Cyber Security and Digital Forensics (4361601) - Summer 2024 Solution

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Question 1(a) [3 marks]

Describe CIA triad with example.

Solution

Table 1. CIA Triad Comparison Table

Component	Definition	Example
Confidentiality	Ensures data is accessible only to authorized users	Bank account details should only be viewed by account holder
Integrity	Ensures data remains accurate and unmodified	Medical records must not be altered without authorization
Availability	Ensures systems and data are accessible when needed	ATM services must be available 24/7 for customers

Mnemonic

"Can I Access" - Confidentiality, Integrity, Availability

Question 1(b) [4 marks]

Explain Public key and Private Key cryptography.

Solution

Table 2. Key Differences Table

Aspect	Public Key Cryptography	Private Key Cryptography
Keys Used	Two keys (public + private)	Single shared key
Key Distribution	Public key can be shared openly	Key must be shared secretly
Speed	Slower encryption/decryption	Faster operations
Security	Higher security, no key sharing problem	Lower security due to key distribution

Key Points:

- **Public Key**: Uses asymmetric encryption with key pairs
- **Private Key**: Uses symmetric encryption with shared secrets
- **Digital Signatures**: Public key enables non-repudiation
- **Key Management**: Private key requires secure distribution

Mnemonic

”PASS” - Public Asymmetric, Symmetric Secret

Question 1(c) [7 marks]

Explain various security services and security mechanism.

Solution

Table 3. Security Services Table

Service	**Purpose**	**Mechanism Example**
Authentication	Verify user identity	Passwords, Biometrics
Authorization	Control access permissions	Access Control Lists
Confidentiality	Protect data privacy	Encryption (AES, RSA)
Integrity	Ensure data accuracy	Digital signatures, Hashing
Non-repudiation	Prevent denial of actions	Digital certificates
Availability	Ensure service accessibility	Firewalls, Backup systems

Security Mechanisms:

- **Encryption**: Transforms plaintext to ciphertext
- **Digital Signatures**: Provides authentication and integrity
- **Access Control**: Restricts unauthorized access
- **Audit Trails**: Monitor and log security events

Mnemonic

”ACIANA” - Authentication, Confidentiality, Integrity, Authorization, Non-repudiation, Availability

OR

Question 1(c) [7 marks]

Explain MD5 hashing algorithm.

Solution

MD5 Algorithm Process:

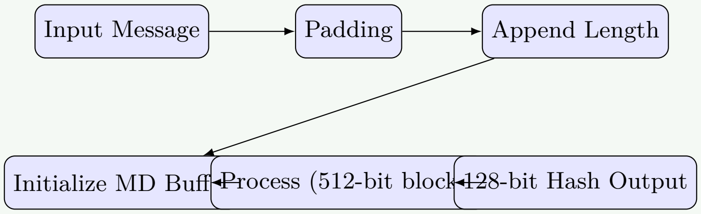


Table 4. MD5 Characteristics Table

Property	Value
Hash Size	128 bits (16 bytes)
Block Size	512 bits
Rounds	64 rounds
Security Status	Cryptographically broken

Key Features:

- **One-way Function**: Cannot reverse hash to original
- **Fixed Output**: Always produces 128-bit hash
- **Avalanche Effect**: Small input change creates large output change
- **Collision Vulnerable**: Multiple inputs can produce same hash

Mnemonic

”MD5 FORB” - Message Digest 5, Fixed Output, Rounds 64, Broken security

Question 2(a) [3 marks]

What is firewall? List out types of firewall.

Solution

Firewall Definition: Network security device that monitors and controls incoming/outgoing traffic based on predetermined rules.

Table 5. Firewall Types Table

Type	Operation Level	Example
Packet Filtering	Network Layer	iptables
Stateful Inspection	Session Layer	Cisco ASA
Application Gateway	Application Layer	Proxy servers
Next-Gen Firewall	Multiple Layers	Palo Alto

Mnemonic

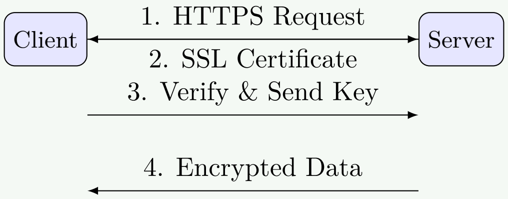
”PSAN” - Packet, Stateful, Application, Next-gen

Question 2(b) [4 marks]

Define: HTTPS and describe working of HTTPS.

Solution

HTTPS Definition: HTTP Secure - encrypted version of HTTP using SSL/TLS protocols.
HTTPS Working Process:



Key Components:

- **SSL/TLS**: Provides encryption layer
- **Digital Certificates**: Verify server identity
- **Port 443**: Default HTTPS port
- **End-to-end Encryption**: Protects data in transit

Mnemonic

”HTTPS SDP4” - Secure, Digital certs, Port 443

Question 2(c) [7 marks]

Give explanation of active attack and passive attack in detail.

Solution

Table 6. Attack Types Comparison

Aspect	**Active Attack**	**Passive Attack**
Detection	Easily detectable	Difficult to detect
System Impact	Modifies system/data	Only observes data
Examples	DoS, Man-in-middle	Eavesdropping, Traffic analysis
Prevention	Firewalls, IDS	Encryption, Physical security

Active Attack Types:

- **Masquerade**: Impersonating authorized user
- **Replay**: Retransmitting valid data transmissions
- **Modification**: Altering message contents
- **Denial of Service**: Preventing legitimate access

Passive Attack Types:

- **Traffic Analysis**: Studying communication patterns
- **Eavesdropping**: Monitoring communications
- **Footprinting**: Gathering system information

Mnemonic

”Active MRMD, Passive TEF” - Masquerade/Replay/Modify/DoS, Traffic/Eavesdrop/Footprint

OR

Question 2(a) [3 marks]

What is digital signature? Explain digital signature properties.

Solution

Digital Signature: Cryptographic mechanism providing authentication, integrity, and non-repudiation.

Table 7. Properties Table

Property	Description
Authentication	Verifies sender identity
Integrity	Ensures message unchanged
Non-repudiation	Prevents sender denial
Unforgeable	Cannot be created without private key

Mnemonic

”AINU” - Authentication, Integrity, Non-repudiation, Unforgeable

OR

Question 2(b) [4 marks]

Define: Trojans, Rootkit, Backdoors, Keylogger

Solution

Table 8. Malware Types Table

Type	Definition	Primary Function
Trojans	Malicious code disguised as legitimate software	Provide unauthorized access
Rootkit	Software hiding presence of other malware	Conceal malicious activities
Backdoors	Secret entry point bypassing security	Remote unauthorized access
Keylogger	Records user keystrokes	Steal passwords/sensitive data

Mnemonic

”TRBK” - Trojans hide, Rootkits conceal, Backdoors bypass, Keyloggers record

OR

Question 2(c) [7 marks]

Explain Secure Socket Layer.

Solution

SSL Architecture:

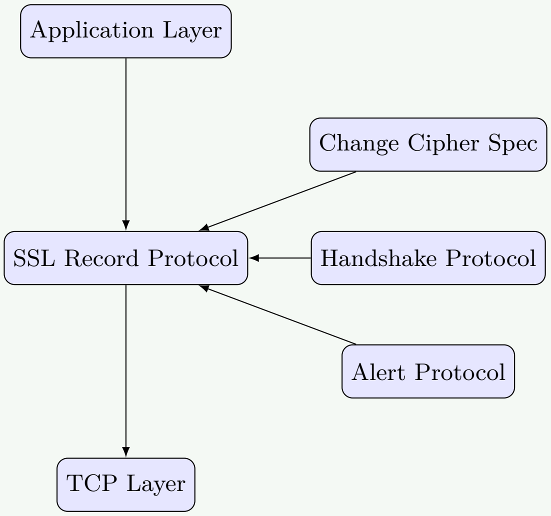


Table 9. SSL Components Table

Component	Function
Record Protocol	Provides basic security services
Handshake Protocol	Establishes security parameters
Change Cipher	Signals encryption changes
Alert Protocol	Handles error conditions

SSL Process:

- **Handshake**: Negotiate security parameters
- **Authentication**: Verify server identity
- **Key Exchange**: Establish session keys
- **Encryption**: Secure data transmission

Mnemonic

”SSL RHCA-HAKE” - Record/Handshake/Change/Alert, Handshake/Auth/Key/Encrypt

Question 3(a) [3 marks]

Explain in detail cybercrime and cybercriminal.

Solution

Table 10. Definitions Table

Term	Definition
Cybercrime	Criminal activities carried out using computers/internet
Cybercriminal	Individual who commits crimes using digital technology

Cybercriminal Types:

- **Script Kiddies**: Use existing tools without deep knowledge
- **Hacktivists**: Motivated by political/social causes
- **Organized Crime**: Professional criminal groups
- **State-sponsored**: Government-backed attackers

Mnemonic

”SSHT” - Script kiddies, State-sponsored, Hacktivists, Teams organized

Question 3(b) [4 marks]

Describe cyber stalking and cyber bullying in detail.

Solution

Table 11. Comparison Table

Aspect	**Cyber Stalking**	**Cyber Bullying**
Target	Specific individual (often adult)	Often minors/peers
Duration	Long-term harassment	Can be one-time or repeated
Intent	Intimidation, control	Humiliation, social exclusion
Methods	Monitoring, threatening messages	Social media harassment, spreading rumors

Common Characteristics:

- **Digital Platforms**: Social media, email, messaging apps
- **Anonymity**: Perpetrators often hide identity
- **Psychological Impact**: Causes emotional distress
- **Legal Consequences**: Violates cyber laws

Mnemonic

”STAL-BULL DPAL” - Digital platforms, Psychological impact, Anonymity, Legal issues

Question 3(c) [7 marks]

Explain Property based classification in cybercrime.

Solution

Table 12. Property-Based Cybercrime Classification

Crime Type	**Description**	**Example**
Credit Card Fraud	Unauthorized use of payment cards	Online shopping with stolen cards
Software Piracy	Illegal copying/distribution of software	Downloading copyrighted software
Copyright Infringement	Violating intellectual property rights	Sharing movies/music illegally
Trademark Violations	Misusing registered trademarks	Creating fake brand websites

Impact Assessment:

- **Financial Loss**: Direct monetary damage
- **Intellectual Property Theft**: Loss of competitive advantage
- **Brand Reputation**: Damage to company image
- **Legal Costs**: Expenses for prosecution/defense

Prevention Measures:

- **Digital Rights Management**: Protect copyrighted content
- **Secure Payment Systems**: Implement fraud detection
- **Legal Enforcement**: Prosecute violators

- **Public Awareness**: Educate about legitimate software

Mnemonic

”CSCT-FILP” - Credit/Software/Copyright/Trademark, Financial/Intellectual/Legal/Public

OR

Question 3(a) [3 marks]

Explain Data diddling.

Solution

Data Diddling Definition: Unauthorized alteration of data before/during input into computer system.

Table 13. Characteristics Table

Aspect	Details
Method	Changing data values slightly
Detection	Very difficult to detect
Target	Financial/sensitive data
Impact	Cumulative significant loss

Mnemonic

”DIDDL” - Data alteration, Input manipulation, Difficult detection, Dollar losses

OR

Question 3(b) [4 marks]

Explain cyber spying and cyber terrorism.

Solution

Table 14. Comparison Table

Aspect	Cyber Spying	Cyber Terrorism
Purpose	Intelligence gathering	Cause fear/disruption
Targets	Government, corporations	Critical infrastructure
Methods	Stealth, long-term infiltration	Destructive attacks
Impact	Information theft	Physical/economic damage

Key Characteristics:

- **Cyber Spying**: State-sponsored, corporate espionage
- **Cyber Terrorism**: Ideologically motivated, mass disruption
- **Common Tools**: Malware, social engineering, zero-day exploits

Mnemonic

”SPY-TER IGSD” - Intelligence/Government/Stealth/Disruption, Terror/Economic/Rapid/Damage

OR

Question 3(c) [7 marks]

Explain article section 65 and section 66 of cyber law.

Solution

Table 15. IT Act 2008 Sections

Section	**Offense**	**Punishment**
Section 65	Computer source code tampering	Up to 3 years imprisonment or fine up to 2 lakh
Section 66	Computer-related offenses	Up to 3 years imprisonment or fine up to 5 lakh

Section 65 Details:

- **Scope**: Knowingly/intentionally concealing, destroying, altering computer source code
- **Intent**: When computer source code required to be kept/maintained by law
- **Application**: Protects integrity of essential software systems

Section 66 Details:

- **Computer Hacking**: Unauthorized access to computer systems
- **Data Theft**: Downloading, copying, extracting data dishonestly
- **System Damage**: Destroying, deleting, altering information
- **Service Disruption**: Denying access to authorized persons

Mnemonic

”65-66 CDHD” - Code tampering, Damage, Hacking, Data theft

Question 4(a) [3 marks]

What is Hacking? List out types of Hackers.

Solution

Hacking Definition: Unauthorized access to computer systems/networks to exploit vulnerabilities.

Table 16. Hacker Types Table

Type	**Motivation**	**Activity**
White Hat	Security improvement	Ethical penetration testing
Black Hat	Malicious intent	Criminal activities
Grey Hat	Mixed motives	Unauthorized but non-malicious
Script Kiddie	Recognition	Using existing tools

Mnemonic

”WBGS Hat” - White, Black, Grey, Script kiddie

Question 4(b) [4 marks]

Explain Vulnerability and 0-Day terminology of Hacking.

Solution

Table 17. Terminology Table

Term	**Definition**	**Risk Level**
Vulnerability	Security weakness that can be exploited	Medium-High
0-Day Vulnerability	Unknown security flaw	Critical
0-Day Exploit	Attack code for 0-day vulnerability	Critical
0-Day Attack	Active exploitation of 0-day	Critical

Key Characteristics:

- **Unknown to Vendors**: No patches available
- **High Value**: Sold in dark markets
- **Stealthy**: Difficult to detect
- **Time-Critical**: Value decreases after disclosure

Mnemonic

”0-Day UHST” - Unknown, High-value, Stealthy, Time-critical

Question 4(c) [7 marks]

Explain Five Steps of Hacking.

Solution

Hacking Process Flow:

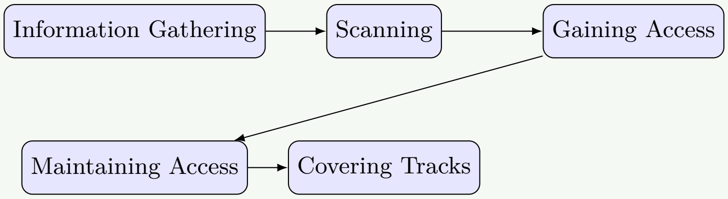


Table 18. Five Steps Detailed

Step	**Purpose**	**Tools/Techniques**
1. Information Gathering	Collect target information	OSINT, Social engineering
2. Scanning	Identify live systems, ports	Nmap, Port scanners
3. Gaining Access	Exploit vulnerabilities	Metasploit, Custom exploits
4. Maintaining Access	Establish persistent presence	Backdoors, Rootkits
5. Covering Tracks	Remove evidence	Log deletion, File cleanup

Each Step Details:

- **Information Gathering**: Passive/Active reconnaissance
- **Scanning**: Network mapping, vulnerability assessment
- **Gaining Access**: Password attacks, buffer overflows
- **Maintaining Access**: Privilege escalation, backdoor installation
- **Covering Tracks**: Anti-forensics techniques

Mnemonic

”ISGMC” - Information, Scanning, Gaining, Maintaining, Covering

OR

Question 4(a) [3 marks]

Explain any three basic commands of kali Linux with suitable example.

Solution

Table 19. Kali Linux Commands Table

Command	Purpose	Example
nmap	Network scanning	`nmap -sS 192.168.1.1`
netcat	Network utility	`nc -l -p 4444`
john	Password cracking	`john --wordlist=passwords.txt hashes.txt`

Command Details:

- **nmap**: Stealth SYN scan on target IP
- **netcat**: Listen on port 4444 for connections
- **john**: Dictionary attack on password hashes

Mnemonic

"NNJ" - Nmap scans, Netcat listens, John cracks

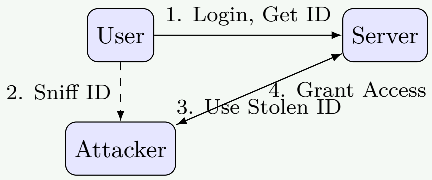
OR

Question 4(b) [4 marks]

Describe Session Hijacking in detail.

Solution

Session Hijacking Process:



Types and Methods:

- **Active Hijacking**: Attacker actively participates
- **Passive Hijacking**: Monitor and capture sessions
- **Network Level**: IP spoofing, ARP poisoning
- **Application Level**: Session ID prediction, XSS

Prevention Measures:

- **HTTPS**: Encrypt session data
- **Session Timeouts**: Limit session duration
- **IP Binding**: Tie sessions to IP addresses
- **Strong Session IDs**: Use unpredictable tokens

Mnemonic

"APNA-HSIS" - Active/Passive/Network/Application, HTTPS/Strong/IP/Session

OR

Question 4(c) [7 marks]

Explain Remote Administration Tools.

Solution

RAT Definition: Software allowing remote control of computer systems, often used maliciously.

Table 20. RAT Functionality Table

Function	Description	Risk Level
Screen Capture	Take screenshots remotely	Medium
Keylogging	Record keystrokes	High
File Transfer	Upload/download files	High
Camera Access	Activate webcam/microphone	Critical

Table 21. Legitimate vs Malicious Use

Aspect	Legitimate	Malicious
Purpose	IT support, administration	Espionage, theft
Consent	User aware and consenting	Installed without knowledge
Access	Authorized personnel only	Unauthorized attackers

Detection and Prevention:

- **Antivirus**: Detect known RAT signatures
- **Network Monitoring**: Unusual outbound connections
- **User Education**: Avoid suspicious downloads
- **Firewall Rules**: Block unauthorized connections

Common RATs:

- **TeamViewer**: Legitimate remote access
- **DarkComet**: Malicious RAT
- **Poison Ivy**: Advanced persistent threat tool

Mnemonic

”RAT SKFC-ANUM” - Screen/Key/File/Camera, Antivirus/Network/User/Monitoring

Question 5(a) [3 marks]

Explain Mobile forensics.

Solution

Mobile Forensics Definition: Process of recovering digital evidence from mobile devices using scientifically accepted methods.

Table 22. Key Aspects Table

Aspect	Description
Data Types	Call logs, SMS, photos, app data
Challenges	Encryption, anti-forensics, variety of OS
Tools	Cellebrite, XRY, Oxygen Suite
Legal	Chain of custody, court admissibility

Mnemonic

”DCTL” - Data types, Challenges, Tools, Legal requirements

Question 5(b) [4 marks]

What is Digital forensics? Write down advantages of Digital forensics.

Solution

Digital Forensics Definition: Scientific examination of digital devices to recover and analyze evidence for legal proceedings.

Table 23. Advantages Table

Advantage	Description
Evidence Recovery	Retrieve deleted/hidden data
Crime Solving	Provide crucial evidence for cases
Cost Effective	Cheaper than traditional investigation
Accurate Results	Scientific methods ensure reliability

Additional Benefits:

- **Time Efficient**: Faster than manual investigation
- **Non-destructive**: Preserves original evidence
- **Comprehensive**: Analyzes multiple data sources
- **Court Acceptable**: Legally admissible evidence

Mnemonic

”ECCA-TNCA” - Evidence/Crime/Cost/Accurate, Time/Non-destructive/Comprehensive/Admissible

Question 5(c) [7 marks]

Describe in detail Locard’s Principle of exchange in Digital Forensics.

Solution

Locard’s Principle: ”Every contact leaves a trace” - any interaction between objects results in exchange of materials.

Digital Application:

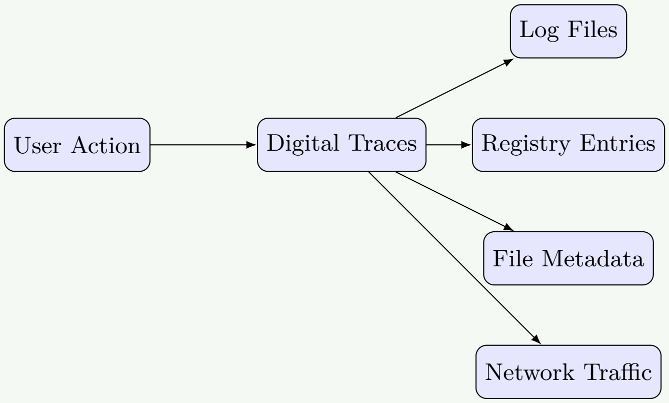


Table 24. Digital Traces Table

Action	Digital Trace	Location
File Access	Access timestamps	File system metadata
Web Browsing	Browser history	Browser databases
Email Sending	Email headers	Mail server logs
USB Connection	Device registry	Windows registry

Forensic Implications:

- **Persistence**: Digital traces often persist longer
- **Accuracy**: Precise timestamps and data
- **Volume**: Large amounts of trace evidence
- **Recovery**: Deleted data can be recovered

Evidence Types:

- **Temporal**: When actions occurred
- **Spatial**: Where actions took place
- **Relational**: Connections between entities
- **Behavioral**: Patterns of user activity

Applications:

- **Criminal Cases**: Prove presence/actions
- **Civil Litigation**: Business disputes
- **Internal Investigations**: Employee misconduct
- **Incident Response**: Security breach analysis

Mnemonic

”LOCARD PVAR-TREB” - Persistence/Volume/Accuracy/Recovery, Temporal/Relational/Evidence/Behavioral

OR

Question 5(a) [3 marks]

Explain Network forensics.

Solution

Network Forensics Definition: Monitoring and analysis of network traffic to gather information and evidence.

Table 25. Key Components Table

Component	Function
Packet Capture	Record network traffic
Traffic Analysis	Examine communication patterns
Protocol Analysis	Decode network protocols
Timeline Creation	Establish sequence of events

Mnemonic

”PTTP” - Packet capture, Traffic analysis, Timeline, Protocol analysis

OR

Question 5(b) [4 marks]

Explain why CCTV plays an important role as evidence in digital forensics investigations.

Solution

Table 26. CCTV Evidence Value

Aspect	Importance
Visual Proof	Direct evidence of events
Timestamp	Precise time correlation
Location Verification	Proves presence at scene
Behavior Analysis	Shows actions and intent

Digital Forensics Integration:

- **Metadata Extraction**: Camera settings, timestamps
- **Video Enhancement**: Improve image quality
- **Format Analysis**: Understand compression artifacts
- **Authentication**: Verify video integrity

Legal Considerations:

- **Chain of Custody**: Maintain evidence integrity
- **Court Admissibility**: Follow legal procedures
- **Privacy Rights**: Respect surveillance laws
- **Technical Validation**: Prove authenticity

Mnemonic

”VTLB-MFAC” - Visual/Timestamp/Location/Behavior, Metadata/Format/Authentication/Chain

OR

Question 5(c) [7 marks]

Explain phases of Digital forensic investigation.

Solution

Digital Forensic Investigation Phases:

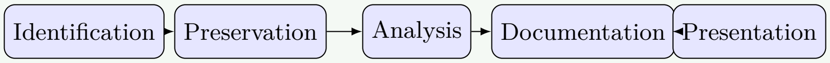


Table 27. Phase Details Table

Phase	Activities	Tools/Methods
Identification	Locate potential evidence sources	Initial assessment, Scene survey
Preservation	Secure evidence without alteration	Imaging, Hash verification
Analysis	Examine evidence for relevant data	Forensic software, Manual review
Documentation	Record findings and procedures	Reports, Screenshots, Logs
Presentation	Present findings to stakeholders	Court testimony, Expert reports

Detailed Activities:

1. Identification Phase:

- **Evidence Sources**: Computers, phones, servers, network logs
- **Scope Definition**: Determine investigation boundaries
- **Legal Authorization**: Obtain warrants/permissions
- **Initial Photography**: Document scene condition

2. Preservation Phase:

- **Bit-by-bit Imaging**: Create exact copies
- **Hash Calculation**: Verify integrity (MD5, SHA)
- **Chain of Custody**: Maintain evidence trail
- **Write Protection**: Prevent evidence modification

3. Analysis Phase:

- **Data Recovery**: Retrieve deleted files
- **Keyword Searching**: Find relevant information
- **Timeline Analysis**: Reconstruct events
- **Pattern Recognition**: Identify suspicious activities

4. Documentation Phase:

- **Methodology Recording**: Document procedures used
- **Evidence Cataloging**: List all findings
- **Screenshot Capture**: Visual evidence documentation
- **Report Preparation**: Comprehensive investigation report

5. Presentation Phase:

- **Expert Testimony**: Court appearances
- **Visual Aids**: Charts, diagrams, demonstrations
- **Technical Translation**: Explain complex concepts
- **Cross-examination**: Answer defense questions

Quality Assurance:

- **Peer Review**: Second examiner verification
- **Tool Validation**: Ensure software accuracy
- **Procedure Adherence**: Follow standard protocols
- **Continuous Training**: Keep skills current

Legal Considerations:

- **Admissibility Rules**: Meet court standards
- **Privacy Protection**: Respect individual rights
- **International Law**: Cross-border investigations
- **Professional Ethics**: Maintain objectivity

Mnemonic

”IPADP-ESLR-HTVC-MSCR-ETVI” - Identification/Preservation/Analysis/Documentation/Presentation with detailed sub-activities