Chemistry 122 | Winter 2009 | Oregon State University
Exam 2 | February 26, 2009 | Dr. Richard Nafshun

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your last name, first name, middle initial, and student identification number. **Leave the class section number and the test form number blank.**

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form in the appropriate stack and present your University ID Card to the proctor. You may keep the exam packet, so please show your work and mark the answers you selected on it.

$R = 0.0821$ L•atm/mol•K
M = mol/L
$\Pi V = nRT$

760 mm Hg = 760 torr = 1 atm
$\Delta T_f = imk_f$
$k_f(H_2O) = 1.86$ °C/m

m = mol/kg
$\Delta T_b = imk_b$
$k_b(H_2O) = 0.512$ °C/m

$$\ln[\frac{A}{A_o}] = -kt$$

SC: $2r = s$ BCC: $4r = s\sqrt{3}$ FCC: $4r = s\sqrt{2}$

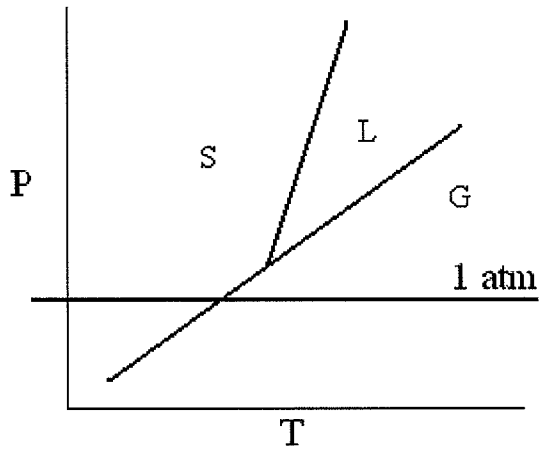
IA							VII					IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na Sodium 22.98977	12 Mg Magnesium 24.305	IIIB	IVB	VB	VIB	VIIB				1B	IIB	13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs Cesium 132.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114				

→ Stable region?

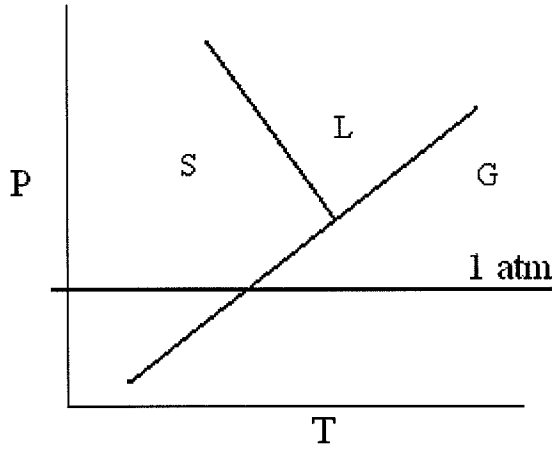
57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262

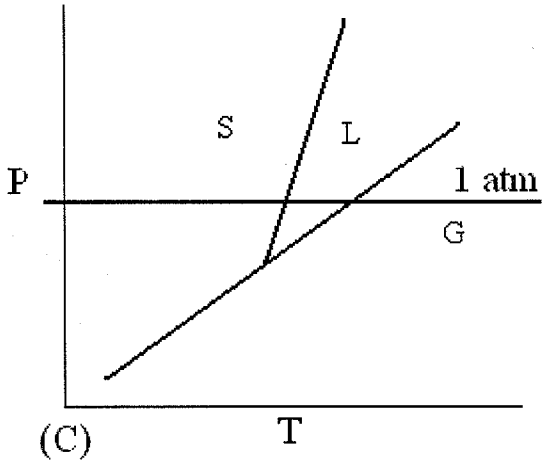
1. Consider the phase diagrams below. Which diagram could correctly describe water?

(A)



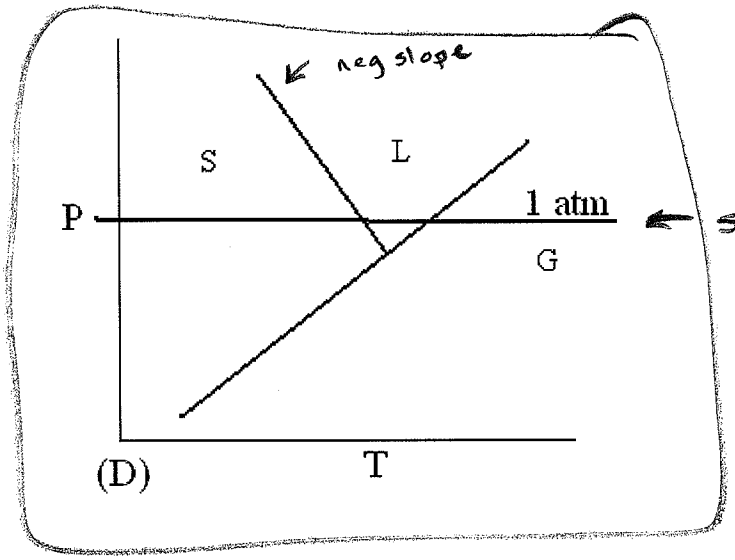
(B)





(C)

(D)



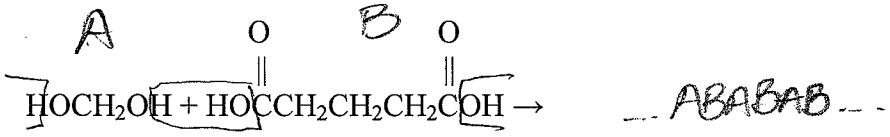
2. Which of the following has a hydrophilic end (polar, water-loving end) and a hydrophobic end (non-polar, water-fearing end) and has the ability to bridge water molecules to non-polar molecules?

(A) Diamond
(B) Graphite
(C) Soap
(D) Lithium
(E) The polymer Teflon ($-CF_2CF_2-$)

Non-Polar End

Polar End

3. The reaction below will produce:



(A) Quartz
(B) A network covalent compound
(C) An ionic compound
(D) Soap
(E) A polymer

4. Which of the following compounds **cannot** undergo free radical polymerization?

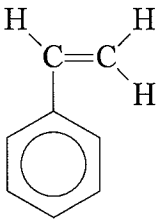
(A) CH_2CH_2

(B) CCl_2CCl_2

(C) CF_2CF_2

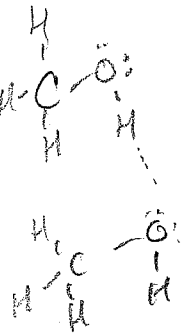
(D) CH_3CH_3 No π-bond

(E)

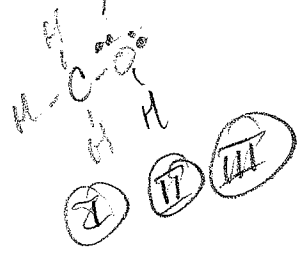


5. Which of the following is **false**?

(A) Quartz, graphite, and diamond are network covalent compounds True
(B) Sodium oxide is an ionic compound Na_2O True
(C) Methanol (CH_3OH) is a polar molecule which exhibits hydrogen bonding True
(D) Sodium oxide melts at a higher temperature than methanol True ionic vs molecular
(E) Argon melts at a higher temperature than methanol



Ar
Inert Gas
I



I II III

NaF NaCl Cl^- is larger than F^-

6. Sodium fluoride melts near 993 °C. Sodium chloride melts near 804 °C. The difference in melting points can be attributed to:

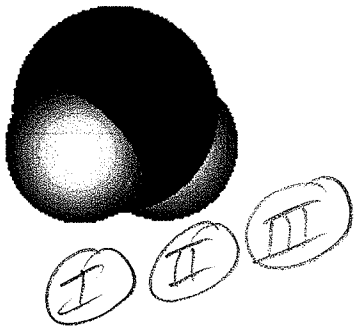
(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)

Na_2O Mg^{2+} O^{2-}

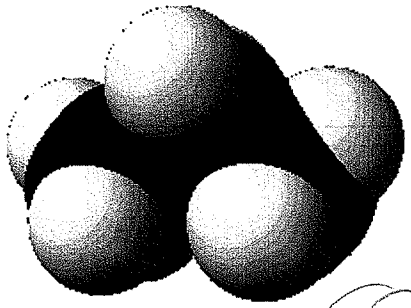
7. Sodium oxide melts at 1132 °C. Magnesium oxide melts near 776 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)

8. Water boils at +100 °C. Propane, $CH_3CH_2CH_3$, boils at −42.09 °C. The difference in boiling points can be attributed to:



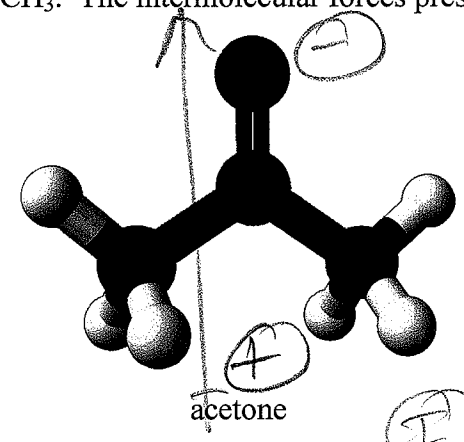
water


propane

I only

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)

9. Consider acetone, CH_3COCH_3. The intermolecular forces present in CH_3COCH_3 are:



(A) Dispersion forces only.
(B) Dipole-dipole forces only.
(C) Dispersion forces and dipole-dipole forces.
(D) Dispersion forces, dipole-dipole forces, and hydrogen bonding.
(E) Hydrogen bonding only.

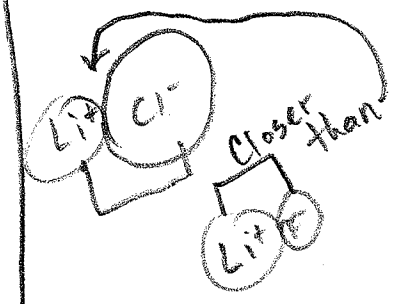
But no hydrogen bonding

10. Consider LiF, Ne, H_2O, diamond, $CH_3CH_2CH_3$, Li_2O, LiCl, and Al_2O_3. Arranged in **increasing** melting point, these are:

	Lowest mp	**Highest mp**
(A)	$Ne < CH_3CH_2CH_3 < Al_2O_3 < H_2O < LiF < LiCl < Li_2O <$ diamond	
(B)	$Ne < CH_3CH_2CH_3 < H_2O < LiCl < LiF < Li_2O < Al_2O_3 <$ diamond	
(C)	$Ne < CH_3CH_2CH_3 < H_2O < LiF < LiCl < Li_2O < Al_2O_3 <$ diamond	
(D)	$Ne < CH_3CH_2CH_3 < H_2O < LiF < LiCl < Li_2O < Al_2O_3 <$ diamond	
(E)	$LiF < Ne < H_2O <$ diamond $< CH_3CH_2CH_3 < Li_2O < LiCl < Al_2O_3$	

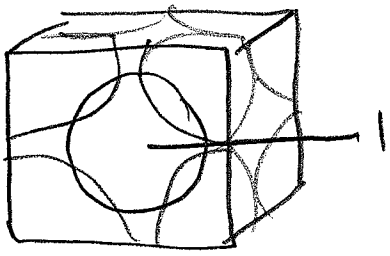
Increasing melting points →

Inert Gases	Molecules		Ionic compounds				Network Covalent Compounds
Ne	$CH_3CH_2CH_3$	H_2O	LiCl	LiF	Li_2O	Al_2O_3	Diamond
	I	I, II, III	+1 -1	+1 -1	+1 -2	+3 -2	



11. The equivalent number of atoms in the BCC unit cell is:

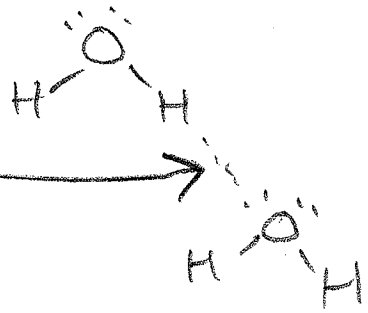
(A) 1
(B) 2
(C) 3
(D) 4
(E) 6



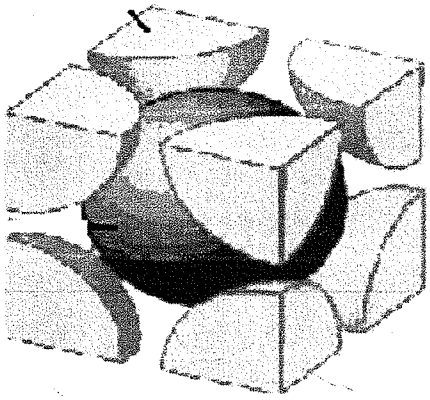
4 x 1/4 = 1

12. The intermolecular forces that are **most** significant in accounting for the high boiling point of liquid water relative to other substances of similar molecular weight is/are the:

(A) Dispersion forces
(B) Dipole-dipole interactions
(C) Hydrogen bonding
(D) Network covalent forces
(E) Ionic charges



13. The structure below [from a *Worksheet*] represents:



(A) An SC unit cell
(B) A BCC unit cell
(C) A FCC unit cell
(D) A resistance cell
(E) A stem cell

14. The cubic form for the fictitious element Robinsonium is BCC. The atomic radius is 161.2 pm and the molar mass is 233.7 g/mol. The density of Robinsonium is:
[1 m = 1 x 10^{12} pm 1 m = 100 cm]

(A) 15.0 g/cm^3
(B) g/cm^3
(C) g/cm^3
(D) g/cm^3
(E) g/cm^3

$d = \frac{g}{cm^3}$

① g $\quad 233.7\frac{g}{mol}\left(\frac{1\ mol}{6.022\times10^{23}\ atoms}\right)\left(\frac{2\ atoms}{BCC}\right) = 7.76\times10^{-22}$ g

② $cm^3 \Rightarrow r = 161.2\ pm\left(\frac{1\ m}{1\times10^{12}\ pm}\right)\left(\frac{100\ cm}{1\ m}\right) = 1.61\times10^{-8}$ cm

$4r = s\sqrt{3} \quad s = \frac{4r}{\sqrt{3}} = \frac{(4)(1.61\times10^{-8}\ cm)}{\sqrt{3}} = 3.72\times10^{-8}$ cm

$V = s^3 = (3.72\times10^{-8}\ cm)^3 = 5.16\times10^{-23}\ cm^3$

$d = \frac{g}{cm^3} \quad \frac{7.76\times10^{-22}\ g}{5.16\times10^{-23}\ cm^3} = 15.0\ g/cm^3$

15. Consider $MgCl_2$

(A) i = 0
(B) i = 1
(C) i = 2
(D) i = 3
(E) i = 4

Mg^{2+} Cl^- Cl^-

3 ions

16. The freezing point of 2.45 m $MgCl_2$ (aq) is:

(A) - 1.86 °C
(B) - 2.45 °C
(C) - 4.56 °C
(D) - 13.7 °C
(E) - 9.11 °C

$\Delta T = i\ m\ k_f$

$= (3)(2.45\ m)(1.86\ ^\circ C/m) = 13.7^\circ C$

$T_f = 0^\circ C - 13.7^\circ C = -13.7^\circ C$

17. Which of the following sets of compounds are expected to be soluble in water?

(A) $LiCl, KCl, CH_3CH_2OH, NH_3$
(B) $NaCl, O_2, CH_4, CH_3OCH_3$
(C) CH_4, CO_2, CF_4
(D) $NaCl, CCl_4, C_4H_{10}$

↓ polar

18. A student dissolves 34.25 g of an unknown polymer in 600 mL of water at 303 K. She measures the osmotic pressure to be 0.0287 mm Hg. What is the molar mass of the polymer?

(A) x 10^6 g/mol
(B) x 10^6 g/mol
(C) 3.76 x 10^7 g/mol
(D) x 10^6 g/mol
(E) x 10^6 g/mol

$\Pi V = nRT$

$$n = \frac{\Pi V}{RT} = \frac{\left(\frac{0.0287\ mm\ Hg}{760\ mm\ Hg}\right)(0.600\ L)}{\left(0.0821\ \frac{L \cdot atm}{mol \cdot K}\right)(303\ K)}$$

$n = 9.11 \times 10^{-7}\ mol$

$$\text{Molar Mass} = \frac{g}{mol} = \frac{34.25\ g}{9.11 \times 10^{-7}\ mol} = 3.76 \times 10^7$$

19. Which of the following statements is **false**?

(A) Increasing the temperature of a reaction will increase the rate. True
(B) Increasing the number of collisions will increase the rate of reaction. True
(C) Lowering the activation energy will increase the rate of reaction. True
(D) The addition of a catalyst will decrease the rate of a process. False - just the opposite
(E) The addition of a catalyst will lower the activation energy of a process. True

20. The half-life is:

(A) The amount of time required for half the sample to decay
(B) 0.500 years
(C) The amount of time required for the entire sample to decay
(D) 42 years
(E) $\left(\frac{A}{A_o}\right)$

21. A student () obtains a 40.0 gram sample of ^{60}Co ($t_{1/2}$ = 5.0 years). How long will it take so that only 5.0 grams of ^{60}Co remain?

(A) 2.0 years
(B) 5.0 years
(C) 10.0 years
(D) 15.0 years
(E) 20.0 years

$40g \rightarrow 20g \rightarrow 10g \rightarrow 5g$

5 yrs 5 yrs 5 yrs = 15 yrs

OR

① Calc k $\ln\frac{1}{2} = -kt$ $-0.6931 = -(k)(5.0y)$ $k = 0.1386\ \frac{1}{y}$

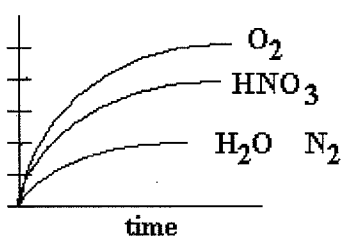
② Calc t $\ln\left[\frac{A}{A_o}\right] = -kt$

$\ln\left(\frac{5.0g}{40.0g}\right) = -(0.1386\ \frac{1}{y})(t)$

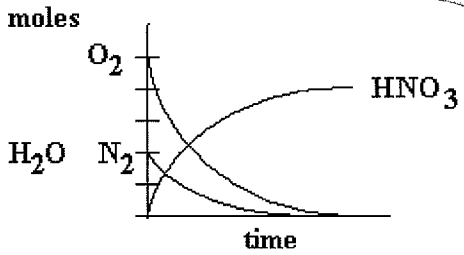
$t = 15.0y$

22. Which graph could correctly depict the changes in concentrations for the reaction $2\ N_2\ (g) + 5\ O_2\ (g) + 2\ H_2O\ (l) \rightarrow 4\ HNO_3\ (aq)$?

(A)



(B)



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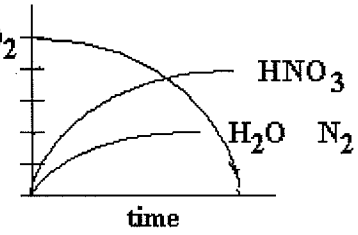
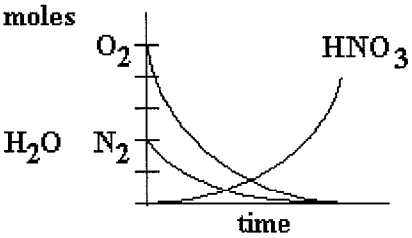


(D)



23. The following are initial rate data for: **A + B → C**

Experiment	Initial [A]	Initial [B]	Initial Rate
1	0.10	0.10	5.1
2	0.20	0.10	5.1
3	0.10	0.20	20.4

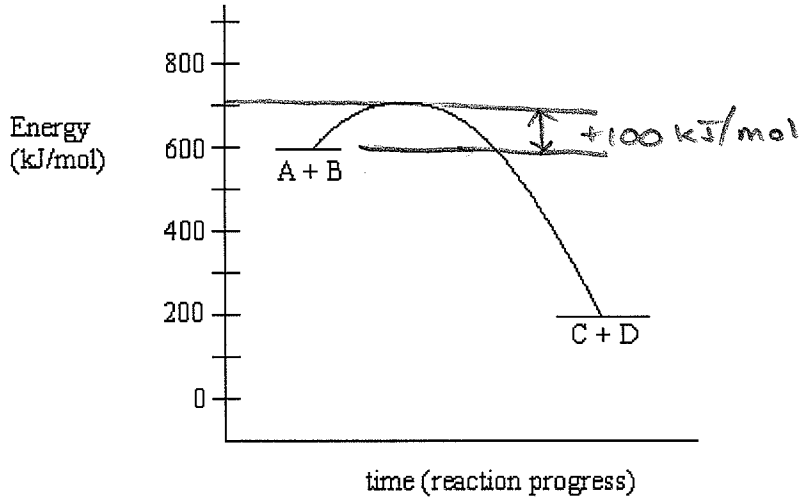
(A) The rate law is Rate = $k[A]^1[B]^2$.
(B) The rate law is Rate = $k[A]^0[B]^2$.
(C) The rate law is Rate = $k[A]^2[B]^0$.
(D) The rate law is Rate = $k[A]^2[B]^1$.
(E) The rate law is Rate = $k[A]^1[B]^4$.

rate = $k[A]^0[B]^2$

24. Based on the thermodynamic data plotted below, the activation energy (E_a) for the reaction $A + B \rightarrow C + D$ are:

(A) the activation energy (E_a) is +100 kJ/mol
(B) the activation energy (E_a) is +200 kJ/mol
(C) the activation energy (E_a) is +400 kJ/mol

(D) the activation energy (E_a) is +500 kJ/mol
(E) the activation energy (E_a) is +600 kJ/mol



25. The Chemistry 122 final exam is Monday, March 16, 2009 at 4:00pm; yes, this is better than early in the morning. After the chemistry final I will be...

(A) Watching the C-SPAN baseball steroid hearings

(B) Making a poster for my dorm room wall that has the daily countdown to the new Indiana Jones movie (In theaters May 22)

(C) Two words: Tom and Gisele

(D) Preparing for my other seven final exams

(E) Re-watching The Oscars

[Any response will receive full credit; even no response]