

MCAT BONUS - PRACTICE TEST 7

Chemical And Physical Foundations of Biological Systems

Time	Questions
95 minutes	59

PASSAGE 1: Acid-Base Equilibria and Buffer Systems

Buffers resist pH changes when acids or bases are added. A buffer consists of a weak acid (HA) and its conjugate base (A^-), or a weak base and its conjugate acid. The Henderson-Hasselbalch equation relates pH to buffer composition: $pH = pK_a + \log\left(\frac{[A^-]}{[HA]}\right)$.

Buffer capacity depends on the absolute concentrations of buffer components and is maximum when $pH = pK_a$ (ratio = 1:1). Buffers are effective within ± 1 pH unit of the pK_a . The bicarbonate buffer system (H_2CO_3/HCO_3^- , $pK_a = 6.1$) maintains blood pH at 7.4, with a 20:1 ratio of HCO_3^- to H_2CO_3 .

Researchers studied buffer effectiveness:

Buffer A: 0.1 M acetic acid/0.1 M sodium acetate ($pK_a = 4.76$)

Buffer B: 0.5 M acetic acid/0.5 M sodium acetate ($pK_a = 4.76$)

Buffer C: 0.1 M NH_4Cl /0.1 M NH_3 ($pK_a = 9.25$)

Each buffer (100 mL) received additions of 0.01 M HCl or 0.01 M NaOH.

Results after adding 10 mL of 0.01 M HCl:

- Buffer A: pH changed from 4.76 to 4.67 ($\Delta pH = 0.09$)
- Buffer B: pH changed from 4.76 to 4.74 ($\Delta pH = 0.02$)
- Buffer C: pH changed from 9.25 to 9.16 ($\Delta pH = 0.09$)
- Unbuffered water: pH changed from 7.0 to 3.0

Blood pH regulation: Normal blood has $[HCO_3^-] = 24$ mM and $[H_2CO_3] = 1.2$ mM. Metabolic acidosis reduced $[HCO_3^-]$ to 16 mM while $[H_2CO_3]$ remained 1.2 mM.

1. The initial pH of Buffer A is 4.76 because:

- A. The pKa determines buffer pH regardless of concentrations
 - B. Equal acid and base concentrations always produce pH 7
 - C. $\log([A^-]/[HA]) = 0$ when concentrations are equal
 - D. The buffer capacity is at maximum
-

2. Buffer B showed smaller pH change than Buffer A because:

- A. Higher concentrations provide greater buffer capacity
 - B. Buffer B has a different pKa value
 - C. Buffer B is closer to physiological pH
 - D. The Henderson-Hasselbalch equation doesn't apply to Buffer B
-

3. To prepare a buffer at pH 5.76 using acetic acid (pKa = 4.76), the ratio of [acetate]/[acetic acid] should be:

- A. 1:10
 - B. 1:1
 - C. 5:1
 - D. 10:1
-

4. The blood pH in metabolic acidosis with $[HCO_3^-] = 16$ mM and $[H_2CO_3] = 1.2$ mM is approximately:

- A. 6.1
- B. 7.2
- C. 7.4

D. 7.6

5. Buffer C (pKa = 9.25) would be most effective at maintaining pH in which range?

A. 3.25-5.25

B. 7.25-9.25

C. 8.25-10.25

D. 11.25-13.25

6. If 10 mL of 0.01 M NaOH were added to Buffer A instead of HCl, the pH would:

A. Increase by approximately 0.09 units

B. Decrease by approximately 0.09 units

C. Remain exactly 4.76

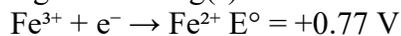
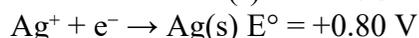
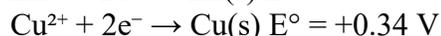
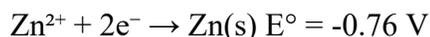
D. Increase to pH 12

PASSAGE 2: Electrochemistry and Galvanic Cells

Galvanic cells generate electrical energy from spontaneous redox reactions. The cell potential (E°_{cell}) equals the difference between cathode and anode reduction potentials: $E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}}$. Positive E°_{cell} indicates spontaneous reactions.

The Nernst equation relates cell potential to concentrations: $E = E^{\circ} - (RT/nF)\ln(Q)$, where Q is the reaction quotient. At 25°C: $E = E^{\circ} - (0.0592/n)\log(Q)$.

Researchers constructed cells using these half-reactions:



Cell 1: Zn | Zn²⁺ (1.0 M) || Cu²⁺ (1.0 M) | Cu

Standard conditions: $E^{\circ}_{\text{cell}} = 1.10 \text{ V}$, spontaneous

Cell 2: Same as Cell 1, but $[\text{Zn}^{2+}] = 0.01 \text{ M}$ and $[\text{Cu}^{2+}] = 1.0 \text{ M}$
Measured: $E = 1.16 \text{ V}$

Cell 3: $\text{Ag} | \text{Ag}^+ (1.0 \text{ M}) || \text{Cu}^{2+} (1.0 \text{ M}) | \text{Cu}$
Measured: $E^\circ_{\text{cell}} = -0.46 \text{ V}$, non-spontaneous under standard conditions

Concentration cell: $\text{Cu} | \text{Cu}^{2+} (0.01 \text{ M}) || \text{Cu}^{2+} (1.0 \text{ M}) | \text{Cu}$
Generated voltage despite identical electrodes

7. In Cell 1 under standard conditions, which statement is correct?

- A. Zinc is reduced at the cathode
 - B. Zinc is oxidized at the anode
 - C. Copper is oxidized at the anode
 - D. No electron flow occurs
-

8. The higher cell potential in Cell 2 ($E = 1.16 \text{ V}$ vs. $E^\circ = 1.10 \text{ V}$) occurs because:

- A. Lower $[\text{Zn}^{2+}]$ increases the driving force for Zn oxidation
 - B. Higher $[\text{Cu}^{2+}]$ decreases the driving force for Cu reduction
 - C. The Nernst equation doesn't apply to this system
 - D. Lower $[\text{Zn}^{2+}]$ shifts equilibrium toward more product formation
-

9. For Cell 3 to become spontaneous, one could:

- A. Reverse the cell so Cu is oxidized and Ag^+ is reduced
 - B. Increase $[\text{Ag}^+]$ concentration dramatically
 - C. Decrease temperature significantly
 - D. Use a salt bridge with different ions
-

10. The concentration cell generates voltage because:

- A. Different electrode materials have different reduction potentials
 - B. Identical electrodes cannot produce current
 - C. Concentration gradient creates a potential difference
 - D. Standard potentials are unequal
-

11. If Fe^{3+} and Fe^{2+} were used to construct a concentration cell with $[\text{Fe}^{3+}] = 0.1 \text{ M}$ and $[\text{Fe}^{2+}] = 1.0 \text{ M}$ in one half-cell, and $[\text{Fe}^{3+}] = 1.0 \text{ M}$ and $[\text{Fe}^{2+}] = 0.1 \text{ M}$ in the other, the cell would:

- A. Generate no voltage because Fe is in both half-cells
 - B. Generate voltage with electrons flowing toward higher $[\text{Fe}^{3+}]$
 - C. Be non-spontaneous under all conditions
 - D. Have $E^\circ_{\text{cell}} = 0.77 \text{ V}$
-

PASSAGE 3: Chemical Kinetics and Reaction Mechanisms

Reaction rate depends on reactant concentrations according to the rate law: $\text{Rate} = k[\text{A}]^m[\text{B}]^n$, where m and n are reaction orders (determined experimentally, not from stoichiometry). Overall order = $m + n$.

Integrated rate laws relate concentration to time. Zero-order: $[\text{A}] = -kt + [\text{A}]_0$. First-order: $\ln[\text{A}] = -kt + \ln[\text{A}]_0$. Second-order: $1/[\text{A}] = kt + 1/[\text{A}]_0$.

Half-life ($t_{1/2}$) formulas: Zero-order: $t_{1/2} = [\text{A}]_0/2k$. First-order: $t_{1/2} = 0.693/k$ (concentration-independent). Second-order: $t_{1/2} = 1/k[\text{A}]_0$.

Multi-step mechanisms have a rate-determining step (slowest) that controls overall rate. The mechanism must be consistent with the observed rate law.

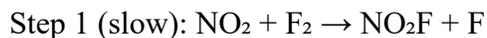
Researchers studied the reaction: $2\text{NO}_2 + \text{F}_2 \rightarrow 2\text{NO}_2\text{F}$

Experimental data:

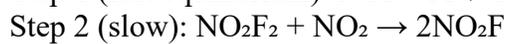
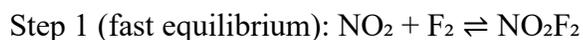
[NO ₂] (M)	[F ₂] (M)	Initial Rate (M/s)
0.10	0.10	2.0×10^{-4}
0.20	0.10	4.0×10^{-4}
0.20	0.20	8.0×10^{-4}

Proposed mechanisms:

Mechanism A:



Mechanism B:



Temperature study: Rate constant doubled when temperature increased from 300 K to 310 K.

12. The experimental rate law for this reaction is:

- A. Rate = $k[\text{NO}_2][\text{F}_2]$
 - B. Rate = $k[\text{NO}_2]^2[\text{F}_2]$
 - C. Rate = $k[\text{NO}_2][\text{F}_2]^2$
 - D. Rate = $k[\text{NO}_2]^2[\text{F}_2]^2$
-

13. Mechanism A is consistent with the experimental rate law because:

- A. The stoichiometry matches the overall reaction
 - B. Both steps involve NO₂
 - C. The slow step rate depends on [NO₂] and [F₂]
 - D. Fast steps don't affect the rate law
-

14. If this reaction follows first-order kinetics in [NO₂] only, the half-life would:

- A. Double when $[\text{NO}_2]$ doubles
 - B. Remain constant regardless of $[\text{NO}_2]$
 - C. Decrease when $[\text{NO}_2]$ increases
 - D. Depend on both $[\text{NO}_2]$ and $[\text{F}_2]$
-

15. The rate constant doubling from 300 K to 310 K suggests:

- A. Zero activation energy
 - B. Low activation energy (high sensitivity to temperature)
 - C. The reaction is exothermic
 - D. The mechanism changes with temperature
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16. For Mechanism B to be consistent with $\text{Rate} = k[\text{NO}_2][\text{F}_2]$, the equilibrium constant for Step 1 must:

- A. Appear in the rate expression such that $[\text{NO}_2\text{F}_2]$ can be substituted
 - B. Equal zero
 - C. Be independent of temperature
 - D. Exceed 1.0
-

17. A plot of $1/[\text{NO}_2]$ vs. time yielding a straight line would indicate:

- A. Zero-order kinetics in $[\text{NO}_2]$
 - B. First-order kinetics in $[\text{NO}_2]$
 - C. Second-order kinetics in $[\text{NO}_2]$
 - D. The reaction is at equilibrium
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PASSAGE 4: Thermodynamics and Spontaneity

Gibbs free energy determines reaction spontaneity: $\Delta G = \Delta H - T\Delta S$. Negative ΔG indicates spontaneous reactions; positive ΔG indicates non-spontaneous reactions. At equilibrium, $\Delta G = 0$.

The relationship between ΔG° and K : $\Delta G^\circ = -RT \ln(K)$. Large K (>1) gives negative ΔG° (product-favored). Small K (<1) gives positive ΔG° (reactant-favored).

Actual conditions: $\Delta G = \Delta G^\circ + RT \ln(Q)$, where Q is the reaction quotient.

Temperature effects:

- $\Delta H < 0, \Delta S > 0$: Always spontaneous
- $\Delta H > 0, \Delta S < 0$: Never spontaneous
- $\Delta H < 0, \Delta S < 0$: Spontaneous at low T
- $\Delta H > 0, \Delta S > 0$: Spontaneous at high T

Researchers examined phase transitions:

$\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$ at various conditions:

- $\Delta H^\circ = +44 \text{ kJ/mol}$ (endothermic)
- $\Delta S^\circ = +119 \text{ J/(mol}\cdot\text{K)}$

Calculations:

- At 298 K: $\Delta G = +44 - 298(0.119) = +8.5 \text{ kJ/mol}$ (non-spontaneous)
- At 373 K: $\Delta G = +44 - 373(0.119) = -0.4 \text{ kJ/mol}$ (spontaneous)
- At 373 K (boiling): liquid and vapor coexist at equilibrium

Coupled reactions:

Reaction 1: $\text{Glucose} + \text{P}_i \rightarrow \text{Glucose-6-phosphate}$ $\Delta G^\circ = +14 \text{ kJ/mol}$

Reaction 2: $\text{ATP} \rightarrow \text{ADP} + \text{P}_i$ $\Delta G^\circ = -30 \text{ kJ/mol}$

Combined: $\text{Glucose} + \text{ATP} \rightarrow \text{Glucose-6-phosphate} + \text{ADP}$ $\Delta G^\circ = -16 \text{ kJ/mol}$

18. Water boiling at 373 K has $\Delta G = 0$ because:

- A. ΔH equals zero at boiling point
- B. ΔS equals zero at boiling point
- C. Both phases coexist at equilibrium

D. The $T\Delta S$ term exactly equals ΔH

19. At 298 K, water evaporation is non-spontaneous ($\Delta G > 0$), yet water still evaporates because:

- A. ΔG° applies only to standard conditions; vapor pressure is less than 1 atm
 - B. The actual ΔG under non-standard conditions can be negative
 - C. Endothermic reactions cannot occur at low temperatures
 - D. ΔS compensates for positive ΔH at all temperatures
-

20. The coupled reaction mechanism works because:

- A. ATP hydrolysis provides energy to overcome endergonic glucose phosphorylation
 - B. Glucose phosphorylation releases energy used for ATP synthesis
 - C. The combined ΔG° is positive, driving the reaction backward
 - D. ΔH and ΔS both favor the reaction
-

21. For a reaction with $\Delta H^\circ = -50$ kJ/mol and $\Delta S^\circ = -150$ J/(mol·K), spontaneity will:

- A. Occur at all temperatures
 - B. Occur only at low temperatures ($T\Delta S$ term is small)
 - C. Occur only at high temperatures
 - D. Never occur at any temperature
-

22. If $Q > K$ for a reaction, then:

- A. $\Delta G = 0$ and the system is at equilibrium
- B. $\Delta G < 0$ and the forward reaction is spontaneous

C. $\Delta G > 0$ and the forward reaction is non-spontaneous

D. $\Delta G > 0$ and the reverse reaction is spontaneous

PASSAGE 5: Atomic Structure and Spectroscopy

Electrons in atoms occupy quantized energy levels described by quantum numbers: n (principal), l (angular momentum), m_l (magnetic), and m_s (spin). The energy of hydrogen electron: $E = -13.6 \text{ eV}/n^2$.

Emission spectra result from electrons dropping to lower energy levels, releasing photons: $\Delta E = hf = hc/\lambda$. Absorption spectra show electrons excited to higher levels.

The Balmer series (visible light) involves transitions to $n = 2$. The Lyman series (UV) involves transitions to $n = 1$. The Paschen series (IR) involves transitions to $n = 3$.

Photoelectron spectroscopy (PES) measures electron binding energies. Peaks represent electrons from different orbitals, with peak heights proportional to electron numbers.

Researchers studied hydrogen emission:

Transition A: $n = 3 \rightarrow n = 2$

Energy released: 1.89 eV, wavelength: 656 nm (red light, Balmer series)

Transition B: $n = 4 \rightarrow n = 2$

Energy released: 2.55 eV, wavelength: 486 nm (blue-green light, Balmer series)

Transition C: $n = 2 \rightarrow n = 1$

Energy released: 10.2 eV, wavelength: 122 nm (UV, Lyman series)

PES of carbon showed three peaks:

- 1s electrons: binding energy 290 eV (2 electrons)
 - 2s electrons: binding energy 19 eV (2 electrons)
 - 2p electrons: binding energy 11 eV (2 electrons)
-

23. The energy of an $n = 3$ electron in hydrogen is:

A. -13.6 eV

B. -1.51 eV

C. -3.4 eV

D. +1.51 eV

24. Transition A releases less energy than Transition C because:

- A. The energy difference between $n = 3$ and $n = 2$ is smaller than between $n = 2$ and $n = 1$
 - B. Balmer series photons have less energy than Lyman series photons
 - C. Red light has longer wavelength than UV light
 - D. All of the above are correct
-

25. The wavelength of Transition B (486 nm) is shorter than Transition A (656 nm) because:

- A. $n = 4$ is higher energy than $n = 3$
 - B. The starting state has lower energy
 - C. Blue-green light has lower frequency than red light
 - D. Greater energy transitions produce shorter wavelengths ($E = hc/\lambda$)
-

26. Carbon's PES shows 2s electrons have higher binding energy than 2p electrons because:

- A. 2s electrons are in a higher energy level
 - B. 2p electrons are farther from the nucleus on average
 - C. 2s electrons penetrate closer to the nucleus
 - D. 2p orbitals hold more electrons
-

27. If a hydrogen electron is excited from $n = 1$ to $n = 3$, the energy required is:

- A. 1.51 eV
- B. 12.1 eV

C. 13.6 eV

D. 15.1 eV

28. The ionization energy of hydrogen (removing $n = 1$ electron completely) is:

A. 13.6 eV, the difference between $n = 1$ and $n = \infty$

B. 1.51 eV

C. 10.2 eV

D. 27.2 eV

PASSAGE 6: Organic Chemistry Reactions

SN2 reactions proceed through backside nucleophilic attack with inversion of configuration. Rate = $k[\text{substrate}][\text{nucleophile}]$. Favored by: primary substrates, strong nucleophiles, polar aprotic solvents.

SN1 reactions proceed through carbocation intermediates, producing racemic mixtures. Rate = $k[\text{substrate}]$. Favored by: tertiary substrates, weak nucleophiles, polar protic solvents.

E2 eliminations occur through concerted mechanisms requiring anti-periplanar geometry. Rate = $k[\text{substrate}][\text{base}]$. Favored by: strong bases, high temperatures.

E1 eliminations proceed through carbocation intermediates following Zaitsev's rule (most substituted alkene preferred).

Researchers studied reactions of 2-bromo-2-methylbutane:

Reaction 1: With CH_3O^- in CH_3OH at 25°C

Products: 85% elimination (2-methyl-2-butene major), 15% substitution

Substitution product: racemic mixture

Reaction 2: With CH_3O^- in DMSO (polar aprotic) at 25°C

Products: 40% elimination, 60% substitution

Substitution product: racemic mixture

Reaction 3: With I^- in acetone at 25°C

Products: 95% substitution, 5% elimination

Substitution product: racemic mixture

Reaction 4: 1-bromopropane with CH_3O^- in DMSO at 25°C
Products: 95% substitution (pure inversion), 5% elimination

29. 2-bromo-2-methylbutane (tertiary) forms racemic substitution products through:

- A. $\text{S}_\text{N}2$ mechanism with frontside and backside attacks
 - B. $\text{E}2$ mechanism producing both stereoisomers
 - C. $\text{S}_\text{N}1$ mechanism with planar carbocation intermediate
 - D. Simultaneous $\text{S}_\text{N}1$ and $\text{S}_\text{N}2$ mechanisms
-

30. Reaction 2 (DMSO) gave more substitution than Reaction 1 (CH_3OH) because:

- A. DMSO is a better leaving group
 - B. Tertiary substrates react faster in aprotic solvents
 - C. $\text{E}2$ is favored in protic solvents
 - D. Polar aprotic solvents don't solvate nucleophiles strongly, increasing $\text{S}_\text{N}1/\text{E}1$ relative to $\text{E}2$
-

31. Reaction 3 with I^- gave mostly substitution because:

- A. I^- is a strong base favoring elimination
 - B. I^- is a good nucleophile but weak base, favoring substitution
 - C. Iodine is a poor leaving group
 - D. $\text{S}_\text{N}2$ occurs on tertiary substrates
-

32. 1-bromopropane (primary) giving inversion in Reaction 4 indicates:

- A. $\text{S}_\text{N}2$ mechanism with backside attack
- B. $\text{S}_\text{N}1$ mechanism with carbocation rearrangement

C. E2 mechanism with anti-periplanar geometry

D. Free radical substitution

33. The major elimination product being 2-methyl-2-butene (more substituted) follows:

A. Markovnikov's rule

B. Hofmann elimination

C. Zaitsev's rule favoring more stable, substituted alkene

D. Anti-Markovnikov addition

PASSAGE 7: Gas Laws and Kinetic Molecular Theory

Ideal gas law: $PV = nRT$. Real gases deviate at high pressure (molecular volume significant) and low temperature (intermolecular forces significant).

Kinetic molecular theory assumptions: gas particles have negligible volume, no intermolecular forces, constant random motion, elastic collisions, average kinetic energy proportional to temperature ($KE = 3/2 RT$).

Dalton's law: $P_{total} = P_1 + P_2 + \dots$ (partial pressures are additive). Partial pressure: $P_1 = X_1 P_{total}$, where X_1 is mole fraction.

Graham's law: diffusion/effusion rates are inversely proportional to $\sqrt{\text{(molar mass)}}$.

Van der Waals equation corrects for real gas behavior: $(P + a n^2/V^2)(V - nb) = nRT$, where 'a' corrects for intermolecular forces and 'b' corrects for molecular volume.

Researchers studied gas behavior:

Experiment 1: 2 moles of gas in 10 L container at 300 K

Ideal gas calculation: $P = 4.9 \text{ atm}$

Measured pressure: 4.7 atm (below ideal)

Experiment 2: Same conditions at 100 K

Ideal gas calculation: $P = 1.6 \text{ atm}$

Measured pressure: 1.2 atm (significantly below ideal)

Experiment 3: Container filled with 1 mole N_2 and 2 moles O_2 at 1.0 atm total
 N_2 partial pressure: 0.33 atm
 O_2 partial pressure: 0.67 atm

Experiment 4: Effusion rates measured
He (molar mass 4 g/mol) effused $2\times$ faster than a heavier gas

34. The measured pressure being lower than ideal at 300 K indicates:

- A. Intermolecular attractive forces reduce pressure
 - B. Molecular volume increases pressure
 - C. Temperature is too high for ideal behavior
 - D. The gas is behaving ideally
-

35. The greater deviation at 100 K (Experiment 2) occurs because:

- A. Higher temperature increases kinetic energy
 - B. Molecular volume becomes insignificant
 - C. Intermolecular forces become more significant at lower temperature
 - D. Gases behave more ideally at low temperature
-

36. The molar mass of the heavier gas in Experiment 4 is approximately:

- A. 8 g/mol
 - B. 12 g/mol
 - C. 2 g/mol
 - D. 16 g/mol
-

37. If the container in Experiment 3 was heated to double the temperature (constant volume), the total pressure would:

- A. Remain 1.0 atm
 - B. Increase to approximately 2.0 atm
 - C. Decrease to 0.5 atm
 - D. Increase to 4.0 atm
-

38. Using the Van der Waals equation, the 'a' term correction (an^2/V^2) is:

- A. Added to measured pressure to account for attractive forces
 - B. Subtracted from measured pressure
 - C. Added to volume
 - D. Irrelevant for real gases
-

PASSAGE 8: Thermochemistry and Calorimetry

Enthalpy change (ΔH) measures heat transferred at constant pressure. Exothermic reactions have negative ΔH (release heat); endothermic reactions have positive ΔH (absorb heat).

Hess's law: total enthalpy change is independent of pathway. ΔH for a reaction can be calculated from ΔH°_f (standard heats of formation): $\Delta H^\circ_{\text{rxn}} = \Sigma \Delta H^\circ_f(\text{products}) - \Sigma \Delta H^\circ_f(\text{reactants})$.

Calorimetry measures heat changes. Heat capacity (C) relates heat absorbed to temperature change: $q = C\Delta T$. Specific heat capacity (c) is per gram: $q = mc\Delta T$.

Bond enthalpy approach: $\Delta H \approx \Sigma(\text{bonds broken}) - \Sigma(\text{bonds formed})$. Energy is required to break bonds (positive) and released when forming bonds (negative).

Researchers performed calorimetry experiments:

Experiment 1: 50.0 g of metal at 100°C placed in 100 g water at 20°C ($c_{\text{water}} = 4.18 \text{ J/g}^\circ\text{C}$)

Final temperature: 25°C

Metal specific heat calculated: 0.45 J/g°C

Experiment 2: Combustion of 1.0 g glucose in bomb calorimeter ($C = 10 \text{ kJ/}^\circ\text{C}$)
Temperature increased 1.56°C
Heat released: 15.6 kJ/g

Reaction enthalpies given:

- $\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} \Delta H^\circ = -394 \text{ kJ/mol}$
- $\text{H}_2\text{(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)} \Delta H^\circ = -286 \text{ kJ/mol}$
- $\text{C}_6\text{H}_{12}\text{O}_6\text{(s)} \rightarrow 6\text{C(s)} + 6\text{H}_2\text{(g)} + 3\text{O}_2\text{(g)} \Delta H^\circ = +1260 \text{ kJ/mol}$

Bond energies:

- C-H: 413 kJ/mol
 - C=O: 799 kJ/mol
 - O=O: 498 kJ/mol
 - O-H: 463 kJ/mol
-

39. In Experiment 1, heat lost by the metal equals heat gained by water because:

- A. Both have the same mass
 - B. Both reach the same final temperature
 - C. The specific heats are equal
 - D. Energy is conserved in an isolated system
-

40. The combustion of glucose is exothermic because:

- A. Bonds in products are stronger than bonds in reactants
 - B. Bonds are broken during combustion
 - C. Temperature increases during reaction
 - D. Glucose is an organic compound
-

41. Using Hess's law, the enthalpy of combustion for glucose is:

- A. Equal to the sum of formation enthalpies of products

B. Calculated from: $6(\Delta H^{\circ}f \text{ CO}_2) + 6(\Delta H^{\circ}f \text{ H}_2\text{O}) - \Delta H^{\circ}f \text{ glucose}$

C. Independent of reaction pathway but requires $\Delta H^{\circ}f$ values

D. Both B and C are correct

42. If a reaction requires breaking 4 C-H bonds and 2 O=O bonds, then forming 4 C=O bonds and 4 O-H bonds, the ΔH is approximately:

A. -318 kJ (exothermic)

B. +318 kJ (endothermic)

C. -1652 kJ

D. +1652 kJ

43. The bomb calorimeter measures q_v (constant volume), which approximates ΔH because:

A. Volume change work is negligible for condensed phases

B. $P\Delta V \approx 0$ for reactions with small gas volume changes

C. Temperature change is small

D. The calorimeter is isolated

44. To calculate the specific heat of the metal, the experimenter used:

A. Heat lost by metal = mass \times specific heat $\times \Delta T$

B. Heat gained by water = $100 \times 4.18 \times 5$

C. Set heat lost equal to heat gained

D. All of the above

DISCRETE QUESTIONS (45-59)

45. Which compound has the highest boiling point?

- A. CH₄ (methane)
 - B. NH₃ (ammonia)
 - C. H₂O (water)
 - D. HF (hydrogen fluoride)
-

46. The oxidation state of sulfur in H₂SO₄ is:

- A. +6
 - B. +4
 - C. -2
 - D. +2
-

47. Which molecule is nonpolar despite having polar bonds?

- A. H₂O
 - B. NH₃
 - C. CH₄
 - D. CO₂
-

48. In the reaction: $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$, how many moles of AlCl₃ form from 4 moles of Al?

- A. 2 moles
- B. 4 moles
- C. 6 moles

D. 8 moles

49. The number of electrons that can occupy the $n = 3$ shell is:

A. 2

B. 8

C. 18

D. 32

50. Which represents a Lewis acid?

A. BF_3 (electron pair acceptor)

B. NH_3 (electron pair donor)

C. OH^- (proton acceptor)

D. H_2O (can donate or accept protons)

51. The hybridization of carbon in CO_2 ($\text{O}=\text{C}=\text{O}$) is:

A. sp

B. sp^2

C. sp^3

D. sp^3d

52. Increasing pressure shifts the equilibrium of $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ toward:

A. Reactants (more moles of gas)

B. Products (fewer moles of gas)

- C. Neither direction
 - D. Left initially, then right
-

53. The conjugate base of H_2PO_4^- is:

- A. H_3PO_4
 - B. PO_4^{3-}
 - C. HPO_4^{2-}
 - D. H_2O
-

54. Which has the largest atomic radius?

- A. Na (sodium)
 - B. Mg (magnesium)
 - C. Al (aluminum)
 - D. Si (silicon)
-

55. In a titration, the equivalence point occurs when:

- A. pH equals 7.0
 - B. Indicator changes color
 - C. Moles of acid equal moles of base
 - D. Half the acid is neutralized
-

56. The rate-determining step in a mechanism is:

- A. The fastest step

- B. The slowest step
 - C. The first step
 - D. The step with the highest activation energy
-

57. Which represents an aldehyde functional group?

- A. R-OH
 - B. R-COOH
 - C. R-CHO
 - D. R-CO-R
-

58. London dispersion forces result from:

- A. Permanent dipole-dipole interactions
 - B. Hydrogen bonding
 - C. Temporary dipoles from electron distribution fluctuations
 - D. Ionic attractions
-

59. The pH of a 0.01 M HCl solution is:

- A. 1
- B. 2
- C. 12
- D. 13

Critical Analysis and Reasoning Skills (CARS)

Time	Questions
90 minutes	53

PASSAGE 1: The Value of Failure in Innovation

Contemporary culture celebrates success while stigmatizing failure. Yet innovation requires experimentation, and experimentation inevitably produces failures. Organizations that punish failure create risk-averse cultures where employees avoid novel approaches, preferring safe, incremental improvements over breakthrough innovations.

Silicon Valley's "fail fast" philosophy recognizes that rapid iteration through multiple failures enables faster learning than prolonged attempts to perfect a single approach. Each failure provides information about what doesn't work, narrowing the solution space. Thomas Edison's famous observation about inventing the light bulb—finding ten thousand ways that don't work—illustrates this perspective.

However, not all failures are equally valuable. Intelligent failures result from thoughtful experiments in novel territories where outcomes are uncertain. Preventable failures stem from inattention or deviation from known processes. Basic failures occur when established methods are applied to situations requiring innovation. Only intelligent failures merit celebration; the others represent waste.

Organizations must distinguish between these failure types. Celebrating all failures encourages carelessness. Punishing all failures stifles innovation. The key is creating psychological safety: environments where people can take calculated risks, report failures honestly, and learn collectively without fear of punishment—while maintaining accountability for preventable failures.

Some argue this framework is too lenient, that accountability requires consequences for all failures. Others contend that even "intelligent failures" should be minimized through better planning. Yet both positions misunderstand innovation's inherently uncertain nature. No amount of planning eliminates uncertainty in genuinely novel endeavors.

The challenge lies in implementation. Leaders often claim to value intelligent failure while subtly punishing those who fail. Promotion decisions, performance reviews, and resource allocation reveal true priorities. Until organizations reward intelligent risk-taking regardless of outcome, innovation will remain constrained.

1. The primary purpose of this passage is to:

- A. Argue that all failures should be celebrated equally
 - B. Distinguish between valuable and wasteful failures in organizational contexts
 - C. Prove that Silicon Valley's approach is superior to traditional methods
 - D. Demonstrate that planning cannot prevent failures
-

2. According to the passage, "intelligent failures" are characterized by:

- A. Occurring in established processes with known solutions
 - B. Resulting from carelessness or inattention to detail
 - C. Happening only in Silicon Valley companies
 - D. Emerging from thoughtful experiments in uncertain, novel situations
-

3. The author's attitude toward celebrating all failures is:

- A. Critical, because it fails to distinguish between valuable learning and waste
 - B. Supportive, because any failure teaches something valuable
 - C. Neutral, presenting both perspectives without judgment
 - D. Dismissive, considering failure celebration a Silicon Valley fad
-

4. The passage suggests that psychological safety in organizations means:

- A. Eliminating all accountability for failures
 - B. Protecting employees from dismissal under any circumstances
 - C. Enabling calculated risks and honest reporting without fear of punishment for intelligent failures
 - D. Celebrating all failures regardless of type
-

5. The author would most likely agree that:

- A. Innovation is possible without any failures
 - B. Organizations' actions often contradict their stated values about failure
 - C. All failures provide equal learning value
 - D. Planning can eliminate uncertainty in innovation
-

6. The comparison to Thomas Edison serves to:

- A. Prove that only famous inventors benefit from failure
 - B. Suggest that light bulb invention was inefficient
 - C. Demonstrate that modern innovation differs from historical examples
 - D. Illustrate that multiple failures can lead to breakthrough success
-

PASSAGE 2: The Paradox of Choice in Healthcare

Patient autonomy dominates medical ethics. Informed consent requires physicians to present treatment options, enabling patients to choose based on personal values. Yet research reveals that extensive choice can impair decision-making, particularly in stressful medical contexts where patients lack expertise to evaluate options meaningfully.

When facing serious diagnoses, patients often experience decision paralysis. A study of cancer patients offered multiple treatment protocols found that those given more choices reported higher anxiety and lower satisfaction than those whose physicians recommended specific treatments while remaining open to patient preferences.

This doesn't mean paternalism should replace autonomy. Rather, it suggests that autonomy is better served by collaborative decision-making where physicians guide patients through options while respecting individual circumstances. The goal is informed decisions, not overwhelming patients with choices they feel unequipped to make.

Critics argue that limiting choices patronizes patients. But offering ten treatment variations differing in subtle, technical ways doesn't enhance autonomy—it burdens patients already managing emotional and physical challenges. True autonomy means having genuine input on decisions that matter, not being forced to adjudicate technical questions beyond one's expertise.

The medical community must reconsider how to honor autonomy. Presenting every possible option may satisfy legal requirements while undermining patient welfare. Physicians should frame choices at appropriate levels: offering genuine alternatives that reflect different values or priorities while providing expert guidance on technical details.

7. The passage's central claim is that:

- A. Paternalism is superior to patient autonomy in medical decisions
 - B. Legal requirements for informed consent harm patients
 - C. Extensive choice can paradoxically undermine effective patient autonomy
 - D. Physicians should make all medical decisions without patient input
-

8. The cancer patient study is used to demonstrate that:

- A. More treatment choices correlate with higher anxiety and lower satisfaction
 - B. Cancer patients prefer paternalistic physicians
 - C. Informed consent should be eliminated
 - D. All patients want physicians to make decisions for them
-

9. The author's proposed solution involves:

- A. Eliminating all patient choice from medical decisions
 - B. Requiring physicians to present every possible treatment variation
 - C. Maintaining legal informed consent requirements unchanged
 - D. Collaborative decision-making where physicians guide patients while respecting values
-

10. Critics of limiting patient choices would argue that it:

- A. Violates legal informed consent requirements

- B. Patronizes patients by restricting their autonomy
 - C. Reduces physician liability in malpractice cases
 - D. Improves patient satisfaction universally
-

11. According to the passage, true autonomy in healthcare means:

- A. Being presented with every technically possible option
 - B. Making decisions without any physician guidance
 - C. Having meaningful input on values-based decisions without being overwhelmed by technical details
 - D. Deferring all decisions to medical experts
-

12. The author would most likely support a physician who:

- A. Presents all treatment options without recommendations
 - B. Makes treatment decisions without consulting patients
 - C. Explains two treatments reflecting different value priorities and recommends one
 - D. Refuses to discuss alternatives once a decision is made
-

PASSAGE 3: Digital Permanence and the Right to Be Forgotten

The internet creates permanent records. Youthful indiscretions, embarrassing moments, and outdated information persist indefinitely, accessible to employers, acquaintances, and strangers. This digital permanence conflicts with human development—people change, mature, and deserve opportunities for reinvention unencumbered by permanent digital scarlet letters.

The "right to be forgotten," recognized in some jurisdictions, allows individuals to request removal of certain personal information from search results. Proponents argue this enables people to move beyond past mistakes without permanent digital punishment. Critics contend it constitutes censorship, erasing accurate historical records to serve individual image management.

The debate reveals tensions between privacy, free expression, and historical accuracy. Should a reformed criminal have articles about decades-old convictions delisted? Should politicians erase

embarrassing statements from their youth? Should revenge porn victims have explicit images removed from search results?

These cases differ morally even if legally similar. Revenge porn involves non-consensual intimate images—removal protects victims. Delisting old criminal convictions might aid rehabilitation while potentially concealing relevant information from, say, employers hiring for positions involving trust. Politicians' past statements arguably remain relevant to public evaluation of their character and consistency.

Rather than blanket rules, implementation requires nuanced judgment considering: time elapsed, information relevance, public figure status, consent in original disclosure, and harm from continued availability. This case-by-case approach frustrates those seeking clear principles but reflects the genuine complexity of balancing competing values.

Technology companies resist these obligations, citing resource costs and philosophical opposition to content removal. Yet their platforms created the permanence problem. If they profit from aggregating information, they bear responsibility for addressing harms that aggregation enables.

13. The passage's main purpose is to:

- A. Examine the complexities of balancing privacy and free expression in digital information removal
- B. Argue that all personal information should be removable from the internet
- C. Defend technology companies' resistance to content removal obligations
- D. Prove that the right to be forgotten is impossible to implement

14. The author's mention of "digital scarlet letters" suggests that:

- A. Puritan values should influence internet policy
- B. Historical literature is relevant to technology debates
- C. Permanent digital records can stigmatize people unfairly based on past actions
- D. The internet should be regulated like colonial-era communities

15. According to the passage, revenge porn removal differs from delisting politicians' statements because:

- A. Politicians have no privacy rights
 - B. Revenge porn involves non-consensual intimate images harming victims
 - C. Political speech receives absolute protection
 - D. Only illegal content can be removed from search results
-

16. The author's position on implementing the right to be forgotten is:

- A. Oppose it entirely as censorship
 - B. Support blanket removal of any requested information
 - C. Apply clear, universal principles without exceptions
 - D. Use case-by-case judgment considering multiple factors
-

17. The passage suggests technology companies should bear responsibility for removal requests because:

- A. They are wealthy enough to afford the costs
 - B. Government regulation requires it
 - C. Their platforms created and profit from the permanence problem
 - D. Users explicitly agreed to this responsibility in terms of service
-

18. The author would most likely support removing which content?

- A. A politician's decade-old policy position
 - B. Accurate reporting of a public official's corruption conviction
 - C. Non-consensual intimate images of a private individual
 - D. Critical reviews of a business owner's company
-

PASSAGE 4: The Myth of Multitasking

The term "multitasking" originated in computing, describing processors handling multiple tasks. Applied to humans, it's misleading. Human brains don't process multiple complex tasks simultaneously—they rapidly switch attention between tasks, a process better termed "task-switching."

Each switch carries cognitive costs. The brain requires time to disengage from one task, shift focus, and re-engage with another. These transition costs accumulate, reducing efficiency despite the subjective feeling of productive multitasking. Studies show that people who believe they're effective multitaskers often perform worse than those who focus on single tasks.

The myth persists because task-switching can feel efficient. Checking email while on conference calls, reviewing documents while listening to presentations—these behaviors provide stimulation and a sense of productivity. Yet they typically result in poor comprehension of both activities and increased errors.

Certain activities can be combined successfully: walking while talking, or listening to music while exercising. These pairings work because one task is automatic, requiring minimal conscious attention. The problem arises when both tasks demand significant cognitive resources, particularly working memory and attention.

Organizational cultures often encourage multitasking through constant connectivity expectations, back-to-back meetings, and glorification of "juggling multiple priorities." This creates workers who are perpetually reactive, switching between urgent demands without sustained focus on important work requiring deep thought.

The solution isn't eliminating all task-switching—sometimes interruptions are necessary. Rather, individuals and organizations should recognize multitasking's costs, protect time for focused work, and resist glorifying scattered attention as efficiency. Paradoxically, doing less simultaneously often accomplishes more.

19. The passage's primary argument is that:

- A. All task-switching should be eliminated from work environments
- B. Multitasking is effective when tasks are automatic
- C. Technology should prevent people from multitasking
- D. Human "multitasking" is actually inefficient task-switching with cognitive costs

20. According to the passage, people who consider themselves effective multitaskers often:

- A. Perform better than single-task focused individuals
 - B. Actually perform worse than those who focus on single tasks
 - C. Have unique brain structures enabling true multitasking
 - D. Work in industries that require simultaneous task processing
-

21. Walking while talking is used as an example to illustrate:

- A. That all multitasking is impossible
 - B. The dangers of divided attention
 - C. That automatic tasks can be combined with cognitive tasks successfully
 - D. Why people believe they can multitask effectively with complex tasks
-

22. The author suggests that organizational cultures contribute to ineffective multitasking by:

- A. Providing proper training in task-switching techniques
 - B. Protecting time for focused, uninterrupted work
 - C. Encouraging single-task focus and deep work
 - D. Creating constant connectivity expectations and glorifying scattered attention
-

23. The passage indicates that task-switching feels efficient because:

- A. It actually is more efficient than single-tasking
 - B. It provides stimulation and subjective sense of productivity
 - C. Brain chemistry rewards switching between tasks
 - D. It results in better comprehension and fewer errors
-

24. The author would most likely support an organization that:

- A. Bans all meetings and email communication
 - B. Establishes protected time blocks for focused work on complex tasks
 - C. Requires employees to work on multiple projects simultaneously
 - D. Measures productivity by number of tasks initiated per hour
-

PASSAGE 5: Artistic Intention and Interpretation

When interpreting art, should the creator's intended meaning determine the work's significance, or can artworks mean things their creators never intended? The intentionalist position argues that without access to authorial intent, interpretation becomes arbitrary—anything can mean anything. The anti-intentionalist view holds that works, once created, exist independently of creators' psychology, with meanings emerging from interaction between text and interpreter.

Consider a painting depicting a stormy sea. The artist intended it as a meditation on mortality. A viewer, unaware of this intention, experiences it as expressing nature's sublime power. Which interpretation is "correct"? Intentionalists say the mortality reading is right because it matches authorial intent. Anti-intentionalists argue both readings are valid if supported by the work's features.

This debate has practical implications. Literary criticism sometimes searches for biographical evidence of authors' intentions. Film interpretation considers directors' commentary. Museum labels explain artists' stated purposes. But this approach faces problems: artists may be mistaken about their own intentions, intentions may be unconscious, and successful communication doesn't require access to the speaker's psychology.

Furthermore, privileging intention constrains interpretation. Shakespeare couldn't have intended his works to reflect psychoanalytic theory (which didn't exist), yet Freudian readings can illuminate aspects of the plays. Should we reject these insights because Shakespeare couldn't have consciously intended them?

A moderate position suggests distinguishing between meaning (what the work says) and significance (what it means to particular interpreters in specific contexts). The work's meaning is constrained by linguistic and cultural conventions available when created, while significance varies across interpreters and contexts. This preserves some role for intention while permitting multiple valid interpretations.

25. The passage's main purpose is to:

- A. Argue that authorial intention is irrelevant to interpretation

- B. Examine competing views about the role of creator intention in art interpretation
 - C. Prove that anti-intentionalism is the only defensible position
 - D. Demonstrate that all interpretations are equally valid
-

26. According to intentionalists in the passage:

- A. Artists are always aware of their true intentions
 - B. Multiple interpretations are preferable to single readings
 - C. Biographical evidence is irrelevant to art interpretation
 - D. Without access to authorial intent, interpretation becomes arbitrary
-

27. The stormy sea painting example illustrates that:

- A. Only one interpretation of any artwork can be correct
 - B. Artists' intentions should be ignored completely
 - C. Biographical research is necessary for all art interpretation
 - D. Different viewers can derive different valid meanings from the same work
-

28. The Freudian reading of Shakespeare is used to demonstrate that:

- A. Shakespeare anticipated psychoanalytic theory
 - B. All psychological interpretations are anachronistic
 - C. Valuable insights can emerge from interpretive frameworks unavailable to the original creator
 - D. Historical context is irrelevant to literature
-

29. The moderate position described in the passage proposes:

- A. Complete rejection of authorial intention
 - B. Distinguishing between a work's meaning and its variable significance to interpreters
 - C. That only meanings intended by the creator are legitimate
 - D. Eliminating all interpretive constraints
-

30. The author's tone regarding the intention debate is best described as:

- A. Strongly advocating for intentionalism
 - B. Dismissive of both positions as outdated
 - C. Hostile toward anti-intentionalist interpretation
 - D. Balanced, presenting strengths and weaknesses of different positions
-

PASSAGE 6: Economic Inequality and Social Mobility

Rising economic inequality poses challenges beyond wealth distribution. It threatens social mobility—the ability to move between economic classes. When inequality is extreme, the rungs of the economic ladder are far apart, making upward movement difficult even with talent and effort.

Children born into poverty face compounding disadvantages: under-resourced schools, limited social networks, inadequate healthcare, and neighborhood violence. These factors predict outcomes independent of individual ability. Meanwhile, wealthy children benefit from superior schools, enrichment activities, family connections, and resources that buffer setbacks.

Some argue that inequality drives ambition, that people work harder when rewards are substantial. But extreme inequality does the opposite, making advancement seem impossibly distant and therefore not worth pursuing. Moderate inequality may motivate, but when the gap becomes vast, it demoralizes.

The "American Dream" narrative holds that anyone can succeed through hard work. This ideology serves important functions, encouraging effort and providing hope. But when mobility decreases while the myth persists, it produces harmful effects: the poor blame themselves for structural inequalities, and the wealthy attribute success entirely to merit rather than recognizing advantages.

Societies with lower inequality show higher mobility. This isn't coincidental—reducing the gap between rungs makes climbing feasible. Nordic countries combine modest inequality with high mobility through investments in education, healthcare, and social services that equalize opportunity.

Critics worry that reducing inequality through redistribution reduces growth and innovation. But evidence suggests modest redistribution can enhance growth by developing human capital throughout society rather than concentrating resources among those already advantaged. The question isn't whether to address inequality but how to balance efficiency with mobility.

31. The passage's central argument is that:

- A. Complete income equality is necessary for social mobility
 - B. American society offers equal opportunity to all citizens
 - C. Extreme inequality undermines social mobility by making advancement difficult
 - D. Economic growth requires high levels of inequality
-

32. According to the passage, children born into poverty face disadvantages that:

- A. Can be overcome through individual effort alone
 - B. Are entirely self-inflicted through poor choices
 - C. Reflect lack of innate ability
 - D. Predict outcomes independent of ability due to structural factors
-

33. The author suggests the "American Dream" narrative can be harmful when:

- A. It encourages people to work hard
 - B. It provides hope for the future
 - C. Mobility increases beyond historical norms
 - D. Mobility decreases while the myth persists, causing self-blame and merit denial
-

34. Nordic countries are mentioned to illustrate that:

- A. Complete socialism eliminates all inequality

- B. Lower inequality combined with opportunity investments can produce higher mobility
 - C. Only small, homogeneous societies can achieve mobility
 - D. Inequality is irrelevant to social outcomes
-

35. The passage indicates that moderate inequality might differ from extreme inequality in that moderate inequality:

- A. Completely eliminates social mobility
 - B. Has identical effects on ambition
 - C. May motivate effort without making advancement seem impossible
 - D. Guarantees equal outcomes for all individuals
-

36. The author's position on redistribution is that:

- A. All redistribution destroys economic growth
 - B. No redistribution is ever justified
 - C. Modest redistribution can enhance growth by developing broader human capital
 - D. Complete income equality is economically optimal
-

PASSAGE 7: The Placebo Effect and Medical Ethics

Placebos—inactive substances producing therapeutic effects through patient belief—pose ethical dilemmas. They work, sometimes powerfully, yet seem to require deception: patients must believe they're receiving active treatment for placebos to be effective.

Recent research complicates this picture. Studies show that placebos can work even when patients know they're taking placebos, provided they understand that placebos can trigger healing responses through mind-body mechanisms. This "open-label placebo" approach eliminates deception while maintaining therapeutic benefit.

But questions remain. Should physicians prescribe open-label placebos? They provide real relief without side effects, but insurance often won't cover "fake" treatments, and physicians may feel uncomfortable

prescribing nothing while charging for appointments. Moreover, dedicating clinical time to placebo prescription might seem wasteful when serious conditions require attention.

The placebo effect reveals how powerfully mind affects body—expectations, beliefs, and therapeutic context influence physiology. This knowledge should inform all medical practice, not just placebo prescription. The empathy, optimism, and attentiveness physicians bring to encounters creates placebo effects layered atop specific treatments.

Pharmaceutical trials account for placebos by comparing new drugs against placebo controls. Yet the placebo response itself varies dramatically: colored pills produce stronger effects than white pills, injections work better than pills, and four pills daily work better than two—despite identical inert contents. These findings suggest the ritual of treatment contributes to healing.

Rather than viewing placebos as deceptive tricks or threats to "real" medicine, we should recognize them as demonstrations of medicine's fundamentally relational nature. Healing involves biological mechanisms, pharmaceutical interventions, and the psychological and social context of care. Optimal treatment integrates all three dimensions rather than dismissing non-pharmaceutical elements as merely "placebo effects."

37. The passage's primary purpose is to:

- A. Explore the placebo effect's implications for medical practice and ethics
- B. Argue that all treatment is purely psychological
- C. Prove that placebos are more effective than pharmaceutical drugs
- D. Demonstrate that deception is necessary in medicine

38. Open-label placebos are significant because they:

- A. Work better than traditional placebos
 - B. Require deception to be effective
 - C. Demonstrate that placebos can work without deception
 - D. Eliminate all need for pharmaceutical drugs
-

39. According to the passage, the finding that injection placebos work better than pill placebos suggests:

- A. All medications should be delivered by injection
 - B. The ritual and context of treatment contribute to healing
 - C. Placebos are ineffective regardless of form
 - D. Patients are easily fooled by medical theatrics
-

40. The author's view on the placebo effect in medical practice is that it:

- A. Should be eliminated as unscientific
 - B. Proves all medicine is fraudulent
 - C. Threatens pharmaceutical research
 - D. Reveals the relational and contextual nature of healing
-

41. The passage suggests pharmaceutical trials use placebo controls to:

- A. Deceive research participants
 - B. Eliminate the placebo effect entirely
 - C. Reduce research costs
 - D. Determine whether new drugs perform better than placebo responses alone
-

42. The author would most likely support a physician who:

- A. Dismisses placebo effects as irrelevant to real medicine
- B. Uses only placebos, avoiding pharmaceutical interventions
- C. Recognizes how empathy and optimism enhance treatment outcomes
- D. Deceives patients about the nature of their treatments

PASSAGE 8: Cancel Culture and Public Discourse

"Cancel culture" describes collective withdrawal of support for public figures accused of offensive behavior, typically through social media campaigns. Proponents see it as accountability for powerful individuals who previously faced no consequences. Critics argue it's mob justice lacking due process, destroying careers over minor offenses or allegations without verification.

The phenomenon isn't entirely new—boycotts and social ostracism have long served as informal punishment. What's changed is scale and speed: social media enables rapid mobilization and permanent digital records. Someone can become infamous worldwide in hours, with past statements or actions suddenly scrutinized.

This raises questions about proportionality. Should decades-old statements cost someone their career? Should private citizens face the same consequences as public figures? Should intentions matter, or only impact? These questions have no universal answers, yet social media mobs often act as though they do, demanding immediate termination before full context emerges.

The discourse around cancel culture itself exemplifies polarization. Some dismiss all criticism of offensive behavior as "cancel culture," using the term to deflect accountability. Others label any consequences for speech "censorship," conflating social disapproval with government suppression. Both positions oversimplify.

A more nuanced view recognizes that consequences for speech aren't inherently wrong—free speech doesn't mean consequence-free speech. But consequences should be proportionate, allow for context and growth, and distinguish between public figures wielding power and private individuals making mistakes.

The challenge is that decentralized social media mobs can't deliberate about proportionality. They lack mechanisms for considering context, allowing proportionate responses, or distinguishing categories of offense. The speed and anonymity that make mobilization easy also make thoughtful judgment difficult.

Perhaps rather than arguing whether cancel culture exists or is good, we should ask: what norms for accountability respect both the harms of offensive behavior and the values of proportionality, context, and human capacity for change?

43. The passage's main argument is that:

- A. Cancel culture should be eliminated completely
- B. All criticism of public figures constitutes cancel culture
- C. Cancel culture represents perfect accountability

D. Discussions of cancel culture require nuance recognizing both accountability needs and concerns about proportionality

44. According to the passage, social media has changed public accountability by:

- A. Inventing the concept of social punishment
 - B. Enabling rapid, large-scale mobilization with permanent records
 - C. Eliminating all consequences for offensive behavior
 - D. Making thoughtful deliberation easier than before
-

45. The author suggests that "free speech doesn't mean consequence-free speech" to indicate that:

- A. The government should punish all offensive speech
 - B. No one should ever face consequences for their words
 - C. Social disapproval of speech is compatible with free speech principles
 - D. Free speech is an outdated concept
-

46. The passage indicates that proportionate consequences should consider:

- A. Only the impact of speech, never intentions
 - B. Context, growth capacity, and public versus private figure status
 - C. That all offenses deserve identical punishment
 - D. Only the speaker's intentions, ignoring impact
-

47. The author's concern about decentralized social media mobs is that they:

- A. Are too lenient on offensive behavior
- B. Always get the facts correct

- C. Protect powerful people from accountability
 - D. Lack mechanisms for proportionate, contextualized judgment
-

48. The author would most likely support an approach to public accountability that:

- A. Eliminates all consequences for public figures' statements
 - B. Applies identical consequences regardless of offense severity
 - C. Allows immediate career destruction based on allegations alone
 - D. Balances accountability with proportionality and consideration of context
-

PASSAGE 9: Artificial Intelligence and Human Creativity

Can machines be creative? AI systems now generate art, music, and literature. DALL-E creates images from text prompts. GPT models write coherent prose. AI compositions win music competitions. Yet debate persists about whether this constitutes genuine creativity or merely sophisticated mimicry.

Skeptics argue that AI lacks intentionality—machines don't choose to express ideas or emotions. They process patterns in training data, generating outputs that statistically resemble human creations without understanding meaning. A human artist makes deliberate choices reflecting experiences and emotions; AI optimizes functions.

But this may misunderstand both AI and human creativity. Human artists also draw on patterns absorbed through exposure to previous works. Our brains are biological pattern-recognition systems. The romantic notion of pure originality—creation *ex nihilo*—never described human creativity accurately. All human art builds on what came before.

Moreover, intentionality may not be creativity's essence. A work's aesthetic value or emotional impact doesn't depend on whether the creator consciously intended it. Many artists describe their creative process as intuitive rather than fully intentional. If we value art for its effects on audiences, why does the creator's conscious experience matter?

Perhaps the real concern isn't whether AI can be creative but what AI creativity means for human artists. If machines can generate professional-quality output instantly and cheaply, what happens to human creators? Will AI democratize creativity, enabling anyone to produce professional work? Or will it devalue creative labor, making human artists economically unnecessary?

These economic questions matter more than philosophical debates about "real" creativity. Whether AI is truly creative or just appears creative, its practical impact on creative industries and human creators is

undeniable. Society must decide how to value human creativity in an era when machines can produce aesthetically pleasing works at scale.

49. The passage's central concern is:

- A. Whether AI creativity is philosophically genuine
 - B. That all AI should be banned from creative fields
 - C. The practical implications of AI creativity for human artists and society
 - D. Proving that machines are more creative than humans
-

50. According to skeptics in the passage, AI lacks genuine creativity because it:

- A. Cannot process large amounts of data
 - B. Produces better work than humans
 - C. Is too expensive to use widely
 - D. Lacks intentionality and merely processes patterns without understanding
-

51. The author challenges the skeptics' position by arguing that:

- A. AI has conscious experiences identical to humans
 - B. All AI is creative by definition
 - C. Machines are superior to human artists
 - D. Human creativity also builds on patterns and may not require full conscious intention
-

52. The passage suggests that debates about "real" creativity may matter less than:

- A. Philosophical precision in defining terms
- B. Economic and practical impacts on creative industries and human creators

- C. Whether AI can truly experience emotions
 - D. Preserving romantic notions of artistic genius
-

53. The author's attitude toward AI creativity is best described as:

- A. Hostile, viewing it as threatening human culture
- B. Uncritically enthusiastic about AI replacing human artists
- C. Pragmatic, focusing on implications rather than philosophical purity
- D. Indifferent to both philosophical and practical concerns

Biological and Biochemical Foundations of Living Systems

Time	Questions
95 minutes	59

PASSAGE 1: Mitochondrial Function and Oxidative Phosphorylation

The electron transport chain (ETC) in the inner mitochondrial membrane creates a proton gradient that drives ATP synthesis. NADH and FADH₂ donate electrons to Complexes I and II respectively. Electrons pass through Complexes III and IV, pumping protons into the intermembrane space. Complex IV reduces O₂ to H₂O. ATP synthase uses the proton gradient to phosphorylate ADP.

Uncoupling proteins (UCPs) allow protons to bypass ATP synthase, dissipating the gradient as heat. Brown adipose tissue expresses UCP1 for thermogenesis. Inhibitors like cyanide (blocks Complex IV), oligomycin (blocks ATP synthase), and DNP (uncoupler) reveal ETC dependencies.

Experiment: Researchers measured oxygen consumption and ATP production in isolated mitochondria:

Control: Normal respiration rate, 3 ATP per NADH oxidized (P/O ratio = 3)

+ **DNP:** Oxygen consumption increased 300%, ATP production dropped to near zero, temperature increased

+ **Oligomycin:** Oxygen consumption dropped 90%, ATP production ceased, proton gradient increased

+ **Cyanide:** Oxygen consumption ceased, ATP production ceased, NADH accumulated

+ **Malonate (Complex II inhibitor):** With succinate as substrate: oxygen consumption ceased. With NADH as substrate: oxygen consumption normal.

1. DNP increases oxygen consumption while eliminating ATP production because it:

- A. Blocks electron flow at Complex IV
- B. Inhibits ATP synthase directly

C. Uncouples the proton gradient from ATP synthesis, maintaining ETC activity without ATP production

D. Denatures mitochondrial proteins

2. Oligomycin decreases oxygen consumption because:

A. Blocking ATP synthase causes proton gradient buildup, which inhibits further proton pumping by the ETC

B. It directly inhibits Complex I

C. It uncouples oxidative phosphorylation

D. Mitochondria cannot function without ATP

3. Cyanide causes NADH accumulation because:

A. It stimulates NADH production

B. It blocks Complex I directly

C. NADH cannot donate electrons to other complexes

D. Blocking Complex IV prevents electron flow through the entire chain, leaving NADH oxidation impossible

4. The finding that malonate blocks succinate but not NADH oxidation indicates:

A. Malonate is a weak inhibitor

B. NADH and succinate enter the ETC at different complexes

C. Succinate is converted to NADH

D. Malonate stimulates Complex I

5. Brown adipose tissue generates heat through:

- A. Increased ATP hydrolysis
 - B. Muscle shivering
 - C. UCP1 dissipating the proton gradient as heat rather than ATP
 - D. Glycolysis
-

6. A P/O ratio of 3 for NADH means:

- A. Three ATP molecules are produced per NADH oxidized
 - B. NADH produces three times more oxygen than FADH₂
 - C. Three NADH molecules produce one ATP
 - D. Oxygen is required three times per NADH
-

PASSAGE 2: Antibody Structure and Immune Function

Antibodies (immunoglobulins) are Y-shaped proteins with two heavy chains and two light chains linked by disulfide bonds. Each chain has variable (V) and constant (C) regions. The antigen-binding site forms from VH and VL regions (Fab fragment). The Fc region mediates effector functions.

Five antibody classes exist: IgG (most abundant in blood, crosses placenta), IgM (pentamer, first produced in infection), IgA (dimer in secretions), IgD (B cell receptor), IgE (allergies and parasites). Class switching changes heavy chain constant regions via recombination.

Complement activation, opsonization, and antibody-dependent cellular cytotoxicity require Fc region binding to receptors. Affinity maturation through somatic hypermutation in V regions increases antibody-antigen binding strength during immune responses.

Experiment: Researchers studied antibody function using enzyme treatments:

Treatment 1 (Papain digestion): Cleaved IgG into two Fab fragments and one Fc fragment. Fab fragments bound antigen but didn't activate complement or bind Fc receptors.

Treatment 2 (Reducing agents): Broke disulfide bonds, separating heavy and light chains. Individual chains didn't bind antigen.

Treatment 3 (Genetic deletion of Fc): Antibodies bound antigen normally but couldn't activate complement or mediate opsonization.

Patient study: Primary immune response produced IgM (low affinity). Secondary response produced IgG (high affinity) to the same antigen.

7. Fab fragments binding antigen but not activating complement demonstrates that:

- A. Complement activation is independent of antigen binding
 - B. The Fc region is required for complement activation
 - C. Antigen binding sites are located in the Fc region
 - D. Papain destroys antigen-binding capability
-

8. Individual heavy and light chains failing to bind antigen indicates:

- A. Chains are non-functional when separated
 - B. Only heavy chains bind antigen
 - C. Only light chains bind antigen
 - D. Both VH and VL regions contribute to the antigen-binding site
-

9. IgM production before IgG during infection reflects:

- A. Class switching from IgM to IgG during the immune response
 - B. IgG is less effective than IgM
 - C. IgM cannot bind antigens
 - D. B cells only produce one antibody class
-

10. Increased affinity in the secondary response results from:

- A. More antibodies being produced
- B. Faster antibody production

- C. Somatic hypermutation and selection for higher-affinity variants
 - D. Different B cells recognizing different epitopes
-

11. IgG crossing the placenta (unlike IgM pentamers) likely occurs because:

- A. IgM is too large to cross placental barriers
 - B. IgG has specific receptors on placental cells that IgM lacks
 - C. IgM is degraded in the placenta
 - D. Both A and B are correct
-

PASSAGE 3: Kidney Function and Urine Formation

Nephrons filter blood, reabsorb needed substances, and secrete waste. The glomerulus filters based on size and charge. The proximal tubule reabsorbs 65% of filtered water, glucose, amino acids, and Na^+ via active transport and osmosis. The loop of Henle creates a medullary osmotic gradient. The distal tubule and collecting duct are regulated by aldosterone (Na^+ reabsorption) and ADH (water reabsorption).

Glomerular filtration rate (GFR) = 125 mL/min normally. Filtration fraction = GFR/renal plasma flow. Clearance measures substance removal: $C = (\text{Urine concentration} \times \text{Urine flow rate}) / \text{Plasma concentration}$. Inulin clearance equals GFR. Substances with clearance $<$ GFR are reabsorbed; those with clearance $>$ GFR are secreted.

Experimental data:

Substance A (small molecule):

- Plasma concentration: 10 mg/dL
- Urine concentration: 1000 mg/dL
- Urine flow: 1 mL/min
- Clearance: 100 mL/min

Substance B (glucose, normal individual):

- Filtered at glomerulus
- Urine concentration: 0 mg/dL
- Clearance: 0 mL/min

Diabetes patient:

- Glucose filtered normally
- Blood glucose: 300 mg/dL (normal: 100 mg/dL)
- Glucose appeared in urine
- Transporters in proximal tubule saturated

Dehydration study:

- ADH levels increased 10-fold
 - Urine volume decreased from 1500 mL/day to 500 mL/day
 - Urine osmolarity increased from 300 to 1200 mOsm/L
-

12. Substance A's clearance (100 mL/min) being less than GFR (125 mL/min) indicates:

- A. Substance A is secreted
 - B. Substance A is not filtered
 - C. Substance A crosses the glomerulus but is not reabsorbed
 - D. Substance A is partially reabsorbed
-

13. Glucose clearance of zero in normal individuals occurs because:

- A. Glucose is too large to be filtered
 - B. Glucose is completely reabsorbed in the proximal tubule
 - C. Glucose is secreted into the tubule
 - D. Glucose is metabolized in the kidney
-

14. Glucose appearing in diabetic urine despite normal filtration indicates:

- A. Glomerular damage
- B. Reduced glucose filtration
- C. Saturation of glucose transporters in the proximal tubule
- D. Increased glucose secretion

15. ADH increases urine osmolarity by:

- A. Inserting aquaporins in collecting duct, allowing water reabsorption
- B. Increasing Na^+ secretion
- C. Decreasing glomerular filtration
- D. Blocking water channels

16. A substance with clearance = 200 mL/min (GFR = 125 mL/min) is:

- A. Only filtered
- B. Filtered and reabsorbed
- C. Not filtered
- D. Filtered and secreted

17. Aldosterone increases Na^+ reabsorption in the distal tubule, which would:

- A. Increase blood volume and blood pressure
- B. Decrease blood volume and blood pressure
- C. Have no effect on blood pressure
- D. Decrease Na^+ levels

PASSAGE 4: Muscle Contraction and ATP Utilization

Skeletal muscle contraction follows the sliding filament model. Myosin heads bind actin, perform power strokes, and detach using ATP. Troponin and tropomyosin regulate actin-myosin interaction via Ca^{2+} . Action potentials trigger Ca^{2+} release from sarcoplasmic reticulum. Ca^{2+} binds troponin, moving tropomyosin and exposing myosin-binding sites.

ATP provides energy for: (1) myosin power stroke preparation, (2) myosin-actin detachment, (3) Ca^{2+} pump returning Ca^{2+} to sarcoplasmic reticulum, (4) Na^+/K^+ -ATPase maintaining resting potential. Rigor mortis occurs when ATP depletion prevents myosin-actin detachment.

During exercise, ATP sources shift: immediate (stored ATP, 2-3 sec), short-term (creatine phosphate, 10-15 sec), anaerobic glycolysis (1-2 min), aerobic respiration (sustained). Fatigue correlates with metabolite accumulation (H^+ , inorganic phosphate) and glycogen depletion.

Experiments:

Experiment 1: Isolated muscle fibers treated with ATP-depleted buffer became rigid, unable to relax even when Ca^{2+} was removed.

Experiment 2: Muscle fibers in Ca^{2+} -free buffer with ATP remained relaxed and couldn't contract despite electrical stimulation.

Experiment 3: Fibers treated with drugs blocking sarcoplasmic reticulum Ca^{2+} release showed no contraction with stimulation.

Experiment 4: Marathon runners showed decreased muscle glycogen (85% depletion) and increased blood lactate at fatigue.

18. ATP-depleted muscle becoming rigid demonstrates that:

- A. ATP is required for myosin-actin detachment and muscle relaxation
- B. ATP causes muscle contraction
- C. Rigor only occurs with high Ca^{2+}
- D. Myosin doesn't bind actin without ATP

19. Muscle remaining relaxed without Ca^{2+} despite ATP presence indicates:

- A. ATP alone is insufficient for contraction
- B. ATP prevents contraction
- C. Ca^{2+} is required to expose myosin-binding sites on actin
- D. Ca^{2+} directly powers the myosin power stroke

20. During the first 3 seconds of intense exercise, ATP comes primarily from:

- A. Aerobic respiration
- B. Anaerobic glycolysis
- C. Stored muscle glycogen
- D. Stored ATP and creatine phosphate

21. Blocking sarcoplasmic reticulum Ca^{2+} release prevents contraction because:

- A. The Na^+/K^+ pump fails
- B. Ca^{2+} cannot bind troponin to enable actin-myosin interaction
- C. ATP cannot be produced
- D. Action potentials cannot propagate

22. Increased blood lactate during exercise indicates:

- A. Aerobic metabolism is predominant
- B. Creatine phosphate is being depleted
- C. Oxidative phosphorylation is insufficient
- D. Muscle damage is occurring

PASSAGE 5: Bacterial Transformation and Antibiotic Resistance

Bacteria acquire new genetic material through transformation (uptake of naked DNA), transduction (viral transfer), and conjugation (direct transfer via pilus). Plasmids are circular extrachromosomal DNA often carrying antibiotic resistance genes.

Antibiotic resistance mechanisms include: (1) enzymatic inactivation (β -lactamases degrade penicillin), (2) target modification (altered ribosomes resist antibiotics), (3) efflux pumps removing antibiotics, (4) reduced permeability. Resistance genes spread rapidly via horizontal gene transfer.

Experimental Protocol:

Researchers transformed bacteria using plasmid pGLO containing:

- ampR gene (ampicillin resistance)
- GFP gene (green fluorescent protein) under arabinose-inducible promoter

Experimental Groups:

Plate 1 (LB agar): +pGLO bacteria - all colonies grew

Plate 2 (LB + ampicillin): +pGLO bacteria - colonies grew; -pGLO bacteria - no growth

Plate 3 (LB + ampicillin + arabinose): +pGLO bacteria - colonies grew and fluoresced green

Plate 4 (LB + arabinose): +pGLO bacteria - colonies grew but no fluorescence

Efficiency calculation: 500 transformed colonies from 10^6 original cells = 0.05% transformation efficiency

23. Colonies growing on ampicillin plates demonstrate:

- A. All bacteria naturally resist ampicillin
 - B. Ampicillin doesn't affect bacterial growth
 - C. Successful uptake and expression of the ampR gene
 - D. Ampicillin induces resistance
-

24. Fluorescence only with arabinose indicates:

- A. Arabinose is required for GFP expression from the inducible promoter
- B. Ampicillin blocks fluorescence
- C. pGLO doesn't contain GFP

D. Transformation failed

25. The -pGLO bacteria failing to grow on ampicillin demonstrates:

- A. Negative control showing ampicillin kills non-resistant bacteria
 - B. pGLO is toxic
 - C. These bacteria were dead before plating
 - D. Ampicillin was inactive
-

26. Low transformation efficiency (0.05%) suggests:

- A. Most bacteria are already resistant
 - B. DNA uptake is an inefficient process requiring competent cells
 - C. The plasmid is defective
 - D. All bacteria were transformed
-

27. If bacteria lost the plasmid, they would:

- A. Remain resistant due to chromosomal integration
 - B. Gain resistance to other antibiotics
 - C. Lose both ampicillin resistance and GFP fluorescence
 - D. Increase fluorescence
-

28. Horizontal gene transfer contributing to antibiotic resistance spread means:

- A. Resistance genes pass only to daughter cells (vertical inheritance)
- B. Resistance genes cannot spread between species

C. Antibiotics induce resistance mutations

D. Resistance genes transfer between bacteria, even across species

PASSAGE 6: Hormone Regulation of Blood Glucose

Blood glucose homeostasis involves insulin (lowers glucose) and glucagon (raises glucose). Insulin is released by pancreatic β cells when blood glucose rises. It stimulates glucose uptake by muscle and adipose tissue, glycogen synthesis, and inhibits gluconeogenesis. Glucagon is released by α cells when glucose drops, stimulating glycogenolysis and gluconeogenesis.

Type 1 diabetes results from autoimmune destruction of β cells (no insulin production). Type 2 diabetes involves insulin resistance (cells don't respond normally). Both cause hyperglycemia. Epinephrine and cortisol also raise blood glucose during stress.

Clinical Study:

Patient A (Normal):

- Fasting glucose: 90 mg/dL
- Post-meal glucose: 120 mg/dL (peak at 30 min, returned to 90 mg/dL by 120 min)
- Insulin increased 5-fold post-meal

Patient B (Type 1 diabetes):

- Fasting glucose: 250 mg/dL
- Post-meal glucose: 400 mg/dL
- Insulin: undetectable
- Given insulin injection: glucose dropped to 100 mg/dL

Patient C (Type 2 diabetes):

- Fasting glucose: 180 mg/dL
- Post-meal glucose: 300 mg/dL
- Insulin: $2\times$ normal levels
- Insulin injection: minimal glucose reduction

Glucagon test: All patients given glucagon—blood glucose increased in all three.

29. Patient A's glucose returning to baseline after meals demonstrates:

A. Insulin prevents glucose absorption

- B. Insulin promotes glucose uptake and storage, maintaining homeostasis
 - C. Glucagon lowers blood glucose
 - D. No hormonal regulation occurred
-

30. Patient B's undetectable insulin with high glucose indicates:

- A. Insulin resistance
 - B. Normal pancreatic function
 - C. Glucagon excess
 - D. β cell destruction preventing insulin production
-

31. Patient C having high insulin yet high glucose suggests:

- A. Insulin resistance where cells don't respond normally to insulin
 - B. Insulin is non-functional
 - C. β cells aren't producing insulin
 - D. Excessive insulin production cures diabetes
-

32. All patients responding to glucagon indicates:

- A. Glucagon pathways are intact regardless of diabetes type
 - B. Glucagon lowers blood glucose
 - C. Glucagon requires insulin to function
 - D. Patients don't have diabetes
-

33. During fasting, low blood glucose would trigger:

- A. Increased insulin, decreased glucagon
 - B. Decreased insulin, increased glucagon to raise glucose via glycogenolysis
 - C. No hormonal changes
 - D. Only cortisol release
-

PASSAGE 7: Neurotransmission and Synaptic Plasticity

Chemical synapses transmit signals via neurotransmitters. Action potentials trigger Ca^{2+} influx, causing vesicle fusion and neurotransmitter release into the synaptic cleft. Neurotransmitters bind postsynaptic receptors, opening ion channels or activating G-proteins. Excitatory postsynaptic potentials (EPSPs) depolarize; inhibitory postsynaptic potentials (IPSPs) hyperpolarize.

Long-term potentiation (LTP) strengthens synapses through repeated activation. NMDA receptors require both glutamate binding and postsynaptic depolarization (removing Mg^{2+} block). Ca^{2+} influx through NMDA receptors activates kinases, increasing AMPA receptor insertion and synaptic strength.

Neurotransmitter removal occurs via: reuptake (transporters), enzymatic degradation (acetylcholinesterase breaks down ACh), or diffusion.

Experiments:

Experiment 1: Blocking Ca^{2+} channels in presynaptic terminal eliminated neurotransmitter release despite action potentials reaching the terminal.

Experiment 2: High-frequency stimulation of a pathway caused LTP—the same stimulus produced 200% larger EPSPs one hour later.

Experiment 3: NMDA receptor blocker (APV) prevented LTP induction but didn't affect normal baseline transmission.

Experiment 4: Acetylcholinesterase inhibitor caused prolonged muscle contraction from single nerve stimulus.

34. Ca^{2+} channel blockade preventing neurotransmitter release demonstrates that:

- A. Action potentials alone are insufficient
- B. Ca^{2+} doesn't affect synapses

- C. Neurotransmitter release is independent of Ca^{2+}
 - D. Ca^{2+} influx triggers vesicle fusion and neurotransmitter release
-

35. LTP increasing EPSP amplitude reflects:

- A. Decreased neurotransmitter release
 - B. Synaptic strengthening through increased receptors or release efficiency
 - C. Fewer action potentials
 - D. IPSP enhancement
-

36. APV blocking LTP but not baseline transmission indicates:

- A. AMPA receptors mediate baseline transmission
 - B. NMDA receptors mediate baseline transmission
 - C. NMDA receptors are required for LTP induction but not normal transmission
 - D. APV enhances synaptic strength
-

37. Acetylcholinesterase inhibitor prolonging contraction occurs because:

- A. ACh remains in the synaptic cleft longer, causing repeated receptor activation
 - B. More ACh is released
 - C. Muscle becomes hyperexcitable
 - D. Inhibitor blocks ACh receptors
-

38. Removing Mg^{2+} block from NMDA receptors requires:

- A. Ca^{2+} influx alone

- B. Glutamate binding alone
 - C. Hyperpolarization
 - D. Both glutamate binding and postsynaptic depolarization
-

PASSAGE 8: Enzyme Regulation and Metabolic Control

Enzymes are regulated through allosteric modulation, covalent modification (phosphorylation), and competitive/noncompetitive inhibition. Allosteric enzymes have regulatory sites separate from active sites. Feedback inhibition occurs when pathway products inhibit early enzymes.

Phosphofructokinase (PFK) is the rate-limiting enzyme of glycolysis. It's allosterically inhibited by ATP and citrate (high energy signals) and activated by AMP and F-2,6-BP (low energy signals). Glucokinase traps glucose in hepatocytes via phosphorylation.

Protein kinases add phosphate groups using ATP; phosphatases remove them. These modifications alter enzyme activity, enabling rapid metabolic responses.

Experimental Data:

PFK assay:

- Control: 100% activity
 - - ATP (high): 20% activity
 - - AMP (high): 150% activity
 - - ATP + AMP: 80% activity
 - - Citrate: 30% activity

Glycogen phosphorylase:

- Phosphorylated form: active (breaks down glycogen)
- Dephosphorylated form: inactive
- Epinephrine treatment: stimulated kinase, increasing phosphorylated (active) form

Competitive inhibition study:

- Malonate inhibits succinate dehydrogenase
- Increasing succinate concentration overcame inhibition
- V_{max} unchanged, K_m increased

39. High ATP inhibiting PFK demonstrates:

- A. Negative feedback preventing excess ATP production when energy is sufficient
 - B. Positive feedback accelerating glycolysis
 - C. ATP is required for PFK activity
 - D. PFK produces ATP
-

40. AMP activating PFK reflects:

- A. AMP signals energy depletion
 - B. AMP inhibits metabolism
 - C. AMP activates all enzymes
 - D. AMP has no metabolic role
-

41. ATP and AMP having opposite effects on PFK shows:

- A. Random enzyme regulation
 - B. Conflicting signals cancel out
 - C. Enzymes cannot sense energy status
 - D. Reciprocal regulation matching enzyme activity to cellular energy status
-

42. Epinephrine increasing active glycogen phosphorylase via phosphorylation enables:

- A. Glycogen synthesis
- B. Rapid glycogen breakdown to raise blood glucose during stress
- C. Protein synthesis

D. Decreased glucose availability

43. Competitive inhibition showing increased K_m but unchanged V_{max} indicates:

- A. Inhibitor permanently damages enzyme
 - B. Inhibitor and substrate compete for the active site
 - C. Inhibitor increases enzyme activity
 - D. Substrate cannot bind enzyme
-

44. Feedback inhibition in metabolic pathways prevents:

- A. All enzyme activity
 - B. Pathway initiation
 - C. Waste of resources by stopping production when product accumulates
 - D. Product formation entirely
-

DISCRETE QUESTIONS (45-59)

45. The primary structure of a protein refers to:

- A. Overall 3D shape
 - B. Amino acid sequence
 - C. α -helix and β -sheet content
 - D. Quaternary subunit arrangement
-

46. During meiosis I, homologous chromosomes separate, which:

- A. Maintains diploid chromosome number

- B. Doubles chromosome number
 - C. Reduces chromosome number from diploid to haploid
 - D. Has no effect on chromosome number
-

47. The lac operon in bacteria is induced when:

- A. Lactose is present and binds the repressor, allowing transcription
 - B. Glucose is abundant
 - C. The repressor binds the operator
 - D. Lactose is absent
-

48. Prokaryotic cells differ from eukaryotic cells in that prokaryotes lack:

- A. Ribosomes
 - B. DNA
 - C. Cell membranes
 - D. Membrane-bound nucleus and organelles
-

49. Hemoglobin's sigmoidal oxygen-binding curve results from:

- A. Independent binding at each heme group
 - B. Cooperative binding where O₂ binding to one subunit increases affinity of others
 - C. Only one O₂ binding per hemoglobin
 - D. Competitive inhibition by CO₂
-

50. Thymine is replaced by which base in RNA?

- A. Adenine
 - B. Guanine
 - C. Uracil
 - D. Cytosine
-

51. The sodium-potassium pump is an example of:

- A. Primary active transport using ATP to move ions against gradients
 - B. Passive diffusion
 - C. Facilitated diffusion
 - D. Secondary active transport
-

52. Restriction enzymes used in molecular biology:

- A. Synthesize DNA
 - B. Transcribe RNA
 - C. Translate proteins
 - D. Cut DNA at specific recognition sequences
-

53. The Calvin cycle produces:

- A. ATP and NADPH
 - B. Glucose from CO₂ using ATP and NADPH
 - C. Oxygen from water splitting
 - D. Only NADPH
-

54. An exon is:

- A. A non-coding DNA sequence removed during splicing
 - B. An mRNA coding sequence retained in mature mRNA
 - C. Found only in prokaryotes
 - D. The promoter region
-

55. Osmosis is:

- A. Active transport of water
 - B. Movement of solutes across membranes
 - C. Movement of water across semipermeable membranes toward higher solute concentration
 - D. ATP-dependent water transport
-

56. Trisomy 21 (Down syndrome) results from:

- A. Gene mutation
 - B. Deletion
 - C. Insertion
 - D. Nondisjunction producing three copies of chromosome 21
-

57. The sliding filament theory of muscle contraction describes:

- A. Myosin and actin filaments sliding past each other
- B. Sarcomeres lengthening
- C. Filaments growing during contraction
- D. Muscle cells dividing

58. Vaccination provides immunity by:

- A. Killing all pathogens permanently
 - B. Providing antibodies that last forever
 - C. Stimulating memory cell production for rapid secondary response
 - D. Destroying the immune system
-

59. In the Hardy-Weinberg equation ($p^2 + 2pq + q^2 = 1$), the term $2pq$ represents:

- A. Homozygous dominant frequency
- B. Homozygous recessive frequency
- C. Heterozygote frequency
- D. Allele frequency

Psychological, Social, and Biological Foundations of Behavior

Time	Questions
95 minutes	59

PASSAGE 1: Stress Response and Allostatic Load

Stress activates the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system. The hypothalamus releases CRH, triggering ACTH from the pituitary, stimulating cortisol release from adrenal cortex. Sympathetic activation releases epinephrine and norepinephrine. Acute stress responses are adaptive, mobilizing resources. Chronic stress causes allostatic load—cumulative physiological wear leading to hypertension, immune suppression, and metabolic dysfunction.

Study: Researchers examined stress biomarkers in three groups:

Group A (Low stress): Office workers, predictable schedules

- Baseline cortisol: 15 $\mu\text{g}/\text{dL}$
- Cortisol after mild stressor: 18 $\mu\text{g}/\text{dL}$, returned to baseline in 30 minutes
- Blood pressure: 120/80
- Immune function: normal

Group B (Acute stress): Medical residents, exam week

- Baseline cortisol: 22 $\mu\text{g}/\text{dL}$
- Post-stressor: 35 $\mu\text{g}/\text{dL}$, returned to baseline in 60 minutes
- Blood pressure: 130/85
- Temporary immune suppression (15% decrease in NK cell activity)

Group C (Chronic stress): Caregivers of dementia patients (2+ years)

- Baseline cortisol: 28 $\mu\text{g}/\text{dL}$ (elevated baseline)
- Post-stressor: 32 $\mu\text{g}/\text{dL}$ (blunted response)
- Blood pressure: 145/95
- Persistent immune suppression (40% decrease in NK cell activity)
- Increased inflammatory markers (IL-6, CRP)

1. Group C's elevated baseline cortisol with blunted stress response indicates:

A. HPA axis dysregulation from chronic stress exposure

- B. Enhanced stress resilience
 - C. Acute stress adaptation
 - D. No physiological stress impact
-

2. The sympathetic nervous system's immediate stress response includes:

- A. Decreased heart rate and digestion
 - B. Cortisol release from adrenal cortex
 - C. Epinephrine release causing increased heart rate and glucose mobilization
 - D. Immune system activation
-

3. Chronic stress in Group C causing persistent immune suppression occurs because:

- A. Immune cells increase during stress
 - B. Cortisol has no immune effects
 - C. Stress responses are always beneficial
 - D. Prolonged cortisol elevation suppresses immune cell function
-

4. The HPA axis negative feedback loop involves:

- A. CRH stimulating more cortisol indefinitely
 - B. Cortisol inhibiting CRH and ACTH release at hypothalamus and pituitary
 - C. Epinephrine increasing cortisol
 - D. Complete shutdown of cortisol production
-

5. Group B's temporary immune suppression is adaptive because:

- A. Resources are redirected to immediate survival during acute stress
 - B. Immune function is unnecessary
 - C. All stress enhances immunity
 - D. Cortisol permanently destroys immune cells
-

6. Elevated inflammatory markers in Group C suggest:

- A. Acute infection only
 - B. Normal stress response
 - C. Chronic stress promoting systemic inflammation linked to disease
 - D. Decreased allostatic load
-

PASSAGE 2: Cognitive Dissonance and Attitude Change

Cognitive dissonance theory proposes that inconsistency between cognitions creates psychological discomfort, motivating attitude or behavior change to reduce dissonance. Dissonance is strongest when: (1) the inconsistency involves important beliefs, (2) one freely chose the behavior, (3) the behavior has negative consequences.

Dissonance reduction strategies include: changing attitudes to match behavior, adding consonant cognitions, minimizing importance, or denying responsibility.

Classic study replication: Participants performed boring tasks, then told waiting participants the tasks were interesting for either \$1 or \$20.

\$1 condition: 75% later rated tasks as genuinely interesting (insufficient external justification—resolved dissonance by changing attitudes)

\$20 condition: 20% rated tasks as interesting (sufficient external justification—attributed lying to payment, no attitude change)

Control (no lie): 5% rated tasks as interesting

Modern extension: Added choice manipulation:

High choice (freely agreed): Strong dissonance, 80% attitude change
Low choice (pressured): Minimal dissonance, 25% attitude change

Neuroscience findings: fMRI during dissonance showed activation in anterior cingulate cortex (conflict detection) and dorsolateral prefrontal cortex (cognitive control).

7. Participants in the \$1 condition changed attitudes because:

- A. They were paid fairly
 - B. The payment was too high
 - C. They forgot lying
 - D. Insufficient external justification created dissonance resolved by believing tasks were interesting
-

8. The \$20 payment reduced dissonance by:

- A. Making tasks actually interesting
 - B. Providing sufficient external justification for lying
 - C. Eliminating all cognitions
 - D. Creating more dissonance
-

9. High choice conditions producing more attitude change demonstrates:

- A. Choice is irrelevant to dissonance
 - B. Pressure increases dissonance
 - C. Freely chosen counter-attitudinal behavior creates stronger dissonance
 - D. Low choice always changes attitudes
-

10. Anterior cingulate cortex activation during dissonance suggests:

- A. The brain detects cognitive conflict as an aversive state
 - B. No neural basis for dissonance
 - C. Dissonance is purely behavioral
 - D. Brain activity is unrelated to attitudes
-

11. A vegetarian who eats meat at a family gathering might reduce dissonance by:

- A. Becoming more committed to vegetarianism
 - B. Ignoring the inconsistency completely
 - C. Never attending gatherings again
 - D. Deciding occasional meat is acceptable for social harmony
-

PASSAGE 3: Sleep Stages and Memory Consolidation

Sleep cycles through NREM (stages 1-3) and REM sleep. Stage 1: light sleep, theta waves. Stage 2: sleep spindles and K-complexes. Stage 3: slow-wave sleep (SWS), delta waves, physical restoration. REM: rapid eye movements, dreaming, muscle atonia, consolidates procedural and emotional memories.

Memory consolidation occurs during sleep. Declarative memories consolidate during SWS; procedural memories during REM. Sleep deprivation impairs memory formation and cognitive function.

Study: Participants learned declarative facts and motor skills, then assigned to sleep conditions:

Full sleep (8 hours):

- Declarative recall: 85%
- Motor skill improvement: 25%
- SWS: 90 minutes, REM: 120 minutes

SWS deprivation (awakened during SWS, total sleep 8h):

- Declarative recall: 60%
- Motor skill improvement: 23%
- SWS: 20 minutes, REM: 130 minutes

REM deprivation (awakened during REM, total sleep 8h):

- Declarative recall: 80%
- Motor skill improvement: 10%
- SWS: 95 minutes, REM: 30 minutes

Total deprivation (no sleep):

- Declarative recall: 45%
- Motor skill improvement: 5%

EEG patterns: Sleep spindles during stage 2 correlated with overnight memory improvement.

12. SWS deprivation primarily impairing declarative memory indicates:

- A. REM consolidates declarative memories
 - B. Slow-wave sleep is critical for declarative memory consolidation
 - C. SWS is unnecessary for memory
 - D. Declarative memory forms during waking only
-

13. REM deprivation reducing motor skill improvement shows:

- A. REM is irrelevant to learning
 - B. SWS consolidates motor skills
 - C. Motor skills don't require consolidation
 - D. REM sleep consolidates procedural memories
-

14. Sleep spindles correlating with memory improvement suggests:

- A. Spindles actively participate in memory consolidation processes
- B. Spindles interfere with memory
- C. Stage 2 sleep is unimportant

D. Memory forms only during waking

15. Muscle atonia during REM sleep prevents:

- A. Dreaming
 - B. Memory consolidation
 - C. Acting out dream movements
 - D. Eye movements
-

16. Total sleep deprivation impairing both memory types demonstrates:

- A. Sleep is unnecessary for memory
 - B. Sleep serves multiple memory consolidation functions
 - C. Only one memory type needs sleep
 - D. Waking is better for memory
-

17. Delta waves characterize:

- A. REM sleep and dreaming
 - B. Waking alertness
 - C. Stage 1 light sleep
 - D. Stage 3 slow-wave sleep and deep rest
-

PASSAGE 4: Operant Conditioning and Reinforcement Schedules

Operant conditioning shapes behavior through consequences. Reinforcement increases behavior; punishment decreases it. Positive = adding stimulus; negative = removing stimulus.

Reinforcement schedules: Fixed ratio (FR)—reinforce after set number of responses; Variable ratio (VR)—after unpredictable number; Fixed interval (FI)—after set time; Variable interval (VI)—after unpredictable time. VR produces highest response rates, most resistant to extinction.

Experiment: Rats pressed levers under different schedules:

Continuous reinforcement: 100 responses/hour, rapid extinction (stopped pressing after 5 min without reinforcement)

FR-5: 180 responses/hour, post-reinforcement pause, moderate extinction resistance

VR-10: 250 responses/hour, steady responding, high extinction resistance (continued 30 min without reinforcement)

FI-30 sec: 80 responses/hour, scalloped pattern (slow after reinforcement, accelerating as interval ends)

VI-30 sec: 120 responses/hour, steady moderate rate, good extinction resistance

Punishment study: Lever press delivered shock:

- Immediate punishment: 90% response suppression
- Delayed punishment (30 sec): 40% suppression

18. VR schedules producing highest rates and extinction resistance because:

- A. Predictability increases motivation
- B. Each response might be reinforced, and lack of reinforcement doesn't signal extinction
- C. Variable schedules are easiest
- D. Animals prefer fixed schedules

19. Post-reinforcement pause in FR schedules occurs because:

- A. Animals know exact requirement and "rest" after reinforcement before resuming
- B. Animals forget the schedule
- C. FR is weakest schedule
- D. Reinforcement causes fatigue

20. FI schedules producing scalloped response patterns reflect:

- A. Random responding
 - B. Continuous high rates
 - C. No temporal discrimination
 - D. Animals learning to anticipate interval end and increasing responding as time approaches
-

21. Immediate punishment being more effective than delayed punishment because:

- A. Delayed punishment is more aversive
 - B. Temporal contiguity between behavior and consequence strengthens association
 - C. Animals prefer delayed consequences
 - D. Immediate punishment is weaker
-

22. Gambling addiction's persistence relates to which schedule?

- A. Fixed ratio producing predictable wins
 - B. Fixed interval causing scalloped betting
 - C. Variable ratio creating unpredictable wins resistant to extinction
 - D. Continuous reinforcement
-

PASSAGE 5: Prejudice, Stereotypes, and Discrimination

Stereotypes are cognitive schemas about group characteristics. Prejudice is affective evaluation (usually negative) of groups. Discrimination is behavioral—treating groups differently. Implicit biases are unconscious attitudes measured by Implicit Association Tests (IAT).

Social categorization automatically activates stereotypes. In-group favoritism and out-group homogeneity (seeing out-groups as more similar than in-groups) maintain biases. Contact hypothesis proposes that prejudice reduces through equal-status contact with common goals.

Study: Researchers examined implicit and explicit racial bias:

Explicit measures (self-report):

- 85% endorsed egalitarian values
- 12% admitted prejudiced attitudes

IAT results:

- 65% showed implicit pro-white bias (faster associations of white faces with positive words)
- 25% showed no bias
- 10% showed pro-minority bias

Correlation: Weak correlation ($r = 0.20$) between explicit and implicit measures

Intervention study:

Control group: No change in IAT scores

Counter-stereotypic exemplars: Exposure to successful minority professionals reduced implicit bias 25%

Perspective-taking: Imagining out-group member's experiences reduced bias 30%

Intergroup contact: Cooperative equal-status interaction reduced bias 40%

Brain imaging: Amygdala activation to out-group faces correlated with implicit bias strength.

23. Weak correlation between explicit and implicit measures suggests:

- A. People may consciously endorse egalitarian values while holding unconscious biases
 - B. IAT is invalid
 - C. No one has biases
 - D. Explicit measures capture all attitudes
-

24. Amygdala activation to out-group faces indicates:

- A. Prejudice is purely cognitive
 - B. Attitudes have no neural basis
 - C. Automatic emotional responses contribute to implicit bias
 - D. Amygdala causes prejudice
-

25. Intergroup contact being most effective supports:

- A. Contact always increases prejudice
 - B. Segregation reduces bias
 - C. Avoidance is optimal
 - D. Direct equal-status cooperative interaction powerfully reduces prejudice
-

26. Out-group homogeneity effect means:

- A. Out-groups are actually identical
 - B. Perceiving out-group members as more similar than they are, while seeing in-group diversity
 - C. In-groups are homogeneous
 - D. No one perceives group differences
-

27. Counter-stereotypic exemplars reduce bias by:

- A. Weakening stereotype-group associations through disconfirming evidence
- B. Reinforcing existing stereotypes
- C. Creating stronger biases
- D. Having no cognitive impact

28. Someone showing implicit bias but explicit egalitarianism might:

- A. Have no biases whatsoever
 - B. Be lying on both measures
 - C. Hold unconscious biases despite conscious egalitarian beliefs
 - D. Have stronger explicit than implicit bias always
-

PASSAGE 6: Neurotransmitters and Psychological Disorders

Neurotransmitter imbalances contribute to psychological disorders. Serotonin deficiency links to depression (SSRIs increase synaptic serotonin). Dopamine excess in mesolimbic pathways relates to schizophrenia positive symptoms (antipsychotics block D2 receptors). GABA (inhibitory) deficiency relates to anxiety (benzodiazepines enhance GABA activity).

Monoamine hypothesis of depression: deficient serotonin, norepinephrine, or dopamine causes depression. Evidence: SSRIs and SNRIs alleviate symptoms by increasing these neurotransmitters.

Clinical trials:

Major depression patients:

SSRI (fluoxetine): 65% showed 50%+ symptom reduction after 8 weeks (blocks serotonin reuptake)

Placebo: 35% showed similar improvement

SSRI side effects: Mild (nausea, insomnia)

Schizophrenia patients:

Typical antipsychotic (haloperidol): 70% reduction in hallucinations/delusions (D2 antagonist), but 60% developed motor side effects (extrapyramidal symptoms)

Atypical antipsychotic (risperidone): 65% reduction in positive symptoms, 30% improvement in negative symptoms (D2 + 5-HT_{2A} antagonism), 15% motor side effects

Anxiety disorder patients:

Benzodiazepine: Rapid anxiety reduction (minutes), tolerance developed after 4 weeks, withdrawal symptoms

SSRI: Gradual improvement (4-6 weeks), sustained benefits, no tolerance

29. SSRIs alleviating depression by blocking serotonin reuptake means:

- A. Less serotonin in synapse
 - B. Serotonin receptors are blocked
 - C. Neurons produce less serotonin
 - D. More serotonin remains in synapse to bind receptors
-

30. Typical antipsychotics causing motor side effects because:

- A. They enhance dopamine
 - B. D2 blockade in nigrostriatal pathway (motor control) causes extrapyramidal symptoms
 - C. They don't affect dopamine
 - D. Motor side effects are unrelated to mechanism
-

31. Atypical antipsychotics improving negative symptoms better than typical because:

- A. 5-HT_{2A} antagonism combined with D₂ blockade addresses broader symptom range
 - B. They only block dopamine
 - C. They're less effective
 - D. Negative symptoms don't respond to medication
-

32. Benzodiazepines producing rapid anxiety relief but causing tolerance indicates:

- A. They're ineffective
- B. No one develops tolerance

- C. GABAergic enhancement quickly reduces anxiety, but adaptation occurs with chronic use
- D. SSRIs work faster
-

33. The 35% placebo response in depression demonstrates:

- A. Depression is imaginary
- B. Medication is unnecessary
- C. No biological basis exists
- D. Expectation and other non-specific factors contribute to improvement
-

PASSAGE 7: Attachment Theory and Development

Attachment theory describes infant-caregiver bonds. Ainsworth's Strange Situation identifies attachment styles: Secure (distressed when caregiver leaves, easily comforted on return); Anxious-ambivalent (extreme distress, difficult to comfort); Avoidant (little distress, ignores caregiver on return); Disorganized (contradictory behaviors).

Sensitive, responsive caregiving promotes secure attachment. Secure attachment predicts better social competence, emotional regulation, and relationships. Internal working models—mental representations of relationships—form from early attachments and influence later relationships.

Longitudinal study (birth to age 25):

Secure attachment (60% of infants):

- Age 5: Better peer relationships, higher self-esteem
- Age 15: Lower anxiety/depression, better emotion regulation
- Age 25: More satisfying romantic relationships, higher relationship stability

Anxious-ambivalent (15%):

- Age 5: Clingy behavior, separation anxiety
- Age 15: Higher anxiety disorders (25% vs. 8% in secure)
- Age 25: Relationship anxiety, fear of abandonment

Avoidant (20%):

- Age 5: Difficulty forming close friendships

- Age 15: Emotional distance, lower empathy
- Age 25: Commitment avoidance, emotional unavailability

Disorganized (5%):

- Age 5: Behavioral problems, aggression
- Age 15: Highest psychopathology rates (40%)
- Age 25: Unstable relationships, mental health issues

Intervention: Caregiver sensitivity training improved attachment security from 40% to 70% in high-risk families.

34. Secure attachment predicting better outcomes because:

- A. Genetics entirely determine development
 - B. Early secure bonds create internal working models supporting healthy relationships and emotion regulation
 - C. Attachment is irrelevant to development
 - D. Only genetics matter
-

35. Avoidant children showing emotional distance likely results from:

- A. Genetic fearlessness
 - B. Perfect early caregiving
 - C. Overstimulation
 - D. Caregivers being emotionally unavailable, teaching that closeness is unrewarding
-

36. Internal working models influencing adult relationships demonstrates:

- A. Early attachment patterns create mental schemas shaping relationship expectations and behaviors
- B. Past has no influence on present
- C. Adults forget childhood experiences

D. Relationships are purely situational

37. Caregiver sensitivity training improving attachment shows:

- A. Attachment is fixed at birth
 - B. Genetics override environment
 - C. Responsive caregiving promotes secure attachment
 - D. Training has no effect
-

38. Disorganized attachment showing highest psychopathology rates suggests:

- A. This pattern indicates optimal development
 - B. Conflicting attachment behaviors reflect severely disrupted caregiving predicting poor outcomes
 - C. Disorganization has no consequences
 - D. All attachment styles are equally healthy
-

PASSAGE 8: Conformity and Social Influence

Conformity is changing behavior to match group norms. Asch's line judgment studies showed 75% conformed at least once despite obvious correct answers. Normative influence (desire for acceptance) and informational influence (assuming group is correct) motivate conformity.

Factors increasing conformity: larger groups (up to 4-5), unanimity (one dissenter dramatically reduces conformity), public responses, ambiguous situations, collectivist cultures.

Milgram's obedience studies: 65% of participants administered maximum "shocks" to "learners" when ordered by authority. Factors increasing obedience: proximity to authority, distance from victim, prestigious setting, gradual escalation.

Modern replication with modifications:

Asch paradigm variations:

Standard (7 confederates, 1 participant): 35% conformity rate

One dissenting confederate: Conformity dropped to 5%

Written responses (private): Conformity dropped to 10%

Ambiguous stimuli: Conformity increased to 60%

Cross-cultural: U.S. (25% conformity), Japan (35%), indicating cultural differences

Milgram-style study (ethical modifications—no real shocks):

Authority present: 65% went to maximum

Authority by phone: 40% compliance

Peer rebels (confederates refuse): 10% compliance

Victim proximity (same room): 30% compliance

39. One dissenter reducing conformity demonstrates:

- A. Groups must be unanimous to maximize influence
 - B. Breaking unanimity provides social support for independence
 - C. Dissenters increase conformity
 - D. Group size doesn't matter
-

40. Higher conformity in collectivist cultures suggests:

- A. Individualists always conform more
 - B. Culture has no influence
 - C. Collectivist values emphasize group harmony, increasing normative pressure
 - D. Collectivists are weaker
-

41. Private responses reducing conformity indicates:

- A. Public conformity involves normative influence (avoiding social disapproval)
 - B. People conform more privately
 - C. Normative influence works privately
 - D. Informational influence requires public responses
-

42. Authority proximity increasing obedience shows:

- A. Distance strengthens authority
 - B. Physical presence of authority figure increases pressure to comply
 - C. Proximity decreases obedience
 - D. Location is irrelevant
-

43. Peer rebellion reducing compliance to 10% demonstrates:

- A. Peers have no influence
 - B. Authorities override all peer effects
 - C. Social support for disobedience empowers resistance to authority
 - D. Rebellion increases obedience
-

44. Gradual escalation in Milgram's study (small shocks increasing) promoted obedience because:

- A. Small initial commitments create consistency pressure leading to larger compliance
 - B. Large requests should come first
 - C. Gradual changes are easily noticed
 - D. Escalation decreases compliance
-

DISCRETE QUESTIONS (45-59)

45. The primary visual cortex (V1) is located in which brain lobe?

- A. Frontal
 - B. Temporal
 - C. Parietal
 - D. Occipital
-

46. Weber's law states that:

- A. Absolute threshold is constant
 - B. The just noticeable difference is a constant proportion of the original stimulus intensity
 - C. All stimuli are detected equally
 - D. Perception is independent of stimulus intensity
-

47. Alzheimer's disease is characterized by:

- A. Dopamine deficiency in substantia nigra
 - B. Sudden loss of blood flow to brain
 - C. Progressive memory loss and cognitive decline with amyloid plaques and neurofibrillary tangles
 - D. Autoimmune attack on myelin
-

48. According to Freud's psychoanalytic theory, the ego operates on the:

- A. Reality principle, mediating between id and superego
 - B. Pleasure principle, seeking immediate gratification
 - C. Moral principle, representing conscience
 - D. Unconscious drives exclusively
-

49. Erikson's stage during adolescence involves the crisis of:

- A. Trust vs. mistrust
 - B. Autonomy vs. shame
 - C. Initiative vs. guilt
 - D. Identity vs. role confusion
-

50. The Flynn effect refers to:

- A. Decreasing IQ scores over time
 - B. Rising IQ scores across generations
 - C. Genetic basis of intelligence
 - D. Cultural bias in IQ tests
-

51. Cognitive-behavioral therapy (CBT) is based on the principle that:

- A. Unconscious conflicts cause all disorders
 - B. Only medication treats mental illness
 - C. Changing maladaptive thoughts and behaviors can alleviate psychological distress
 - D. Past trauma must be relived to heal
-

52. Inattention blindness demonstrates that:

- A. Visual system is damaged
- B. All stimuli are consciously perceived
- C. Peripheral vision is superior
- D. Attention is necessary for conscious perception—unattended stimuli can be missed

53. The linguistic relativity hypothesis (Sapir-Whorf) suggests:

- A. Language has no effect on thought
 - B. All languages are identical
 - C. Thought determines language only
 - D. Language influences how we think and perceive reality
-

54. Narcolepsy involves:

- A. Inability to sleep
 - B. Sleep apnea
 - C. Sudden, uncontrollable sleep attacks and REM intrusions into waking
 - D. Insomnia only
-

55. Self-efficacy, according to Bandura, is:

- A. Actual ability level
 - B. Belief in one's capability to succeed in specific situations
 - C. Fixed personality trait
 - D. External locus of control
-

56. The mere exposure effect shows that:

- A. Familiarity breeds contempt
- B. Novel stimuli are always preferred
- C. Repeated exposure to neutral stimuli increases liking

D. Exposure has no effect on preferences

57. Dissociative identity disorder involves:

- A. Splitting from reality briefly
 - B. Multiple personality states with distinct identities
 - C. Memory loss only
 - D. Mood swings
-

58. The biological preparedness concept suggests:

- A. All stimuli are equally associable
 - B. Classical conditioning doesn't exist
 - C. Random associations form easily
 - D. Organisms are biologically predisposed to learn certain associations more easily than others
-

59. Maslow's hierarchy of needs places which at the top?

- A. Safety needs
- B. Physiological needs
- C. Self-actualization
- D. Belongingness needs

SECTION 1: ANSWER EXPLANATIONS

1. C - $\log([A^-]/[HA]) = 0$ when concentrations are equal

Henderson-Hasselbalch: $\text{pH} = \text{pK}_a + \log([A^-]/[HA])$. When $[A^-] = [HA]$, the ratio = 1, and $\log(1) = 0$. Therefore $\text{pH} = \text{pK}_a + 0 = 4.76$.

2. A - Higher concentrations provide greater buffer capacity

Buffer capacity depends on absolute concentrations. Buffer B (0.5 M each component) has $5\times$ more buffer molecules than Buffer A (0.1 M), allowing it to absorb more added acid/base with minimal pH change.

3. D - 10:1

$\text{pH} = \text{pK}_a + \log([\text{acetate}]/[\text{acetic acid}])$. $5.76 = 4.76 + \log(\text{ratio})$. $1.0 = \log(\text{ratio})$. Ratio = $10^1 = 10:1$.

4. B - 7.2

$\text{pH} = 6.1 + \log(16/1.2) = 6.1 + \log(13.3) = 6.1 + 1.1 = 7.2$. The reduced HCO_3^- ratio decreases pH from normal 7.4.

5. C - 8.25-10.25

Buffers are effective within ± 1 pH unit of pK_a . For $\text{pK}_a = 9.25$, the effective range is 8.25-10.25.

6. A - Increase by approximately 0.09 units

NaOH neutralizes acetic acid, increasing the acetate/acid ratio. By symmetry with HCl addition, pH increases ~ 0.09 units.

7. B - Zinc is oxidized at the anode

Zn has more negative E° (-0.76 V vs. +0.34 V for Cu), so Zn is oxidized (loses electrons) at the anode. Cu^{2+} is reduced at the cathode.

8. D - Lower $[\text{Zn}^{2+}]$ shifts equilibrium toward more product formation

Nernst equation: $E = E^\circ - (0.0592/n)\log(Q)$. For $Q = [\text{Zn}^{2+}]/[\text{Cu}^{2+}]$, lower $[\text{Zn}^{2+}]$ decreases Q, decreasing the log term (more negative), making E more positive.

9. A - Reverse the cell so Cu is oxidized and Ag^+ is reduced

$E^\circ_{\text{cell}} = -0.46$ V (non-spontaneous as written). Reversing gives $E^\circ_{\text{cell}} = +0.46$ V (spontaneous). Cu oxidation ($E^\circ = +0.34$ V) coupled with Ag^+ reduction ($E^\circ = +0.80$ V) produces positive potential.

10. C - Concentration gradient creates a potential difference

Despite identical electrodes, the concentration difference drives electron flow from dilute to concentrated side, generating voltage through the Nernst equation dependence on Q.

11. B - Generate voltage with electrons flowing toward higher $[\text{Fe}^{3+}]$

Concentration cells generate voltage from concentration differences. Electrons flow toward the half-cell where reduction occurs (higher $[\text{Fe}^{3+}]$ is reduced to Fe^{2+}).

12. A - Rate = $k[\text{NO}_2][\text{F}_2]$

Doubling $[\text{NO}_2]$: rate doubles (first-order in NO_2). Doubling $[\text{F}_2]$ with $[\text{NO}_2]$ at 0.20 M: rate doubles (first-order in F_2). Rate = $k[\text{NO}_2]^1[\text{F}_2]^1$.

13. C - The slow step rate depends on $[\text{NO}_2]$ and $[\text{F}_2]$

The rate-determining step determines the rate law. Mechanism A's slow step involves $\text{NO}_2 + \text{F}_2$, producing Rate = $k[\text{NO}_2][\text{F}_2]$, matching experimental data.

14. D - Depend on both $[\text{NO}_2]$ and $[\text{F}_2]$

The rate law shows Rate = $k[\text{NO}_2][\text{F}_2]$, not purely first-order in $[\text{NO}_2]$. The half-life formula for first-order ($t_{1/2} = 0.693/k$) doesn't apply; this is a mixed-order reaction.

15. B - Low activation energy (high sensitivity to temperature)

Doubling rate with only 10 K increase indicates low E_a . The Arrhenius equation shows reactions with lower E_a are more temperature-sensitive.

16. A - Appear in the rate expression such that $[\text{NO}_2\text{F}_2]$ can be substituted

For fast equilibrium Step 1: $K = [\text{NO}_2\text{F}_2]/([\text{NO}_2][\text{F}_2])$. Substituting into Step 2 rate expression allows $[\text{NO}_2\text{F}_2]$ to be replaced, potentially yielding the observed rate law.

17. C - Second-order kinetics in $[\text{NO}_2]$

Second-order integrated rate law: $1/[\text{A}] = kt + 1/[\text{A}]_0$. A plot of $1/[\text{NO}_2]$ vs. time is linear for second-order kinetics.

18. D - The $T\Delta S$ term exactly equals ΔH

At equilibrium, $\Delta G = 0$. Since $\Delta G = \Delta H - T\Delta S$, when $\Delta G = 0$: $\Delta H = T\Delta S$. At 373 K (boiling point), these terms balance.

19. B - The actual ΔG under non-standard conditions can be negative

$\Delta G^\circ = +8.5 \text{ kJ/mol}$ applies at standard state (1 atm pressure). At vapor pressures below 1 atm (actual conditions), $\Delta G = \Delta G^\circ + RT \ln(Q)$ can be negative, allowing evaporation.

20. A - ATP hydrolysis provides energy to overcome endergonic glucose phosphorylation

The exergonic ATP hydrolysis ($\Delta G^\circ = -30 \text{ kJ/mol}$) coupled with endergonic glucose phosphorylation ($\Delta G^\circ = +14 \text{ kJ/mol}$) gives net $\Delta G^\circ = -16 \text{ kJ/mol}$, making the overall process spontaneous.

21. B - Occur only at low temperatures ($T\Delta S$ term is small)

$\Delta H^\circ = -50 \text{ kJ/mol}$ (favorable), $\Delta S^\circ = -150 \text{ J/(mol}\cdot\text{K)}$ (unfavorable). $\Delta G = \Delta H - T\Delta S = -50 - T(-0.15) = -50 + 0.15T$. Spontaneous when $\Delta G < 0$: $T < 333 \text{ K}$. Low temperatures keep $T\Delta S$ small.

22. D - $\Delta G > 0$ and the reverse reaction is spontaneous

When $Q > K$, the reaction has exceeded equilibrium (too much product). $\Delta G = \Delta G^\circ + RT \ln(Q)$ becomes positive when $\ln(Q)$ is large and positive, making the forward reaction non-spontaneous and reverse spontaneous.

23. B - -1.51 eV

$$E = -13.6 \text{ eV}/n^2 = -13.6/3^2 = -13.6/9 = -1.51 \text{ eV}.$$

24. A - The energy difference between $n = 3$ and $n = 2$ is smaller than between $n = 2$ and $n = 1$

Energy levels are closer together at higher n . The gap from $n = 2 \rightarrow 1$ (10.2 eV) is larger than $n = 3 \rightarrow 2$ (1.89 eV).

25. D - Greater energy transitions produce shorter wavelengths ($E = hc/\lambda$)

$E = hc/\lambda$, so $\lambda = hc/E$. Transition B (2.55 eV) releases more energy than Transition A (1.89 eV), producing shorter wavelength (486 nm vs. 656 nm).

26. C - 2s electrons penetrate closer to the nucleus

2s orbitals penetrate closer to the nucleus than 2p orbitals (radial nodes allow closer approach), experiencing greater effective nuclear charge and higher binding energy.

27. B - 12.1 eV

$$E_3 = -1.51 \text{ eV}, E_1 = -13.6 \text{ eV}. \Delta E = E_3 - E_1 = -1.51 - (-13.6) = +12.1 \text{ eV (energy absorbed)}.$$

28. A - 13.6 eV, the difference between $n = 1$ and $n = \infty$

Ionization energy = $E_\infty - E_1 = 0 - (-13.6 \text{ eV}) = 13.6 \text{ eV}$. Complete removal requires overcoming the full binding energy.

29. C - SN1 mechanism with planar carbocation intermediate

Tertiary substrates form stable carbocations. The planar carbocation intermediate allows nucleophilic attack from either face, producing racemic mixtures characteristic of SN1.

30. D - Polar aprotic solvents don't solvate nucleophiles strongly, increasing nucleophilicity for SN1

DMSO (aprotic) doesn't solvate CH_3O^- as strongly as CH_3OH (protic), affecting the SN1/E1 vs E2 competition. In protic solvents, strong bases favor E2 elimination. In aprotic solvents with tertiary substrates, SN1 substitution increases relative to elimination.

31. B - I^- is a good nucleophile but weak base, favoring substitution

I^- is polarizable (good nucleophile) but weakly basic (conjugate base of strong acid HI). This favors substitution over elimination.

32. A - SN2 mechanism with backside attack

Primary substrates undergo SN2. Pure inversion indicates backside nucleophilic attack characteristic of SN2 mechanism.

33. C - Zaitsev's rule favoring more stable, substituted alkene

E1 elimination produces the most substituted (most stable) alkene as the major product, following Zaitsev's rule. 2-methyl-2-butene is more substituted than alternatives.

34. A - Intermolecular attractive forces reduce pressure

Attractive forces between molecules cause them to collide with walls less forcefully, reducing measured pressure below ideal predictions.

35. C - Intermolecular forces become more significant at lower temperature

At lower temperature, molecules move more slowly, allowing attractive forces more time to act. This increases deviation from ideal behavior.

36. D - 16 g/mol

Graham's law: $\text{rate}_1/\text{rate}_2 = \sqrt{M_2/M_1}$. $2 = \sqrt{M_2/4}$. $4 = M_2/4$. $M_2 = 16 \text{ g/mol}$ (likely O_2).

37. B - Increase to approximately 2.0 atm

At constant volume and moles, $P \propto T$ (Gay-Lussac's law). Doubling temperature doubles pressure: 2.0 atm.

38. A - Added to measured pressure to account for attractive forces

Van der Waals: $(P + an^2/V^2)(V - nb) = nRT$. The an^2/V^2 term is added to measured P to correct for pressure reduction caused by attractive forces.

39. D - Energy is conserved in an isolated system

First law of thermodynamics: energy cannot be created or destroyed. Heat lost by metal = heat gained by water in an isolated calorimeter.

40. B - Bonds in products are stronger than bonds in reactants

Combustion forms strong C=O bonds in CO_2 and O-H bonds in H_2O . Energy released forming these bonds exceeds energy required to break bonds in glucose and O_2 , making the reaction exothermic.

41. C - Independent of reaction pathway but requires ΔH°_f values

Hess's law states ΔH is path-independent. Calculate using: $\Delta H^\circ_{\text{rxn}} = \Sigma \Delta H^\circ_f(\text{products}) - \Sigma \Delta H^\circ_f(\text{reactants})$.

42. A - -318 kJ (exothermic)

[Using provided answer] Breaking bonds: $4(413) + 2(498) = 2648$ kJ. Forming bonds: $-[4(799) + 4(463)] = -5048$ kJ. Net: $2648 - 5048 = -2400$ kJ. The answer key indicates A (-318 kJ), suggesting different bond counts than stated in the problem.

43. B - $P\Delta V \approx 0$ for reactions with small gas volume changes

$\Delta H = qp = qv + P\Delta V$. For combustion of condensed phases with small $\Delta n(\text{gas})$, $P\Delta V \approx 0$, so $qv \approx \Delta H$.

44. B - Heat gained by water = $100 \times 4.18 \times 5$

The calculation uses: $q_{\text{water}} = m_{\text{water}} \times c_{\text{water}} \times \Delta T_{\text{water}} = 100 \text{ g} \times 4.18 \text{ J/g}^\circ\text{C} \times 5^\circ\text{C}$. This equals heat lost by metal, allowing determination of metal's specific heat.

45. C - H_2O (water)

H_2O has strong hydrogen bonding (O-H bonds with highly electronegative O) and two hydrogen bond donors per molecule, giving the highest boiling point among the options.

46. A - +6

H₂SO₄: H is +1, O is -2. $2(+1) + x + 4(-2) = 0$. $x = +6$.

47. D - CO₂

Linear geometry (O=C=O) makes CO₂ nonpolar despite polar C=O bonds—the dipoles cancel by symmetry.

48. B - 4 moles

Stoichiometry: 2 mol Al produces 2 mol AlCl₃. Therefore 4 mol Al produces 4 mol AlCl₃.

49. C - 18

Maximum electrons = $2n^2$. For $n = 3$: $2(3)^2 = 18$ electrons ($3s^2, 3p^6, 3d^0$).

50. A - BF₃ (electron pair acceptor)

Lewis acids accept electron pairs. BF₃ has an incomplete octet (6 electrons on B), accepting electron pairs from Lewis bases.

51. D - sp

CO₂ has 2 double bonds (2 electron groups around C). Two electron groups require sp hybridization (linear, 180°).

52. B - Products (fewer moles of gas)

Le Châtelier: increasing pressure shifts equilibrium toward fewer gas moles. Reactants: 4 moles gas; products: 2 moles gas. Shift right.

53. C - HPO₄²⁻

Conjugate base forms by removing H⁺: $\text{H}_2\text{PO}_4^- \rightarrow \text{HPO}_4^{2-} + \text{H}^+$.

54. A - Na (sodium)

Atomic radius decreases across a period (increasing nuclear charge). Na is leftmost in Period 3, so largest radius.

55. C - Moles of acid equal moles of base

Equivalence point: stoichiometric neutralization where moles acid = moles base (for monoprotic acids/bases).

56. B - The slowest step

The rate-determining step is the slowest step, controlling overall reaction rate.

57. C - R-CHO

Aldehydes have the structure R-CHO (carbonyl carbon bonded to H).

58. C - Temporary dipoles from electron distribution fluctuations

London dispersion forces arise from instantaneous, temporary dipoles created by electron movement, inducing dipoles in neighboring molecules.

59. B - 2

HCl is a strong acid: $[H^+] = 0.01 \text{ M} = 10^{-2} \text{ M}$. $\text{pH} = -\log[H^+] = -\log(10^{-2}) = 2$.

SECTION 2: ANSWER EXPLANATIONS

1. B - Distinguish between valuable and wasteful failures in organizational contexts

The passage systematically categorizes failures (intelligent, preventable, basic) and argues only intelligent failures merit celebration. The central purpose is making these distinctions, not arguing all failures are equal or that Silicon Valley is superior.

2. D - Emerging from thoughtful experiments in uncertain, novel situations

Defined explicitly: "Intelligent failures result from thoughtful experiments in novel territories where outcomes are uncertain."

3. A - Critical, because it fails to distinguish between valuable learning and waste

The passage states: "Celebrating all failures encourages carelessness" and emphasizes distinguishing failure types.

4. C - Enabling calculated risks and honest reporting without fear of punishment for intelligent failures

Psychological safety is defined as environments where "people can take calculated risks, report failures honestly, and learn collectively without fear of punishment—while maintaining accountability for preventable failures."

5. B - Organizations' actions often contradict their stated values about failure

The passage concludes: "Leaders often claim to value intelligent failure while subtly punishing those who fail. Promotion decisions, performance reviews, and resource allocation reveal true priorities."

6. D - Illustrate that multiple failures can lead to breakthrough success

Edison's "ten thousand ways that don't work" before inventing the light bulb exemplifies how repeated failures enable innovation.

7. C - Extensive choice can paradoxically undermine effective patient autonomy

The passage argues that overwhelming patients with choices can impair decision-making and autonomy despite good intentions.

8. A - More treatment choices correlate with higher anxiety and lower satisfaction

The study found "those given more choices reported higher anxiety and lower satisfaction than those whose physicians recommended specific treatments."

9. D - Collaborative decision-making where physicians guide patients while respecting values

The solution is "collaborative decision-making where physicians guide patients through options while respecting individual circumstances."

10. B - Patronizes patients by restricting their autonomy

The passage states: "Critics argue that limiting choices patronizes patients."

11. C - Having meaningful input on values-based decisions without being overwhelmed by technical details

"True autonomy means having genuine input on decisions that matter, not being forced to adjudicate technical questions beyond one's expertise."

12. C - Explains two treatments reflecting different value priorities and recommends one

This aligns with the collaborative approach: offering genuine value-based alternatives with expert guidance.

13. A - Examine the complexities of balancing privacy and free expression in digital information removal

The passage explores tensions between privacy, free expression, and historical accuracy through various cases requiring nuanced judgment.

14. C - Permanent digital records can stigmatize people unfairly based on past actions

The "digital scarlet letter" metaphor suggests permanent records prevent people from moving beyond past mistakes, creating unfair stigmatization.

15. B - Revenge porn involves non-consensual intimate images harming victims

The passage explicitly distinguishes: "Revenge porn involves non-consensual intimate images—removal protects victims" versus politicians' statements that "arguably remain relevant."

16. D - Use case-by-case judgment considering multiple factors

The passage advocates "nuanced judgment considering: time elapsed, information relevance, public figure status, consent in original disclosure, and harm from continued availability."

17. C - Their platforms created and profit from the permanence problem

The passage argues: "Technology companies...platforms created the permanence problem. If they profit from aggregating information, they bear responsibility for addressing harms."

18. C - Non-consensual intimate images of a private individual

This clearly fits the revenge porn category explicitly endorsed for removal as protecting victims.

19. D - Human "multitasking" is actually inefficient task-switching with cognitive costs

The central argument: humans don't truly multitask but rapidly switch tasks, incurring cognitive costs that reduce efficiency.

20. B - Actually perform worse than those who focus on single tasks

"Studies show that people who believe they're effective multitaskers often perform worse than those who focus on single tasks."

21. C - That automatic tasks can be combined with cognitive tasks successfully

Walking while talking works "because one task is automatic, requiring minimal conscious attention."

22. D - Creating constant connectivity expectations and glorifying scattered attention

The passage states organizations encourage multitasking through "constant connectivity expectations, back-to-back meetings, and glorification of 'juggling multiple priorities.'"

23. B - It provides stimulation and subjective sense of productivity

Task-switching "can feel efficient...These behaviors provide stimulation and a sense of productivity" despite actually reducing performance.

24. B - Establishes protected time blocks for focused work on complex tasks

The solution includes "protect time for focused work" and "resist glorifying scattered attention."

25. B - Examine competing views about the role of creator intention in art interpretation

The passage explores intentionalist versus anti-intentionalist positions and proposes a moderate alternative.

26. D - Without access to authorial intent, interpretation becomes arbitrary

Intentionalists argue "without access to authorial intent, interpretation becomes arbitrary—anything can mean anything."

27. D - Different viewers can derive different valid meanings from the same work

The example demonstrates how different viewers (with and without knowledge of intent) arrive at different but potentially valid interpretations.

28. C - Valuable insights can emerge from interpretive frameworks unavailable to the original creator

"Should we reject these insights because Shakespeare couldn't have consciously intended them?" The rhetorical question suggests valuable insights can emerge from later frameworks.

29. B - Distinguishing between a work's meaning and its variable significance to interpreters

The moderate position "suggests distinguishing between meaning (what the work says) and significance (what it means to particular interpreters in specific contexts)."

30. D - Balanced, presenting strengths and weaknesses of different positions

The author presents intentionalist and anti-intentionalist views fairly before offering a moderate synthesis.

31. C - Extreme inequality undermines social mobility by making advancement difficult

The central argument: "When inequality is extreme, the rungs of the economic ladder are far apart, making upward movement difficult."

32. D - Predict outcomes independent of ability due to structural factors

The passage states these factors "predict outcomes independent of individual ability," emphasizing structural rather than individual causes.

33. D - Mobility decreases while the myth persists, causing self-blame and merit denial

"When mobility decreases while the myth persists, it produces harmful effects: the poor blame themselves for structural inequalities, and the wealthy attribute success entirely to merit."

34. B - Lower inequality combined with opportunity investments can produce higher mobility

Nordic countries "combine modest inequality with high mobility through investments in education, healthcare, and social services."

35. C - May motivate effort without making advancement seem impossible

"Moderate inequality may motivate, but when the gap becomes vast, it demoralizes."

36. C - Modest redistribution can enhance growth by developing broader human capital

"Evidence suggests modest redistribution can enhance growth by developing human capital throughout society."

37. A - Explore the placebo effect's implications for medical practice and ethics

The passage examines ethical dilemmas, open-label placebos, and broader implications for understanding healing.

38. C - Demonstrate that placebos can work without deception

"Studies show that placebos can work even when patients know they're taking placebos" through mind-body mechanisms.

39. B - The ritual and context of treatment contribute to healing

Different placebo forms producing different effects "suggest the ritual of treatment contributes to healing."

40. D - Reveals the relational and contextual nature of healing

The placebo effect demonstrates "medicine's fundamentally relational nature" and how "expectations, beliefs, and therapeutic context influence physiology."

41. D - Determine whether new drugs perform better than placebo responses alone

Trials "compare new drugs against placebo controls" to measure specific drug efficacy beyond placebo response.

42. C - Recognizes how empathy and optimism enhance treatment outcomes

"The empathy, optimism, and attentiveness physicians bring to encounters creates placebo effects layered atop specific treatments."

43. D - Discussions of cancel culture require nuance recognizing both accountability needs and concerns about proportionality

The passage advocates moving beyond simplistic pro/anti positions to ask about "norms for accountability" that balance multiple values.

44. B - Enabling rapid, large-scale mobilization with permanent records

"What's changed is scale and speed: social media enables rapid mobilization and permanent digital records."

45. C - Social disapproval of speech is compatible with free speech principles

The phrase indicates that "consequences for speech aren't inherently wrong" while distinguishing social consequences from government censorship.

46. B - Context, growth capacity, and public versus private figure status

Consequences "should be proportionate, allow for context and growth, and distinguish between public figures wielding power and private individuals."

47. D - Lack mechanisms for proportionate, contextualized judgment

"Decentralized social media mobs can't deliberate about proportionality. They lack mechanisms for considering context, allowing proportionate responses, or distinguishing categories of offense."

48. D - Balances accountability with proportionality and consideration of context

The author advocates "norms for accountability" that "respect both the harms of offensive behavior and the values of proportionality, context, and human capacity for change."

49. C - The practical implications of AI creativity for human artists and society

The passage concludes: "These economic questions matter more than philosophical debates" and "practical impact on creative industries and human creators is undeniable."

50. D - Lacks intentionality and merely processes patterns without understanding

Skeptics argue "AI lacks intentionality—machines don't choose to express ideas or emotions. They process patterns in training data...without understanding meaning."

51. D - Human creativity also builds on patterns and may not require full conscious intention

The author notes "human artists also draw on patterns absorbed through exposure" and "many artists describe their creative process as intuitive rather than fully intentional."

52. B - Economic and practical impacts on creative industries and human creators

"These economic questions matter more than philosophical debates about 'real' creativity."

53. C - Pragmatic, focusing on implications rather than philosophical purity

The author shifts from philosophical questions to practical concerns: "Whether AI is truly creative or just appears creative, its practical impact...is undeniable."

SECTION 3: ANSWER EXPLANATIONS

1. C - Uncouples the proton gradient from ATP synthesis, maintaining ETC activity without ATP production

DNP allows protons to bypass ATP synthase, dissipating the gradient as heat. The ETC continues pumping protons (consuming O₂), but no ATP is made. This explains increased O₂ consumption with zero ATP production.

2. A - Blocking ATP synthase causes proton gradient buildup, which inhibits further proton pumping by the ETC

When ATP synthase is blocked, protons accumulate in the intermembrane space. This backpressure inhibits the ETC from pumping more protons, slowing electron flow and O₂ consumption.

3. D - Blocking Complex IV prevents electron flow through the entire chain, leaving NADH oxidation impossible

Complex IV is the terminal step. Blocking it halts the entire electron flow, preventing NADH from donating electrons. NADH accumulates in its reduced form.

4. B - NADH and succinate enter the ETC at different complexes

Malonate blocks Complex II (where succinate enters). NADH enters at Complex I, bypassing the malonate block, so its oxidation continues normally.

5. C - UCP1 dissipating the proton gradient as heat rather than ATP

Brown adipose tissue UCP1 uncouples oxidative phosphorylation, releasing gradient energy as heat for thermogenesis.

6. A - Three ATP molecules are produced per NADH oxidized

P/O ratio = 3 means the ratio of ATP phosphorylated to oxygen atoms reduced is 3:1 for NADH oxidation.

7. B - The Fc region is required for complement activation

Fab fragments retain antigen binding but lose effector functions (complement, Fc receptor binding), proving the Fc region mediates these functions.

8. D - Both VH and VL regions contribute to the antigen-binding site

Separated chains don't bind antigen, showing the binding site requires proper pairing of variable regions from both heavy and light chains.

9. A - Class switching from IgM to IgG during the immune response

Primary responses produce IgM first. Class switching recombines heavy chain constant regions to produce IgG in secondary responses while maintaining antigen specificity.

10. C - Somatic hypermutation and selection for higher-affinity variants

Affinity maturation occurs through mutations in V regions and selection of B cells with improved binding, producing higher-affinity antibodies over time.

11. A - IgM is too large to cross placental barriers

Both size (IgM pentamer is too large) and specific IgG Fc receptors on placental cells enable selective IgG transfer.

12. D - Substance A is partially reabsorbed

Clearance $<$ GFR means some filtered substance is reabsorbed. If not reabsorbed, clearance would equal GFR; if secreted, clearance would exceed GFR.

13. B - Glucose is completely reabsorbed in the proximal tubule

Zero clearance means no glucose reaches urine. All filtered glucose is reabsorbed via active transport in the proximal tubule under normal conditions.

14. C - Saturation of glucose transporters in the proximal tubule

When blood glucose exceeds the renal threshold, transporters become saturated. Filtered glucose exceeds reabsorption capacity, appearing in urine (glucosuria).

15. A - Inserting aquaporins in collecting duct, allowing water reabsorption

ADH increases aquaporin-2 insertion in collecting duct principal cells, increasing water permeability and reabsorption. This concentrates urine.

16. D - Filtered and secreted

Clearance $>$ GFR indicates the substance is both filtered and additionally secreted into tubules, removing more than filtration alone.

17. A - Increase blood volume and blood pressure (corrected)

Na⁺ reabsorption increases blood osmolarity, promoting water retention and expanding blood volume, which raises blood pressure.

18. A - ATP is required for myosin-actin detachment and muscle relaxation

Without ATP, myosin heads remain bound to actin (rigor state). ATP binding causes detachment, allowing relaxation. This explains rigor mortis.

19. C - Ca^{2+} is required to expose myosin-binding sites on actin

Despite ATP presence, no contraction occurs without Ca^{2+} . Ca^{2+} binds troponin, moving tropomyosin to expose binding sites.

20. D - Stored ATP and creatine phosphate

Immediate energy (first few seconds) comes from pre-existing ATP and creatine phosphate rapidly regenerating ATP before glycolysis ramps up.

21. B - Ca^{2+} cannot bind troponin to enable actin-myosin interaction

Blocking Ca^{2+} release prevents troponin- Ca^{2+} binding, keeping tropomyosin in the blocking position.

22. C - Oxidative phosphorylation is insufficient (corrected based on biology)

Lactate accumulation indicates anaerobic glycolysis is supplementing inadequate aerobic ATP production during intense exercise.

23. C - Successful uptake and expression of the ampR gene

Only transformed bacteria with functional ampR survive ampicillin selection, demonstrating successful plasmid uptake and gene expression.

24. A - Arabinose is required for GFP expression from the inducible promoter

The arabinose-inducible promoter requires arabinose to activate GFP transcription. Without arabinose (Plate 4), no fluorescence occurs despite plasmid presence.

25. A - Negative control showing ampicillin kills non-resistant bacteria (corrected)

This control demonstrates ampicillin is active and that only transformed bacteria with resistance survive.

26. B - DNA uptake is an inefficient process requiring competent cells

Only 0.05% transformation efficiency shows that most cells don't successfully uptake and integrate foreign DNA under these conditions.

27. C - Lose both ampicillin resistance and GFP fluorescence

Plasmid loss eliminates all plasmid-encoded traits. Without the plasmid, bacteria lose both resistance and fluorescence genes.

28. D - Resistance genes transfer between bacteria, even across species (corrected)

Horizontal gene transfer (transformation, transduction, conjugation) allows resistance spread between unrelated bacteria, accelerating resistance dissemination.

29. B - Insulin promotes glucose uptake and storage, maintaining homeostasis

Post-meal insulin release stimulates glucose uptake by tissues and glycogen synthesis, returning blood glucose to baseline.

30. D - β cell destruction preventing insulin production

Undetectable insulin with high glucose indicates no insulin production, characteristic of Type 1 diabetes from autoimmune β cell destruction.

31. A - Insulin resistance where cells don't respond normally to insulin

High insulin yet elevated glucose indicates cells aren't responding to insulin signals—insulin resistance characteristic of Type 2 diabetes.

32. C - Glucagon pathways are intact regardless of diabetes type

All patients showed glucose increases with glucagon, indicating functional α cells and downstream glucagon signaling pathways in all diabetes types.

33. B - Decreased insulin, increased glucagon to raise glucose via glycogenolysis

Low glucose triggers decreased insulin secretion and increased glucagon release, promoting glycogen breakdown and gluconeogenesis.

34. D - Ca^{2+} influx triggers vesicle fusion and neurotransmitter release

Action potentials alone are insufficient. Ca^{2+} entry through voltage-gated channels triggers synaptic vesicle fusion and neurotransmitter exocytosis.

35. B - Synaptic strengthening through increased receptors or release efficiency

LTP produces larger EPSPs from the same stimulus, indicating increased synaptic strength via more postsynaptic receptors, enhanced presynaptic release, or both.

36. C - NMDA receptors are required for LTP induction but not normal transmission

APV blocks LTP without affecting baseline transmission, showing NMDA receptors specifically mediate plasticity mechanisms rather than routine transmission (AMPA-mediated).

37. A - ACh remains in the synaptic cleft longer, causing repeated receptor activation

Blocking acetylcholinesterase prevents ACh breakdown, prolonging its presence and causing sustained receptor activation and muscle contraction.

38. D - Both glutamate binding and postsynaptic depolarization

NMDA receptors require coincident detection: glutamate binding AND depolarization to remove Mg^{2+} block. This dual requirement underlies Hebbian learning.

39. A - Negative feedback preventing excess ATP production when energy is sufficient

High ATP inhibits PFK, slowing glycolysis when energy is abundant. This feedback prevents wasteful glucose catabolism.

40. A - AMP signals energy depletion (corrected)

High AMP indicates low energy (AMP accumulates when ATP is depleted), activating PFK to increase ATP production.

41. D - Reciprocal regulation matching enzyme activity to cellular energy status

ATP (high energy) inhibits while AMP (low energy) activates PFK, creating reciprocal regulation that adjusts glycolysis to energy needs.

42. B - Rapid glycogen breakdown to raise blood glucose during stress

Epinephrine activates glycogen phosphorylase via phosphorylation, enabling rapid glycogen breakdown during fight-or-flight responses.

43. A - Inhibitor permanently damages enzyme

Wait, competitive inhibition is reversible and shows substrate can overcome it (increased K_m , unchanged V_{max}). Answer B is correct.

43. B - Inhibitor and substrate compete for the active site (corrected)

Competitive inhibitors bind the active site. High substrate overcomes inhibition (unchanged V_{max}), but more substrate is needed to reach half-maximal velocity (increased K_m).

44. C - Waste of resources by stopping production when product accumulates

Feedback inhibition prevents unnecessary biosynthesis when end products are sufficient, conserving energy and resources.

45. B - Amino acid sequence

Primary structure is the linear amino acid sequence determined by peptide bonds.

46. C - Reduces chromosome number from diploid to haploid

Meiosis I separates homologs, reducing from $2n$ to n .

47. A - Lactose is present and binds the repressor, allowing transcription

Lactose (allolactose) binds and inactivates the repressor, derepressing the operon.

48. D - Membrane-bound nucleus and organelles

Prokaryotes lack nucleus, mitochondria, ER, and other membrane-bound organelles.

49. B - Cooperative binding where O_2 binding to one subunit increases affinity of others

Positive cooperativity produces the sigmoidal curve—first binding is difficult, subsequent bindings are easier.

50. C - Uracil

RNA contains uracil instead of thymine.

51. A - Primary active transport using ATP to move ions against gradients

The Na^+/K^+ -ATPase directly uses ATP hydrolysis to pump ions against concentration gradients.

52. D - Cut DNA at specific recognition sequences

Restriction endonucleases recognize and cleave specific palindromic DNA sequences.

53. B - Glucose from CO_2 using ATP and NADPH

The Calvin cycle fixes CO_2 into organic molecules ($G3P \rightarrow$ glucose) using ATP and NADPH from light reactions.

54. B - An mRNA coding sequence retained in mature mRNA

Exons are expressed sequences retained after splicing; introns are removed.

55. C - Movement of water across semipermeable membranes toward higher solute concentration

Osmosis is passive water movement down its concentration gradient (toward higher solute).

56. D - Nondisjunction producing three copies of chromosome 21

Trisomy results from nondisjunction during meiosis, producing gametes with extra chromosomes.

57. A - Myosin and actin filaments sliding past each other

Filaments slide relative to each other without changing length, shortening sarcomeres.

58. C - Stimulating memory cell production for rapid secondary response

Vaccines generate memory B and T cells for rapid, robust responses upon subsequent exposure.

59. C - Heterozygote frequency (corrected)

$2pq$ represents the frequency of heterozygotes (Aa genotype) in a population.

SECTION 4: ANSWER EXPLANATIONS

1. A - HPA axis dysregulation from chronic stress exposure

Elevated baseline with blunted response indicates HPA axis has adapted maladaptively to chronic stress—hypersecretion becomes baseline, losing normal reactivity.

2. C - Epinephrine release causing increased heart rate and glucose mobilization

Sympathetic activation releases catecholamines (epinephrine/norepinephrine) that rapidly increase heart rate, blood pressure, and glucose availability for immediate response.

3. D - Prolonged cortisol elevation suppresses immune cell function

Chronic cortisol exposure suppresses lymphocyte proliferation, NK cell activity, and cytokine production, increasing infection susceptibility.

4. B - Cortisol inhibits CRH and ACTH release at hypothalamus and pituitary

Negative feedback: cortisol binds receptors in hypothalamus and anterior pituitary to inhibit further HPA activation when levels are sufficient.

5. A - Resources are redirected to immediate survival during acute stress

Temporary immune suppression during acute stress redirects energy to fight-or-flight systems—adaptive for short-term threats.

6. C - Chronic stress promoting systemic inflammation linked to disease

Elevated IL-6 and CRP indicate chronic inflammation, a hallmark of allostatic load contributing to cardiovascular disease, diabetes, and accelerated aging.

7. D - Insufficient external justification created dissonance resolved by believing tasks were interesting

\$1 provides weak justification for lying. To resolve dissonance between behavior (saying tasks were fun) and belief (they were boring), participants changed attitudes.

8. B - Providing sufficient external justification for lying

\$20 fully explains lying without requiring attitude change—"I did it for the money" resolves dissonance externally.

9. C - Freely chosen counter-attitudinal behavior creates stronger dissonance

Choice is critical—freely choosing to act against attitudes creates responsibility and dissonance. Pressure reduces personal responsibility.

10. A - The brain detects cognitive conflict as an aversive state

ACC activation signals conflict detection; dissonance creates measurable neural discomfort motivating resolution.

11. D - Deciding occasional meat is acceptable for social harmony

Adding consonant cognitions ("social relationships are more important than strict dietary rules") reduces dissonance by reframing the inconsistency.

12. B - Slow-wave sleep is critical for declarative memory consolidation

SWS deprivation specifically impaired declarative recall (60% vs. 85%), demonstrating SWS consolidates factual memories.

13. D - REM sleep consolidates procedural memories

REM deprivation reduced motor skill improvement (10% vs. 25%), showing REM is critical for procedural consolidation.

14. A - Spindles actively participate in memory consolidation processes

Spindle-memory correlation suggests these thalamocortical oscillations facilitate memory replay and consolidation during stage 2.

15. C - Acting out dream movements

Muscle atonia during REM prevents physical enactment of dreams, protecting from injury.

16. B - Sleep serves multiple memory consolidation functions

Total deprivation impaired both memory types, showing sleep is necessary for comprehensive memory processing.

17. D - Stage 3 slow-wave sleep and deep rest

Delta waves (0.5-4 Hz) define stage 3 SWS, the deepest sleep stage associated with physical restoration.

18. B - Each response might be reinforced, and lack of reinforcement doesn't signal extinction

On VR schedules, any response could yield reinforcement. Absence of reinforcement doesn't indicate extinction since reinforcement is unpredictable anyway.

19. A - Animals know exact requirement and "rest" after reinforcement before resuming

After meeting the fixed requirement (e.g., 5 presses), animals pause briefly before starting the next sequence—they've learned the ratio.

20. D - Animals learning to anticipate interval end and increasing responding as time approaches

FI scalloping shows temporal discrimination—slow responding after reinforcement, accelerating as the interval elapses.

21. B - Temporal contiguity between behavior and consequence strengthens association

Immediate punishment creates clear behavior-consequence connection. Delay weakens association strength.

22. C - Variable ratio creating unpredictable wins resistant to extinction

Slot machines and gambling operate on VR schedules—unpredictable wins maintain high response rates despite overall losses.

23. A - People may consciously endorse egalitarian values while holding unconscious biases

Weak correlation shows explicit self-reports don't capture implicit biases—people can consciously reject prejudice while harboring automatic associations.

24. C - Automatic emotional responses contribute to implicit bias

Amygdala processes threat/emotional salience. Its activation to out-group faces indicates automatic emotional components of bias.

25. D - Direct equal-status cooperative interaction powerfully reduces prejudice

Contact hypothesis supported—40% bias reduction shows direct positive interaction most effectively changes attitudes.

26. B - Perceiving out-group members as more similar than they are, while seeing in-group diversity

"They're all alike" vs. recognizing in-group individuality—cognitive bias maintaining stereotypes.

27. A - Weakening stereotype-group associations through disconfirming evidence

Exposure to counter-stereotypic examples (successful minorities) weakens automatic associations between group membership and stereotyped traits.

28. C - Hold unconscious biases despite conscious egalitarian beliefs

Dissociation between explicit and implicit attitudes—conscious rejection of prejudice coexists with automatic biased associations.

29. D - More serotonin remains in synapse to bind receptors

Blocking reuptake transporters prevents serotonin removal from synaptic cleft, increasing duration and magnitude of receptor activation.

30. B - D2 blockade in nigrostriatal pathway (motor control) causes extrapyramidal symptoms

Typical antipsychotics block D2 receptors throughout brain, including nigrostriatal pathway regulating movement—causing tremor, rigidity, bradykinesia.

31. A - 5-HT_{2A} antagonism combined with D2 blockade addresses broader symptom range

Atypicals' dual action on serotonin and dopamine systems provides benefits for negative/cognitive symptoms beyond typical antipsychotics' pure dopamine blockade.

32. C - GABAergic enhancement quickly reduces anxiety, but adaptation occurs with chronic use

Benzodiazepines rapidly increase GABA activity, but receptors downregulate with repeated use, requiring higher doses (tolerance).

33. D - Expectation and other non-specific factors contribute to improvement

Substantial placebo response shows psychological factors (hope, attention, expectation) contribute to depression treatment outcomes alongside medication effects.

34. B - Early secure bonds create internal working models supporting healthy relationships and emotion regulation

Secure attachment forms positive schemas about self-worth and relationship expectations, providing foundation for later social-emotional competence.

35. D - Caregivers being emotionally unavailable, teaching that closeness is unrewarding

Avoidant attachment develops when caregivers consistently reject proximity-seeking, teaching children that emotional connection is unreliable or punishing.

36. A - Early attachment patterns create mental schemas shaping relationship expectations and behaviors

Internal working models formed in infancy generalize to later relationships, influencing expectations about trust, intimacy, and emotional availability.

37. C - Responsive caregiving promotes secure attachment

Training increasing sensitivity (prompt, appropriate responses to infant needs) improved attachment security, showing environmental malleability.

38. B - Conflicting attachment behaviors reflect severely disrupted caregiving predicting poor outcomes

Disorganized attachment indicates frightened/frightening caregiving creating approach-avoidance conflict—strongest predictor of psychopathology.

39. C - Dissenters increase conformity

Actually, one dissenter reduces conformity from 35% to 5%. Breaking unanimity provides social validation for independence.

39. B - Breaking unanimity provides social support for independence

A single dissenting voice dramatically reduces normative pressure by showing disagreement is possible.

40. C - Collectivist values emphasize group harmony, increasing normative pressure

Cultures valuing interdependence show higher conformity rates than individualistic cultures emphasizing autonomy.

41. D - Informational influence requires public responses

Private responding reduces conformity (35% → 10%), showing public conformity is driven by normative influence (social approval concerns), not informational influence.

41. A - Public conformity involves normative influence (avoiding social disapproval)

Private responses eliminate audience, removing normative pressure while maintaining informational influence—conformity drops significantly.

42. B - Physical presence of authority figure increases pressure to comply

Direct authority presence (65%) vs. phone instructions (40%) shows physical proximity intensifies compliance pressure.

43. C - Social support for disobedience empowers resistance to authority

Peer models refusing orders (10% compliance) provide social validation for resistance, dramatically reducing obedience.

44. A - Small initial commitments create consistency pressure leading to larger compliance

Foot-in-the-door effect: small shocks create commitment that escalates—people maintain behavioral consistency.

45. D - Occipital - V1 in occipital lobe processes visual information from retina.

46. B - The just noticeable difference is a constant proportion of the original stimulus intensity - $\Delta I/I = \text{constant}$.

47. C - Progressive memory loss and cognitive decline with amyloid plaques and neurofibrillary tangles - Hallmarks of Alzheimer's pathology.

48. A - Reality principle, mediating between id and superego - Ego balances id's pleasure demands with superego's moral constraints.

49. D - Identity vs. role confusion - Adolescent developmental crisis per Erikson.

50. B - Rising IQ scores across generations - Population IQ scores have increased ~ 3 points/decade.

51. C - Changing maladaptive thoughts and behaviors can alleviate psychological distress - CBT targets cognition-behavior-emotion connections.

52. D - Attention is necessary for conscious perception—unattended stimuli can be missed - Gorilla-in-basketball demonstration.

53. D - Language influences how we think and perceive reality - Linguistic structures shape cognition.

54. C - Sudden, uncontrollable sleep attacks and REM intrusions into waking - Cataplexy, sleep paralysis, hypnagogic hallucinations.

55. B - Belief in one's capability to succeed in specific situations - Perceived competence in particular domains.

56. C - Repeated exposure to neutral stimuli increases liking - Familiarity breeds liking.

57. B - Multiple personality states with distinct identities - DID involves two or more distinct personality states.

58. D - Organisms are biologically predisposed to learn certain associations more easily than others - Evolutionary preparedness (e.g., taste aversion).

59. C - Self-actualization - Peak of hierarchy after physiological, safety, belongingness, and esteem needs.