

The University of the State of New York REGENTS EXAMINATION

PHYSICAL SETTING CHEMISTRY Tuesday, June 24, 2014 — 9:15 a.m. to 12:15 p.m., only

This is a test of your knowledge of chemistry. Use that knowledge to answer all questions in this examination. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in this examination booklet.

**Part A Answer all questions in this part.**

*Directions (1–30):* For *each* statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Chemistry*.

- 1 Compared to the charge of a proton, the charge of an electron has  
(1) a greater magnitude and the same sign      (2) a greater magnitude and the opposite sign  
(3) the same magnitude and the same sign      (4) the same magnitude and the opposite sign
- 2 Which atom has the largest atomic radius?    (1) potassium    (2) rubidium    (3) francium    (4) cesium
- 3 In the wave-mechanical model of the atom, an orbital is defined as  
(1) a region of the most probable proton location  
(2) a region of the most probable electron location  
(3) a circular path traveled by a proton around the nucleus  
(4) a circular path traveled by an electron around the nucleus
- 4 When an excited electron in an atom moves to the ground state, the electron  
(1) absorbs energy as it moves to a higher energy state  
(2) absorbs energy as it moves to a lower energy state  
(3) emits energy as it moves to a higher energy state  
(4) emits energy as it moves to a lower energy state
- 5 Which polyatomic ion is found in the compound represented by the formula  $\text{NaHCO}_3$ ?  
(1) acetate      (2) hydrogen carbonate      (3) hydrogen sulfate      (4) oxalate
- 6 The atomic mass of magnesium is the weighted average of the atomic masses of  
(1) all of the artificially produced isotopes of Mg  
(2) all of the naturally occurring isotopes of Mg  
(3) the two most abundant artificially produced isotopes of Mg  
(4) the two most abundant naturally occurring isotopes of Mg
- 7 Which element has atoms that can form halide ions?    (1) iodine    (2) silver    (3) strontium    (4) xenon

- 8 Two forms of solid carbon, diamond and graphite, differ in their physical properties due to the differences in their  
(1) atomic numbers    (2) crystal structures    (3) isotopic abundances    (4) percent compositions
- 9 Which quantity can be calculated for a solid compound, given only the formula of the compound and the Periodic Table of the Elements?  
(1) the density of the compound  
(2) the heat of fusion of the compound  
(3) the melting point of each element in the compound  
(4) the percent composition by mass of each element in the compound
- 10 Which terms identify types of chemical reactions?  
(1) decomposition and sublimation                      (2) decomposition and synthesis  
(3) deposition and sublimation                         (4) deposition and synthesis
- 11 The greatest amount of energy released per gram of reactants occurs during a  
(1) redox reaction    (2) fission reaction    (3) substitution reaction    (4) neutralization reaction
- 12 Which element has atoms with the strongest attraction for electrons in a chemical bond?  
(1) chlorine    (2) nitrogen    (3) fluorine    (4) oxygen
- 13 Compared to the physical and chemical properties of the compound  $\text{NO}_2$ , the compound  $\text{N}_2\text{O}$  has  
(1) different physical properties and different chemical properties  
(2) different physical properties and the same chemical properties  
(3) the same physical properties and different chemical properties  
(4) the same physical properties and the same chemical properties
- 14 Which phrase describes a molecule of  $\text{CH}_4$ , in terms of molecular polarity and distribution of charge?  
(1) polar with an asymmetrical distribution of charge  
(2) polar with a symmetrical distribution of charge  
(3) nonpolar with an asymmetrical distribution of charge  
(4) nonpolar with a symmetrical distribution of charge
- 15 Which sample of copper has atoms with the *lowest* average kinetic energy?  
(1) 10. g at  $45^\circ\text{C}$                       (2) 20. g at  $35^\circ\text{C}$                       (3) 30. g at  $25^\circ\text{C}$                       (4) 40. g at  $15^\circ\text{C}$
- 16 Which change results in the formation of different substances?  
(1) burning of propane                      (2) melting of  $\text{NaCl}_{(s)}$   
(3) deposition of  $\text{CO}_{2(g)}$                       (4) solidification of water

17 Which substance can *not* be broken down by a chemical change?

- (1) ammonia      (2) ethanol      (3) propanal      (4) zirconium

18 According to Table *I*, which equation represents a change resulting in the greatest quantity of energy released?

- (1)  $2\text{C}_{(s)} + 3\text{H}_{2(g)} \rightarrow \text{C}_2\text{H}_{6(g)}$       (2)  $2\text{C}_{(s)} + 2\text{H}_{2(g)} \rightarrow \text{C}_2\text{H}_{4(g)}$   
(3)  $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightarrow 2\text{NH}_{3(g)}$       (4)  $\text{N}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{(g)}$

19 Which element is a liquid at STP?    (1) bromine      (2) cesium      (3) francium      (4) iodine

20 Which statement describes a reversible reaction at equilibrium?

- (1) The activation energy of the forward reaction = the activation energy of the reverse reaction.  
(2) The rate of the forward reaction = the rate of the reverse reaction.  
(3) The concentration of the reactants must equal the concentration of the products.  
(4) The potential energy of the reactants must equal the potential energy of the products.

21 Given the balanced equation representing a reaction:  $\text{O}_2 \rightarrow \text{O} + \text{O}$

What occurs during this reaction?

- (1) Energy is absorbed as bonds are broken.      (2) Energy is absorbed as bonds are formed.  
(3) Energy is released as bonds are broken.      (4) Energy is released as bonds are formed.

22 In terms of entropy and energy, systems in nature tend to undergo changes toward

- (1) lower entropy and lower energy      (2) lower entropy and higher energy  
(3) higher entropy and lower energy      (4) higher entropy and higher energy

23 Which term is defined as the difference between the potential energy of the products and the potential energy of the reactants in a chemical reaction?

- (1) activation energy      (2) thermal energy      (3) heat of fusion      (4) heat of reaction

24 What is the atomic number of the element whose atoms bond to each other in chains, rings and networks?    (1) 10      (2) 8      (3) 6      (4) 4

29 Which compounds are classified as Arrhenius acids?

- (1) HCl and NaOH      (2)  $\text{HNO}_3$  and NaCl      (3)  $\text{NH}_3$  and  $\text{H}_2\text{CO}_3$       (4) HBr and  $\text{H}_2\text{SO}_4$

31 Which notations represent different isotopes of the element sodium?

- (1)  $^{32}\text{S}$  &  $^{34}\text{S}$       (2)  $\text{S}^{2-}$  and  $\text{S}^{6-}$       (3)  $\text{Na}^+$  &  $\text{Na}^0$       (4)  $^{22}\text{Na}$  and  $^{23}\text{Na}$

32 Which electron configuration represents the electrons in an atom of Ga in an excited state?

- (1) 2-8-17-3      (2) 2-8-17-4      (3) 2-8-18-3      (4) 2-8-18-4

33 Which statement describes the general trends in electronegativity and first ionization energy as the elements in Period 3 are considered in order from Na to Cl?

- (1) Electronegativity increases, and first ionization energy decreases.  
(2) Electronegativity decreases, and first ionization energy increases.  
(3) Electronegativity and first ionization energy both increase.  
(4) Electronegativity and first ionization energy both decrease.

34 What is the gram-formula mass of  $\text{Fe}(\text{NO}_3)_3$ ?

- (1) 146 g/mol      (2) 194 g/mol      (3) 214 g/mol      (4) 242 g/mol

35 Given the balanced equation representing a reaction:  $\text{Al}_2(\text{SO}_4)_3 + 6\text{NaOH} \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{Na}_2\text{SO}_4$

The mole ratio of NaOH to  $\text{Al}(\text{OH})_3$  is      (1) 1:1      (2) 1:3      (3) 3:1      (4) 3:7

36 Which equation represents a single replacement reaction?

- (1)  $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$       (2)  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$   
(3)  $\text{H}_2\text{SO}_4 + \text{Mg} \rightarrow \text{H}_2 + \text{MgSO}_4$       (4)  $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}$

37 The accepted value for the percent by mass of water in a hydrate is 36.0%. In a laboratory activity, a student determined the percent by mass of water in the hydrate to be 37.8%. What is the percent error for the student's measured value?      (1) 5.0%      (2) 4.8%      (3) 1.8%      (4) 0.05%

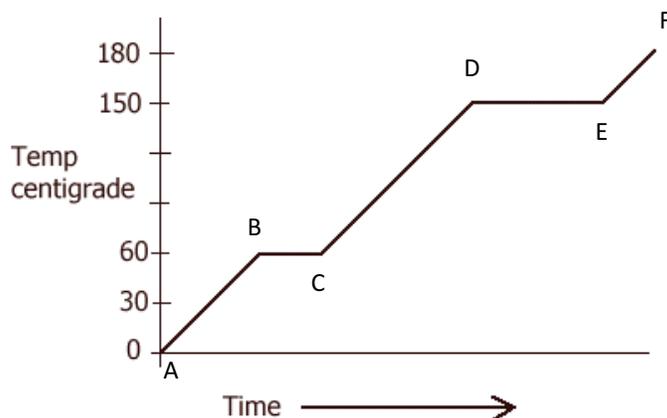
38 The boiling points, at standard pressure, of four compounds are given in this table. Which type of attraction can be used to explain the unusually high boiling point of  $\text{H}_2\text{O}$ ?

- (1) ionic bonding  
(2) hydrogen bonding  
(3) polar covalent bonding  
(4) nonpolar covalent bonding

Compound	Boiling Point ( $^{\circ}\text{C}$ )
$\text{H}_2\text{O}$	100.0
$\text{H}_2\text{S}$	-59.6
$\text{H}_2\text{Se}$	-41.3
$\text{H}_2\text{Te}$	-2.0

39 Which formula represents a molecule with the most polar bond?      (1) CO      (2) NO      (3) HI      (4) HCl

- 40 The graph here represents the uniform heating of a substance from the solid to the gas phase.  
Which line segment of the graph represents boiling?  
(1)  $A-B$       (2)  $B-C$       (3)  $C-D$       (4)  $D-E$



- 41 A 1-gram sample of a compound is added to 100 grams of  $H_2O_{(l)}$  and the resulting mixture is then thoroughly stirred. Some of the compound is then separated from the mixture by filtration. Based on Table F, the compound could be      (1)  $AgCl$       (2)  $CaCl_2$       (3)  $NaCl$       (4)  $NiCl_2$

- 42 At standard pressure, the total amount of heat required to completely vaporize a 100. gram sample of water at its boiling point is  
(1)  $2.26 \times 10^1 J$       (2)  $2.26 \times 10^2 J$       (3)  $2.26 \times 10^3 J$       (4)  $2.26 \times 10^5 J$

- 43 A sample of helium gas is in a sealed, rigid container. What occurs as the temperature of the sample is increased?  
(1) The mass of the sample decreases.      (2) The number of moles of gas increases.  
(3) The volume of each atom decreases.      (4) The frequency of collisions between atoms increases.

- 46 What is the oxidation number of manganese in  $KMnO_4$ ?      (1) +7      (2) +2      (3) +3      (4) +4

- 48 What is the color of the indicator thymol blue in a solution that has a pH of 11?  
(1) red      (2) blue      (3) pink      (4) yellow  
(We have not done acid base indicators yet, but they are on table M. See if you can deal with this)

## Answers to June 2014 Regents Part 1

1. (4) protons and electrons have equal but opposite charges. All atoms have the same number of  $p^+$  and  $e^-$  which is why they are electrically neutral. (mass of proton = mass of neutron)
2. (3) francium, look this up on table S. I almost "guessed" cesium, thinking it might be a tricky question, a break in the trend, but I LOOKED IT UP, so I got this one right.
3. (2) wave mechanical model = modern model. Electrons are in zones, or orbitals, and they are "statistical models", we don't know "where" as much as we know where will the electrons be *most* of the time.
4. (4) excited electrons are in the excited state, because they gained energy. When they return to the lower energy level of the ground state, they emit energy we see as spectra
  
5. (2) LOOK at table E, which has a title of POLYATOMIC IONS. LOOK
6. (2) this is a definition. Isotopes are naturally occurring (which are measured) and sometimes in nuclear chem we will see that scientists can "make" isotopes by blasting smaller atoms together (not naturally occurring)
7. (1) halide = halogen = vocabulary word for group 17 atoms. Only iodine is in group 17 in this short list.
8. (2) allotropes = vocabulary = substances made of 1 kind of atom, but bonded together in a different way, with different physical and different chemical properties (like oxygen and ozone)
9. (4) density requires volume,  $H_f$  is a constant not on periodic table, melting point is a constant not on periodic table, percent comp can be calculated with formula and atomic masses (on the periodic table)
10. (2) sublimation + deposition are phase changes (physical changes). Decomp + Synth was Chem from September
11. (2) you don't know this yet (so what, I got my rock moves) but it's easy. Chemical reactions can be exothermic but nuclear reactions (fission and fusion) are crazy ways to release energy. It's not even close, it's off the chart. Fusion and Fission are both nuclear reactions.
12. (3) strongest attraction for electrons = highest electronegativity value (look it up on table S)
13. (so what, it's on the regents) (1) these are 2 different chemical substances = vocabulary = different physical and different chemical properties
14. (4) methane is a nonpolar molecule because it has radial symmetry. It has polar bonds between the H-C because it has a difference in electronegativity. The + of each H is offset by the balanced shape of the molecule.
  
15. (4) average means you don't care about size, it's per unit mass, all sizes become equal. Lowest Kinetic Energy means LOWEST TEMPERATURE (like that hand and that glove).
16. (1) new stuff forming is due to a chemical reaction, not a physical change. Propane combusts into water and carbon dioxide. Melting salt gives you melted salt, deposition is gas to solid—same stuff, solidification is 6th grade chem for freezing—another phase change
17. (4) zirconium is an ELEMENT = vocabulary = elements cannot be broken down. All of the other 3 are compounds, which form from 2 or more elements bonding together (and which can un-bond again)
18. (3) LOOK AT TABLE I, heat's of reaction is the title of that one. A  $-\Delta H$  means exothermic. The largest  $-\Delta H$  should NOT be confused with the larger  $+\Delta H$ , which is the coldest (most endothermic)
19. (1) You could check the FP/BP on table S, but you could just KNOW that both bromine and mercury are the only liquids at STP, they are the only BLUE symbols in our class table.
20. (2) vocabulary again, reversible reactions at equilibrium means dynamic equilibrium. It's the rates that are equal

21. (1) bonds form and energy is released is our famous one liner. Here it's the opposite, the oxygen breaks into two atoms, and that takes energy. Regents loves to reverse stuff, it's still true but you must think.
22. (3) you don't know this yet either (so what rock star) Just think, the Universe is spreading out, energy is being spread out, things break down (more entropy), try to remember this forever.
23. (4) a better name would be  $\Delta H$ , but on table I, the heats of reaction are given as  $\Delta H$ . The others are just wrong
24. (3) carbon, carbon, carbon. 10= noble gas neon, no bonding, 8= oxygen single or double bonds only, atom #4 is beryllium which makes only metallic bonds to itself.
29. (4) Arrhenius acids (you will learn soon) have  $H^{+1}$  ions in solution. NaOH is a base, NaCl is neither,  $NH_3$  is a base
31. (4) Isotopes have different masses (different numbers of neutrons). S = Sulfur!,  $Na^{+}$  is an ion  $Na^{\circ}$  = neutral atom
32. (2) you have to have 31 electrons so 1 is wrong, so is 4. choice 3 is gallium in ground state.
34. (4) DO THE MATH, the whole little chart and you can't get this wrong
35. (3) NaOH :  $Al(OH)_3$  is of course 6:2, which reduces to 3:1 (John Dalton) NOT 1:3, which is BACKWARDS
36. (3) one is decomp, two is synthesis, four is acid base neutralization, 3 has Mg replacing H in solution (you did that actual experiment in lab and tooted the gas to prove it was hydrogen)
37. (1) write a formula, do the math slowly. A better answer would be +5.00% (sign and SF) choose best answer
38. (2) water has a high BP because it has hydrogen bonding.
39. (4) greatest difference in the electronegativity values (LOOK THEM UP on table S)
40. (4) Boiling is the HOT PHASE CHANGE and temp is constant
41. (1) if you can remove it by filtering it did not dissolve. Table F reminds you that silver chloride is not aqueous
42. (4)  $q = mH_v = (100. \text{ g})(2260 \text{ J/g}) = 226,000 \text{ J} = 2.26 \times 10^5 \text{ J}$  (do the math)
43. (4) temperature up, pressure up due to increased number of particle collisions
46. (1) the compound has net zero oxidation, so, K = +1, each O = -2...  $(+1) + (-8) + (X) = 0$      $X = +7$
48. (2) Table M shows us that it's blue. There is NOTHING to understand, this is reading a table for data