1. Consider the process: $CO_2(g) \rightarrow CO_2(s)$
The name of this process is

A. condensation
B. sublimation
C. deposition
D. freezing

2. Which of the following contains an element, a compound and a mixture?

A. $H_2O(l)$, $H_2(g)$, $FeS(s)$
B. $Cl_2(aq)$, $Br_2(g)$, $NaBr(l)$
C. $CH_4(g)$, $I_2(l)$, $CO_2(l)$
D. $NaCl(aq)$, $CO(g)$, $H_2S(g)$

3. Which compound has the greatest percentage by mass of carbon?

A. C_6H_6
B. C_2H_6
C. CH_4
D. $C_6H_{12}O_6$

4. 0.100 g of calcium carbonate is reacted with 10.0 cm^3 of 0.100 mol dm^{-3} hydrochloric acid. The equation for the reaction is

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The volume of carbon dioxide produced at STP is given by which of the following expressions?

The molar volume of a gas at STP is 22.7 dm^3 mol^{-1}

A. $\dfrac{0.100 \times 22.7}{100.09}$
B. $\dfrac{10.0 \times 0.100 \times 22.7}{1000}$
C. $\dfrac{0.100}{100.09 \times 22.7}$
D. $\dfrac{10.0 \times 0.100 \times 22.7}{2 \times 1000}$

5. A student carried out an experiment to determine the value of x in the formula $MgSO_4.xH_2O$. They weighed a sample of $MgSO_4.xH_2O$, heated it to drive off the water and then weighed it again. The experimental data is shown in the table:

Mass of $MgSO_4.xH_2O$ / g	2.46
Mass of $MgSO_4$ after heating / g	1.20

The value of x is

A. 2
B. 4
C. 5
D. 7

6. Which of the following is correct about the $^{70}Ga^{3+}$ ion?

A. it contains more protons than neutrons
B. there are 70 protons in the nucleus
C. it contains 39 neutrons and 34 protons
D. it contains more neutrons than electrons

7. Which electron transition emits radiation of the highest frequency

A. n=1 → n=6
B. n=3 → n=1
C. n=5 → n=2
D. n=7 → n=3

8. The full electron configuration of an atom of an element is

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$

Which of the following statements is correct

A. The element is in Group 2
B. The element is a Group 8
C. The element is in Group 6
D. The element is in Period 3

9. How many lone pairs of electrons in a molecule of CO_2?

A. 0
B. 2
C. 4
D. 6

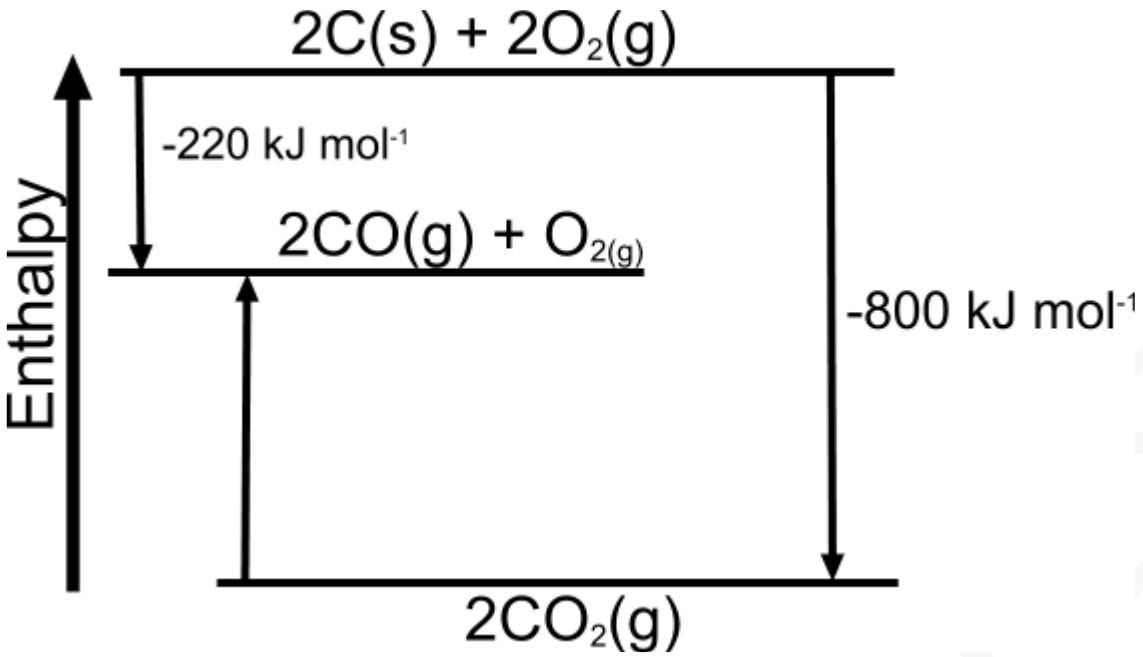
10. Which of the following correctly describes the distribution of electrons and shape of the nitrate(V) ion, NO_3^-?

	Electron domain geometry	**Shape**	**Bond angle /^{o}**
A.	tetrahedral	tetrahedral	109.5
B.	tetrahedral	trigonal pyramidal	107
C.	trigonal planar	trigonal planar	120
D.	trigonal pyramidal	trigonal planar	90

11. A substance has a melting point of 1080 ^{o}C, conducts electricity in the solid state, does not dissolve in water and reacts with oxygen to form a basic oxide. The structure and bonding in the substance is most likely to be

A. giant ionic
B. giant covalent
C. molecular covalent
D. giant metallic

12. An enthalpy level diagram is shown below



What is the enthalpy change for the conversion:

$$CO_2(g) \rightarrow CO(g) + {}^1/_2O_2(g)$$

A. 580 kJ mol^{-1}
B. -580 kJ mol^{-1}
C. 290 kJ mol^{-1}
D. -290 kJ mol^{-1}

13. The enthalpy change for the combustion of methanol is represented by the equation

$$CH_3OH(l) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

The literature value for this enthalpy change is ΔH = -715 kJ mol^{-1}

A student calculates a value using bond enthalpies and obtained the value, ΔH = -401 kJ mol^{-1}.

Which of the following does not contribute to the difference in values?

A. bond energies are average values
B. more heat is lost to the surroundings in bond enthalpy experiments
C. bond energies only apply to substances in the gaseous state
D. intermolecular forces have not been taken into account

14. Which of the following is correct

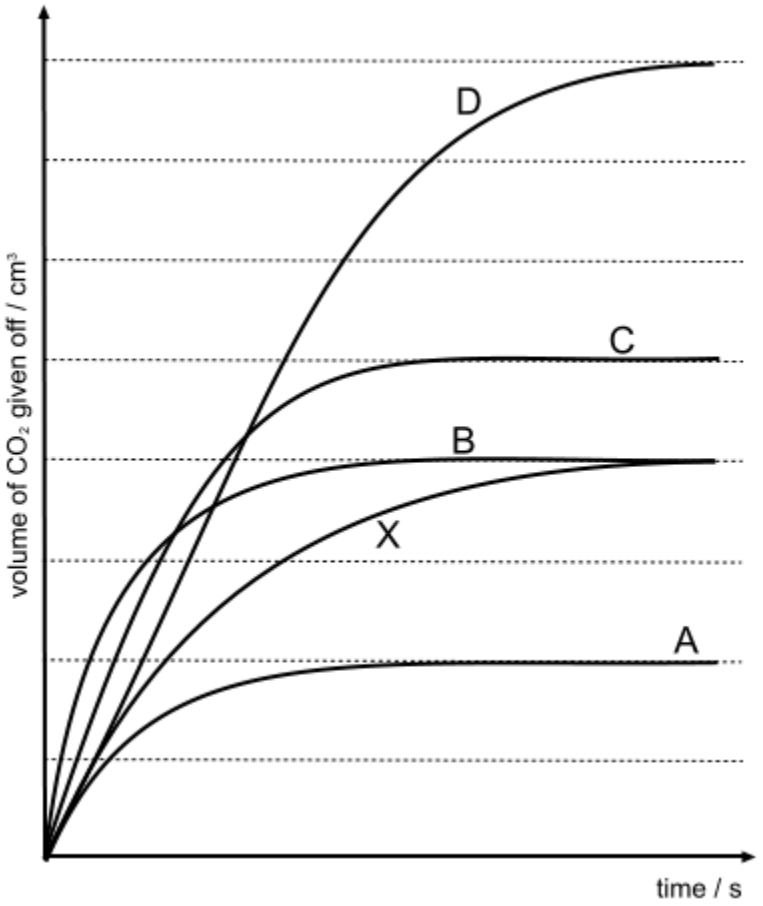
A. In an exothermic reaction the reactants are more stable than the products
B. In an endothermic reaction the products are hotter than the reactants
C. Exothermic reactions occur more quickly than endothermic reactions
D. Heat energy is given out to the surroundings in an exothermic reaction

15. Ozone (O_3) absorbs longer wavelength ultraviolet radiation than dioxygen (O_2). From this it can be deduced that

A. the bonds between O atoms in O_3 are stronger than in O_2
B. there is a double bond in O_2 but not in O_3
C. the average O-O bond enthalpy is lower in O_3 than in O_2
D. O_3 absorbs more UV radiation than O_2

16. 0.20 g of small marble chips ($CaCO_3$) and 20.0 cm^3 of 0.30 mol/dm^3 hydrochloric acid are reacted together at 20°C. The hydrochloric acid was in excess. The results for this experiment are labelled X on the graph below.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$



In a second experiment 0.20 g of small marble chips ($CaCO_3$) and 20.0 cm^3 of 0.40 mol/dm^3 hydrochloric acid were reacted at 20°C. Which graph could have been produced from this experiment?

17. In which reaction could the progress of the reaction be followed using a colorimeter?

A. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$
B. $H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$
C. $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$
D. $CH_3COOC_2H_5(l) + OH^-(aq) \rightarrow CH_3COO^-(aq) + CH_3CH_2OH(aq)$

18. What is the expression for the reaction quotient, Q, for the following reaction?

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

A. $Q = \frac{[N_2]x[H_2]}{[NH_3]}$

B. $Q = [NH_3]^2x[H_2]^3x[N_2]$

C. $Q = \frac{[NH_3]^2}{[N_2]x[H_2]^3}$

D. $Q = \frac{2x[NH_3]}{[N_2]x3x[H_2]}$

19. $H_2SO_4(aq) + H_2O(l) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$ Reaction 1
$SO_4^{2-}(aq) + H_2O(l) \rightleftharpoons HSO_4^-(aq) + OH^-(aq)$ Reaction 2

Which of the following is correct?

A. HSO_4^- acts as a Brønsted-Lowry acid in reaction 1 and reaction 2
B. SO_4^{2-}/HSO_4^- and H_2SO_4/HSO_4^- are conjugate acid-base pairs
C. H_3O^+ is the conjugate acid of H_2SO_4
D. H_2O is a Brønsted-Lowry base in reaction 1 and in reaction 2

20. Which of the following does not react with dilute sulfuric acid

A. Cu
B. $CuCO_3$
C. CuO
D. $Cu(OH)_2$

21. Which of the following is **not** a redox reaction?

A. $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$
B. $U_{(s)} + 6ClF_{(l)} \rightarrow UF_{6(l)} + 3Cl_{2(g)}$
C. $Zn(NO_3)_{2(aq)} + Mg_{(s)} \rightarrow Mg(NO_3)_{2(aq)} + Zn_{(s)}$
D. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

22. Which is the reduction half-equation for the redox reaction shown?

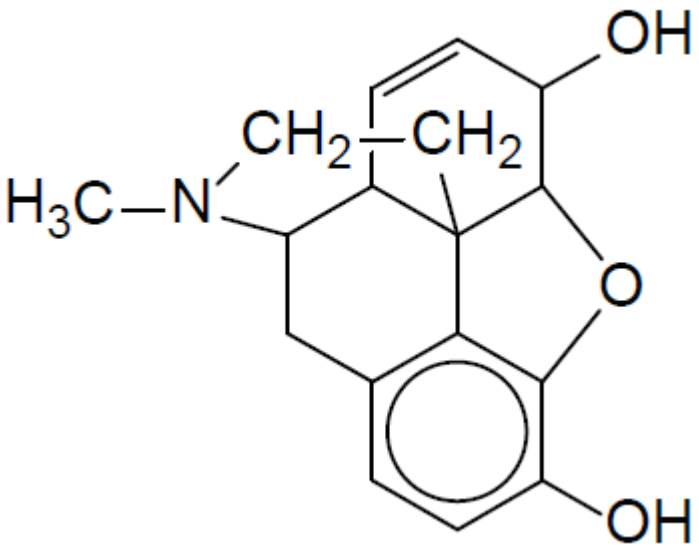
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3I_2(aq)$

A. $Cr_2O_7^{2-}(aq) \rightarrow 2Cr^{3+}(aq) + 8e^-$
B. $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
C. $2I^-(aq) \rightarrow I_2(aq) + 2e^-$
D. $I_2(aq) + 2e^- \rightarrow 2I^-(aq)$

23. Which of the following are correct for a voltaic cell and an electrolytic cell?

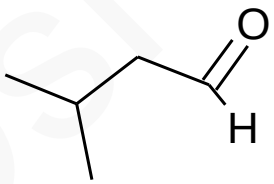
	Voltaic cell	**Electrolytic cell**
A.	the anode is positive	the anode is negative
B.	reduction occurs at the cathode	reduction occurs at the cathode
C.	the cathode is negative	the anode is positive
D.	oxidation occurs at the anode	reduction occurs at the anode

24. Which functional groups are present in morphine?



A. ester
B. carboxamide
C. amine
D. carboxyl

25. What is the IUPAC name of the molecule shown?



A. 1,2-dimethylpropanal
B. 2-methylbutanal
C. 3-methylbutanal
D. 3-methylbutanone

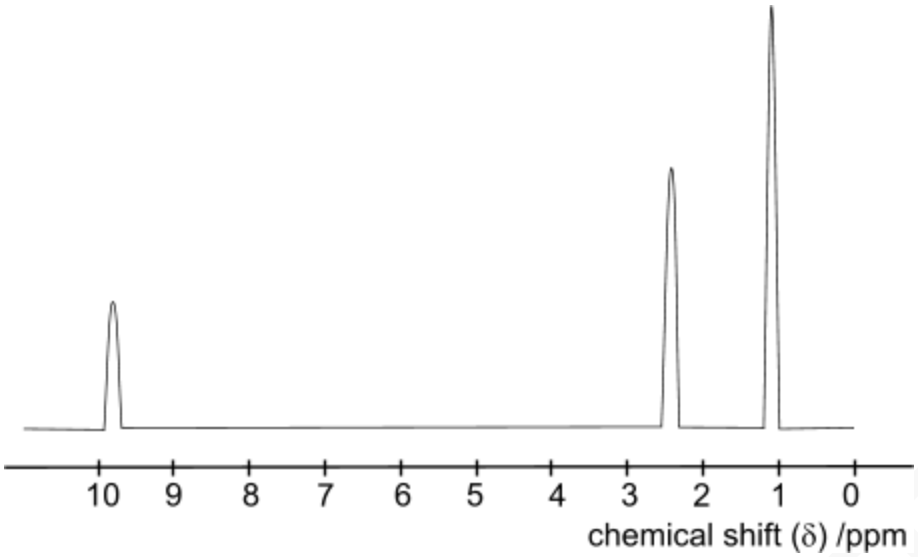
26. The conditions to convert ethanol to ethanoic acid are

A. excess acidified dichromate(VI), heat, reflux
B. excess acidified dichromate(IV), heat, reflux
C. acidified dichromate(IV), excess ethanol, heat, distillation
D. acidified dichromate(VI), excess ethanol, heat, distillation

27. Which of the following lists contains a primary halogenoalkane, a secondary alcohol and a tertiary amine?

A. $CH_3CH_2CH_2Br$, $(CH_3)_3CHOH$, $(CH_3)_3CNH_2$
B. $(CH_3)_3CH_2Br$, $(CH_3)_3CH(OH)CH_3$, $(CH_3)_3CNH_2$
C. $(CH_3)_3CH_2Br$, $(CH_3)_3CH(OH)CH_3$, $(CH_3)_3N$
D. $CH_3CH_2CH_2Br$, $CH_3CH_2OCH_3$, $(CH_3)_3CN$

28. The ^{1}HNMR spectrum of a compound is shown below.



The compound could be

A. propanone
B. propanal
C. ethanal
D. propan-1-ol

29. What is the index of hydrogen deficiency (IHD) of compounds with molecular formula $C_6H_6Cl_2O$

A. 1
B. 2
C. 3
D. 4

30. A student carried out an experiment to determine the amount of heat (Q) in J given out in a reaction.

Initial temperature / ^{o}C	23.2 ± 0.1
Maximum temperature / ^{o}C	43.2 ± 0.1
Mass of substance (m) / g	200 ± 1
Specific heat capacity(c) / J g^{-1} ^{o}C^{-1}	4.18

They used the equation $Q=mc\Delta T$

The values they should record for the temperature change (ΔT) and the heat given out are

A. $\Delta T = 20.0 \pm 0.1$ Q=16700 J
B. $\Delta T = 20.0 \pm 0.2$ Q=16700 J
C. $\Delta T = 20 \pm 0.2$ Q=17000 J
D. $\Delta T = 20.0 \pm 0.2$ Q=16720 J