1) A 355-mL container holds 0.146 g of Ne and an unknown amount of Ar at 35°C and a total pressure of 626 mmHg. Calculate the number of moles of Ar present.
   A) 0.00433 mol
   B) 0.00116 mol
   C) 0.00734 mol
   D) 0.0116 mol
   E) 0.0433 mol

2) How many grams of phosphorus react with 35.5 L of O_2 at STP to form tetraphosphorus decoxide? $P_{4(s)} + 5O_{2(g)} \rightarrow P_4O_{10(s)}$
   A) 0.317 g
   B) 0.639 g
   C) 19.62 g
   D) 39.25 g
   E) 195.7 g

3) A weather balloon containing 600. L of He is released near the equator at 1.01 atm and 305 K. It rises to a point where conditions are 0.489 atm and 218 K and eventually lands in the northern hemisphere under conditions of 1.01 atm and 250 K. If one-fourth of the helium leaked out during this journey, what is the volume (in L) of the balloon at landing?
   A) 123 L
   B) 369 L
   C) 425 L
   D) 300 L
   E) 257 L

4) Analysis of a newly discovered gaseous silicon-fluorine compound shows that it contains 33.01 mass % silicon. At 27°C, 2.60 g of the compound exerts a pressure of 1.50 atm in a 0.250-L vessel. What is the molecular weight of the compound?
   A) 171 g/mol
   B) 200 g/mol
   C) 155 g/mol
   D) 234 g/mol
   E) 187 g/mol

5) After 0.600 L of Ar at 1.20 atm and 227°C is mixed with 0.200 L of O_2 at 501 torr and 127°C in a 400-mL flask at 27°C, what is the pressure in the flask in atmospheres?
   A) 103.2 atm
   B) 0.0215 atm
   C) 1.32 atm
   D) 2.67 atm
   E) 3.12 atm

6) Which statement is incorrect regarding internal energy (U, E) and the first law of thermodynamics?
   A) The first law of thermodynamics states that energy must be conserved.
   B) When the system gains heat and performs work, then Δ{U, E} for the system must be positive.
   C) The first law of thermodynamics does implies that energy can be converted to work.
   D) When the system loses heat and performs work, then Δ{U, E} for the system must be negative.
   E) When its Δ{U,E} increases, then the system must gain heat or have work performed on it, or both.

7) Deterioration of buildings, bridges, and other structures through the rusting of iron costs millions of dollars a day. The enthalpy of formation of rust, $Fe_2O_3(s)$, is −826.0 kJ/mol. How much heat is released (in kJ) when 0.500 kg of Fe reacts with 200. g of O_2, forming $Fe_2O_3(s)$?
   A) 3442 kJ
   B) 3696 kJ
   C) 6864 kJ
   D) 7392 kJ
   E) 1650 kJ

8) Find the heat of formation of gaseous HCl

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$	H = -91.8 kJ
$N_{2(g)} + 4H_{2(g)} + Cl_{2(g)} \rightarrow 2NH_4Cl_{(s)}$	H = -628.8 kJ
$NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$	H = -176.2 kJ

   A) -92.3 kJ
   B) -184.6 kJ
   C) -87.6 kJ
   D) -445 kJ
   E) -574.4 kJ

9) A chemical engineer placed 1.520 g of a hydrocarbon in the bomb of a calorimeter. The bomb was immersed in 2.550 L of water and the sample was burned. The water temperature rose from 20.00°C to 23.55°C. If the calorimeter (excluding the water) had a heat capacity of 403 J/K, what was the heat released per gram of hydrocarbon in kJ/g?
   A) 1.430 kJ/g
   B) 39.30 kJ/g
   C) 37.88 kJ/g
   D) 25.86 kJ/g
   E) Not enough information

10) A pure gold ring (C=0.128 J/g°C) and pure silver ring (C=0.235 J/g°C) have a total mass of 15.3g. The two rings are heated to 62.1°C and dropped into a 13.1mL of water at 20.9°C. When equilibrium is reached, the temperature of the water is 22.9°C . What was the mass of the gold ring?

A) 17.6 g
B) 10.3 g
C) 7.5 g
D) 5.2 g
E) 3.4 g

11) If 150. grams of iron (0.450 J/g°C) at 100°C is combined with 150. grams of water at 20°C in an insulated container, what will be the final temperature of the water?

A) 10.4°C
B) 27.8°C
C) 30.8°C
D) 34.5°C
E) 60.0°C

12) Select the true statement(s)

I. Photons of green light have greater energy than photons of red light
II. The light emitted from an n=4 to n=2 transition will have greater energy than light from an n=3 to n=1 transition
III. The energy of a photon is directly related to its frequency and inversely related to its wavelength
IV. There are only 2 subshells associated with the n=2 energy level

A) I and II
B) II, III, and IV
C) I and III
D) III only
E) I, III, and IV

13) The optic nerve needs a minimum of 2.0×10^{-17} J of energy to trigger a series of impulses that eventually reach the brain. How many photons of blue light (475 nm) are needed?

A) 4.19×10^{-19} photons
B) 47.8×10^{23} photons
C) 47.8 photons
D) 53.9 photons
E) Not enough information

14) Which of the following pairs of quantum numbers are not feasible?

I. $n = 2; l = 0; m_l = -1$
II. $n = 4; l = 3; m_l = -1$
III. $n = 3; l = 1; m_l = 0$
IV. $n = 5; l = 2; m_l = 3$

A) I and IV
B) I, II, and IV
C) II and III
D) III only
E) IV only

15) Find the rate law for the following reaction mechanism
$HNO_2 + H^+ \rightarrow H_2O + NO^+$ (fast)
$NH_4^+ \rightarrow NH_3 + H^+$ (fast)
$NO^+ + NH_3 \rightarrow NH_3NO^+$ (slow)
$NH_3NO^+ \rightarrow H_2O + H^+ + N_2$ (fast)

A) Rate = k $[NO^+]$ $[NH_3]$
B) Rate = k $[NO^+]$ $[NH_4^+]$ $[H^+]^{-1}$
C) Rate = k $[NO^+]$ $[NH_4^+]$ $[H^+]$
D) Rate = k $[HNO_2]$ $[NH_4^+]$ $[H_2O]^{-1}$
E) Rate = k $[NH_3]$ $[H^+]$ $[HNO_2]$ $[H_2O]^{-1}$

16) The rate law for $2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$ was experimentally determined to be rate = $k[NO]^2[O_2]$. Based on this information, which of the following are plausible mechanisms for this reaction?

I:	$2\ NO(g) \rightleftarrows N_2(g) + O_2(g)$ (slow equilibrium step) $N_2(g) + 2\ O_2(g) \rightarrow 2\ NO_2(g)$ (fast second step)
II:	$2\ NO(g) \rightleftarrows N_2O_2(g)$ (fast equilibrium step) $N_2O_2(g) + O_2(g) \rightarrow 2\ NO_2(g)$ (slow second step)
III:	$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$ (one step)

A) Only I
B) Only II
C) I and III
D) II and III
E) I, II, and III

17) Give the individual reaction orders for all substances and the overall reaction order from the following rate law: Rate = $k[BrO_3^{--}][Br^{--}][H^+]^2$
By what factor does the rate change if each of the following changes occurs: (a) $[BrO_3^{--}]$ is doubled; (b) $[H^+]$ is quadrupled?

A) Rate is doubled; Rate is quadrupled
B) Rate is doubled; Rate is increased by a factor of 16
C) Rate is halved; Rate is increased by a factor of 16
D) Rate is quadrupled; Rate is doubled
E) Rate is unchanged; Rate is quadrupled

18) For the reaction 4A(g) + 3B(g) -> 2C(g) the following data were obtained at constant temperature. What is the rate law for the reaction?

Experiment	Initial [A] (Mol/L)	Initial [B] (Mol/L)	Initial Rate (Mol/L*min)
1	0.100	0.100	5.00
2	0.300	0.100	45.0
3	0.100	0.200	10.0
4	0.300	0.200	90.0

A) Rate=k[A][B]

B) Rate=k$[A]^2$[B]

C) Rate=k[A]$[B]^2$

D) Rate=k[A]

E) Rate=k[B]