Before We Get Started

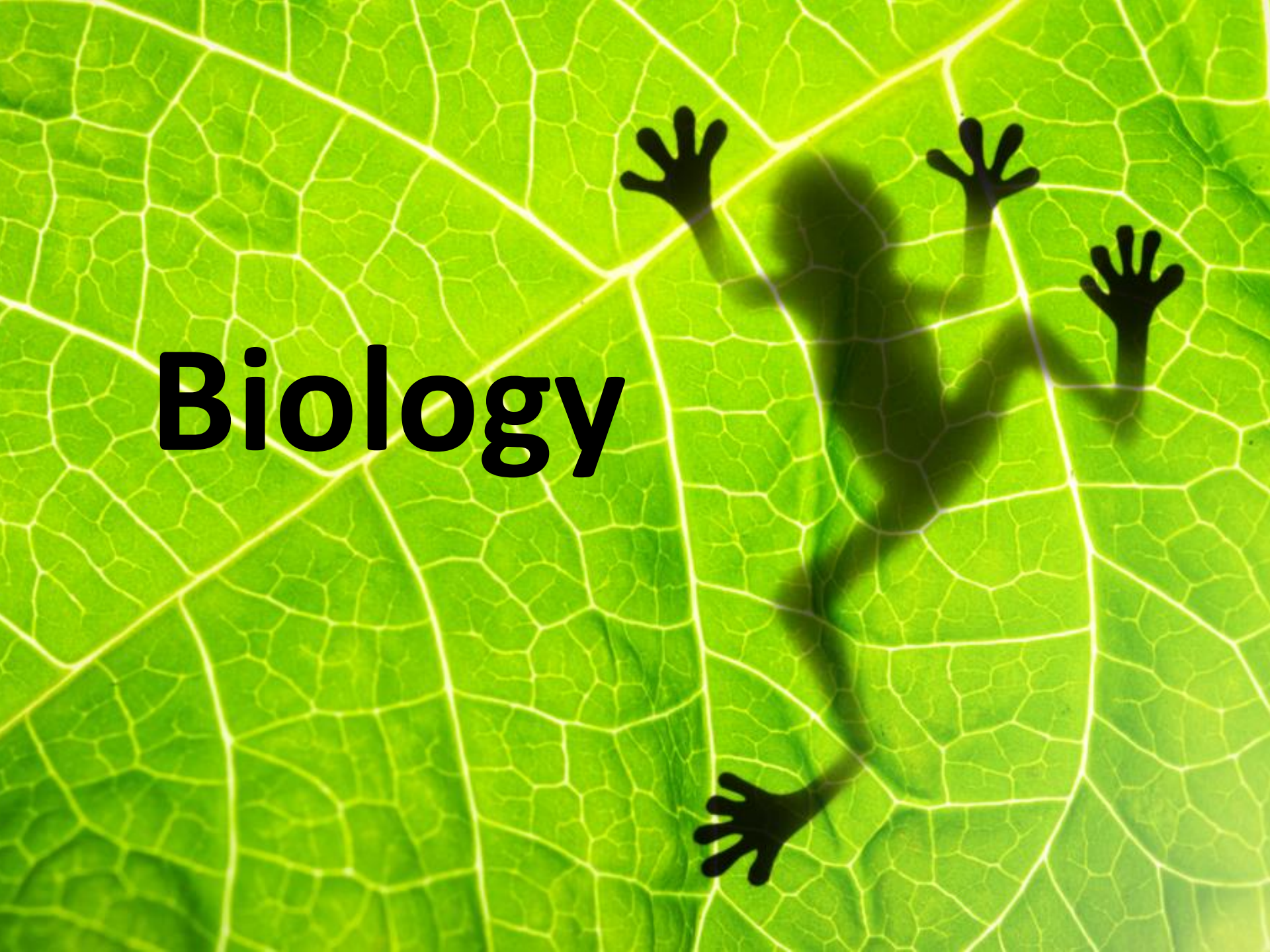
Remember to register your attendance and complete session evaluations.

Session numbers are in your program.

		
Attendance	**Online Handouts**	**Session Evaluations**

Sample Test Questions
Science
2022-2023

Biology



Examine all of the answer choices below. Which choice is the most inclusive (e.g. the grouping that would include all of the others)?

A) Class

B) Genus

C) Family

D) Species

E) Order

Solution

- Level 1
- Biological hierarchy
- King Phillip Cried Out For Green Soup
- Kingdom
    - Phylum
        - Class
            - Order
                - Family
                    - Genus
                        - Species

A population in Hardy-Weinberg equilibrium contains a total of 6992 individuals. Out of the total, 724 exhibit the dominant phenotype. What is the frequency of the recessive allele in this population?

A) 0.0532

B) 0.1035

C) 0.3218

D) 0.8965

E) 0.9468

Steps to solve H-W questions: $p^2 + 2pq + q^2$ and $p + q = 1$

- Level 2, population genetics

1. Look for wording that helps find q or q^2

   "Out of the total, 724 exhibit the dominant phenotype."

   Therefore, the remaining must have recessive phenotype and be homozygous recessive

   $6992 - 724 = 6268$

2. Determine the frequency of homozygous recessive (q^2).

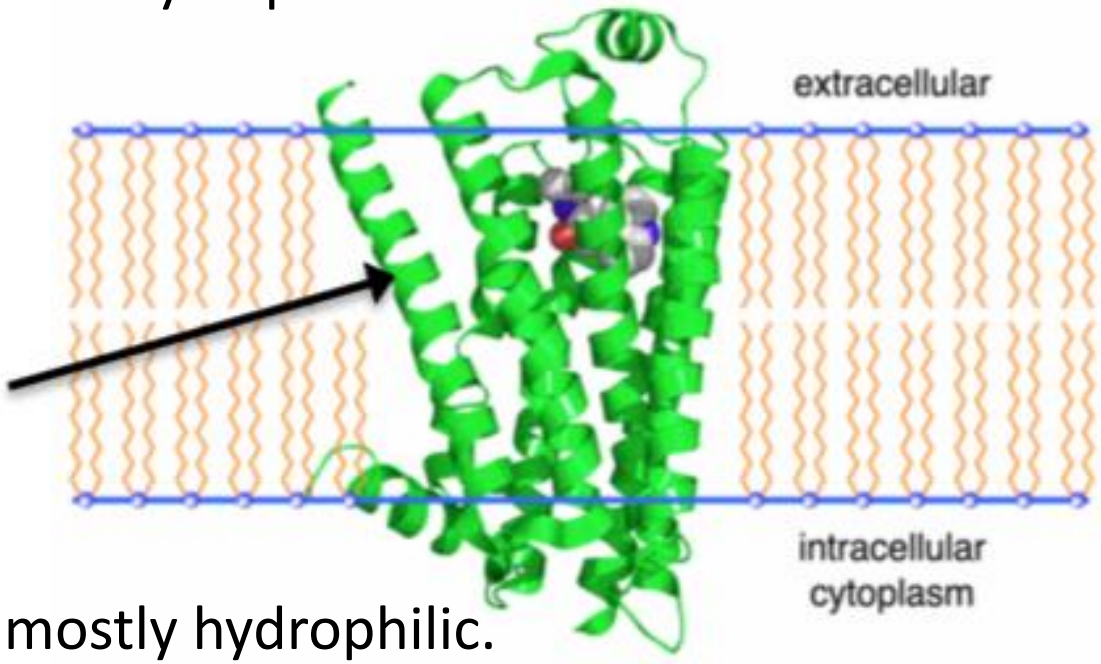
   $6268/6992 = 0.8965$

3. Solve for the "frequency of the recessive allele" (q)

   $q^2 = 0.8965$

   $q = \sqrt{0.8965} = 0.9468$

Examine the image of a transmembrane protein embedded within a biological membrane. What can you predict about the area indicated by the arrow?



A) The amino acids are mostly hydrophilic.

B) The amino acids are mostly hydrophobic.

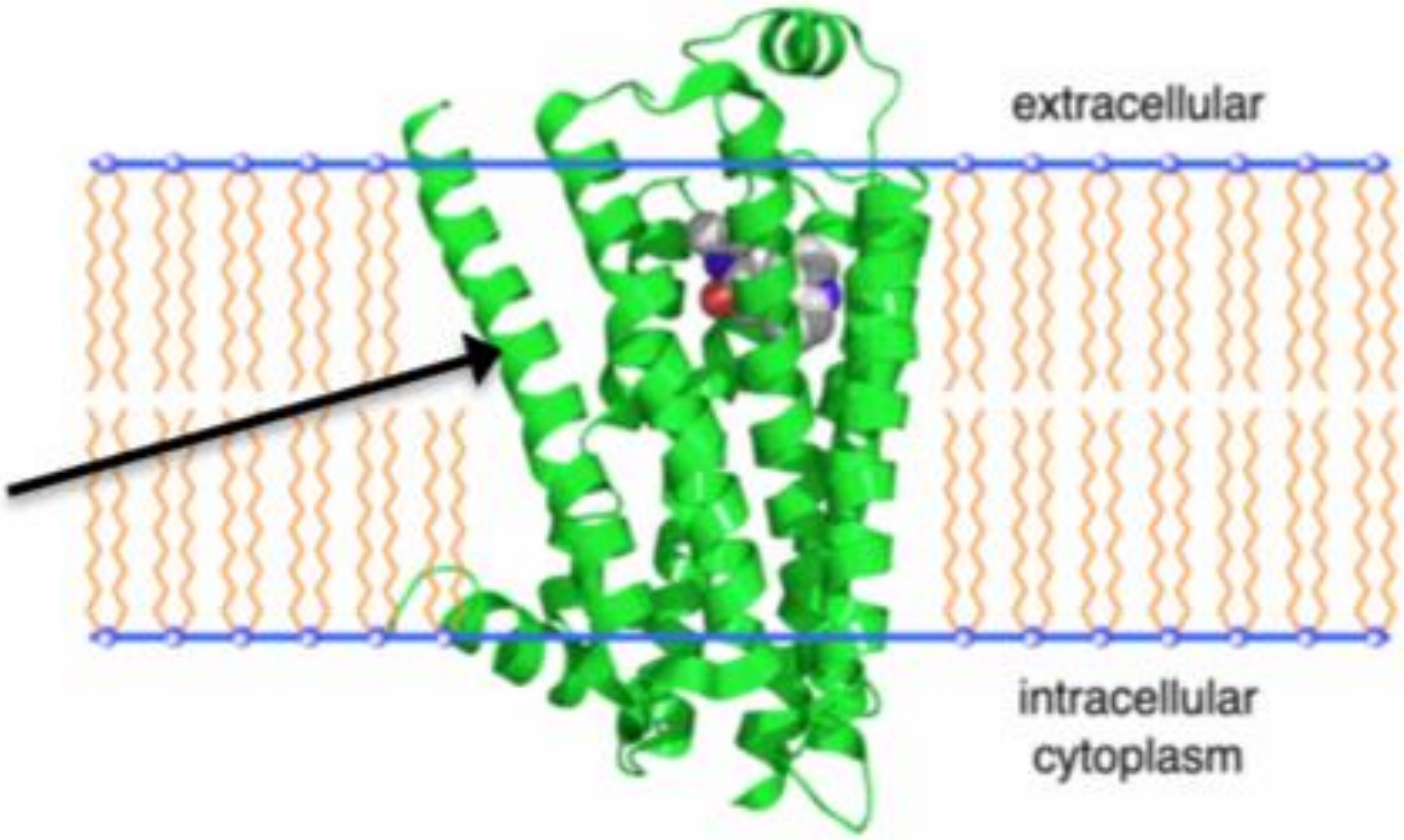
C) The indicated area could easily move between the current embedded state and the extracellular or intracellular environment.

D) The indicated structure is a fatty acid.

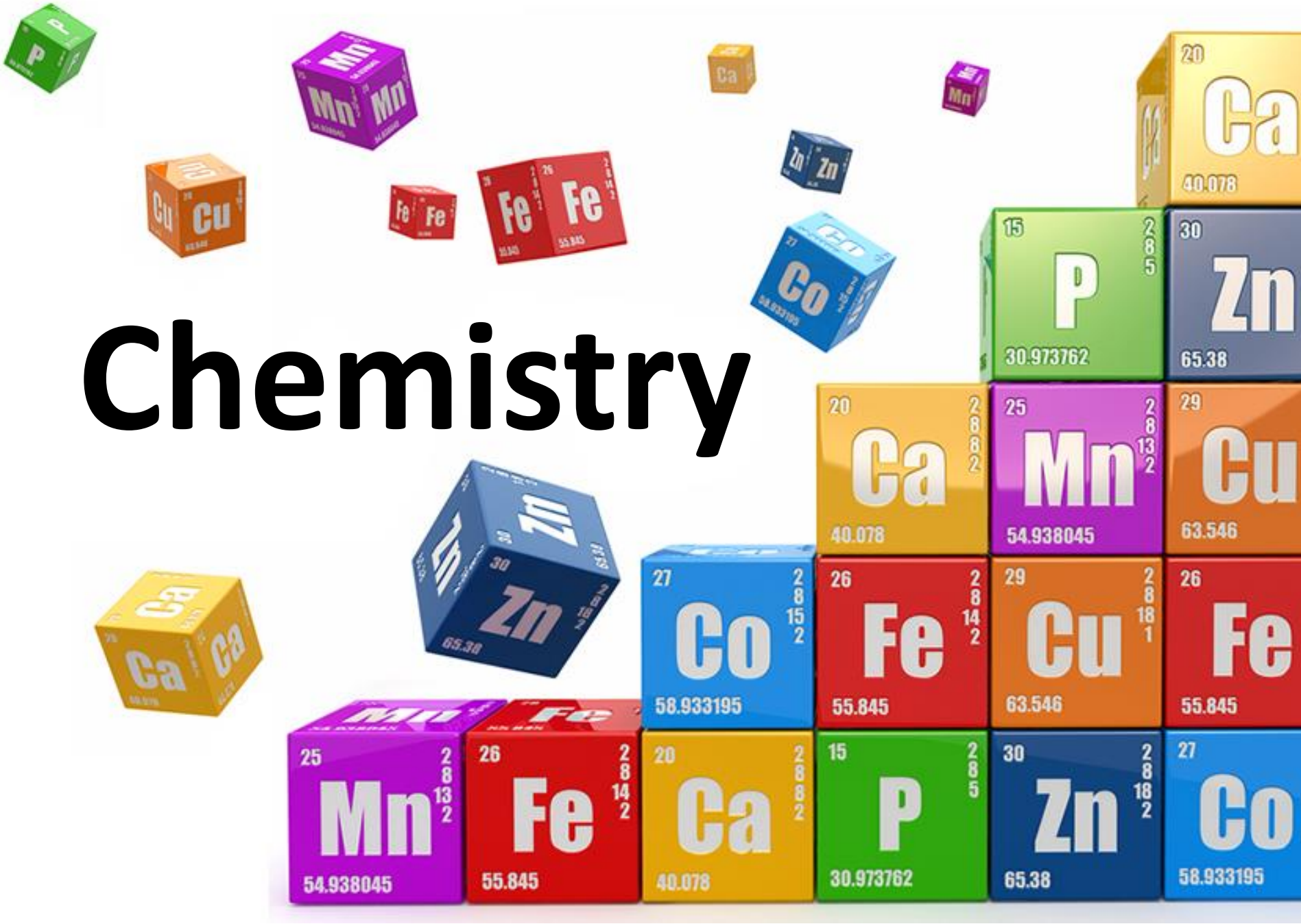
E) The embedded portions of the protein would be covalently bonded to adjacent phospholipids.

Solution

- Level 3
- Membrane and organic molecule structure/function



Chemistry


P
Mn Mn
Ca
Mn
Cu Cu
Fe Fe
Fe Fe
55.845
Zn Zn
Co
20 Ca 40.078
15 P 2 8 5 30.973762
30 Zn 65.38
20 Ca 2 8 8 2 40.078
25 Mn 2 8 13 2 54.938045
29 Cu 63.546
Ca Ca
Zn
30 Zn 65.38
27 Co 2 8 15 2 58.933195
26 Fe 2 8 14 2 55.845
29 Cu 2 8 18 1 63.546
26 Fe 55.845
25 Mn 2 8 13 2 54.938045
26 Fe 2 8 14 2 55.845
20 Ca 2 8 8 2 40.078
15 P 2 8 5 30.973762
30 Zn 2 8 18 2 65.38
27 Co 58.933195

1. For the reaction

$$3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$$

Hint: 46 g/mol 18 g/mol 63 g/mol 30 g/mol

What is the maximum amount of HNO_3 that could be formed from 184 g of NO_2 and 27 g of H_2O?

a) 126. g

b) 211. g

c) 94.5 g

d) 25.3 g

e) 168. g

Limiting Reactant Problem:

Find the limiting reactant first, then get the answer.

184g NO_2/46 g/mol × $2HNO_3/3NO_3$ = 2.67 mol HNO_3

27g H_2O/18g/mol × 2 $HNO_3/1H_2O$ = 3.00 mol HNO_3

NO_2 is limiting reactant.

2.67 mol HNO_3 × 63 g/mol = 168 g HNO_3

2. Which of the following liquids has the highest vapor pressure?

a) H_2O

b) C_5H_{12}

c) C_2H_5OH

d) $C_{10}H_{12}$

- The liquid with the fewest/weakest intermolecular forces (imfs) will have the highest vapor pressure.
- Small imfs mean faster/easier vaporization rates and higher vapor pressures.
- Water and ethanol both have relatively strong imfs (H-bonding) and therefore have relatively low vapor pressures.
- Pentane and decane both only have dispersion forces which are very weak.
- Overall imf strength scales with molecular size – so decane has stronger imfs than pentane.
- So pentane will have the highest vapor pressure.

3. The heat of combustion (ΔH°) for propane is 2220 kJ/mol. How many kJ of energy are released when 5.00 L of propane at 2.45 atm and 25°C is burned?

a) 1110 kJ

b) 2220 kJ

c) 1875 kJ

d) 555 kJ

e) 3330 kJ

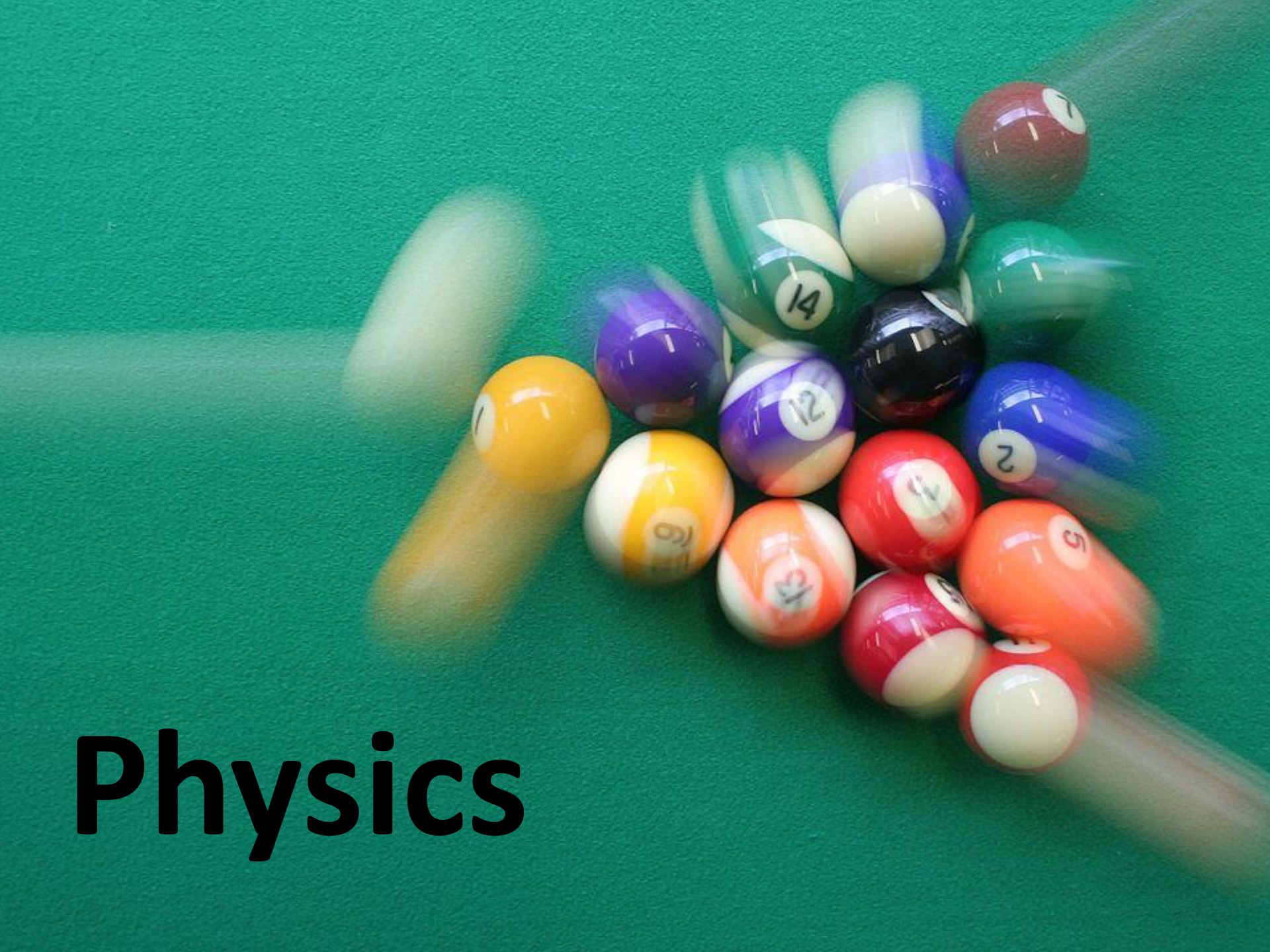
V=5.00L; P=2.45atm; T (in K)=°C + 273.15

=298.15K

use the ideal gas law to get moles of propane

$n = PV/RT = (2.45 \times 5.00)/(0.08206 \times 298.15) = 0.500$ mol

0.500 mol × 2220 kJ/mol = 1110 kJ



Physics

Energy and Work Example

1. A hockey puck with a mass of 150.0 g slides horizontally across ice. The initial velocity of the puck is 13.0 m/s. If the puck comes to a stop after sliding 47.0 m, what is the coefficient of friction between the puck and the ice?

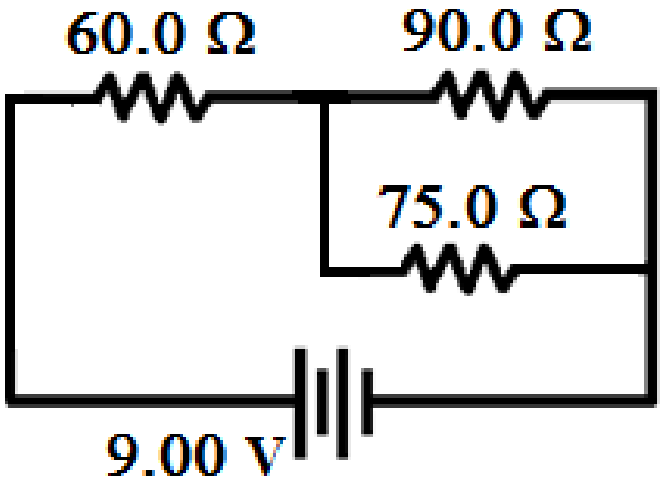
A) 0.0570
B) 0.0920
C) 0.180
D) 0.270
E) 0.370

- $K = \frac{1}{2}mv^2 = (0.5)(0.15)(13)^2 = 12.68\,J.$
- The puck comes to rest, so all of this energy is converted to heat by friction.
- $W = fd = K = 12.68\,J.$
- $F_N - mg = 0.$
- $F_N = mg = (0.15)(9.8) = 1.47N.$ Then friction is: $f = \mu F_N = 1.47\mu.$
- $W = fd = (1.47\mu)(47) = 12.68\,J.$
- So, $\mu = 0.18.$

Electric Circuit Example

2. Given the circuit shown, what is the current flowing in the 75.0 Ω resistor?

A) 120 mA
B) 89.2 mA
C) 48.6 mA
D) 40.5 mA
E) 19.8 mA



- First $^{1}/_{R_p} = {}^{1}/_{90} + {}^{1}/_{75}$, which gives $R_p = 40.9\ \Omega$.
- Now $R_{Total} = 40.9 + 60 = 100.9\ \Omega$.
- $I_{Total} = \frac{9.00}{100.9} = .0892\ A$.
- Then the voltage drop across the 60 Ω resistor is
- $V_{60} = (.0892)(60) = 5.35\ V$.
- $V_2 = 9.00 - 5.35 = 3.65\ V$.
- So, $(V_{75} = 3.65\ V)$.
- Thus, $I_{75} = {}^{V_{75}}/_{75} = {}^{3.65}/_{75} = .0486\ A = 48.6mA$

Optics Example

3. A lens taken from a pair of glasses has a focal length of -22.0 cm. If the lens is used to view a 15.0 cm tall candle that is 1.00 m away, how tall is the image of the candle?

A) 2.70 cm
B) 3.30 cm
C) 4.23 cm
D) 7.07 cm
E) 12.3 cm

This is a thin lens problem, so $\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$.

$\frac{1}{100}+\frac{1}{q}=\frac{1}{-22}$, which gives: $q=-18.0\ cm$.

Magnification is given by:
$M=-\frac{q}{p}=\frac{18}{100}=0.18.$

So, the image height is
$h'=(0.18)(15.0)=2.70\ cm.$

End of sample questions