction at a higher temperature. On these diagrams, Q represents the activation energy at the higher temperature.

Which diagram is correct?



16 Ammonia molecules react to produce ammonium ions.

Some statements about this reaction are listed.

反应数 + 1

- 1/ Ammonia acts as a Brønsted–Lowry base.
- 2/ The H–N–H bond angle increases.
- 3/ An ammonium ion contains the same number of electrons as an ammonia molecule.

Which statements are correct?

- ☒ A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

17 The elements Cl, Mg, Si and S are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

	lowest melting point	→		highest melting point
A	Cl	S	Mg	Si
B	Cl	S	Si	Mg
C	Mg	Si	S	Cl
D	Si	Mg	S	Cl

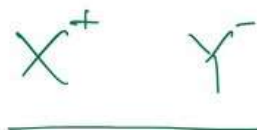


18 X and Y are elements in Period 3 of the Periodic Table.

- The atomic radius of X is greater than the atomic radius of Y.
- For common ions, the ionic radius of Y is greater than the ionic radius of X.

Which statement is correct?

- ☒ A X has a greater atomic number than Y.
- ☒ B The oxide of Y is acidic.
- C The chloride of X is basic. *No way*
- ☒ D X has a greater 1st ionisation energy than Y.



A = D 直接排
C 没听过 不选

- 19 0.010 mol of anhydrous magnesium nitrate is thermally decomposed.

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

- A 240 cm³ of NO₂ only
 B 240 cm³ of NO₂ and 60 cm³ of O₂
 C 240 cm³ of NO₂ and 360 cm³ of O₂
 D 480 cm³ of NO₂ and 120 cm³ of O₂

1 1 2 1/2

- 20 Which row is correct?

	fourth ionisation energy		reaction with water	
	magnesium	barium	magnesium	barium
A	higher	lower	faster	slower
B	higher	lower	slower	faster
C	lower	higher	faster	slower
D	lower	higher	slower	faster

同 group 第四 IE 一样

(reactivity 就是 IE⁻¹)

- 21 A solid mixture of barium oxide and magnesium nitrate is stirred into water. The mixture is filtered and a colourless solution, Y, and a white solid, Z, are obtained. Z is washed with distilled water and dried.

Which observations are made when Y and Z are added separately to an excess of dilute sulfuric acid?

	observation with Y	observation with Z
A	colourless solution	colourless solution
B	colourless solution	white precipitate
C	white precipitate	white precipitate
D	white precipitate	colourless solution

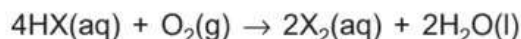
BaO → Ba(OH)₂ Mg(NO₃)₂

Ba(OH)₂ Mg(OH)₂

1:2 1:1

- 22 Solutions of HBr(aq) and HI(aq) react separately with O₂(g).

The equation shows the reaction, where HX represents either HBr(aq) or HI(aq).



Which statement is correct?

- A** HBr(aq) reacts more vigorously than HI(aq) because Br⁻ is a stronger oxidising agent than I⁻.
B HBr(aq) reacts more vigorously than HI(aq) because Br⁻ is a stronger reducing agent than I⁻.
C HBr(aq) reacts less vigorously than HI(aq) because Br⁻ is a weaker oxidising agent than I⁻.
D HBr(aq) reacts less vigorously than HI(aq) because Br⁻ is a weaker reducing agent than I⁻.

- 23 The equation shows the reaction of chlorine with cold aqueous sodium hydroxide.



Chlorine also reacts with hot aqueous sodium hydroxide. *NaClO₃*

Which statements are correct?

- 1* Both reaction conditions produce chloride ions.
2 The reaction of chlorine with hot aqueous sodium hydroxide is a disproportionation reaction. *f-3*
3 Hot aqueous sodium hydroxide also reacts with chlorine in a 2 : 1 mole ratio.

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

- 24 When burned, sulfur forms gas P which can be oxidised to produce gas Q. *SO₂* *SO₃*

Gas Q reacts with water to produce R. *H₂SO₄*

Which row correctly shows the oxidation states of sulfur in P, Q and R?

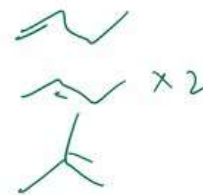
	P	Q	R
A	-2	+4	+4
B	-2	+4	+6
C	+4	+6	+4
D	+4	+6	+6

Constant

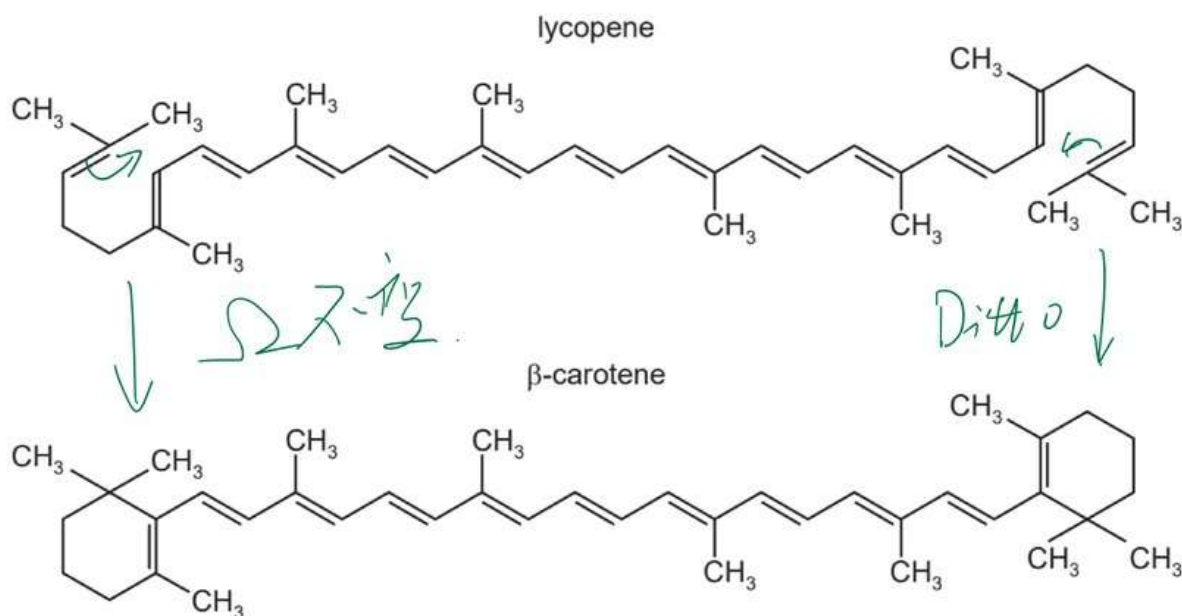
- 25 Structural isomerism and stereoisomerism should be considered when answering this question.

How many isomers with the formula C_4H_8 have structures that contain a π bond?

- A 1 B 2 C 3 **D 4**



- 26 The diagrams show the structures of lycopene and β -carotene.

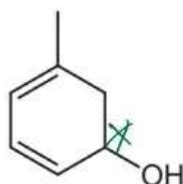


When lycopene is converted into β -carotene, what is the loss or gain, if any, of hydrogen atoms per molecule?

- A two lost
B no change
 C two gained
 D four gained

老学姐 + 1.

- 27 The skeletal formula of an organic molecule is shown.



How many chiral centres does the molecule contain?

- A 0 **B 1** C 2 D 3

- 28 Aqueous bromine is added dropwise to a sample of 2,3-dimethylcyclohexene with shaking.

Which colour change is observed?

- A colourless to orange
 B colourless to green
 C orange to green
 D orange to colourless

alkene is decolourised.

- 29 Some reagents are listed.

- 1 $\text{PCl}_3(\text{l})$
 2 $\text{Cl}_2(\text{g})$
 3 $\text{KCl}(\text{s})$ with concentrated H_2SO_4

Which reagents convert propan-2-ol into 2-chloropropane?

- A 1 and 2 B 1 and 3 C 1 only D 2 and 3

- 30 But-1-ene is reacted with steam, in the presence of phosphoric acid.

In a second step, the **main** organic product of this reaction is reacted with an excess of acidified potassium manganate(VII).

What is the organic product of the second step?

- A butan-1,2-diol
 B butanal
 C butanoic acid
 D butanone



- 31 Three statements about reactions of 1-bromopropane are listed.

- 1 1-bromopropane reacts with hot KCN in ethanol to produce propanenitrile.
 2 1-bromopropane reacts with hot ethanolic NH_3 under pressure to produce propylamine.
 3 1-bromopropane reacts with hot aqueous NaOH to produce propan-1-ol.

Which statements are correct?

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

32 $(\text{CH}_3)_3\text{CBr}$ is heated with $\text{NaOH}(\text{aq})$. An intermediate is formed.

Which row is correct?

	shape of intermediate	type of mechanism
A	pyramidal	$\text{S}_{\text{N}}2$
B	pyramidal	$\text{S}_{\text{N}}1$
C	trigonal planar	$\text{S}_{\text{N}}2$
D	trigonal planar	$\text{S}_{\text{N}}1$



33 Which compound reacts with both alkaline $\text{I}_2(\text{aq})$ and hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$?

A $\text{OHCCH}_2\text{CH}_2\text{CHO}$

B $\text{CH}_3\text{CH}_2\text{COOCH}_3$

C $\text{CH}_3\text{COCH}_2\text{CHO}$

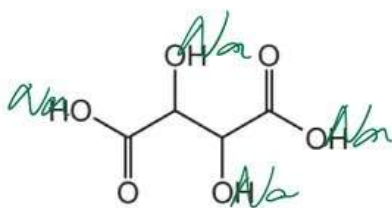
D $\text{CH}_3\text{COCOCH}_3$

34 Ethanal, CH_3CHO , undergoes an addition reaction with HCN in the presence of CN^- .

Which row is correct?

	type of reaction	name of product
A	electrophilic addition	2-hydroxypropanenitrile
B	electrophilic addition	2-hydroxyethanenitrile
C	nucleophilic addition	2-hydroxypropanenitrile
D	nucleophilic addition	2-hydroxyethanenitrile

35 The structure of tartaric acid is shown.



Four moles of substance X react with one mole of tartaric acid.

What is substance X?

- ☒ A sodium
- ☐ B sodium carbonate
- ☐ C sodium hydrogencarbonate
- ☐ D sodium hydroxide

36 Bromine reacts with propene in an organic solvent at room temperature.

What is the mechanism of this reaction?

- ☒ A electrophilic addition
- ☐ B free-radical substitution
- ☐ C nucleophilic addition
- ☐ D nucleophilic substitution

37 Methyl propanoate can be produced by reacting together a carboxylic acid and an alcohol in the presence of a catalyst.

Which row describes the reaction that takes place?

	type of reaction	catalyst
☒ A	condensation	aqueous sodium hydroxide
☐ B	condensation	concentrated sulfuric acid
☐ C	elimination	aqueous sodium hydroxide
☐ D	hydrolysis	concentrated sulfuric acid

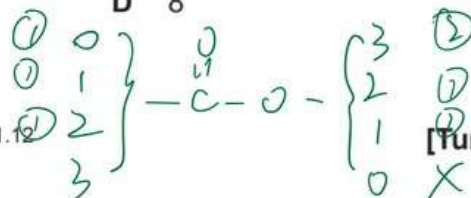
38 How many different organic compounds, in total, are produced by the acid hydrolysis of all esters with the molecular formula $C_4H_8O_2$?

A 4

B 6

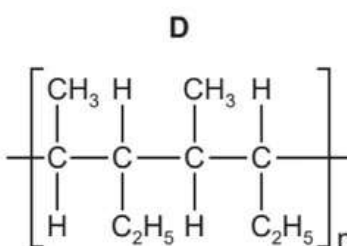
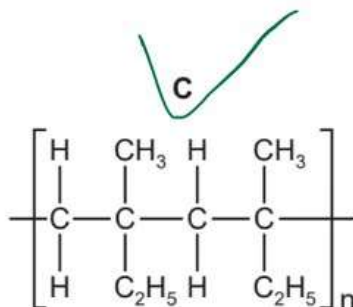
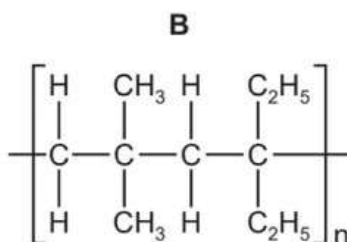
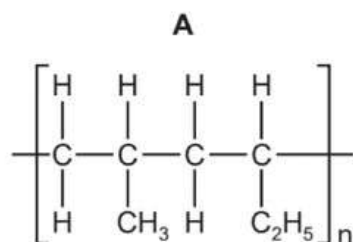
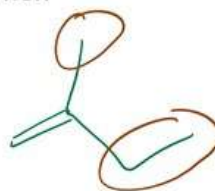
☒ C 7

D 8



39 2-methylbut-1-ene is used as a monomer to produce an addition polymer.

What is the structure of the addition polymer that it forms?



40 Statements about the mass spectrum of pentane, C_5H_{12} , are listed.

- 1 ✓ All peaks in the spectrum are due to positive ions.
- 2 ✓ The abundances of the M^+ ion and the $[\text{M}+1]^+$ ion can be used to calculate the number of carbon atoms in the pentane molecule.
- 3 ✗ An $[\text{M}+2]^+$ peak is seen at $m/e = 60$.

Which statements are correct?

A 1 and 2

B 1 and 3

C 2 and 3

D 2 only

Important values, constants and standards

molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
Avogadro constant	$L = 6.022 \times 10^{23} \text{ mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K (25 °C))
specific heat capacity of water	$c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ ($4.18 \text{ J g}^{-1} \text{ K}^{-1}$)

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[illegible]

actinoids

57	La	lanthanum	138.9
58	Ce	cerium	140.1
59	Pr	praseodymium	140.9
60	Nd	neodymium	144.2
61	Pm	promethium	—
62	Sm	samarium	150.4
63	Eu	europtium	152.0
64	Gd	gadolinium	157.3
65	Tb	terbium	158.9
66	Dy	dyprosium	162.5
67	Ho	holmium	164.9
68	Er	erbium	167.3
69	Tm	thulium	168.9
70	Yb	ytterbium	173.1
71	Lu	lutetium	175.0
72	Hf	hafnium	178.5
73	Ta	tantalum	180.9
74	W	tungsten	183.8
75	Re	rhenium	186.2
76	Os	osmium	190.2
77	Ir	iridium	192.2
78	Pt	platinum	195.1
79	Au	gold	197.0
80	Hg	mercury	200.6
81	Tl	thallium	204.4
82	Pb	lead	207.2
83	Bi	bismuth	209.0
84	Po	polonium	—
85	At	astatine	—
86	Rn	radon	—
87	Fr	francium	—
88	Ra	radium	—
89	Ac	actinium	—
90	Th	thorium	232.0
91	Pa	protactinium	231.0
92	U	uranium	238.0
93	Np	neptunium	—
94	Pu	plutonium	—
95	Am	americium	—
96	Cm	curium	—
97	Bk	berkelium	—
98	Cf	californium	—
99	Es	einsteinium	—
100	Fm	fermium	—
101	Md	mendelevium	—
102	No	nobelium	—
103	Lr	lawrencium	—