

# Markscheme

**May 2017**

**Computer science**























**Standard level**


**Paper 2**

This markscheme is **confidential** and for the exclusive use of examiners in this examination session.

It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Global Centre, Cardiff.

The following are the annotations available to use when marking responses.

Annotation	Explanation	Associated shortcut
	Good Response/Good Point	(Alt+) 0
	Incorrect Point	(Alt+) 1
	Unclear	
	Benefit of the doubt	
	No benefit of doubt	
	Seen	
	Too vague	
	Repetition	
	Follow through	(Alt+) 2
	(Comp Sci) Language	(Alt+) 3
	Description	(Alt+) 4
	Analysis	(Alt+) 5
	Reference	(Alt+) 6
	Development	(Alt+) 7
	Balanced argument	
	Off course	(Alt+) 8
	Evaluation	
	Opinion	
	Dynamic, horizontal line that can be expanded	(Alt+) 9
	Dynamic, horizontal wavy line that can be expanded	
	Dynamic, vertical wavy line that can be expanded	
	Text box	

You **must** make sure you have looked at all pages. Please put the  annotation on any blank page, to indicate that you have seen it.

### General marking instructions

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.
2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.
3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**
4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use RM™ Assessor annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.
5. Personal codes/notations are unacceptable.
6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, enter a zero in the mark panel on the right-hand side of the screen. Where an answer to a part question is worth no marks because the candidate has not attempted the part question, enter an “NR” in the mark panel on the right-hand side of the screen.
7. Please ensure you check all scanned pages. The candidate may have answered more than one option.
8. **If a candidate has attempted more than one Option** within a paper, mark all the candidate’s work. RM™ Assessor will only award the marks for the higher scoring Option. Once all the work the candidate has attempted has been marked, please click “COMPLETE”; all the other questions from the other Options will auto complete to “NR” for “no response”.
9. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp “SEEN” on any page that contains no other annotation.
10. A mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the “CON” stamp.

**Subject details: Computer science SL paper 2 markscheme****Mark allocation**

Candidates are required to answer **all** questions in **one** Option. Total 45 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	<ul style="list-style-type: none"> <li>• In the case of an “identify” question, read all answers and mark positively up to the maximum marks. Disregard incorrect answers.</li> <li>• In the case of a “describe” question, which asks for a certain number of facts <i>eg</i> “describe two kinds”, mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications.</li> <li>• In the case of an “explain” question, which asks for a specified number of explanations <i>eg</i> “explain two reasons ...”, mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation <i>etc.</i></li> </ul>

**Option A — Databases**

1. (a) *Award up to [2 max].*  
**Note:** *Reasons must be primarily focused on data, on processing (querying), on communications or system design, not on storage.*

DBMS allows organisation of data / parents' details in a way that supports efficient and secure access (to parents) / (hence) chances of data loss are relatively low;  
Enables specific operations/processing/querying of data (search/sort/analyse);  
Permits the production/printing of reports on searched information in specific formats;  
Supports the modular extension of system by adding new fields without need of redesigning the system;  
Supports the possibility of re-using the resources/tools/scheme for comparable activities (e.g. when the school open a secondary campus);  
Relies on widespread use of standards that ensures a smooth integration of systems / so that the school does not struggle with the upgrades of technology;  
Automatically supports the data validation/data verification when filling the database;

*Award [1 max] if the response only makes a direct comparison with a spreadsheet.*

Provides the ability to store a greater number of records than a spreadsheet;  
Provides more ability to customise the nature of the information output in records compared to a spreadsheet;  
Provides the ability to manipulate the data better than in a spreadsheet, especially on screen;  
It supports the operation of data mining, something that would not be possible in a spreadsheet;

[2]

- (b) *Award up to [1 max].*  
Name (eg Chris Smith) / Address / Phone number;  
**Note:** *Any item of data that can plausibly be stored in a school database and referring to the parents is acceptable.*

[1]

- (c) *Award up to [2 max].*  
*Award [1] for identifying the technique to reduce data input errors and [1] for a development/elaboration.*

Data validation;  
Checks that the input is well-formed/appropriately composed/suitable so to be valid for the program specification;  
For example, checking that a phone number that is input contains only numbers and asking to re-input it, should it contain other (non-valid) characters / type check (num or char) / range check (months with 30 or 31 days) / length check (prefixed length of some values);

Data verification;  
Is the process that checks the accuracy of the data in the database/ checks that the software is correct given the specification / checks the integrity of the database in comparison to the data provided in input / checks in the database the presence of the record associated to the input;

[2]

- (d) Award up to **[5 max]**.  
**Note:** The question asks for interactions between parent and DBMS while processing a payment: this should remain the focus during marking.

**Example 1:**

Award **[3 max]** if non-specific language is used  
Award **[1]** for **each** description

**Notification sent to parent:**

DBMS used to retrieve parent's detail to enable mailing system to send out invoice;

**Authentication / Validation:**

Parents log in to DBMS with their credentials for authentication / validation of credentials by DBMS (the DBMS checks that data input are well-formed / appropriate);

**Verification:**

Data verification /The DBMS verifies that the parent's details are stored, as this could be a new parent who was provided details to log in, but the DBMS has not been updated. **NOTE** accept any message on screen of the kind "contact the school manager", if verification fails);

**Restricted Access granted:**

(Upon success of data verification) the DBMS provides access to reserved portion of data in database where parent can perform the operations (e.g. search the activity/period of time) / DBMS ensures access to the part of the Database storing child's activities for payment;

**Preparation of payment:**

Parent provides detail that enable submitting a payment / system requires data from parent (new and from DB) to proceed with payment / system triggers the processing of payment using different part of the system, the DBMS, and data provided by parents about bank account;

**System update:**

DBMS is used to update accounting record system **AND** to produce the receipt to parents. **Note:** the second part of the sentence is needed to address the interaction) / DBMS is used to update accounting record system **IF/WHEN** the parent performs a top-up of their balance;

**Confirmation by email:**

(Credentials of) open session on DBMS are passed to mailing system to send out email to parents with notification of payment/receipt;

**Log-out /Close session/Time-out closure:**

Parent closes session on DBMS with the effect of closing access to dedicated portion of database (in search and/or reading) / if parent does not log out, DBMS automatically closes access after time-out;

**Example 2:**

**Note:** Example of answer worth **[1]** mark.

*It identifies the working of the payment system and it allows to detect some form of interaction.*

- Parent authenticated by the DBMS
- Transaction is initiated
- Payment details added / entered
- If payment details and payment can be processed by DBMS then
  - transaction is completed by DBMS
  - Account is credited
  - Automatic e-mail notification of payment sent to parent
- Else
  - Transaction is rolled back
  - Notification of the failed transaction sent to the parent

**[5]**

(e) Award up to **[3 max]**.

**Note:** One of the marks should address the fact that the workspace is partitioned, so if this is not addressed, **[2 max]**.

Multiuser/concurrent access in reading/searching/querying of database;  
But records in database are partitioned, to ensure privacy in access / each parent can access only the part of the database relative to his family data / Database has a row-locking mechanism, so that access is restricted to individuals only in permitted areas / there is no conflict/competition in accessing the same area of database;  
(This/The partition/the row locking/the partial access) ensures **isolation / separation of data** (to prevent to transaction processing);  
Therefore, multiple transactions (from different parents) may safely occur simultaneously on non-overlapping portions of the database during payment;  
And this simplifies the management of system updates/recovery of (separated) transactions;

**[3]**



2. (a) *Award up to [1 max].*  
Collections of database tables that are linked via the fields / attributes / keys;  
A database structured in a way so that the data can be recognised / accessed /  
retrieved by using relations; [1]

- (b) *Award up to [4 max].*  
**Do not credit** a description of what can be seen in an ERD, the command term is  
“explain”.

The role of an ERD is to provide a compact view/graphical representation of  
entities/sets/actions/attributes/cardinality of entities/relations among entities;  
(So) it facilitates the planning/extension of a database because it provides a  
unique (and common) abstract representation of features independently from the  
actual implementation/nature of the database;  
(So) it informs the construction of the system at the logical level/represents the  
logical structure of the information system/DB;  
Enabling a structured and systematic development that can be better undertaken  
either by individuals or by teams of developers;  
And it informs over time how to model the data (in terms of its logical  
organisation) such as effect of system upgrades/ new formats needed to extend  
the old one); [4]

- (c) *Award up to [2 max].*  
Award [1 max] for identifying an issue (I) and [1 max] for an expansion/example  
(consequence – C).

**NOTE: There must be reference to the given scenario.** The wording also  
suggests also the “use” of the tables as they are (i.e. **with no**  
**deletions/additions/updates**).

*Award [1 max] for correct descriptions that lack reference to the given scenario,  
but still remain within the scope of “use”.*

*Answers may include:*

- I: Referential integrity is violated in TABLE\_2 by the lowermost record, because  
there is no entry in TABLE\_1 referring to Student\_ID= 21;  
C: Therefore, any query built on a JOIN of the two tables, and referring to this  
value of Student\_ID, cannot be answered;
- I: We want to use both tables to retrieve the email address in of the student  
whose ID is 21 in TABLE\_2;  
C: But we cannot possibly do this, and the query cannot be answered, because  
the table will not be complete/will not be inhabited by the needed values,  
because referential integrity is broken on the value 12 of Student\_ID in TABLE\_2
- I: We want to use both tables to retrieve the email addresses of whomever is  
involved with the chess club;  
C: But we cannot possibly do this, and the query cannot be answered, because  
the table will not be complete/will not be inhabited by the needed values,  
because referential integrity is broken on the value 12 of Student\_ID in  
TABLE\_2

[2]

- (d) (i) *Award up to [2 max].  
Award [1 max] for identifying an issue that could occur after the deletion and [1 max] for an expansion,  
Note: Do not credit generic or non-specific responses or the use of referential integrity with no development (i.e. just being mentioned).*

**Example 1:**

We may not be able to find the email address of the Captain of the chess club;  
Because the deletion of the whole record in TABLE\_1 does not allow us to search in TABLE\_2 with the value Student\_ID=12;

**Example 2:**

We lose the value 12 of the primary key in TABLE\_1 (losing entity integrity);  
Therefore, a later successive insertion of a new record with primary key 12 in TABLE\_1 may link with that value for the foreign key in TABLE\_2, yet the meaning of the relation might be compromised;

**Example 3:**

We lose the value 12 of the primary key in TABLE\_1 (losing entity integrity);  
Therefore, the DBMS needs to have a method to decide what to do with the value 12 that appears in the foreign-key in TABLE\_2;

[2]

(ii) Award up to **[3 max]**.

Award **[2 max]** for evidence of **understanding referential integrity**.

Award **[1]** for an example, clearly referring to the primary and foreign keys

OR an expansion on how to limit the unwanted effects;

**Do not credit** the term referential integrity being used with no development (i.e. just being mentioned).

**NOTE:** Be aware of possible repetitions with marks awarded in 2c(i).

Understanding:

Data (in the relational database) should satisfy the property of referential integrity;

Which requires that **each value of any field in some relation**/table exists also as value in some field of another relation/table

OR

That requires that the values of the foreign key in one table, completely relates to all values of the primary key of another table;

**Examples:**

Student\_ID is a primary key in TABLE\_1 and foreign key in TABLE\_2 and deleting a value in the primary key will have an effect on the foreign key;

The system must have procedure to restrict the effects of the violation, e.g. by setting the affected values in the foreign key to a default value "null" (so Student\_ID in TABLE\_2 will get value "null");

OR

by cascading (deleting) in all referencing foreign keys;

OR

by checking in advance whether a violation of referential integrity may happen and not allow the deletion at the start;

OR

by recommending completion with null values and do normalisation, to reduce incurring into violation of the property;

**[3]**

3. (a) (i) Award up to **[2 max]**

**Note:** The question explicitly asks to focus on the data structure as displayed

**Example 1:**

The proposed data structure/sequence/list used to store SMS messages has no determinate length/has unbounded length;

Therefore, we would have a table with an undefined number of columns (and only the first two values are fixed in size for all subscribers);

**Example 2:**

The values in the two data structures show some repetitions / redundancy (**Note:** do **not** accept duplication of data);

Not addressing this in an implementation of a sequence/list may eventually generate tables that are bigger than necessary;

**[2]**

- (ii) Award up to **[4 max]**.  
The table must store each SMS separately as a row.  
**Do not award any marks** if more than one table is constructed.

**[1]** for Primary key or Primary Composite key, fully correct  
**[1]** presence of fields to store Sender's details (2 columns SenderPhNr and SenderName)  
**[1]** presence of fields to store Receiver's details and text messages (3 columns)  
**[1]** the table has three rows of records (in addition to the headers of the fields)

**Example 1:**

<u>SenderPhone Number</u>	Sender Name	<u>ReceiverPhone Number</u>	Receiver Name	<u>TextMessage</u>
1111	fred	1234	Smith	Hi there
1111	fred	1234	Smith	Call me
1234	smith	1111	Fred	Later

Award **[3 max]** if contents of table are correct but the composite key is incorrect or not identified.

**Example 2:**

Table with extra unique identifier for messages, as primary key.

<u>MsgCode</u>	SenderPhone Number	Sender Name	ReceiverPhone Number	Receiver Name	TextMessage
A0001	1111	fred	1234	Smith	Hi there
A0002	1111	fred	1234	Smith	Call me
A0003	1234	smith	1111	Fred	Later

**Example 3:**

Award **[2 max]** for an un-normalized representation of a table

SenderPhone Number	Sender Name	ReceiverPhone Number	Receiver Name	TextMessage
1111	fred	1234	Smith	Hi there
		1234	Smith	Call me
1234	smith	1111	Fred	Later

**[4]**

- (b) Award up to **[2 max]**.  
Data redundancy is the repetition of the same data field/attribute (or just data values that may populate two attributes with different names) within the database; This may happen either across a number of tables in the database or within the same table (if there is just one);

**[2]**

- (c) Award up to **[4 max]**.  
The tables must relate to the table created in 3a(ii) so follow through errors must not be penalized.

**[1]** for a table SUBSCRIBERS, correct, with two fields only;  
**[1]** for indicating the primary key in SUBSCRIBERS;

**[1]** for a table SMS that contains exactly **three** fields, **AND** only one element for the receiver (ether name or phone) and only one element for the sender (either name or phone) are indicated;

OR  
**[1]** for a table SMS that contains exactly **four** fields, **AND** only one element for the receiver (ether name or phone) and only one element for the sender (either name or phone) is indicated;

**[1]** to correctly indicate the primary key in the SMS table;

**Example 1:**

**Note:** Accept all those variants that indicate in Subscribers the key as Name, and use it in the SMS, or that use in this latter table the name of the receiver. A variant is using TextMsg as primary key.)

Possible answer deriving from Example 1 and Example 3 in 3a(ii)

**SMS**

<u>SenderPhoneNumber</u>	<u>ReceiverPhoneNumber</u>	TextMessage
--------------------------	----------------------------	-------------

**SUBSCRIBERS**

<u>(Sender)PhoneNumber</u>	Name
----------------------------	------

**Example 2:**

**Note:** Accept all those variants that indicate in Subscribers the key as Name, and use it in the SMS, or that use in this latter table the name of the receiver. A variant is using TextMsg as primary key.

Possible answer deriving From Example 2 in 3a(ii)

**SMS**

<u>MsgCode</u>	SenderPhoneNumber	ReceiverPhoneNumber	TextMessage
----------------	-------------------	---------------------	-------------

**SUBSCRIBERS**

<u>(Sender)PhoneNumber</u>	Name
----------------------------	------

**Example 3:**

Award **[2 max]** if three tables are constructed.

Award **[1]** if the three tables are correctly constructed.

Award **[1]** if the key is correctly identified in each table.

The SMS table may or may not include the MessageID field depending whether it was derived from Example 1 or Example 2 in 3a(ii).

**SMS**

<u>SenderPhoneNumber</u>	<u>ReceiverPhoneNumber</u>	TextMessage
--------------------------	----------------------------	-------------

**SUBSCRIBERS**

<u>(Sender)PhoneNumber</u>	Name
----------------------------	------

**RECEIVERS**

<u>(Receiver)PhoneNumber</u>	Name
------------------------------	------

- (d) Award up to **[3 max]**.  
Award **[1]** for evidence of using **TWO/BOTH** tables (with a JOIN).  
Award **[1]** for evidence that the filtering is triggered by the TextMessage.  
Award **[1]** for evidence of correct referencing through receiver and phone number across the two chosen tables.

**Note:** SQL is not required, it is used here for shorthand notation to illustrate the structure of the types of response expected.

**Note:** The question asks for the “steps” – evidence of computational thinking/procedural thinking is required.

**NOTE:** There can be variations in style of providing the answer, yet the guidance for the Markscheme is general enough to observe the steps to retrieve the Name of the Receiver given the message.

**Example 1:**

If two tables are used in 3(c):

```
SELECT ReceiverName
FROM RECEIVER JOIN SMS
WHERE
SMS.textMessage="thismessage"
AND
SMS.ReceiverPhoneNr=RECEIVER.PhoneNr
```

**Example 2:**

If three tables are used in 3(c):

```
SELECT Name
FROM RECEIVER JOIN SMS
WHERE
SMS.textMessage="thismessage"
AND
SMS.RecPhoneNr=SUBSCRIBERS.PhoneNr
```

**[3]**

- (e) *Award up to [2 max].  
Award [1] for identifying the function (underlined) and  
Award [1] for an appropriate development / elaboration.*

Ensure backups are run regularly / maintaining archived data in backups /  
backing up and restoring databases;  
To reduce the risk of losing data;

Ensure consistency checks are run on the database, (e.g. such as maintaining  
indexes / managing and controlling data replication);  
To ensure no data is inconsistent (across the related tables);

Ensure access rights are set correctly / setting appropriate access rights at  
various levels administrator, user, etc;  
To limit the risk of misuse across different users;

Check the need to install and upgrade database software / ensure database is  
up-to-date to handle hardware/software changes / monitoring the database  
performance;  
To be sure that the data do not become vulnerable to external attacks because of  
obsolescence;

[2]



- (f) Award up to **[3 max]**:  
Award **[1]** for the identification an ethical issue, and up to **[2 max]** for discussion/elaboration.

**NOTE:** The focus (conclusion) is usually on the trade-off between the rights of the individual to privacy/anonymity vs the needs for society to security / the greater good).

**Example:**

Personal information may be used by third party without the person knowing, therefore violating their privacy / anonymity;  
However, this violation may be justified by security reasons, for example national security / personal safety / monitoring of threats or hate speech;  
For example, from SMS one may extract information about locations/habits (gambling)/sensitive information (banks communications);

This enables third parties to:

- build up a profile of the individual through data aggregation (e.g the individual is a game-addict, but they didn't want to make this public);
- use for fraudulent actions over time (monitoring how often the bank transactions happen through a credit card, and generate hoax/impersonations/ further sell these data);
- use this data for marketing purposes (e.g. spamming messages);
- identify the location where an individual is, at particular times / surveillance / identify where and when an individual is not at home;

**[3]**

**Option B — Modelling and simulation**

4. (a) 0.1 [1]

(b) Award [1] for using the two given probabilities and [1] for a correct expression.  
 $1 - (\text{PROB}[i, j] + \text{PROB}[j, i])$  or  $1 - \text{PROB}[i, j] - \text{PROB}[j, i]$  [2]

(c) 30 [1]

(d)

	A	B	C	D
1	$30 - (14 + 10)$	5	0	5
2	2			
3	9			
4	3			

Add a team's wins and losses;  
 Subtract from 30 and insert in correct diagonal;  
 ( eg  $A1 = 30 - (\text{sum}(A2;A3;A4) + \text{sum}(B1;C1;D1))$   
 or even  $A1 = 30 - A2 - A3 - A4 - B1 - C1 - D1$   
 ... both examples cover the first two marking points)  
 Repeat for other teams;

**Example 1** (based on candidates work):

	A	B	C	D
1	M1	5	0	5
2	2	M2	8	5
3	9	1	M3	4
4	3	5	4	M4

$M1 = 30 - (2+5) - (9+0) - (3+5) = 6$   
 $M2 = 30 - (2+5) - (1+8) - (5+5) = 4$   
 $M3 = 30 - (9+0) - (1+8) - (4+4) = 4$   
 $M4 = 30 - (3+5) - (5+5) - (4+4) = 4$

**Example 2** (based on candidates work):

$A1 = 30 - (B1 + A2 + C1 + A3 + D1 + A4)$   
 $B2 = 30 - (A2 + B1 + C2 + B3 + D2 + B4)$   
 $C3 = 30 - (A3 + C1 + B3 + C2 + D3 + C4)$   
 $D4 = 30 - (A4 + D1 + B4 + D2 + C4 + D3)$

[3]

- (e) Award **[1]** for each condition which increments the correct cell (accept the use of the macro in part (d)).

For example:

```

if m>n then
  PLAYED[i, j] = PLAYED[i, j] + 1
else if n>m
  PLAYED[j, i] = PLAYED[j, i] + 1
else {
  PLAYED [i, i] = PLAYED [i, i]+1
  PLAYED [j, j] = PLAYED [j, j]+1
}
end if

```

Accept if ... if ... if.

If the student has used the wrong parameters in a consistent manner, award **[2]** max on FT.

If the student has not used the correct increment, award **[1]** max for a correct nested if...else structure or if ... if ... if.

**[4]**

- (f) A mathematical model reduces a situation to mathematical expressions and rules;  
 In the example, the results of matches and points gained is expressed mathematically / table PROB;  
 A simulation applies the model in order to investigate or measure the result;  
 In this case the probabilities were applied to give expected season results / table PROB10;

**[4]**

- (g) If the results are very different;  
 Something has changed from last year;  
 Can investigate any change in players/trainer;  
 Can check the calculations are correct;  
 Can be used to identify improvements and unexpected failures from specific teams;  
 Implies changing the probabilities for the following year;  
 That takes this year's results;  
 And ignores the previous year;  
 Or give up using past form as it is no indication for the following year;

**[4]**

5. (a)  $V < D$  or  $V \leq D$  or  $V - D < 0$  [1]
- (b) Award [1] for each appropriate factor identified and [1] for a description up to [2 max] for each of the **three** variables.

Mark as 2 and 2 and 2

**For Input (R)**

Measure river / rain fluctuation;  
Over a period of time to establish average values / the maximum and minimum expected values / outliers;

**For Output (T)**

Measure the amount used by the town;  
at different times (day/night, weekday/weekend, workday/holiday, summer/winter, etc);  
to establish average values / the maximum and minimum expected values / outliers;  
(Do not award this marking point if already awarded for R.)

**For overflows/outflows (E)**

Use the data gathered from the analysis of Input (R), Output (O);  
To plan for sufficient overflow capacity;

**NOTE:** for T and E do not accept the size of the pipes or the outlets since the purpose of the simulation is to establish those. Also, the stem indicates that the pipe will be large enough to fulfil the water needs of the town.  
For R do not accept size of 'inlets' - there are no inlets.

**NOTE:** *establishing average values was originally not intended, but most students provide this and it is a reasonable factor to consider ... however, do not award this marking point for both R and T. The average does not apply to E at all - since outlets are man-made and controlled.*

[6]

- (c) *Award marks as follows, up to [6 max].  
Award [3] for statements concerning the creation of the graphs;  
Award [3] for statements concerning the interpretation of the graphs;*

For example:

Setting up a suitable relationship (like  $V_{\text{current}} = V_{\text{initial}} + R - T - E$ );

Graphing the values of  $V$  for fixed values of  $T$  and  $E$ , as  $R$  goes from minimum to maximum levels;

Including a horizontal line for danger level ( $D$ );

This should identify combinations of  $R$ ,  $T$  and  $E$  that are problematic;

By showing situations where the level of  $V$  exceeds  $D$ ;

Indicating the maximum required value of  $E$ ;

**Note:** *Many alternative systems are possible, for example more complex ones that graph  $V$  over time for fixed / changing values of  $R$  and  $T$ , leading to required values of overflow ( $E$ ). These should be credited if described / discussed well. A much simpler (alternative) system which checks that  $R = T + E$  and works on minimum and maximum values of  $R$  should be credited in the same way for SL.*

[6]

- (d) *Award marks that clearly indicate that the physical model will be designed to meet the needs identified in the previous simulation of water flow.*

For example:

Knowing the maximum volumes of  $E$  that are needed;

Will help with the planning of the overflow outlets;

Overflow outlets can be placed at the appropriate water level to function in time;

The simulation could include future developments (like growth of the town);

In order to ensure that the reservoir design will not be outdated in the foreseeable future;

[4]

6. (a) Award [1] for a suitable application and [1] for an expansion, up to [2 max].

For example, a map showing the journey from one point to another;  
When only the route needs to be shown on a phone or otherwise;  
As 3D version could take up too much space;  
If no internet connection would be too slow;

**Note:** Accept situations that are 2D in nature, like graphing a v-t diagram. [2]

- (b) A series of sketches could show the design from a limited number of angles;  
Whereas the CAD system would allow an initial wire frame to be constructed which  
could be rotated;  
Changes could be (easily) made and the effect of the 3D shape from other angles  
seen immediately;  
Easy to undo a change to the model, rather than erase part of the sketch;  
Easy to scale the design;  
CAD files are less likely to get damaged than physical drawings;

**Note:** Do not accept vague statements like “CAD is more precise”. [3]

- (c) Rendering would take place;  
To apply light and texture to the model;  
Using such techniques as ray tracing;  
To the (wireframe) 2D representation;  
To produce a realistic view of the final product in the chosen material; [4]

**Option C — Web science**

7. (a) *Award up to [4 max].*  
 For each of the **two** reasons:  
 award **[1 max]** for identifying a reason (R) and **[1 max]** for an explanation (E).
- R: The banner will be the same in all pages of the site / on top of all pages;  
 E: Making the site easily recognizable among many other merchants / easily identifiable / making the logo of the merchant visible;
- R: The banner usually contains a hotspot button to go back to the homepage /  
 (Note: accept the logo itself as hotspot button);  
 E: So that navigation becomes easy;  
 This is the place where the hotspot button is expected to be found /  
 This is consistent use (normal practice) with other sites /  
 This is the place which can be viewed first on all digital devices (Laptop,  
 Mobile, Tablet etc.) therefore useful for scrolling; **[4]**
- (b) *Award up to [1 max].*  
 Copyright notice/privacy statement/link to terms & conditions/link to commercial laws; **[1]**
- (c) (i) *Award up to [1 max].*  
 HTML / XHTML / XHTML; **[1]**
- (ii) *Award up to [3 max].*  
*Award [3] if the three actions are correct and their order is correct.*  
*Award [2] if three actions are correctly identified but their order is incorrect.*  
*Award [1] if two actions are correctly identified, no matter the order.*  
*Award [0] in all other cases*
- User **selects** one among Spikes/Trail/Endurance (accept: “one of the three/available options” or words to that effect);  
Then **inputs** the size;  
Then **clicks on a Submit** button (accepts submits) to send out the form; **[3]**

- (d) (i) *Award up to [5 max].  
Award [1] for each of the processing steps indicated below.  
Required elements are underlined.*
- Server uses process.php to process information input via the form;
  - Server uses process.php to process item and size input via the submitted form;
  - Size is checked for being a numeric value **AND** in the range [34,46] included;  
OR  
Size is tested for type-checking (well-formedness) **AND** range-check (legitimate values), i.e. number between 34 and 46, extremes included;
  - Check fails: (appropriate) error messages are output / echoed / displayed back to user;
  - Check ok: server performs a protected access to the internal database CatalogDB in localhost;  
OR
  - Check ok: server performs an access, protected by username and pwd, to the internal database CatalogDB in localhost;
  - Server performs a query on CatalogDB with the two parameters instantiated from the input form;  
OR  
Server performs a query on CatalogDB with the (actual) values of the parameters item and size from the input form;
  - Nothing is found on CatalogDB matching the query: return/output/echo appropriate error message  
(**Note:** do not accept ‘the query fails’; the point is that the query succeeds but the selection is empty, accept words to that effect).
  - Result of query is non-empty (**Note:** accept words to that effect): return/echo/display **ALSO** image and price from CatalogDB (in addition to item and size)
  - Server closes connection to database;

**[5]**



- (ii) *Award up to [2 max].  
Award [1] for an example and [1] for an explanation (to address clients' side scripting)*

**Example:**

add a script/Javascript (using `<script> .. </script>`) to the form to magnify text / to change background colour / to use specific fonts/ to provide animation;

**Explanation:**

Features depending on user's taste/needs are processed faster on clients' side and would heavily clog transmission/generate bottleneck if they were depending on the server;

**Note:** *Accept alternative examples.*

**Note:** *Candidates are not expected to write JavaScript code.*

**[2]**

8. (a) *Award up to [4 max].*  
*Award up to [2] in relation to posting in blogs and forums*  
*Award up to [2] in relation to commenting in blogs and forum.*

**Note:** award **max 2 marks** for responses that lists evidence of understanding generic posting / commenting but with no explicit connection between the blog and the forum.

**Posting:**

In a blog only the owner can post an article / open a thread of discussion / start a theme;

Whereas in a forum all registered participants can post an article / open a thread;

**Commenting:**

In a blog registered visitors may be allowed to comment but the blog owner may moderate

Whereas in a forum all registered users are allowed to comment (without moderation);

**Example 1:**

A blog is associated to / led by one person (the blog owner/the journalist) who drives / leads / coordinates the discussion;

Only the owner can post a new thread and the registered users may comment just to animate the debate, even they have different views/opinions;

However, registered users may be subject to moderation by the blog owner, especially if this is the journalist publishing in a major newspaper, to the purpose of filtering out comments that are inappropriate / offensive / out of scope / non-suitable for the newspaper policies / ensuring quality of content / relevance of posting / quality of discussions;

This is quite different from what happens in a discussion forum, where registered users are not subject to moderations and therefore can both open/post threads and comments in all threads;

With the effect of delivering a sense of participation / enforce a spirit of community / aggregate people on general ideas;

[4]

- (b) *Award up to [5 max].*

Tags are primarily important to help users navigate the blog site;

By relating posts within the same category/tag/theme in the blog;

Hence tags / they contribute links from web pages inside the blog;

Tags are visible, so they can be easily accessed by web crawlers;

That will be guided to discover the site content following the links;

To avoid the risk of isolated pages in the blog that would not be indexed.

[5]

(c) *Award up to [2 max].*

It has not been accessed enough, yet (possibly because there aren't many registered users, yet);

It contains keywords that are out-of-fashion/in disuse that nobody currently uses for their searches;

The whole site might be hosted by a company without a good reputation (and this penalizes ranking);

The site can only be accessed by browsing and does not have a feeder for mobile devices / automatic updates (eg RSS, Twitter, etc);

**[2]**

9. (a) (i) *Award up to [1 max].*

It is the idea of performing computing anytime and anywhere (pervasive) using any device / (using in everyday objects);

**Note:** Accept "Computing embedded into everyday objects for healthcare purposes"

**[1]**

- (ii) *Award up to [4 max].*  
*For each of the two examples:*  
*Award [1] for identifying an object in which the technology is embedded.*  
*Award [1] for the use to which this is put.*

*Answers may include:*

Obj - (Digital) control/transmitters that are embedded in domestic appliances such as fridges / cookers / microwave or doors etc /smart appliances;

Use - So that the different objects can communicate among them to avoid a surcharge in power demand/avoid a power blackout;

Obj - (semiautonomous) wheelchair with sensors/camera;

Use - so to avoid specific obstacles when used in a closed environment / 'knows' the path to traverse a certain area of the flat/hall/living environment

Obj - smart white stick (for sight-impaired people);

Use - the tip of the stick has awareness of the environment and sends back, to the handle, impulses that code information to the user, for example it may signal a wet floor

Obj - A (smart) biometric watch;

Use - That routinely reports the vital parameters / elaborates statistics / checks the pulse;

Obj - voice recognition systems integrated on appliances/doors;

Use - for example a user with limited mobility may just say 'open the door' to the main door, but the recognition must be calibrated so to recognise only the owner

Obj - An app on a smartphone/computer/interactive screen;

Use - that prompts the user to regularly make some movements for rehabilitative physiotherapy, at home, on their own (soft gym/physiotherapy)

Obj - sensors in the floor/bathroom;

Use - detect whether the person has fallen and this can be integrated with other services to alert the nurse;

Obj - infrared camera

Use - to detect movements/presence/whether the person is sleeping or not/ body temperature therefore signalling parameters for possible illnesses;

Obj - weight sensor embedded in the bed

Use - to determine changes in weight that can be transmitted to other services;

- (b) *Award up to [5 max].*  
*Award up to [2 max] in relation to the public cloud.*  
*Award up to [2 max] in relation to the private cloud.*  
*Award [1 max] for a conclusion.*

**Note:** *Do not accept “Access for doctors/nurses...” as it is included in the stem of the question.*

**Example one:**

Public cloud could be accessed by many people;  
Although access is restricted to their authorized area;  
Private cloud provides dedicated infrastructure for one client;  
Which makes it more secure;  
Because resources are not shared;  
(A breach of security in a private cloud means less data loss than if it happened in a public cloud);  
(*Conclusion*) As this data is sensitive, it should therefore be stored in a private cloud (and encrypted);

**Example two:**

Public clouds are usually maintained by expert people;  
SW updates to prevent security risks are very sophisticated;  
Private clouds are usually maintained by people with less expertise;  
When updates are needed in a private cloud it is harder to ensure the same level of security (as in a public cloud) across the private clouds, making it more vulnerable;  
(*Conclusion*) This makes the private cloud not necessarily more secure,  
Therefore, encryption is needed to prevent eavesdropping;

**[5]**

- (c) *Award up to [2 max].  
Award [1] for identifying a risk and [1 max] for an expansion/description.*

**Note:** *Do not accept “(Quality of) security of data storage”*

Risk: Malfunctioning / reliability of the device (reliability of Hardware);  
The device fails to communicate (to send the signal) and the supervisor  
might not intervene on time / user might be induced to think the situation is  
OK;

Risk: Wearables could be lost / misplaced;  
Consequently, there is an interruption in monitoring some vital parameters;

Risk: Compatibility among devices;  
The user might be provided cheaper equipment that is not conform to  
standards, raising problems of interoperability with existing equipment;

Risk: Network may be down / stuttering / low bandwidth;  
The user might become isolated and unable to set it back up on their own  
(don't know how to make a WiFi work);

Risk: Privacy / protection and personal safety;  
The user's habits at home could be determined by monitoring the vital  
parameters (sleep/awake or pulse) and this information may be used for  
unlawful / unethical  
purposes;

[2]

- (d) CDMA / 3G / 4G / UMTS / GAN / GSM / iDEN / WiMAX / Wi-Fi.

[1]

- (e) *Award up to [5 max].  
Award up to [2 max] for describing the role of protocol and standards and  
up to [3 max] for an explanation (examples may be included).*

Protocols and standards provide tested and verified techniques and technologies;  
To support data protection/security/privacy;  
Protocols and standards are essential in a complex system that includes different  
subsystems/components that interact;

*Possible lines to develop an explanation:*

- For example, in **transmission** (SSL/TLS):  
So that all information is encrypted/is protected for eavesdropping or  
man-in-the-middle attack/has Integrity and authenticity protection;  
For example, for the transmission of data/signals from wearables to the cloud;
- For example, in **storage and access**:  
In relation to Availability/Integrity/authenticity/Access control/logging;  
For example, to prevent risks for patients due to inappropriate data monitoring;
- For example, in relation to **evolution of the system**:  
In relation to the expansion of the system or changed architecture of  
the system;  
Which might include further/future devices/services involving the cloud /  
so that new devices are (backward) compatible with the existing ones;

[5]

**Option D — Object-oriented programming**

10. (a) Award up to **[3]** marks.

**Note:** An example is required with detailed explanation (up to **[2 max]**);  
Award **[1 max]** if there is lack of detail).

A class describes/provides the template for a particular object;  
Whereas an instantiation of a class actually creates an object for that class;  
For example:

An employee class would contain characteristics/actions that describe an employee, and an instantiation would represent a particular employee;

**[3]**

- (b) Award marks as follows up to **[4 max]**:

Award up to **[2 max]** for each of the **two** required examples (award **[1]** mark for correct example but lack of terminology/detail/competence)

**Note:** Examples should show competent use of terminology in describing the use of inheritance, to get full marks.

The responses should focus on these aspects, with keywords underlined:

- Several sub-classes can inherit characteristics from a superclass;
- Whilst adding specific characteristics particular to themselves;

Examples can then expand or be described to include the features above.

For example:

There could be a “GUI” superclass that contains the main elements for the UIs with the GUI for each screen inheriting from its parent;

For example:

An “Employee” superclass that allows the different types of employees to inherit standard characteristics;

**[4]**

- (c) Award up to **[3 max]**:

Library programs are programs that have already been written;  
They are standard/frequently used programs;  
Development time will be saved if they can be incorporated into the design;  
They have been tested / Will be free of bugs;

**Note:** Allow **[1 mark]** for responses that include examples that expand on any of the aspects listed above.

**[3]**

11. (a) Award **[max 2 marks]**:

**[1 mark]** for each of the two correct assignments.

```
public SalesPerson (String id)
{
    this.id = id;
    salesHistory = new Sales [100];
}
```

**Note:** Allow any reasonable value for the number of *Sales* objects.

**[2]**

(b) Award up to [3 max].

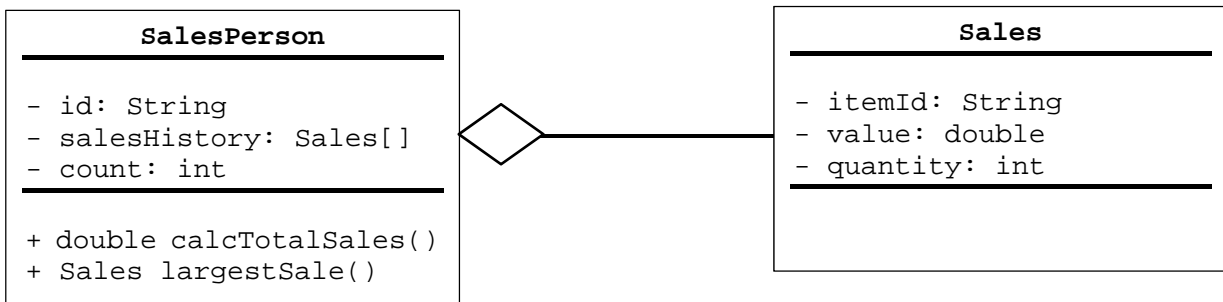
**Note:** Use of competent/detailed terminology (underlined) is required.

As the variables are declared as private;  
They/their values cannot be accessed directly from outside this class;  
Therefore, public accessor methods are needed to permit access;

[3]

**Note:** Either accessor **or** access required.

(c) (i) Award up to [4 max] as follows (there are 5 marking points):  
[1] for two classes BOTH with basic three-tier structure layout;  
[1] for correct dependency shown (eg diamond arrow) /  
"has a" from SalesPerson to Sales/  
1:N relation.  
[1] in SalesPerson, for all vars and methods (contentwise) with type  
(allow if constructor/ accessor/mutator methods are present);  
[1] in Sales, for all vars and methods (contentwise) with type  
(allow if constructor/ accessor/mutator methods are present);  
[1] for correct use of +/- for public/private;



[4]

(ii) Award up to [2 marks].

Any change in the Sales class might require a rewriting of some  
SalesPerson methods/might not work;  
For example, the calcTotalSales() is dependent upon/uses data from  
the Sales  
class;

[2]

**Note:** Accept any reasonable example.

(d) Award up to [4 marks].

102;  
2;  
2550.40;  
5000.00; (**Note:** Accept, only in this case, 5000)

[4]



- (e) Award marks up to **[5 max]** as follows:  
**[1]** for assigning an appropriate value to total;  
**[1]** for correct loop;  
**[2]** for correctly updating total OR **[1]** for a reasonable effort;  
**[1]** for returning the total;

```
public double calcTotalSales() // returns total value of all
                               // of the sales
{
    double total = 0;
    for (int x = 0; x<count; x++)
    {
        total = total + salesHistory[x].getValue()
                    *salesHistory[x].getQuantity();
    }
    return total;
}
```

**[5]**

- (f) Award marks as follows up to **[5 max]**:  
**[1]** for correct initialization;  
**[1]** for correct loop;  
**[1]** for correct comparison AND **[1]** for correct reassignment of total;  
**Note:** Award **[1 max]** for these two parts if dot notation is not used.  
Award **[1]** for correct re-assignment of index;

```
public String highest()
{
    double total = 0;
    int index = -1;
    for (int x=0; x<100; x++)
    {
        if (SalesPeople[x].calcTotalSales() > total)
        {
            total = SalesPeople[x].calcTotalSales();
            index = x;
        }
    }
    return SalesPeople[index].getId();
}
```

**[5]**

**Note:** There will be other correct versions, but the markscheme shown above should still apply.

- (g) Award marks up to **[4 max]** as follows:  
**[1]** for correct loop;  
**[1]** for correct comparison (either as part of the loop condition, or within a for - loop);  
**[1]** for assignment (with or without use of set);  
**[1]** for correct use of get / set methods.  
**Note:** Allow for a “follow through” (FT) if the loop is incorrect

**Example of solution with while-loop**

```
public void addSales(Sales s, String id)
{
    int x = 0;
    while (salesPeople[x].getId() != id)
    {
        x++;
    }
    salesPeople[x].setSalesHistory(s);
}
```

**Example of solution with for-loop**

```
public void addSales(Sales s, String id)
{
    for(int i=0;i<salesPeople.length; i++)
    {
        if(salesPeople[i].getId().equals(id))
        {
            salesPeople[i].setSalesHistory(s);
            break;
        }
    }
}
```

**[4]**

- (h) Award up to **[3 max]**:

A date variable must be added to the Sales class;  
 And included in its constructor;  
 Get/set methods added for the date;  
 The calcTotalSales() would have to be rewritten;

**[3]**

**Note:** The spirit of the question is to address the question from a programmer/developer point of view. We are looking for elements of programming/functionality of the programs. Please take this perspective when marking vague responses.

(i) *Award up to [3 max]:*

This is shown by the two constructors in the `SalesPerson` class;

Which is an example of overloading;

The constructor that is executed (by the compiler);

Is the one in which the parameters match up with the arguments in the calling statement;

**[3]**

---