Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2024

Computer science

Higher level

Paper 2

33 pages

Subject details: Computer science HL paper 2 markscheme

Mark allocation

Candidates are required to answer **all** questions in **one** Option. Total 65 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.
- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.
- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	• In the case of an "identify" question, read all answers and mark positively up to the maximum marks. Disregard incorrect answers. • In the case of a "describe" question, which asks for a certain number of facts *eg* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. • In the case of an "explain" question, which asks for a specified number of explanations *eg* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc*.

1. (a) *Award **[2 max]***
*Award **[1]** for 3 correct tables or 2 correct tables with a 1–M*
*Award **[2]** for three correct tables and relationships*

(b) *Award **[3 max**]*
Improves data accuracy/reduce record anomalies / improves data retrieval accuracy;
Improves data consistency / Maintain relationships / Ensure records in a linked table relates to data in another table (via primary key and foreign) to allow extraction of data from different table;
Ensure that a deleted record does not leave hanging records unlinked to other tables;
To simplify update/maintenance through cascade delete/update;

***Note**: Accept related example such as if a police officer who interviewed a witness, is deleted, they cannot be identified from the interview record*.

(c) *Award **[3 max**]*
A name is assigned to a new view/CREATE VIEW view_name AS;
Fields (columns) are selected/SELECT field1, field2, FROM table(s);
The condition is specified/WHERE condition/filter applied;
Which will reduce the subset of data to include required data only;

A query/filter provides a subset of the database;
Which can be saved and used regularly (e.g. weekly updates);
The view is not part of the physical schema;
The view can be organised/sorted according to the reporting needs;

***Note:** Do not award marks from different clusters.*

2. (a) *Award **[1 max]***
It is a non-identifying field used to find row in a table;
It is an additional key which can be used to locate specific data;
It is a candidate key that is not the primary key;

(b)(i) *Award **[2 max]***
The three combined keys do not uniquely identify each interview;
A witness can be interviewed more than once by the same officer for the same crime;
A primary key (e.g. INTERVIEWID) is more suitable than a composite key with many fields /A composite key would need to include DateTimeStatement;
Indexing works better with one key than a composite key with multiple fields;

(b)(ii) *Award **[4 max]***
The table is not in 1NF/2NF so cannot be in the 3NF;
There is no (unique) Primary Key;
There is partial dependency // non-key attribute depends on part of primary key only...
... Example: CrimeLocation is dependent on CrimeID only (and not the composite key);
The table has transitive/non-key dependency; ...
... Example: StationPhone is dependent on Station;

(c) *Award [**2 max**]*
Phone number is not a value/amount/magnitude;
May start with 0 and get removed if integer type is used;
May include brackets and/or + symbol;
May need to search for part of the number;

(d) *Award **[6 max]***
Award 1 mark for identifying 4 tables with correct fields without PK;
Award 1 mark for EVIDENCE with EvidenceID as PK and correct fields;
Award 1 mark for CRIME with CrimeID as PK and correct fields;
Award 1 mark for VICTIM with VictimID as PK and correct fields;
Award 1 mark for OFFICER with OfficerID as PK and correct fields;
Award 1 mark for identifying CrimeID as FK in EVIDENCE;
Award 1 mark for CRIMEOFFICER with correct fields and PK;
Award 1 mark for VICTIMCRIME with correct links and PK;

CRIME(CrimeID, CrimeType, CrimeAddress, CrimeDate, CrimeTime)
CRIMEOFFICER(CrimeID, OfficerID)
EVIDENCE(EvidenceID, EvidenceType, CrimeID*, EvidenceDesc)
VICTIMCRIME(CrimeID*, VictimID*)
VICTIM (VictimID, VictimName, VictimPhone)
OFFICER (OfficerID, OfficerName)

Accept CrimeDateTime in CRIME
Accept a primary key for VICTIMCRIME
Accept EvidenceTypeID in EVIDENCE as a foreign key
Students may split OfficerName to OfficerFirstname and OfficerSurname

3. (a) *Award **[3 max]***
Data locked could be applied to a record/row as soon as it's opened in edit mode/when a transaction is being carried out;
A second officer would have read-only access/would not be given editing rights;
Until the edit is complete/until a timeout period has been applied;
Locks can be applied and removed in two phases to ensure serial sequences (two phase locking);

(b) *Award **[5 max]***
Advantages
It eliminates data duplicates / update anomalies;
And improves the integrity/consistency of data;

Improves quick access / sharing of data (between different law enforcement agencies);
As there is no need to look at different sources;
Thus, reducing time required to solve crimes;

Crimes committed in other regions can be cross-referenced;
To improve the accuracy of investigations;

It increases available (historical) data;
And this improves the insight from data analytics;

Disadvantages
One central point can be attacked by hackers;
Leading to complete data loss / privacy issues;

Central computer is a single point of failure;
Which can cause system downtime (hampering crime investigation);

Increased bureaucracy (as getting access to the data might require several levels of security clearances);
Can prevent timely access to crime data;

Data can be intercepted (and replayed) during transmission;
Compromising the investigation;
Raising privacy issues leading to data protection breaches;

Costs of development/maintenance can be high;
In terms of the hardware / security / transmission infrastructure;

Conclusion
A valid conclusion with a justified opinion.

*Mark as **[2] + [2] + [1]***

(c) (i) *Award **[4 max]***

Explanation of data mining (the use of pattern recognition logic to identify trends within a large dataset);
DM finds hidden patterns and correlations within crime data;
DM analyses historical crime data which reveals trends;
DM enables the exploration of relationships and associations between different entities/uses link analysis;
DM can build predictive models (based on historical data);
DM can identify anomalies or outliers in crime data;
For example, the algorithm might predict the location/time of the next crime from a series of related crimes.

***Note**: only award full marks if there is a valid reference to the scenario. Accept other examples. Award 3 marks Max if there is no reference to the scenario.*

(c)(ii) *Award **[4 max]***

Explanation of data matching (the comparison of different sets of data with the aim of identifying links/similarity between them);
Data matching identifies records that correspond to the same entities (e.g. suspects, location, type of crime);
Data matching can be run across multiple databases such as hospital records, insurance claims, vehicle registration;
Unrelated crimes or entities may be grouped together (classified) by common data;
The results of data matching can be further used to reveal connections between past and present crimes;

Examples may include:
CCTV footage may link a car to more than one investigation;
Suspect identification – matching physical characteristics to several crimes;
Alias detection – criminals using multiple aliases to hide their identity;
Network analysis – linking criminals together into a crime syndicate;

***Note**: only award full marks if there is a valid reference to the scenario. Accept other examples. Award 3 marks Max if there is no reference to the scenario.*

(d) (i) *Award [**4 max**]*

Dictionary / brute force attack;
Because of weak passwords e.g., the user only used letters/numbers;

Users choose the same password for everything;
Leaked password from hacked software/written down/obvious password;

Keylogging may be used to obtain password;
if two or three-factor authentication is not used/an on-screen keyboard isn't used;

A password is susceptible to a MITM attack;
If no encryption is used;

*Mark as **[2] + [2]***

(d) (ii) *Award [3 **max**]*

By providing a framework for ethical storage of data/requiring companies to fairly and lawfully process data;
By requiring companies to register with the data protection governing body;
By enforcing (financial) penalties on organisations that fail to follow guidelines;
Holding data for the period of time that is required only;
Using data collected for intended purpose only;
Not sharing data without permission (outside organisations/counties);
Giving individuals the right to view data about themselves;
Storing data that is adequate, relevant and not excessive;
Ensuring data is accurate and up-to-date;

4. (a) *Award **[2 max]***
Hierarchical Structure/Tree-like structure;
Multiple parent records/Multiple children records;
Data linked to other data points / web-like structure of nodes;
Natural relationships/relationship navigation;
Many to many relationships between entities;
Flexible data access due to the network of relationships;

***Note:** Accept an example, criminal linked to crime records.*

(b) *Award **[5 max]***
Advantages
OODBS allow efficient representation and management of complex data structures and relationships e.g. they allow the storage of objects multimedia data/polygons/points as opposed to storing integers, strings and real numbers in RDBMS;
OODBS uses similar features to OOP (inheritance, encapsulation, polymorphism) which are unavailable to RDMS. These features support code reusability and simplify application development;
OODBS offer improved performance as they can directly store program objects. RDBMS must first flatten program objects before storing and recreate objects when loading them. This creates performance impedance;
OODBS are better at modelling real-world objects and relationships than RDBMS. It is easy to extend functionality of objects by modifying the underlying classes through inheritance and polymorphism;

Disadvantages
RDBDS is more widely used/more accessible so there is a lot for support for the database model;
The availability of numerous vendors of RDBMS means there cannot be vendor-lock in as in OODBS;
RDBMS has greater compatibility (interoperability) with other systems;
RDMBS are easy to design and modify and extend/OODBS are more complex to modify and extend;
RDMBS have standard query tools/report generators;
RDMBS has higher integrity and lower redundancy due to availability of various constraints like referential integrity constraints, domain integrity constraints;
RDMBS offer better performance in heavy multiuser systems because the data model handles concurrency better and more effectively than OODMS;
RDMBS are better at dealing with large datasets/complex queries;

Conclusion/Opinion
The conclusion should do more than repeat the stated information.

*Mark as **[2]** + **[2] + [1]***

(c) *Award **[4 max]***
Centralises data from multiple sources;
Cleans the data through the ETL processes;
So that standardised searches can be used/to avoid separate searches on different sources;

Data warehouses have more data than a database/petabytes or terabytes compared to gigabytes;
Which increases the chances of finding patterns/noticing anomalies;

Databases only store transaction data/day to day operations;
Data warehouse time stamps data so that when the data was collected can be factored into the analysis;
Providing historical intelligence (and making trend analytics possible);

Data warehouses have advance OLAP tools;
Which allows data mining/data matching/link analysis techniques / allows for classification, cluster analysis, and associations/ allows for predictions;

*Mark as **[2]** + **[2]***

(d) *Award **[4 max]***
PM is an accurate way to predict and forecast likely future crimes;
By analysing demographics/socio-economic indicators/environmental factors;

PM outcomes enable Europol to allocate resources/resource optimization;
Europol has limited resources, so PM makes the best use of them;

PM will automatically update to factor in changes in the underlying data;
With an emphasis on information-bearing patterns;

PM will ignore random patterns/outliers/errors/variation (noise) so they don't affect outcomes;
And can be applied to structured and unstructured data;

PM often leverages domain-specific knowledge or rules;
Making it useful when patterns are well-defined like cases on homicide;

PM can unearth crime patterns linked to specific times and events;
Enabling law enforcement agencies to develop strategies and be ready in those periods.

*Mark as **[2]** + **[2]***

(e) *Award **[5 max]***

Link analysis identifies relationships between large quantities of crime data;
Link analysis examines relationships among individuals, locations, organizations, objects and events;
Link analysis can be applied to many databases (associating data between them);
Link analysis may discover new patterns of interest (including individuals, locations, organizations, objects and events);
Link analysis can check the similarity between the datasets using data matching techniques;
Link analysis can find anomalies where known patterns are violated;
Identified anomalies can be linked to fraudulent activities/behaviours requiring further investigation;
Accept example, such as criminal network using phone records/credit card theft identification using patterns of transactions;

***Note**: Award 4 marks max if there is no reference to the scenario*

5. (a) *Award **[4 max]***

Enter 2 to 40 in Column A;
In cell B1 enter the formula =(A1*(A1-1)/2;
In cell C1 = (364/65)^B1;
In cell D1 = 1-C1;
drag down cells B1, C1 and D1 to row 40;

(b) *Award **[4 max]***
*Award **[1]** for comparing a cell with the range e.g. COUNTIF*
*Award **[1]** for using an absolute cell reference for the range*
*Award **[1]** for SUM of values to check if there is a duplicate*
*Award **[1]** for outputting an indication whether there are shared birthdays (or not), for example an IF statement; True/False, "Shared birthday"/"No Shared birthdays", or AND(EXACT)*

Example 1

	A	B	C
1	1	=randbetween(1,365)	=countif(B$1:B$15,B1)
2	2	=randbetween (1,365)	=countif(B$1:B$15,B2)
3	3	=randbetween (1,365)	=countif(B$1:B$15,B3)
4..13	..		
14	14	=randbetween (1,365)	=countif(B$1:B$15,B14)
15	15	=randbetween (1,365)	=countif(B$1:B$15,B15)
16			=if(sum(C2:C15)>A15, TRUE, FALSE)

Example 2

	A	B	C
1	1	=randbetween(1,365)	=if(countif(B$1:B$15,B1)>1, TRUE, FALSE)
2	2	=randbetween (1,365)	=if(countif(B$1:B$15,B2)>1, TRUE, FALSE)
3	3	=randbetween (1,365)	=if(countif(B$1:B$15,B3)>1, TRUE, FALSE)
4..13	..		
14	14	=randbetween (1,365)	=countif (A$1:A$15,A14)
15	15	=randbetween (1,365)	=countif (A$1:A$15,A15)
16			=(NOT(AND(EXACT(C2:C16,C2))))

Accept alternative models that produce True or False based on duplicate birthdays

(c) *Award **[8 max]***
*Award **[1]** outer loop 10,000 times*
*Award **[1]** populate the DAY array with random numbers*
*Award **[1]** initialise FOUND to False and change to True*
*Award **[1]** loop from 0 to 22, with incrementing index (NUM1)*
*Award **[1]** inner loop from 1 to 22, with incrementing index (NUM2)*
*Award **[1]** if DAY[NUM1] == DAY[NUM2]*
*Award **[1]** if FOUND == True then add 1 to PAIR*
*Award **[1]** for outputting the correct percentage*

Solution 1

```
LOOP = 10000
GROUPSIZE = 23
PAIR = 0
loop COUNT from 0 to LOOP-1
   loop NUM from 0 to GROUPSIZE - 1
      DAY[NUM] = RANDINT(1,365)
   end loop
   FOUND = False
   NUM1 = 0
   loop while NUM1 < GROUPSIZE and NOT FOUND
      NUM2 = NUM1 + 1
      loop while NUM2 < GROUPSIZE and NOT FOUND
         if DAY[NUM1] = DAY[NUM2]:
            FOUND = True
         end if
         NUM2 = NUM2 + 1
       end loop
       NUM1 = NUM1 + 1
   end loop
   if FOUND == True:
      PAIR = PAIR + 1
   end if
end loop
output("Pair", PAIR/LOOP*100, "%")
```

(d) *Award **[2 max]***
A (much) larger number (e.g. 1,000,000) may take too long to run;
A smaller number (e.g. 10) may give an inaccurate result;
A balance between speed and accuracy is required;
The bigger the sample, the more accurate the result / Law of large numbers applies;

6. (a) *Award **[2 max]***
population;
growth_rate;
gender;
life_expectancy;
birth_rate;
death_rate;
population_age;

Accept other appropriate variables.

(b) *Award **[5 max]***
A model is a representation of a real-world entity/event/behaviour / population growth is a real-world behaviour;
A simulation is an algorithm / method of implementing a model;
A model/simulation requires data to make predictions and data exists;
Population growth has many variables (e.g. birth rate, age of population, etc..) that affect outcomes;
It allows changing variables / to explore what if scenarios;
These parameters/variables can be adjusted to investigate its subsequent behaviour;
There is historical data on population growth to test your model (before applying it to future predictions);

(c) *Award **[5 max]***
*Award **[1]** for each point up to **[5 max]***
Data collection/data separating/data cleansing;
Split the training data into training and testing;
Choose a statistic model e.g. linear regression;
Build or train the model on the data/use cost function (predicted vs actual);
Run the model/run the statistical test;
Conduct sensitivity analysis/fine tune parameters (birth rate/dead rate);
Test assumptions by rerunning the simulation/model.

(d) *Award **[2 max]***
Balance the number of predictive factors;
By increasing/decreasing the model complexity;

Break down the world's population by country;
Make country-specific adjustments/use different formula for each country;

List all of the variables that need to be input;
Add weighting to each of these variables based on influence;

Explore previous population-related events in history (e.g. wars, crop cultivation, viral outbreaks, birth-related developments);
Factor these past issues in future predictions;

Explore future events that might affect population growth (e.g. sustainability policies, political conflict);
Factor in these events into the prediction;

Use stochastic/probabilistic mathematical predictive model;
e.g. Bayesian Approach / Markov Chain / Monte Carlo algorithms;

(e) *Award **[6 max]***
Answers may include economic, medical, housing, jobs, education

Example 1: Economic
Predicted population is used to determine expenditure for public services (schools/hospitals/police);
Overpredicting population growth could result in overspending in the public sector;
Underpredicting population growth could result in high unemployment and economic problems;

Example 2: Medical
Predicted population is used to determine the number of hospitals/doctors/nurses;
Underpredicting population growth could result in inadequate healthcare;
Leading to an increase in unnecessary deaths;
Overpredicting population growth could result in empty beds or unused hospitals;
Oversupply of doctors and nurses leading to redundancies;

Example 3: Urban Planning
Predicted population is used to determine the development such as transportation systems, sewage and water systems, and electricity supply;
Overpredicting population could lead to wastage of public funds, increased public debt, or higher taxes;
Underpredicting population could result in overcrowded transportation systems, strain on utility supplies, and insufficient recreational facilities;
The impacts could include lowered quality of life, dissatisfaction with public services, traffic congestion, and strain on existing resources;

*Mark as **[3] + [3]***

Accept other examples

7. (a) *Award **[1 max]***
Representation of (binary) data in an image;

(b) *Award **[2 max]***
Low memory requirements for a (modern) computer/phone/tablet;
Memory needs are relative to resolution/visualisation detail;
Memory needs are relative to the rendering techniques;

(c) *Award **[4 max]***
The type of rendering affects the memory needs;
For example, Ray tracing is more processor intensive and requires more memory than scanline;
Lighting / shadows / textures increase the processing/memory overheads;
A graphic processing unit (GPU) is recommended;
The GPU should have at least 8GB of DDRAM;
Inadequate processing/memory will result in a low-quality animation;

8. (a) (i) *Award **[1 max]***
An array/list/chromosome;
54 countries/city names;

(ii) *Award **[2 max]***
Randomness adds population diversity;
To ensure that a (near) optimal solution is found/avoid local extrema;

(b) *Award **[2 max]***
Selection method;
Crossover method;
Mutation rate;
Elitism;
Fitness function;

(c) *Award **[5 max]***
Photographs of people with known ages are collected / Gather a data set with labels (known age);
The dataset is split into training, (validation), and test data;
The machine learning model is trained with the training data;
The test data is used to determine accuracy;
Errors in results are used to improve accuracy;

Accept
The process is repeated;
The model is then run on the unknown photographs;

(d) *Award **[4 max]***

Cognitive models are based on *human cognition/learning processes*;
whereas the heuristics uses algorithms to learn from large datasets (*data-driven*);
Cognitive models learn using *rules and logic* to mirror human language learning;
whereas heuristics learn through *pattern recognition and optimization* (trial-and-error);
Cognitive models generate language in a *human-like* way (i.e. syntax, grammar and semantics);
whereas heuristics do not *'understand'* language like humans (more *abstract*).
Cognitive models *struggle* with language nuances;
whereas heuristic models can sometimes *outperform* cognitive models in tasks such as language translation;
Cognitive models demonstrate reasoning behind decisions that can be understood;
whereas heuristic models act as "black boxes," making it hard to interpret.
Cognitive models may provide an optimal solution;
whereas heuristics may provide a near optimal solution;
Cognitive models can be *complex* due to their attempt to replicate the intricacies of human cognition, whereas heuristic models are *simpler*
Cognitive models require less *data/computational resources* than heuristic models;

(e) *Award **[6 max]***

UL reveals language patterns that humans might easily miss / bridges the causal gap between input and output observations / does not have human bias;
It explores raw data with an unknown structure;

UL requires a large quantity of language data;
There may not be enough data (for some African languages) for the algorithm to work;

Does not require datasets of labelled data;
Which human experts have to identify, categorize, and annotate (saves time / expense);

Difficult to measure accuracy or effectiveness;
Output is unknown so results may be difficult to interpret / Need to be tested with humans;

Possible to learn larger and more complex models;
e.g. the connection between two sets of observations;

9. (a) *Award **[1 max]***
one2seven.org
Note: *Do not accept www.one2seven.org*

(b) *Award **[2 max]***
Banner;
Navigation bar;
Hero section;
Logo;
Content sections (Embedded) video / presentation / image gallery;

Note: *Accept any other reasonable answer.*

(c) *Award **[2 max]***
Rendering Web Pages: Displays HTML, CSS, and JavaScript content from websites, allowing users to view and interact with web pages;
HTTP/HTTPS Communication: Sends requests to web servers and receives responses, handling protocols to securely access websites;
JavaScript Execution: Executes JavaScript code, enabling interactive elements like forms, buttons, and animations on web pages;
Managing Cookies and Local Storage: Stores cookies and other data locally, which websites can use to remember user preferences, sessions, or login states;
Bookmarking: Allows users to save and organize favorite websites for easy access;
History Management: Keeps a record of previously visited websites, enabling users to revisit or find past web pages;
Tab Management: Provides the ability to open multiple pages in separate tabs, making it easier to switch between and organize websites;
Extensions and Plugins Support: Supports additional functionalities through extensions or plugins, which can add features like ad-blocking, password management, and more;
Security and Privacy: Manages security features like SSL certificate validation, safe browsing checks, private/incognito browsing mode, and phishing protection;
Caching: Saves copies of web resources locally, improving load times for frequently visited sites by reducing the need to reload all elements from the server;
Developer Tools: Offers tools for developers to inspect HTML, CSS, JavaScript, and network requests to debug and optimize web pages;

Note: *Accept any other reasonable answer.*

(d) *Award **[3 max]***
The use of CSS allows a consistent format to be used across multiple pages;
One change in the CSS code can cascade through many pages, updating styles site-wide;
This saves developer time when updating the website, as edits are centralized;

Faster page loading speed is achieved as file sizes are smaller (styles are centralized);
CSS provides more flexible formatting options, improving the user experience;
Quicker page development time is possible due to the separation of style and content;

CSS improves compatibility across different devices, allowing pages to adapt to various screen sizes;
It supports responsive design, helping websites look good on both mobile and desktop devices;
This centralized styling approach makes it easier to scale and maintain large websites;

***Note:** Do not allow mixing of points from different clusters.*

(e) (i) *Award **[1 max]***
client side scripting;
(accept - script which executes on the client / browser);

(ii) *Award **[3 max]***
Checks for the parameter “check=false” in the url/search string;
If the parameter exists then it does nothing;
Checks for the device type as iPhone, iPad, Android, Blackberry or WebOS in the (user agent string);
If any of these exist, it redirects the browser to a different location/page (mobile.html);

(iii) *Award **[1 max]***
The user agent originates in the browser (before being sent as an HTTP Header to the server);
It saves time by not sending the user agent to the server;
It reduces the server load/demand on the server;
enhances the user experience by avoiding a server round-trip;

(f) *Award **[3 max]***

Client-side scripting -
Client-side scripting is simpler to implement than server-side scripting;
It is suitable for basic tasks that do not require access to sensitive information;
Using client-side scripting can improve the user experience on web pages;
Instant feedback on data input, such as validation, animation, and visualization, is possible;

Server-side scripting -
Server-side scripting allows the school to restrict access to databases and prevent potential hacks;
This is possible as databases are not accessible from outside the school LAN;
Server-side scripting helps the school safeguard the security of sensitive information;
Sensitive data protection is ensured by handling access control through server-side scripting;

Conclusion -
Using a combination of client-side and server-side scripting gives the school the best of both worlds;
The school can make quick and easy changes to the website;
Security of information is maintained while enhancing website functionality.

*Mark as **[1] + [1] + [1].***

10. (a) *Award **[2 max]***
On demand self service;
Broad network access;
Multi tenancy and resource pooling;
Rapid elasticity and scalability;
Measured service;

(b) *Award **[3 max]***
Distributed cloud networks offer higher reliability by minimizing downtime;
They enable better scalability to handle increased traffic;
They support load balancing to prevent overload;

Improved latency as data centers are closer to users;
Enhanced disaster recovery with backups across regions;
Flexibility to integrate services globally without single points of failure;

Note: *The response point must be a direct a direct advantage over client-server networks.*

(c) *Award **[2 max]***
Lossy compression reduces file size by removing content;
Some content may not be recovered when decompressed;
This leads to a reduction in video quality;
Certain colors or details may be altered;
These changes are not reversible, affecting visual fidelity;
Quality loss is more noticeable on high-resolution displays;

(d) *Award **[3 max]***
Potential intellectual property issues may arise due to copyright, trademarks, or patents;
Streaming media can be copied or pirated without the owner's consent;
Content may be reproduced or sold illegally;

Media could be modified without the author's approval;
IP rights vary by country, leading to legal inconsistencies;
An act may be an IP issue in one country but not in another;

Amazon or Netflix may unintentionally breach copyright laws;
Content availability in restricted formats or regions could violate IP laws;
This risk increases with global distribution of digital media;

(e) *Award **[3 max]***
The web allows content to be accessed from any global location;
This can lead to the rise of English as a lingua franca;
It fosters a perception that borders between countries have been removed;

Users can use VPNs to access region-restricted information;
This can make it seem like the user is in one country while actually in another;
International borders may exist on maps, but appear blurred in cyberspace;

The global nature of the web promotes cross-cultural interactions;
It enables collaboration and communication beyond physical boundaries;
As a result, the web reshapes how people perceive and interact with different regions;

11. (a) *Award **[1 max]***
A search engine is a software system designed to search / index / and retrieve information from the web;
It helps users find relevant web pages by matching their queries with indexed content;
Search engines index content across multiple websites to improve search accuracy;

(b) *Award **[2 max]***
Time taken to generate results;
Number of hits or pages found matching the query;
Quality of results based on relevance and accuracy;
Impressions, or the number of times a result is displayed;
Click-through rate, indicating user engagement with results;
Bounce rate, measuring how quickly users leave after clicking a result;
User location and personalization factors affecting result relevance;

Note: *Accept other appropriate examples.*

(c) (i) *Award **[2 max]***
PageRank works by counting the number and quality of inlinks to estimate a page's importance;
The assumption is that important websites receive more links from other websites;
Pages are assigned a score (rank) based on the quantity and quality of links;
Links from highly ranked pages contribute more to a page's rank;
PageRank considers both the structure and authority of the web to prioritize search results;

(ii) *Award **[2 max]***
Biases, either implicit or explicit, may be 'built into' the algorithm;
This may lead to a skewing of results that can advantage or disadvantage certain individuals or groups;
Assumptions in the algorithm may prioritize certain types of content over others;
Results can be influenced by factors such as popularity rather than quality or relevance;
The algorithm's structure may unintentionally reinforce existing trends or viewpoints;

(d) *Award **[3 max]***
Standardization;
HTTP and HTTPS are widely accepted protocols;
that allow for consistent communication between web clients and servers;

Reliability;
HTTP and HTTPS use TCP;
to ensure that all data is delivered without errors or omissions;

Security;
HTTPS adds an additional layer of security;
by encrypting the data being transferred between the web browser and the server;

State management;
HTTP supports state management; allowing web applications to provide personalized experiences to users;

Flexibility;
HTTP supports various data formats;
enabling web developers to create rich and dynamic web applications with multimedia content;

(e) *Award **[3 max]***
XYZ Pharma may view limited black hat techniques as unethical but not illegal;
These methods could boost website rankings and increase exposure;
Higher rankings may lead to profits, allowing a shift to white hat SEO once stable;

XYZ Pharma may see black hat SEO as conflicting with company values;
Short-term exposure may decrease, but ethical practices enhance long-term credibility;
A strong reputation supports sustainable market presence;

In a competitive market, black hat techniques may seem tempting for quick gains;
Risks like penalties or lost trust could outweigh benefits;
A balanced, ethical SEO approach fosters customer loyalty and steady growth;

(f) *Award **[3 max]***
Search engines are managed by multinational companies such as Meta and Microsoft;
These companies operate in multiple countries and choose where to place their Head Office;
This flexibility may allow them to circumvent laws aimed at preventing monopolies;

Large companies can dominate the search engine market, reducing competition;
They may prioritize their own services in search results, impacting user choice;
This market control can lead to an unregulated monopoly with limited oversight;

Smaller companies may struggle to compete with these established giants;
Users become increasingly dependent on a few major search engines;
The lack of competition may stifle innovation and reduce market diversity;

12. (a) *Award **[2 max]***
Creates a simple visualization of a complex entity like the internet;
Allows for a basic understanding of the entity's functioning;

Illustrates the interrelationships between different parts of the system;
Enables easier identification of structural patterns and connections;

Simplifies the analysis of web dynamics and information flow;
Supports predictions about future development trends;

Allows researchers to study the impact of changes within the network;
Helps in understanding user interactions and network evolution over time;

(b) *Award **[3 max]***
The number of users per site often follows a power law distribution, where "the rich get richer";
Sites with large user bases are likely to attract more new users than smaller sites;
This trend is especially noticeable on social media platforms;
A high number of existing users can create a more diverse and engaging experience for newcomers;
Power laws help predict future growth patterns in web-based networks;
They illustrate how popular sites tend to gain further traction, reinforcing their dominance;

13. (a) *Award **[2 max]***
Use quotation marks to include a specified phrase, such as "Australian Prime Minister";
Use boolean operators to narrow, broaden, or eliminate unwanted terms;
Use wildcards or regular expressions to match partial search terms;
Apply filters like date, location, or file type to refine results;
Limit searches to specific domains or websites to focus on relevant sources;
Use advanced search tools to combine multiple refinements in a single query;
***Note:** Accept any other reasonable response.*

(b) *Award **[2 max]***
Users add tags or metadata to define content on the websites;
Allows content to be organized and categorized by users;
Enables easier searching and discovery of related content;
Tags reflect user perspectives, making the system more flexible and adaptable;
Creates a community-driven system for content classification;
Supports collaborative sorting and labelling of information across the platform;

(c) *Award **[2 max]***
Leads to a crowd-driven, informal categorization of information;
Contrasts with traditional approaches of categorization in taxonomies or ontologies;

Reflects user interests and evolving trends in content organization;
Allows for dynamic and flexible classification that adapts to user needs;

Encourages community participation in content labelling;
Enables a more diverse range of perspectives in content organization;
Note: Award [1] + [1].

(d) *Award **[3 max]***
Uses feature selection or extraction to identify specific objects in the image;
Recognized text within the image is captured to provide context or options;
Relationships between detected objects add meaning, making the search more specific;
May combine image data with GPS or sensor data to refine results further
Objects in the image can trigger additional searches;
This approach amplifies results and retrieves relevant content or options;

(e) *Award **[6 max]***
Advantages
Collective intelligence costs less per unit than hiring professionals;
Multiple individuals can complete a task faster than a single person;
Provides on-demand access to numerous contributors for specific tasks;
Ideal for quickly providing non-critical information, like on Wikipedia;
Useful in urgent situations needing input from many people, such as health updates;
Offers diverse perspectives, enhancing innovation;

Disadvantages
Quality control is challenging in a deregulated collective intelligence environment;
Originality and authorship may be difficult to verify without clear tracking;
Lack of centralized planning or hierarchy may make it hard to evaluate ideas thoroughly;

Conclusions
Collective intelligence can effectively help organizations solve certain types of problems;
It is particularly useful in scenarios needing quick information dissemination or non-critical content;

Use the following rubric:

1 – 2 marks	Limited Understanding and Analysis: The response demonstrates minimal understanding of collective intelligence and its application in solving climate change. There is little to no analysis of MIT's decision, and claims are largely unsupported.
3 – 4 marks	Basic Understanding and Evaluation: The response shows a basic understanding of collective intelligence and provides some relevant analysis of MIT's decision. Strengths and weaknesses are identified, but the evaluation lacks depth or supporting examples.
5 – 6 marks	Comprehensive Understanding and Insightful Analysis: The response offers a thorough understanding of collective intelligence, including its significance in addressing climate change. The analysis of MIT's decision is comprehensive, with a clear evaluation of strengths and weaknesses, supported by relevant evidence and examples.

14. (a) *Award **[1 max]***
Total number of trips offered by the school is 16;
`allTrips` array stores Trip objects and there are a maximum of 16 trips;

(b) *Award **[2 max]***
method name;
list of parameters (passed to the method);

(c) *Award **[2 max]***
Wrapping of data variables and methods into a single unit;
Data is limited to the specific object (Trip, Student or TripAllocator) in which it is defined (like `tripNumber, tripTitle, tripDesc` etc is limited to Trip object);
It prevents data from being accessed by the code outside the class (`Trip/Student/TripAllocator`) / Data of a class is hidden from any other class and can be accessed only through methods of this class;
All class variables are private and methods are public;
Accessors / Mutators are needed to access / manipulate the private attributes;

***Note:** Award 1 mark only if no reference to either the `Trip, Student` or `TripAllocator` classes.*

(d) *Award **[2 max]***
The method would check if the number of places filled is greater than 9 / `placesFilled` > 9 / greater than or equal to 10;
If the condition is met, it will assign true to `isRunning` variable / change the status of trip to true;

(e) *Award **[6 max]***
*Award **[1]** for setting a* `boolean` *flag or similar variable to stop the loop;*
*Award **[1]** for correct* `while` *(or a* `for`*) loop;*
*Award **[1]** for an attempt to check the* `allTrips` *array;*
*Award **[1]** for correctly checking the* `placesFilled <25` *in* `allTrips` *array using the* `getPlacesFilled();`
*Award **[1]** for an attempt to assign* `tripName` *to a student;*
*Award **[1]** for correctly assigning* `tripName` *to a student using* `setTripAssigned()` *and* `getTripTitle();`
*Award **[1]** for correctly adding student to* `tripList;`
*Award **[1]** for correctly updating* `placesFilled;`

***Note:** For the wrong index in* `allTrips[]`*, penalise once only and then award mark as FT.*

Example Answer:

```
public void assignTrip(Student s)
{
    int i = 0;
    boolean done = false;
    while (!done && i <10)
    {
        int n = s.sPreferenceList[i];
        if (allTrips[n-1].getPlacesFilled()<25)
        {
              s.setTripAssigned(allTrips[n-1].getTripTitle());
              allTrips[n-1].addStudentToTripList(s);
              allTrips[n-1].updatePlacesFilled();
              done = true;
        }
        i++;
    }
}
```

(f) *Award **[2 max]***
A trip may have less than 10 students hence it cannot run (after the sign-up ends);
Students who were assigned to this trip need to be assigned to a different trip that is running;

A student may want to switch a trip for different reasons;
A `reAssignTrip` method is needed to reassign students to a new trip, updating the trip list by removing their names from the current one;

A student may withdraw from a trip after the assignment of the trips;
This may affect the `placesFilled` and students in this trip may need to be assigned to another trip;

15. (a) *Award **[1 max]***
Student class needs another (private) variable to store the friend's student ID / Name;

(b) *Award **[4 max]***
*Award **[1]** for initial idea + **[1]** for expansion*

The method must check if `friendId` is not null;
Check for availability (`placesFilled` is less than 24);

The `updatePlacesFilled()` method will need to be called twice;
to increase the `placesFilled` for the trip by 2;

Both student names must be added to the `tList;`
and the trip must be assigned to both students

*Mark as **[2]** and **[2]***

(c) *Award **[5 max]***
*Award **[1]** for correct loop (`< 16 / allTrips.length`);*
*Award **[1]** for correct if condition, must check for both <25 spots and >9* `placesFilled /`
accept `allTrips[i].isRunning() && allTrips[i].getPlacesFilled()<25;`
*Award **[1]** for correctly calculating number of places left;*
*Award **[1]** for correct output (allow FT of MP3);*
*Award **[1]** for correct format;*

```
public void displayPlacesLeft()
{
  for (int i=0; i<allTrips.length; i++)   // accept i < 16;
  {
       if(allTrips[i].getPlacesFilled()>9 && allTrips[i].getPlacesFilled()<25)
       {
            System.out.print("Trip# "+(i+1)+ allTrips[i].getTripTitle());
            System.out.println("places left: " + (25-allTrips[i].getPlacesFilled()));
       }
  }
}
```

(d) *Award **[5 max]***
*Award **[1]** for correct method return type & corresponding return variable of the same type;*
*Award **[1]** for correct loop (`for / while / foreach`);*
*Award **[1]** for correctly calling `getTripAssigned()` method;*
*Award **[1]** for a correct equality check with "zzz" (accept the use of '==');*
*Award **[1]** for incrementing the counter;*

Example answer 1:

```
public int noTrip()
{
    int noTripCount = 0;
    for (int i=0; i<allStudents.length; i++)  // accept i < 250;
        if(allStudents[i].getTripAssigned().equals("zzz")) //accept ==
            noTripCount++;
    return noTripCount;
}
```

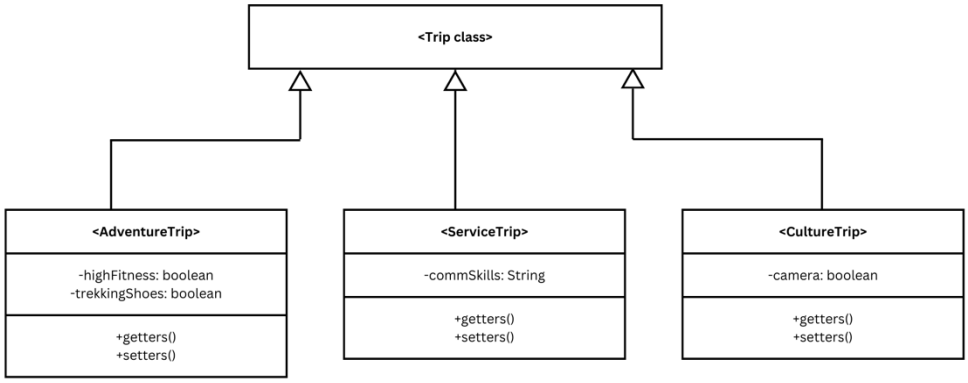
Example answer 2:

```
public int noTrip()
{
    int noTripCount = 0;
    int i = 0;
    while (i < allStudents.length) // accept i < 250
    {
        if(allStudents[i].getTripAssigned().equals("zzz")) //accept ==
        {
            noTripCount++;
        }
        i++;
    }
    return noTripCount;
}
```

Example answer 3:

```
public int noTrip()
{
    int count = 0;
    for (Student s : allStudents)
        if(s.getTripAssigned().equals("zzz"))
            count++;
    return count;
}
```

16. (a) (i) *Award **[5 max]***
*Award **[1]** for four boxes with class names;*
*Award **[1]** for correct inheritance relationship / allow a regular arrow with "is a";*
*Award **[1]** for additional attributes in `AdventureTrip` sub class;*
*Award **[1]** for additional attribute in `ServiceTrip` sub class;*
*Award **[1]** for additional attribute in `CultureTrip` sub class;*



***Note:** Please ignore the access specifier for the additional attributes.*

(ii) *Award **[1 max]***
class AdventureTrip `extends` Trip; / class ServiceTrip `extends` Trip; / class CultureTrip `extends` Trip;
***Note:** Do not just accept the use of 'extends' keyword.*

(iii) *Award **[4 max]***
*Award **[1]** for each advantage and **[1]** for expanding it*

Reuse of code;
through inheritance sub classes can use methods of the superclass / less code needs to be written / saves time in coding;

Code flexibility/extensibility;
extending the parent's action and data, without redefining them (polymorphism);

child class redefines the base class methods (Overriding);
to provide a different functionality to existing method of the parent class;

Easy to debug;
As the existing code (base class methods) are already tested / less code needs to be debugged;

Easier to maintain;
as the changes in the parent class are automatically reflected in the child class;
*Mark as **[2]** and **[2]***

(iv) *Award **[1 max]***
It reduces the maintenance overhead;
It reduces the effect of change in your code;

(b) *Award **[4 max]***
*Award **[1]** for each advantage and **[1]** for expanding it.*

Easier / faster to debug;
because there are far fewer mistakes in the smaller/individual modules.

Speedier / faster completion of the project;
because different teams work on different modules.

facilitates reusability of the code;
as the existing modules can be reused across other modules.

Improves code readability / organisation;
smaller manageable modules leading to better logical organization.

Reduces the coupling effect;
leading to easier/faster maintenance of module not affecting others;

Note: Do not allow mixing the points from different clusters. Do not allow easier/faster without any further description in context of modularity.

*Mark as **[2]** and **[2]***

17. (a) *Award **[4 max]***
*Award **[1]** for correct outer loop;*
*Award **[1]** for correct inner loop of the 2D array; // allow FT of array index starting at 1;*
*Award **[1]** for initializing and correctly updating a total;*
*Award **[1]** for finding average popularity and storing to `tripPop` array;*

Example answer:

```
public void avgPopularity(int [][]popularity, int[] tripPop)
{
     for (int r=0; r<popularity.length; r++)  // accept r < 16
     {
          int total =0;
          for(int c=0; c<popularity[r].length; c++) // accept c < 5
               total = total+ popularity[r][c];
     tripPop[r]= total / 5;
     }
}
```

(b) *Award **[3 max]***
*Award **[1]** for correct loop;*
*Award **[1]** for correctly check value in popularity array with `tripPop` array value;*
// accept popularity[i][1] as FT from the previous question (17a);
*Award **[1]** for correctly output the trip title using `getTripTitle()` method;*

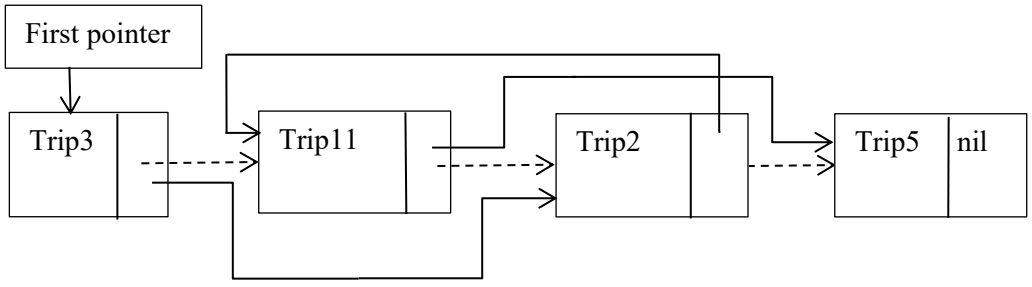
Example answer:

```
for(int i=0; i<tripPop.length; i++) // accept i < 16
{
       if(popularity[i][0]<tripPop[i])
         System.out.println(allTrips[i].getTripTitle());
}
```

(c) *Award **[3 max]***
*Award **[1]*** for saving Trip3's next pointer to temp1 and *setting* Trip3's next pointer to Trip11's next pointer;

*Award **[1]*** for saving Trip2's next pointer to temp2 and setting Trip2's next pointer to temp1;

*Award **[1]*** for setting Trip11's next pointer to temp2;



***Note:** The diagram itself is not enough, max 1 mark only; it must be annotated to get the full marks. The annotated diagram must show the sequence of steps and use of a 'temp' variable to save the next's pointer.*

18. (a) (i) *Award **[2 max]***
The queue operates in FIFO / the first forms are processed first;
this increases the chance for early students to get their most preferred trip choice;

Processing the forms can be started as soon as the forms start coming in;
Will encourage students to turn in their form early;
***Note:** Accept other valid answers referring to a queue in this scenario.*

(ii) *Award **[2 max]***
A student might be sick and not able to turn in form;
are less likely to get their preferred trips;

A queue is difficult to modify for deleting a node;
when a student gets sick;
***Note:** Accept other valid answers referring to a queue in this scenario.*

(b) (i) *Award **[2 max]***
This algorithm adds the names of all students to the ArrayList `aList` ;
for all the trips that are not running;

(ii) *Award **[2 max]***
*Award **[1]** for a correct loop;*
*Award **[1]** for correctly copying the statements in the loop;*

Example answer 1:

```
for (int n=0; n<16; n++)
{
     if(allTrips[n].isRunning()==false)
     for (int i=0;i <allTrips[n].getList().size(); i++)
          aList.add((String) allTrips[n].getList().get(i));
}
```

Example answer 2:

```
for (int n=15; n>-1; n--)
{
     if(allTrips[n].isRunning()==false)
          for (int i=0;i <allTrips[n].getList().size(); i++)
               aList.add((String) allTrips[n].getList().get(i));
}
```

(iii) *Award **[2 max]***
Using proper styling convention improves code readability;
Supports code maintenance / extensibility;
This saves money /time/ effort for the programming team;