



2013 Academic Challenge

CHEMISTRY TEST - REGIONAL

This Test Consists of 40 Questions

Chemistry Test Production Team

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GENERAL DIRECTIONS

Please read the following instructions carefully. This is a timed test; any instructions from the test supervisor should be followed promptly.

The test supervisor will give instructions for filling in any necessary information on the answer sheet. Most Academic Challenge sites will ask you to indicate your answer to each question by marking an oval that corresponds to the correct answer for that question. Only one oval should be marked to answer each question. Multiple ovals will automatically be graded as incorrect answers.

Be sure ovals are marked as  , not  ,  ,  , etc.

If you wish to change an answer, erase your first mark completely before marking your new choice.)

You are advised to use your time effectively and to work as rapidly as you can without losing accuracy. Do not waste your time on questions that seem too difficult for you. Go on to the other questions, and then come back to the difficult ones later if time remains.

***** TIME: 40 MINUTES *****

DO NOT OPEN TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO!

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Periodic Table of the Elements

1A		1A										2A		3A										4A										5A										6A										7A										8A																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
1 H 1.008		3 Li 6.941		4 Be 9.012		11 Na 22.99		12 Mg 24.31		19 K 39.10		20 Ca 40.08		21 Sc 44.96		22 Ti 47.88		23 V 50.94		24 Cr 52.00		25 Mn 54.94		26 Fe 55.85		27 Co 58.93		28 Ni 58.69		29 Cu 63.55		30 Zn 65.38		31 Ga 69.72		32 Ge 72.59		33 As 74.92		34 Se 78.96		35 Br 79.90		36 Kr 83.80		37 Rb 85.47		38 Sr 87.62		39 Y 88.91		40 Zr 91.22		41 Nb 92.91		42 Mo 95.94		43 Tc (98)		44 Ru 101.1		45 Rh 102.9		46 Pd 106.4		47 Ag 107.9		48 Cd 112.4		49 In 114.8		50 Sn 118.7		51 Sb 121.8		52 Te 127.6		53 I 126.9		54 Xe 131.3		55 Cs 132.9		56 Ba 137.3		57 La* 138.9		58 Ce 140.1		59 Pr 140.9		60 Nd 144.2		61 Pm (145)		62 Sm 150.4		63 Eu 152.1		64 Gd 157.3		65 Tb 158.9		66 Dy 162.5		67 Ho 164.9		68 Er 167.3		69 Tm 168.9		70 Yb 173.1		71 Lu 175.1		72 Hf 178.5		73 Ta 180.9		74 W 183.9		75 Re 186.2		76 Os 190.2		77 Ir 192.2		78 Pt 195.1		79 Au 197.0		80 Hg 200.6		81 Tl 204.4		82 Pb 207.2		83 Bi 209.0		84 Po (209)		85 At (210)		86 Rn (222)		87 Fr (223)		88 Ra 226		89 Ac** (227)		90 Th 232		91 Pa 231		92 U 238		93 Np 237		94 Pu 244		95 Am 243		96 Cm 247		97 Bk 247		98 Cf 251		99 Es 252		100 Fm 257		101 Md 258		102 No 259		103 Lr 262		104 Rf 261		105 Db 262		106 Sg 266		107 Bh 264		108 Hs 277		109 Mt 268		110 Ds 271		111 Rg 272		112 Uub 285		113 Uut 284		114 Uuq 289		115 Uub 288		116 Uuh 294		117 Uus 293		118 Uuq 297		119 Uub 296		120 Uuh 304		121 Uus 303		122 Uuq 307		123 Uub 306		124 Uuh 310		125 Uus 309		126 Uuq 315		127 Uub 314		128 Uuh 320		129 Uus 319		130 Uuq 323		131 Uub 322		132 Uuh 327		133 Uus 326		134 Uuq 331		135 Uub 330		136 Uuh 335		137 Uus 334		138 Uuq 339		139 Uub 338		140 Uuh 343		141 Uus 342		142 Uuq 347		143 Uub 346		144 Uuh 351		145 Uus 350		146 Uuq 355		147 Uub 354		148 Uuh 359		149 Uus 358		150 Uuq 363		151 Uub 362		152 Uuh 367		153 Uus 366		154 Uuq 371		155 Uub 370		156 Uuh 375		157 Uus 374		158 Uuq 379		159 Uub 378		160 Uuh 383		161 Uus 382		162 Uuq 387		163 Uub 386		164 Uuh 391		165 Uus 390		166 Uuq 395		167 Uub 394		168 Uuh 399		169 Uus 398		170 Uuq 403		171 Uub 402		172 Uuh 407		173 Uus 406		174 Uuq 411		175 Uub 410		176 Uuh 415		177 Uus 414		178 Uuq 419		179 Uub 418		180 Uuh 423		181 Uus 422		182 Uuq 427		183 Uub 426		184 Uuh 431		185 Uus 430		186 Uuq 435		187 Uub 434		188 Uuh 439		189 Uus 438		190 Uuq 443		191 Uub 442		192 Uuh 447		193 Uus 446		194 Uuq 451		195 Uub 450		196 Uuh 455		197 Uus 454		198 Uuq 459		199 Uub 458		200 Uuh 463		201 Uus 462		202 Uuq 467		203 Uub 466		204 Uuh 471		205 Uus 470		206 Uuq 475		207 Uub 474		208 Uuh 479		209 Uus 478		210 Uuq 483		211 Uub 482		212 Uuh 487		213 Uus 486		214 Uuq 491		215 Uub 490		216 Uuh 495		217 Uus 494		218 Uuq 499		219 Uub 498		220 Uuh 503		221 Uus 502		222 Uuq 507		223 Uub 506		224 Uuh 511		225 Uus 510		226 Uuq 515		227 Uub 514		228 Uuh 519		229 Uus 518		230 Uuq 523		231 Uub 522		232 Uuh 527		233 Uus 526		234 Uuq 531		235 Uub 530		236 Uuh 535		237 Uus 534		238 Uuq 539		239 Uub 538		240 Uuh 543		241 Uus 542		242 Uuq 547		243 Uub 546		244 Uuh 551		245 Uus 550		246 Uuq 555		247 Uub 554		248 Uuh 559		249 Uus 558		250 Uuq 563		251 Uub 562		252 Uuh 567		253 Uus 566		254 Uuq 571		255 Uub 570		256 Uuh 575		257 Uus 574		258 Uuq 579		259 Uub 578		260 Uuh 583		261 Uus 582		262 Uuq 587		263 Uub 586		264 Uuh 591		265 Uus 590		266 Uuq 595		267 Uub 594		268 Uuh 599		269 Uus 598		270 Uuq 603		271 Uub 602		272 Uuh 607		273 Uus 606		274 Uuq 611		275 Uub 610		276 Uuh 615		277 Uus 614		278 Uuq 619		279 Uub 618		280 Uuh 623		281 Uus 622		282 Uuq 627		283 Uub 626		284 Uuh 631		285 Uus 630		286 Uuq 635		287 Uub 634		288 Uuh 639		289 Uus 638		290 Uuq 643		291 Uub 642		292 Uuh 647		293 Uus 646		294 Uuq 651		295 Uub 650		296 Uuh 655		297 Uus 654		298 Uuq 659		299 Uub 658		300 Uuh 663		301 Uus 662		302 Uuq 667		303 Uub 666		304 Uuh 671		305 Uus 670		306 Uuq 675		307 Uub 674		308 Uuh 679		309 Uus 678		310 Uuq 683		311 Uub 682		312 Uuh 687		313 Uus 686		314 Uuq 691		315 Uub 690		316 Uuh 695		317 Uus 694		318 Uuq 699		319 Uub 698		320 Uuh 703		321 Uus 702		322 Uuq 707		323 Uub 706		324 Uuh 711		325 Uus 710		326 Uuq 715		327 Uub 714		328 Uuh 719		329 Uus 718		330 Uuq 723		331 Uub 722		332 Uuh 727		333 Uus 726		334 Uuq 731		335 Uub 730		336 Uuh 735		337 Uus 734		338 Uuq 739		339 Uub 738		340 Uuh 743		341 Uus 742		342 Uuq 747		343 Uub 746		344 Uuh 751		345 Uus 750		346 Uuq 755		347 Uub 754		348 Uuh 759		349 Uus 758		350 Uuq 763		351 Uub 762		352 Uuh 767		353 Uus 766		354 Uuq 771		355 Uub 770		356 Uuh 775		357 Uus 774		358 Uuq 779		359 Uub 778		360 Uuh 783		361 Uus 782		362 Uuq 787		363 Uub 786		364 Uuh 791		365 Uus 790		366 Uuq 795		367 Uub 794		368 Uuh 799		369 Uus 798		370 Uuq 803		371 Uub 802		372 Uuh 807		373 Uus 806		374 Uuq 811		375 Uub 810		376 Uuh 815		377 Uus 814		378 Uuq 819		379 Uub 818		380 Uuh 823		381 Uus 822		382 Uuq 827		383 Uub 826		384 Uuh 831		385 Uus 830		386 Uuq 835		387 Uub 834		388 Uuh 839		389 Uus 838		390 Uuq 843		391 Uub 842		392 Uuh 847		393 Uus 846		394 Uuq 851		395 Uub 850		396 Uuh 855		397 Uus 854		398 Uuq 859		399 Uub 858		400 Uuh 863		401 Uus 862		402 Uuq 867		403 Uub 866		404 Uuh 871		405 Uus 870		406 Uuq 875		407 Uub 874		408 Uuh 879		409 Uus 878		410 Uuq 883		411 Uub 882		412 Uuh 887		413 Uus 886		414 Uuq 891		415 Uub 890		416 Uuh 895		417 Uus 894		418 Uuq 899		419 Uub 898		420 Uuh 903		421 Uus 902		422 Uuq 907		423 Uub 906		424 Uuh 911		425 Uus 910		426 Uuq 915		427 Uub 914		428 Uuh 919		429 Uus 918		430 Uuq 923		431 Uub 922		432 Uuh 927		433 Uus 926		434 Uuq 931		435 Uub 930		436 Uuh 935		437 Uus 934		438 Uuq 939		439 Uub 938		440 Uuh 943		441 Uus 942		442 Uuq 947		443 Uub 946		444 Uuh 951		445 Uus 950		446 Uuq 955		447 Uub 954		448 Uuh 959		449 Uus 958		450 Uuq 963		451 Uub 962		452 Uuh 967		453 Uus 966		454 Uuq 971		455 Uub 970		456 Uuh 975		457 Uus 974		458 Uuq 979		459 Uub 978		460 Uuh 983		461 Uus 982		462 Uuq 987		463 Uub 986		464 Uuh 991		465 Uus 990		466 Uuq 995		467 Uub 994		468 Uuh 999		469 Uus 998		470 Uuq 1003		471 Uub 1002		472 Uuh 1007		473 Uus 1006		474 Uuq 1011		475 Uub 1010		476 Uuh 1015		477 Uus 1014		478 Uuq 1019		479 Uub 1018		480 Uuh 1023		481 Uus 1022		482 Uuq 1027		483 Uub 1026		484 Uuh 1031		485 Uus 1030		486 Uuq 1035		487 Uub 1034		488 Uuh 1039		489 Uus 1038		490 Uuq 1043		491 Uub 1042		492 Uuh 1047		493 Uus 1046		494 Uuq 1051		495 Uub 1050		496 Uuh 1055		497 Uus 1054		498 Uuq 1059		499 Uub 1058		500 Uuh 1063		501 Uus 1062		502 Uuq 1067		503 Uub 1066		504 Uuh 1071		505 Uus 1070		506 Uuq 1075		507 Uub 1074		508 Uuh 1079		509 Uus 1078		510 Uuq 1083		511 Uub 1082		512 Uuh 1087		513 Uus 1086		514 Uuq 1091		515 Uub 1090		516 Uuh 1095		517 Uus 1094		518 Uuq 1099		519 Uub 1098		520 Uuh 1103		521 Uus 1102		522 Uuq 1107		523 Uub 1106		524 Uuh 1111		525 Uus 1110		526 Uuq 1115		527 Uub 1114		528 Uuh 1119		529 Uus 1118		530 Uuq 1123		531 Uub 1122		532 Uuh 1127		533 Uus 1126		534 Uuq 1131		535 Uub 1130		536 Uuh 1135		537 Uus 1134		538 Uuq 1139		539 Uub 1138		540 Uuh 1143		541 Uus 1142		542 Uuq 1147		543 Uub 1146		544 Uuh 1151		545 Uus 1150		546 Uuq 1155		547 Uub 1154		548 Uuh 1159		549 Uus 1158		550 Uuq 1163		551 Uub 1162		552 Uuh 1167		553 Uus 1166		554 Uuq 1171		555 Uub 1170		556 Uuh 1175		557 Uus 1174		558 Uuq 1179		559 Uub 1178		560 Uuh 1183		561 Uus 1182		562 Uuq 1187		563 Uub 1186		564 Uuh 1191		565 Uus 1190		566 Uuq 1195		567 Uub 1194		568 Uuh 1199		569 Uus 1198		570 Uuq 1203		571 Uub 1202		572 Uuh 1207		573 Uus 1206		574 Uuq 1211		575 Uub 1210		576 Uuh 1215		577 Uus 1214		578 Uuq 1219		579 Uub 1218		580 Uuh 1223		581 Uus 1222		582 Uuq 1227		583 Uub 1226		584 Uuh 1231		585 Uus 1230		586 Uuq 1235		587 Uub 1234		588 Uuh 1239		589 Uus 1238		590 Uuq 1243		591 Uub 1242		592 Uuh 1247		593 Uus 1246		594 Uuq 1251		595 Uub 1250		596 Uuh 1255		597 Uus 1254		598 Uuq 1259		599 Uub 1258		600 Uuh 1263		601 Uus 1262		602 Uuq 1267		603 Uub 1266		604 Uuh 1271		605 Uus 1270		606 Uuq 1275		607 Uub 1274		608 Uuh 1279		609 Uus 1278		610 Uuq 1283		611 Uub 1282		612 Uuh 1287		613 Uus 1286		614 Uuq 1291	

*Lanthanides	58	Ce	140.1	59	Pr	140.9	60	Nd	144.2	61	Pm	(145)	62	Sm	150.4	63	Eu	152.0	64	Gd	157.3	65	Tb	158.9	66	Dy	162.5	67	Ho	164.9	68	Er	167.3	69	Tm	168.9	70	Yb	173.0	71	Lu	175.0	
	**Actinides	90	Th	232.0	91	Pa	(231)	92	U	238.0	93	Np	(237)	94	Pu	(244)	95	Am	(243)	96	Cm	(247)	97	Bk	(247)	98	Cf	(251)	99	Es	(252)	100	Fm	(257)	101	Md	(258)	102	No	(259)	103	Lr	(260)

Potentially Useful Information

$$q = m \cdot C_s \cdot \Delta T$$

$$\Delta T_b = i K_b \cdot m$$

$$P_{\text{solvent}} = C_{\text{solvent}} \cdot P^{\circ}_{\text{solvent}}$$

$$\ln\left(\frac{[A]_t}{[A]_0}\right) = -kt$$

$$[A]_t - [A]_0 = -kt$$

$$\ln\left(\frac{K_2}{K_1}\right) = \frac{-\Delta H_{rxn}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$\text{pH} = \text{pK}_a = \log \left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

$$\Delta G^{\circ} = \Delta H^{\circ} - T\Delta S^{\circ}$$

$$\Delta E = B \left(\frac{1}{n_f^2} - \frac{1}{n_{fi}^2} \right)$$

$$\Delta G^{\circ} = nF\mathcal{E}^{\circ}$$

$$F = 96485 \text{ C/mol}$$

$$R = 0.08206 \text{ L atm/mol K; } 8.3145 \text{ J/mol K}$$

$$1.0 \text{ kg} = 2.2 \text{ lb}$$

$$1.0 \text{ in} = 2.54 \text{ cm}$$

$$1 \text{ lb} = 453.59 \text{ g}$$

$$c = 2.998 \times 10^8 \text{ m/s}$$

$$\Delta T_f = -i K_f \cdot m$$

$$S_{\text{gas}} = k_H \cdot P_{\text{gas}}$$

$$k = Ae^{-E_a/RT}$$

$$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H_{vap}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\text{pOH} = -\log [\text{OH}^-]$$

$$\Delta S_{\text{surr}} = \frac{-\Delta H_{\text{sys}}}{T}$$

$$E_{\text{cell}}^{\circ} = E_{\text{red}}^{\circ} + E_{\text{ox}}^{\circ}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$K_w = 1.0 \times 10^{-14}$$

$$B = -2.18 \times 10^{-18} \text{ J}$$

$$N_A = 6.022 \times 10^{23}$$

$$1 \text{ atm} = 101,325 \text{ Pa} = 1.01325 \text{ bar}$$

$$1 \text{ J} = 1 \text{ N m} = 1 \text{ kg m}^2 \text{ s}^{-2} = 0.239 \text{ cal}$$

$$c = \lambda \nu$$

Assume all gases behave ideally unless specifically told to do otherwise

Assume all solutions are aqueous and at 25 °C unless specifically told otherwise

Assume all gases are at STP unless specifically told otherwise

Simple Rules for the Solubility of Salts in Water

1. Most nitrates are soluble
2. Most salts containing Group 1 ions or ammonium (NH_4^+) are soluble
3. Most chloride, bromide, and iodide salts are soluble except those of Ag^+ , Pb^{2+} , and Hg_2^{2+} .
4. Most sulfates are soluble with the exception of Ba^{2+} , Pb^{2+} , Hg_2^{2+} , and Ca^{2+}
5. Most hydroxide salts are only slightly soluble with the exception of Group 1 hydroxides. Group 2 (Ba^{2+} to Ca^{2+}) are slightly soluble.
6. Most sulfides, carbonates, chromates, and phosphates are only slightly soluble.

WYSE – Academic Challenge
Chemistry Test (Regional) – 2013

1. Which of the following statements is false?
- A. Nitrogen and phosphorous have a relative mass of 14.01 amu to 30.97 amu.
 - B. Nitrogen and phosphorous are both nonmetals.
 - C. 14.01 g of nitrogen and 30.97 g of phosphorous contain the same number of atoms.
 - D. Nitrogen and phosphorous each contain five valence electrons.
 - E. N^{3-} and P^{3-} contain different number of protons, but the same number of electrons.

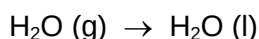
2. Atoms X, Y, Z, and R have the following nuclear compositions:



Which two are isotopes?

- A. X & Y
 - B. X & Z
 - C. Y & R
 - D. Z & Y
 - E. X & R
3. A gas sample is heated from -20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.105 atm, what is the final pressure?
- A. 0.0358 atm
 - B. -0.133 atm
 - C. 0.308 atm
 - D. 0.181 atm
 - E. 0.0609 atm
4. Which of the following is an example of the law of multiple proportions?
- A. Two different samples of water are found to have the same ratio of hydrogen to oxygen.
 - B. When hydrogen and oxygen react to form water, the mass of the water formed is exactly equal to the mass of hydrogen and oxygen that reacted.
 - C. The mass ratio of oxygen to hydrogen in water is 8:1. The mass ratio of oxygen to hydrogen in hydrogen peroxide (which contains only hydrogen and oxygen) is 16:1.
 - D. Samples of calcium carbonate from egg shells and from chalk are found to have the same mass ratios of calcium to carbon to oxygen.
 - E. During a chemical reaction the masses of the reactants and products are the same.
5. The density of mercury, the only metal to exist as a liquid at room temperature, is 13.6 g/cm^3 . What is that density in pounds per cubic inch?
- A. 849 lb/in^3
 - B. 376 lb/in^3
 - C. 0.490 lb/in^3
 - D. $1.83 \times 10^{-3} \text{ lb/in}^3$
 - E. None

6. What is the sign of ΔH for the process below and what can be said about this process?

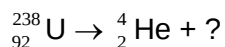


- A. positive; process is endothermic
- B. negative; process is endothermic
- C. positive; process is exothermic
- D. negative; process is exothermic
- E. not enough information given to answer the question

7. Which of the following would you expect to have the shortest bond length?

- A. NO^- B. F_2 C. O_2 D. O_2^{2-} E. C_2^{2-}

8. Identify the missing particle in the following equation:



- A. ${}_{94}^{242}\text{Pu}$ B. ${}_{90}^{234}\text{Th}$ C. ${}_{90}^{242}\text{Th}$ D. ${}_{92}^{234}\text{U}$ E. None of these

9. Which of the following represent a physical change:

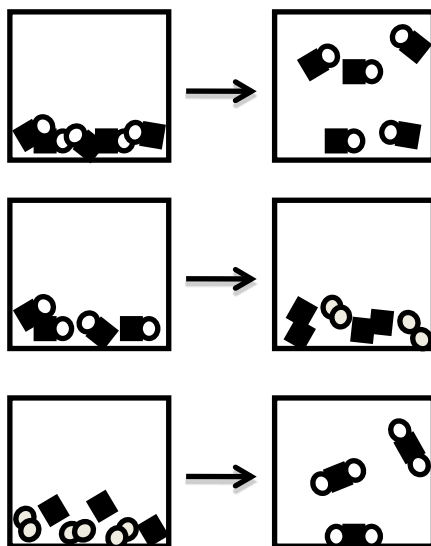
- I. Water evaporating on your hand
 II. Gasoline burning
 III. Butter melting on hot toast
 IV. Frying an egg
 V. Rust forming on a nail left outside in the rain

- A. I, II, III B. I, IV, V C. II, IV, V D. I, III E. All of the above

10. Which of the following metric relationships is incorrect?

- A. 1 microliter = 10^{-6} liters
 B. 1 gram = 10^3 kilograms
 C. 10^3 milliliters = 1 liter
 D. 1 gram = 10^2 centigrams
 E. 10 decimeters = 1 meter

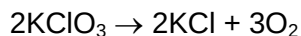
11. In the following pictures, the boxes represent atoms of one type of element and the circles another. How many of the following represent chemical changes



- A. 1 B. 2 C. 3 D. None E. Impossible to determine

12. Which of the following has the smallest atomic radius?
A. Ba B. Ca C. As D. At E. Ar
13. You measure water in two containers: a 10-mL graduated cylinder with marks at every mL, and a 1-mL pipet marked at every 0.1 mL. If you have some water in each of the containers and add them together, to what decimal place could you report the total volume of water?
A. 0.01 mL B. 0.1 mL C. 1 mL D. 10 mL E. None of these
14. The correct name for FeO is
A. iron oxide
B. iron monoxide
C. iron(III) oxide
D. iron(II) oxide
E. iron(I) oxide
15. How many of the following are true concerning balanced chemical equations?
I. The number of molecules is conserved.
II. The coefficients for the reactants tell you how much of each reactant you are given.
III. Atoms are neither created nor destroyed.
IV. The coefficients indicate the mass ratios of the substances used.
VI. The sum of the coefficients on the reactant side equals the sum of the coefficients on the product side.
A. 1 B. 2 C. 3 D. 4 E. 5
16. A radio station broadcasts at a frequency of 107.1 MHz. What is the wavelength associated with this radio station?
A. 3.570 m
B. 3.570×10^9 m
C. 3.213×10^{15} m
D. 3.213×10^6 m
E. 2.799 m
17. Two successive reactions, $D \rightarrow E$ and $E \rightarrow F$, have yields of 48% and 73% , respectively. What is the overall percent yield for conversion of D to F?
A. 25% B. 48% C. 73% D. 35% E. 1.25%
18. Which of the following equations is not balanced?
A. $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$
B. $\text{C}_2\text{H}_6 + \frac{7}{2} \text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$
C. $2\text{KClO}_3 \rightarrow 2\text{KCl} + \text{O}_2$
D. $4\text{P}_4 + 5\text{S}_8 \rightarrow 4\text{P}_4\text{S}_{10}$
E. $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$

19. A 7.05-g sample of potassium chlorate was decomposed according to the following equation:



How many moles of oxygen are formed?

- A. 2.76 mol B. 0.0575 mol C. 0.0384 mol D. 0.0863 mol E. None of these
20. Lithium (1.62 g) is reacted with 6.00 g oxygen. Which of these reactants is the limiting reagent and how much product will be formed? $4\text{Li} + \text{O}_2 \rightarrow 2\text{Li}_2\text{O}$
- A. Li limiting; 6.97 g product
B. Li limiting; 3.50 g product
C. O_2 limiting; 5.60 g product
D. O_2 limiting; 11.21 g product
E. O_2 limiting; 1.87 g product
21. Nitrogen dioxide can dissociate to nitric oxide and oxygen.

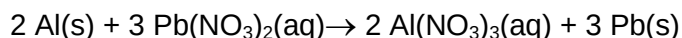


Under which reaction conditions would you expect to produce the largest amount of oxygen at equilibrium?

- A. high temperature, high pressure
B. low temperature, high pressure
C. high temperature, low pressure
D. low temperature, low pressure
E. None of the above
22. You prepare 1000. mL of tea and transfer it to a 1.00 quart pitcher for storage. Which of the following is true?
- A. The pitcher will be filled to 100% of its capacity with no tea spilled.
B. The pitcher will be filled to about 95% of its capacity.
C. The pitcher will be filled to about 50% of its capacity.
D. The pitcher will be completely filled and a small amount of tea will overflow.
E. The pitcher will be completely filled and most of the tea will overflow.
23. Equilibrium is reached in chemical reactions when:
- A. The rates of the forward and reverse reactions become equal.
B. The concentrations of reactants and products become equal.
C. The temperature shows a sharp rise.
D. All chemical reactions stop.
E. The forward reaction stops.

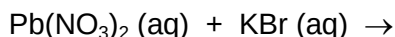
24. Which is Boyle's Law?
- A. Equal amounts of gases occupy the same volume at constant temperature and pressure.
 - B. The rates of effusion of gases are inversely proportional to the square roots of their molar masses.
 - C. The volume of a fixed amount of gas is directly proportional to its temperature in Kelvin at constant pressure.
 - D. The total pressure of a mixture of gases is the simple sum of the partial pressure of all the gaseous compounds.
 - E. The volume of a fixed amount of gas is inversely proportional to its pressure at a constant temperature.

25. Pure aluminum can react with aqueous lead(II) nitrate to form aqueous aluminum nitrate and solid lead. If you start with 453.25 g of solid aluminum and an excess of lead(II) nitrate how many total moles of products will you form assuming the reaction goes to completion?



- A. 6.719 mol B. 16.798 mol C. 33.597 mol D. 41.996 mol E. 83.993 mol
26. Which of the following acids has the lowest pH?
- A. 0.1 M $\text{C}_2\text{O}_4\text{H}_2$, $\text{pK}_a = 1.25$
 - B. 0.1 M $\text{HOCH}_2\text{CH}_2\text{NH}_2$, $\text{pK}_a = 4.49$
 - C. 0.1 M CH_3COOH , $\text{pK}_a = 4.74$
 - D. 0.1 M HBrO , $\text{pK}_a = 8.63$
 - E. 0.1 M HIO , $\text{pK}_a = 10.64$
27. What is the H_3O^+ concentration when 300.0 mL of 0.10 M NaOH is combined with 300.0 mL of 0.15 M HCl?
- A. 0.015 M B. 0.025 M C. 0.05 M D. 0.075 M E. 0.15 M
28. What is the molarity of a solution that contains 50.0 g of NaOH in 750.0 mL of solution?
- A. 0.600 M B. 0.800 M C. 1.07 M D. 1.25 M E. 1.67 M

29. What can be said about the reaction below?



- A. PbBr_2 will precipitate and KNO_3 will remain in the aqueous phase.
- B. KNO_3 will precipitate and PbBr_2 will remain in the aqueous phase.
- C. There will be no precipitation.
- D. Both KNO_3 and PbBr_2 will precipitate.
- E. Nitrogen gas will be evolved.

30. Select the arrangement of electromagnetic radiation which starts with the lowest energy and increases to the greatest energy.
- A. Radio, visible, infrared, ultraviolet
 - B. Microwave, infrared, visible, ultraviolet
 - C. Visible, ultraviolet, infrared, gamma rays
 - D. X-ray, visible, infrared, microwave
 - E. None of the above is in the correct order
31. You are holding four identical balloons each containing 10.0 g of a different gas. Which gas would have the largest balloon?
- A. H_2
 - B. He
 - C. Ne
 - D. N_2
 - E. All have the same volume.
32. You have a 400-mL rigid container with 55.0% He and 45.0% Ar by mass at 25°C and 1.5 atm total pressure. You heat the container to 100°C . What is the total pressure?
- A. 1.20 atm B. 1.50 atm C. 1.88 atm D. 2.01 atm E. None of these
33. Which of the following has the most negative electron affinity?
- A. Na B. S C. Br D. Cl E. As
34. Which of the following pairs is incorrect?
- A. iodine trichloride, ICl_3
 - B. phosphorus heptoxide, P_2O_7
 - C. ammonia, NH_3
 - D. sulfur hexafluoride, SF_6
 - E. All of the above pairs are correct.
35. What will be the result from balancing the half reaction below in acidic solution?
- $$\text{U}^{3+}(\text{aq}) \rightarrow \text{UO}_2^{2+}$$
- A. 4H^+ on the right and 2e^- on the left.
 - B. 4H^+ on the right and 2e^- on the right.
 - C. 4H^+ on the right and 1e^- on the right.
 - D. 4H^+ on the right and 3e^- on the right.
 - E. $2\text{H}_2\text{O}$ molecules on the left and 2e^- on the right.
36. Hydrogen has three isotopes (^1H , ^2H , and ^3H) and chlorine has two isotopes (^{35}Cl and ^{37}Cl). How many kinds of HCl molecules are there?
- A. 1 B. 3 C. 5 D. 6 E. 9

37. Which of the following compounds has the highest percentage of carbon by mass?
A. CH_3COOH B. $\text{C}_2\text{H}_5\text{OH}$ C. C_2H_6 D. CaC_2 E. $\text{H}_2\text{C}_2\text{O}_4$
38. A first-order reaction is 45% complete at the end of 33 minutes. What is the length of the half-life of this reaction?
A. 29 min. B. 38 min. C. 48 min. D. 2.0 hours E. None of the above
39. In which of the following are the electrons arranged approximately in a tetrahedral arrangement around the central atom?
A. NH_2^- B. NO_3^- C. NO_2^- D. N_2H_2 E. NO^+
40. Which response contains all the characteristics listed that should apply to PF_3 ?
(i) The molecular shape is trigonal planar.
(ii) It has one unshared pair of electrons on the central atom.
(iii) The phosphorus is sp^2 hybridized.
(iv) It is a polar molecule.
(v) The molecule contains polar bonds.
A. (i), (iv), and (v)
B. (ii), (iii), and (iv)
C. (i), (ii), and (iv)
D. (ii), (iv), and (v)
E. (i), (iii), and (v)