MULTIPLE CHOICE COMPETITION

SOLUTIONS

DECEMBER 4th 2019

MCQ Final
<table>
<thead>
<tr>
<th>Q1</th>
<th>Answer D</th>
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<tbody>
<tr>
<td><strong>Explanation</strong></td>
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<tr>
<td>$\sum F \propto t^2$ (Given) $\Rightarrow \frac{\Delta v}{\Delta t} \propto t^2$</td>
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<tr>
<td>$v \propto t^3$</td>
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<td>$v^2 \propto t^6$</td>
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<td>$E_k \propto v^2$</td>
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<td>$E_k \propto t^6$</td>
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<th>Q2</th>
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<tr>
<td><strong>Explanation</strong></td>
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<tr>
<td>$\sum F = 0$</td>
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<tr>
<td>$B - w_c - w_p = 0$</td>
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<tr>
<td>$m_wg - m_cg = m_pgnp$</td>
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<tr>
<td>$\rho_w V_w - \rho_c V_c = m_pgnp$</td>
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<td>$\pi r^2 h(\rho_w - \rho_c) = m_pgnp$</td>
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<td>$n_p = \frac{\pi r^2 h(\rho_w - \rho_c)}{m_p}$</td>
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<td>$n_w = \frac{\pi r^2 h(\rho_w - \rho_c)}{m_p}$</td>
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<td>$n_o = \frac{\pi r^2 h(\rho_o - \rho_c)}{m_p}$</td>
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<td>$n_w = \frac{(\rho_w - \rho_c)}{(\rho_o - \rho_c)}$</td>
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<tr>
<td><strong>Explanation</strong></td>
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<tr>
<td>During light hours, algae carry out photosynthesis and release oxygen</td>
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<td><strong>Explanation</strong></td>
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<td>for i: is true because the bold lines signify a separation of phases.</td>
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<td>For ii: incorrect as lowering pressure does not change temperature</td>
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<td>for iii: Correct as it is the triple point.</td>
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<td>for iv: incorrect as the vapor pressure is equal to the atmospheric pressure (i.e. definition of boiling point)</td>
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<tr>
<td>Therefore, I and iii are the correct answers.</td>
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Q5

Answer A

Explanation
This is a dimensional analysis question starting with 12 molecules of water: in 1 molecule of water there is 1 molecule of NH\(_3\); and in 2 molecules of NH\(_3\) there are 3 molecules of H\(_2\).

A second option: 12 molecules \(\times (3/2) = 18\) molecules

A third option is to convert molecules to moles and moles to molecules cancelling Avogadro’s constant.

OR

\[-\text{balance} \quad \text{N}_2 + 3 \text{H}_2 \rightarrow 2\text{NH}_3\]
\[\text{NH}_3 + \text{CH}_3\text{Cl} + \text{NaOH} \rightarrow \text{NaCl} + \text{CH}_3\text{NH}_2 + \text{H}_2\text{O}\]

\[3 \text{H}_2 \rightarrow 2\text{NH}_3 \quad \text{ratio} \quad 3 : 2\]
\[3 \times 6.02 \times 10^{23} \rightarrow 2 \times 6.02 \times \]
\[\text{NH}_3 \rightarrow \text{H}_2\text{O} \quad \text{ratio} \quad 1 : 1\]
\[6.02 \times 10^{23} \rightarrow 6.02 \times 10^{23}\]

\[\text{SO} \quad \text{H}_2 : \text{NH}_3 : \text{H}_2\text{O}\]

\[3 : 2 : 1\]

\[\frac{3}{2} : \frac{2}{2} \quad \text{H}_2 \rightarrow \text{H}_2\text{O}\]

\[3 \left( 6.02 \times 10^{23} \right) \rightarrow 2 \left( 6.02 \times 10^{23} \right)\]

\[X \left( 6.02 \times 10^{23} \right) \rightarrow 12 \left( 6.02 \times 10^{23} \right)\]

\[X = 18 \text{ molecules}\]

Q6.

Answer D

Explanation
Data from the figures

Q7.

Answer D

Explanation

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Q8.

Answer D

Explanation
basic knowledge
\[ I_1 = I_2 + I_3 \]
\[ 12.0 = 2.00I_3 + 4.00I_1 \]
\[ 8.00 = 6.00I_2 - 2.00I_3 \]

Solving the equations 1, 2, 3 gives:
\[ I_2 = 1.64 \text{ A} \]
\[ I_3 = 0.909 \text{ A} \]
\[ I_1 = 2.55 \text{ A} \]

The potential difference between points c, d
\[ \Delta V = 2.00 \times I_3 \]
\[ \Delta V = 1.82 \text{ V} \]

And point c with higher potential than point d.
Q10
Answer A
Explanation
basic knowledge

Q11.
Answer A
Explanation
In (I) the trait appears in the father may be dominant or recessive.
As the trait appears in females and not in males’ children, therefore mother is not a carrier and the trait will not appear in females unless it is dominant.
Therefore, it is X-linked dominant
In (II) As the trait doesn’t appear in both parents and appears in the only males of their kids, the mother carries the trait as recessive.
Therefore, it is X-linked recessive.

Q12.
Answer C
Explanation
Energy level (n) = 5 is not included in the silver ion as the 4s\(^1\) electron is lost.
- Ag \(1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^{10}, 4p^6, 5S^1, 4d^{10}\)
- Ag\(^{1+}\) \(1S^2, 2S^2, 2P^6, 3S^2, 3p^6, 4S^2, 3d^{10}, 4p^6, 4d^1\)

Q13.
Answer C
Explanation
\(\theta_2 = \sin^{-1}\left(\frac{n_1 \sin \theta_1}{n_2}\right) = 23.7^\circ\)
\(x_1 = h \cdot \tan \theta_2 = 0.044m\)
\(\theta_3 = 28.9^\circ\)
\(x_2 = 0.055m\)
\(x_3 = 0.084m\)
\(x_{net} = 0.183m = 18.3cm\)
**Q14.**

**Answer C**

**Explanation**
- \( \text{Cl}_2(g) + 2e^- \rightarrow 2 \text{Cl}^-(g) \)
- \( \text{Cl}_2(g) \rightarrow 2 \text{Cl}^-(g) \) \( \Delta H = R \)
- \( \text{Cl}^-(g) + e^- \rightarrow \text{Cl}^-(g) \) \( \Delta H = S \)
- Net reaction
- \( \text{Cl}_2(g) + 2e^- \rightarrow 2 \text{Cl}^-(g) \) \( \Delta H = R + 2S \)

**Q15.**

**Answer B**

**Explanation**

**Step 1:** is to write the balanced combustion reaction of methanol to yield \( \text{CO}_2 \) and \( \text{H}_2\text{O} \).
Therefore, \( \Delta H \) must be multiplied by 2.

\[
2\text{CH}_3\text{OH} + 3\text{O}_2 \rightarrow 2 \text{CO}_2 + 4 \text{H}_2\text{O} \quad \Delta H = (-726.4 \times 2) = -1452.8 \quad (1)
\]

**Step 2:**
- \( \text{C} + \text{O}_2 \rightarrow \text{CO}_2 \) \( \Delta H = -393.5 \quad (2) \)
- \( \text{H}_2 + 1/2 \text{O}_2 \rightarrow \text{H}_2\text{O} \) \( \Delta H = -285.8 \quad (3) \)

**Step 3:** Inverse equation (1)

\[
2 \text{CO}_2 + 4 \text{H}_2\text{O} \rightarrow 2\text{CH}_3\text{OH} + 3\text{O}_2 \quad \Delta H = +1452.8 \quad (4)
\]

**Step 4:** Multiply equation (2) \( \times 2 \) and equation (3) \( \times 4 \)

\[
2\text{CO}_2 \rightarrow 2\text{CO}_2 \quad \Delta H = -787 \quad (5)
\]

\[
4\text{H}_2 + 2\text{O}_2 \rightarrow 4\text{H}_2\text{O} \quad \Delta H = -1143.2 \quad (6)
\]

**Step 5:** By sum equations (4), (5) and (6)

\[
2\text{C} + 4\text{H}_2 + \text{O}_2 \rightarrow 2\text{CH}_3\text{OH} \quad \Delta H = -477.4 \quad (7)
\]

**Step 6:** Divide (7) by 2

\[
\text{C} + 2\text{H}_2 + 1/2 \text{O}_2 \rightarrow \text{CH}_3\text{OH} \quad \Delta H = -238.7 \text{ KJ/mol}
\]

**OR:**

**Step 1:** write a balanced reaction and reverse the reaction, reversing the \( \Delta H \) sign

\[
\text{CH}_3\text{OH} + 3/2\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O} \quad \Delta H = -726.4 \quad (1)
\]

\[
\text{CO}_2 + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{OH} + 3/2\text{O}_2 \quad \Delta H = +726.4 \quad (1)
\]

**Q16.**

**Answer A**

**Explanation**

At point F, the highest concentration is of HA and a slight (small) change in pH.
At point H, as KOH is added, HA is gradually converted to \( \text{A}^- \) (buffering region), . Beyond point G, the concentration of \( \text{A}^- \) is higher compared to HA.
Q17.
Answer D

**Explanation**

Molar mass $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2 = (8 \times 12.011) + (1.008 \times 10) + (4 \times 14.007) + (2 \times 15.999) = 194 \text{ g/mol}$

No. of moles in half Finjan $= \frac{2.05 \times 10^{-3} \text{ g}}{194 \text{ g/mol}} = 1.05 \times 10^{-5} \text{ mol}$

Conc in half-filled Finjan $= \frac{1.05 \times 10^{-5} \text{ mol}}{12.5 \times 10^{-3} \text{ L}} = 0.084 \times 10^{-2} \text{ M}$

No. of molecules in half Finjan $= \frac{0.084 \times 10^{-2} \text{ mol}}{12.5 \times 10^{-3} \text{ L}} \times 6.02 \times 10^{23} \text{ molecules}$

Q18.
Answer A

**Explanation**

Water:
$m_w = 13.40 \text{ g}$
$c_w = 4.184$
$\Delta t = (46.97 - 20) \degree \text{C}$

Gold:
$m_{Au} = (152 - m_{Cu}) \text{ g}$
$c_{Au} = 0.129$
$\Delta t = (46.97 - 96.72) \degree \text{C}$

Copper:
$m_{Cu} = \frac{? \text{ g}}{12.389}$
$\Delta t = (46.97 - 96.72) \degree \text{C}$

$q_w = -(q_{Cu} + q_{Au})$
$4.184 \times 13.40 \times 26.97 = -(m_{Cu} \times 0.389 \times -49.75) + (152 - m_{Cu}) \times 0.129 \times -49.7$
$536.591 = 12.935 m_{Cu}$
$m_{Cu} = 41.483 \text{ g}$

$\% = \frac{41.483}{152} = 27.291\%$

Q19.
Answer B

**Explanation**

$\rho_A g h_A = \rho_B g h_B$

$\frac{1}{3} \times \frac{2}{2} = \rho_B x$

$\frac{\rho_A}{\rho_B} = \frac{2}{3}$
Q20.

Answer B

Explanation

\[ \text{Mg(OH)}_2 \rightarrow \text{Mg}^{2+} + 2\text{OH}^- \]

\[ \text{Ksp} = [\text{Mg}^{2+}] [\text{OH}^-]^2 \]

\[ \text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^- \]

\[ \text{pOH} = \text{pK}_b + \log \left( \frac{[\text{NH}_4^+]}{[\text{NH}_3]} \right) \]

\[ \text{pOH} = (-\log 1.77 \times 10^{-5}) + \log (0.2073/0.7147) \]

\[ \text{pOH} = 4.2145 \]

\[ [\text{OH}^-] = 10^{-4.2125} \]

\[ [\text{OH}^-] = 6.1024 \times 10^{-5} \text{ M} \]

\[ \text{Ksp} = [\text{Mg}^{2+}] [\text{OH}^-]^2 \]

\[ 1.2 \times 10^{-11} = [\text{Mg}^{2+}] (6.1024 \times 10^{-5})^2 \]

\[ [\text{Mg}^{2+}] = 3.22 \times 10^{-3} \text{ M} \]

Q21.

Answer C

Explanation

Nitrogen cycle


Q22.

Answer C

Explanation

An exothermic process, by definition, involves a reaction in which the products are lower in energy than the reactants. The reduction in chemical energy results in a release of heat from the reaction.

In the diagram, the path between points is irrelevant. We are simply looking for any instances in which the product point is below the reactant point. Point L has less energy than point K, and point N has less energy than K, L, or M. Transitions from K to L, M to N, or L to N will all result in a reduction of chemical energy, and a release of heat.
### Q23.

**Answer D**

**Explanation**

\[
\rho = \frac{2\pi \cdot \pi \cdot \pi^2 \cdot 10^{-6}}{4 \cdot 4\pi \cdot 10^{-2}} = \frac{8}{\pi^2} \cdot 10^{-4} = 8.11 \times 10^3 \Omega^{-1}m^{-1}
\]

### Q24.

**Answer A**

**Explanation**

\[
E = PE + KE
\]

\[
E = mgh
\]

**h0 = 1.2 m**

**h1 = 1.2 \times 0.84 = 1.008 m**

**h2 = 1.008 \times 0.84 = 0.8467 m**

\[
d_0 = 0.8467 m
\]

**f = 0.5 m**

\[
\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_0}
\]

\[
\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_0}
\]

\[
d_i = 1.22 m
\]

Distance between the ball and its image = 1.22 - 0.8467 = 0.37 m

### Q25

**Answer C**

**Explanation**

\[
m \cdot g \sin \theta = E \cdot q \cos \theta
\]

\[
\tan \theta = \frac{2.00 \times 10^3 \times 3.00 \times 10^{-6}}{4.00 \times 9.81 \times 10^{-3}}
\]

\[
\theta = 8.69
\]

\[
X = 20.0 \sin 8.69 = 3.02 cm
\]

\[
20.0 - z = 20.0 \cos 8.69
\]

\[
Z = 0.230 cm
\]

\[
R = \sqrt{3.02^2 + 0.230^2} = 3.03 cm
\]
Q26.  
**Answer B**  
**Explanation**  
\[ \frac{\rho_b V_{bg} - \rho_w V_{wg}}{ \rho_b V_{bg} } = \frac{kx_2}{kx_1} \]  
\[ \frac{x_2}{x_1} = \frac{17}{27} \]

Q27.  
**Answer B**  
**Explanation**  
Absorbent spectrum of light is high of the blue colour

Q28.  
**Answer C**  
**Explanation**  
Basic information of enzymatic activity and data in the table

Q29.  
**Answer C**  
**Explanation**  
1. Explanation: 1: stay the same boiled (dead seeds)  
2. : Soda lime is a chemical that absorbs carbon dioxide  
3. : stay the same boiled (dead seeds)  
The gas pushes the fluid in the syringe

Q30.  
**Answer A**  
**Explanation**  
\[ f_{d1} = fs \left( \frac{v - v_d}{v - v_s} \right) = 500 \left( \frac{343 - 4.00}{343 - 30.0} \right) = 542 \text{ Hz} \]  
\[ f_{d2} = fs \left( \frac{v - v_d}{v - v_s} \right) = 500 \left( \frac{343 - (-4.00)}{343 - (-30.0)} \right) = 465 \text{ Hz} \]  
\[ \Delta f_d = f_{d2} - f_{d1} = 465 - 542 = -0.76 \times 10^2 \text{ Hz} \]
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