Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2019

Information technology in a global society

Higher level

Paper 3

12 pages

Critical Thinking – explanation, analysis and evaluation

These trigger words often signal critical thinking. The bold words are the key terms in the various criteria.
Explanation – *Because, as a result of, due to, therefore, consequently, for example*
Analysis – *Furthermore, additionally, however, but, conversely, likewise, in addition, on the other hand, whereas*
Evaluation – *My opinion, overall, although, despite, on balance, weighing up*

Examiners should be aware that in some cases, candidates may take a different approach, which if appropriate should be rewarded. If in doubt, check with your Team Leader.

If candidates answer more than the prescribed number of 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) Information is communicated between a driverless vehicle and the road infrastructure.

(i) Identify **one** piece of information communicated from the driverless vehicle to the road infrastructure. **[1]**

Answers may include:
- speed of car
- information about the car e.g. size, car specifications
- exact location of car
- route information.

Do not accept - distance between the vehicle and object/infrastructure.

*Award **[1]** for identifying a piece of information that could be communicated from a driverless vehicle to the road infrastructure.*

(ii) Identify **one** piece of information communicated from the road infrastructure to the driverless vehicle. **[1]**

Answers may include:

From road infrastructure to driverless vehicle (pushes out a signal that informs the car of):
- information about traffic e.g. congestion
- road conditions ahead e.g. colour of traffic lights, lane markings, road signs
- construction zones
- parking availability
- variable speed limits
- breakdown/accident ahead
- toll booths.

Do not accept - weather conditions as this is not explicitly linked to the conditions of the road.

Note to examiners:
Road infrastructure is defined broadly and includes not only physical objects near or on the road but digital communications equipment used to communicate to and from a central traffic monitoring centre, and other possible communication devices. But excluding vehicle to vehicle communications as infrastructure is deemed as being static and permanent.

*Award **[1]** for identifying a piece of information communicated from the road infrastructure to the driverless vehicle.*

(b) Outline **one** economic advantage of the introduction of autonomous vehicles. **[2]**

Answers may include:
- cars can be used during the day and night
- which leads to a more productive use of the car

- car-pooling is made easier
- so no need to buy a car / savings on cost of car and running of car

- the best route for can be used
- which saves fuel due to shorter route / less congestion

- driverless cars will lead to fewer accidents
- saving money on medical expenses, hospitals and possible reduced insurance costs

- cars can be used 24 hours a day
- so less need to build car parks and garages

- increased productivity
- as people can work in the car / less road congestion due to fewer cars on the roads

- public transport/taxis/delivery trucks may not use human drivers
- long term cost savings as salaries do not need paying, reductions in costs lead to higher profits or reduced prices for customers

- attracts Investors
- introduction of countries producing autonomous vehicles– may attract foreign investment and improve on country's GDP.

Do not accept - countries having invested in autonomous vehicle research and development saves costs for other countries will do not need to invest in this research.

Economic gain from the sale of (internally or exported) autonomous cars (not linked to the use of the autonomous vehicle).

Notes to examiners:
Economic is defined as less cost, financial benefits or greater productivity due to time saving and more effective use of time. Economic benefit must not be general, e.g. greater productivity, as it must be linked to the use of autonomous vehicles.

*Award **[1]** for identifying each economic advantage of the introduction of autonomous vehicles and **[1]** for the development of the economic advantage identified up to a maximum of **[2]**.*

2. Explain the function of both GPS **and** LIDAR in a fully autonomous vehicle at level 5 of the SAE scale. **[6]**

Answers may include:

GPS
- identification of function – provide accurate position of the car
- explanation / development of that function
  - position is identified so that it can be located on the in-built maps
  - position is identified so that it can communicate its location to other vehicles and road infrastructure, including a central location
  - GPS guides the vehicle to the destination
  - the GPS receiver in the car will use three or more satellite signals to triangulate and hence to locate the position of the car
- further development of that function related to level 5 – level 5 vehicles autonomous cars need to know their location so that they can use the in-built maps and other information to steer the car safely without the need for the occupant to take action.

*Award **[1]** for identifying the function/role of GPS, **[1]** if function/operation is described in the context of a car and **[1]** if its function is linked to its role in a fully autonomous vehicle at level 5 of the SAE scale up to a maximum of **[3]**.*

*Without reference to the autonomous nature of the car maximum **[2]** marks.*

LIDAR
- identification of function – to provide data about the location, size and movement of objects that surround the car
- explanation / development of that function
  - LIDAR (Light Imaging, Detection And Ranging), short and long-range radar, that will provide 360-degree “vision” and the ability to determine the precise distance to the objects it “sees”
  - uses the pulse from a laser to collect measurements which can then be used to create 3D models and maps of objects and environments
  - it could create a 3D image/map of the car’s surroundings, enabling it to better able to more easily calculate a path to avoid objects
  - LIDAR has beams tht point high enough to detect tall objects, road signs as well as navigating up and down slopes
  - LIDAR can measure the speed and distance of another object
- further development of that function related to level 5 – the information about the location and nature of objects outside the car is required so that the autonomous car can avoid colliding with them without the need for the occupants to take action.

Note to examiners:
Different technologies include: Sound waves (Sonar or Ultrasonic), Electromagnetic waves (Radar), light rays/non-visible laser beam (LIDAR)

*Award **[1]** for identifying the function/role of LIDAR, **[1]** if function/operation is described in the context of a car and **[1]** if its function is linked to its role in a fully autonomous vehicle at level 5 of the SAE scale up to a maximum of **[3]**.*

*Without reference to the autonomous nature of the car up to a maximum of **[2]**.*

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

3. Discuss whether it will be possible to develop an ethical framework that could be used for driverless cars in a number of different countries, such as China, India, USA and Germany. **[8]**

Answers may include:

Reasons that it would be possible to develop

- a rule based ethical framework such as Deontology/Markkula (Santa Clara) ethical decision making will work in all countries:
  - road rules have largely been standardised across the world
  - countries largely agree that the priority of human life above damage to buildings and other objects
- the brain of the driverless car would be programmed to anticipate problems a long way ahead and stop if it senses that its rules would not cope with the situation, hence by-passing the lack of rules
- if the law courts agreed on blame/liability for accidents if there is a sudden situation like a child coming out from behind a car the driverless car would be able to react faster than a human; but if not, it should be treated as an "accident" with no blame to the car as happens now
- If the driverless cars had the feature to transfer control when conditions of public roads did not meet the standards required for autonomous cars e.g. out in the country of a less economically developed country where there are rough tracks and often unsealed roads. Again, by-passing the problem of developing a set of universal rules for all situations
- consequence based rule framework (such as Consequentialism):
  - a simple rule that in the case of human life being in danger no matter what happens the lesser damage to human life is the choice. However, this is a calculation of the "lesser of
    two evils" that humans do not cope with well either.

Reasons that it would not be possible to develop as the one set of rules would not be applicable to all countries

- working at the macro/intranational level it may be possible to write a set of overarching principles, but these overarching principles may be no more than very general statements such as "the driverless car should not cause harm". These may be effectively meaningless
- Deontology focuses on the rightness or wrongness of actions themselves which may be based on indigenous knowledge of that country, trying to change this for countries to be aligned would be very difficult
- there are too many exceptions for each country, for example:
  - road rules in all countries (*ie* working at the macro level), and even cities, have variations to suit *eg* at a roundabout, unusual turning rules, unusual right of way rules at intersections, that are based on historical circumstances. There is no way that all of them could be included in a driverless car at the micro level
  - in some countries it may be culturally significant to not harm animals due to religious reasons or cultural priorities to farm animals
  - in some countries the priority could always be set to pedestrian and the driver would always be to blame if something happened
- consequence based rule framework:
  - the many different practical situations may not able to be included in the rules programmed into the brain of the driverless car
  - and the brain of the computer would have problems working out all the consequences and balancing them out.

Example Evaluative Comments
In effect, you would get the worst of both worlds. The macro approach would be too generic and the micro approach would create such a long list of criteria that have to be met, the driverless vehicle would not be able to go above 4 mph. In effect it would not add utility and the proposed venture would fail.

Overall, the rules and situations are generally very common in all countries. The brain could be programmed with these standard set of rules that would cover agreed international road rules and have an add-on pack that can be downloaded for each country. This is the same as a human driver needing to learn the rules of a country when driving a car there. Also, the best way is not to try to develop a universal framework, but for each country to have rules that limit the use of driverless vehicles to situations where its brain can cope.

Expecting the driverless car to be able to overcome all the problems humans have is unrealistic given the state of the technology, as it is unrealistic to expect humans to be able to cope all the time.

Note to examiners:
The two main ethical systems that can be used in driverless cars are rules based and consequence-based system. Virtuous ethical systems are unlikely to be applicable as the values included would need to be programmed as a rules system which is very difficult to do due to the impreciseness of the definitions of virtuous behaviour, which are probably more varied than the differences in road rules across a range of countries.

Utilitarianism is a form of consequentialism with the most ethical choice being the one that will produce the greatest good for the greatest number. Utilitarianism is a theory in philosophy about right and wrong actions. It says that the morally best action is the one that makes the most overall happiness or "utility" (usefulness).

SL and HL paper 1 part (c) and HL paper 3 question 3 markband

Marks	***Level descriptor***
No marks	• *A response with no knowledge or understanding of the relevant ITGS issues and concepts.* • *A response that includes no appropriate ITGS terminology.*
Basic ***1–2 marks***	• *A response with minimal knowledge and understanding of the relevant ITGS issues and concepts.* • *A response that includes minimal use of appropriate ITGS terminology.* • *A response that has no evidence of judgments and/or conclusions.* • *No reference is made to the scenario in the stimulus material in the response.* • *The response may be no more than a list.*
Adequate ***3–4 marks***	• *A descriptive response with limited knowledge and/or understanding of the relevant ITGS issues and/or concepts.* • *A response that includes limited use of appropriate ITGS terminology.* • *A response that has evidence of conclusions and/or judgments that are no more than unsubstantiated statements. The analysis underpinning them may also be partial or unbalanced.* • *Implicit references are made to the scenario in the stimulus material in the response.*
Competent ***5–6 marks***	• *A response with knowledge and understanding of the relevant ITGS issues and/or concepts.* • *A response that uses ITGS terminology appropriately in places.* • *A response that includes conclusions and/or judgments that have limited support and are underpinned by a balanced analysis.* • *Explicit references to the scenario in the stimulus material are made at places in the response.*
Proficient ***7–8 marks***	• *A response with a detailed knowledge and understanding of the relevant ITGS issues and/or concepts.* • *A response that uses ITGS terminology appropriately throughout.* • *A response that includes conclusions and/or judgments that are well supported and underpinned by a balanced analysis.* • *Explicit references are made appropriately to the scenario in the stimulus material throughout the response.*

4. A government has decided to allow fully autonomous cars to operate on its roads despite the concern of some citizens that not all of the potential problems have been resolved.

Evaluate the decision of this government to allow fully autonomous cars to operate on its roads. **[12]**

Answers may include:

Some reasons to ALLOW fully autonomous vehicles to operate on public roads

- Technical - the roads would have infrastructure that would allow the car to be aware of other vehicles and items near or on the road. The public roads would have information communicated to it about the conditions of the road and traffic ahead. The candidate may specify a range of infrastructure that could be involved
- Technical/ethical -fail-safe mechanisms have been put in place if the driverless car itself has problems or the infrastructure is damaged or malfunctions.
- Legal - the road laws have been modified to take into account the way driverless car operates
- Legal - the insurance issues related to the accountability of the driverless car in case of accidents have been solved
- Legal - the legal liability of the occupants, owners, developers, *etc* of driverless car have been solved
- Technical/ethical - fail-safe mechanisms have been put in place if the driverless car itself has problems or the infrastructure is damaged or malfunctions
- Ethical - the role of the occupants in controlling the vehicle in emergencies and hazardous situations have been solved
- Economic - the use of the driverless car will provide economic benefits such as car sharing, less parking facilities, etc
- Economic – potential cheaper public transport to efficiently transport citizens around the country
- Economic – impact on jobs required for autonomous cars/infrastructure development/maintenance and manufacturer
- Technical/phycological - the brain of the driverless car has been trained to make “ethical” decisions when hazards appear, and these have been accepted by the public
- fail-safe mechanisms have been put in place if the driverless car itself has problems or the infrastructure is damaged or malfunctions
- Social- provides a greater range of transport for those who can no longer drive e.g. elderly, disabled – improves the well-being of a country's citizens.
- Government may benefit from the tracking/surveillance advantages from having access to autonomous vehicle/infrastructure information e.g. help in tracking criminals,stolen cars
- Environmental – less pollution as autonomous cars may be electric and/or use of carpooling/reduced congestion.

Some reasons to NOT ALLOW fully autonomous vehicles to operate on public roads (usually, a contrast pair to the above)

- Technological - some public roads might have features that the driverless car is not capable of understanding and responding too, *e.g.* on a country road with no edges
- Technological/financial - not enough infrastructure has been put in place to facilitate the use of driverless cars
- Technical - not all vehicles on the road would have the ability to communicate with the driverless car
- Technical - the brain of the driverless car may not be trained enough to handle all the many circumstances that can happen on a public road

- Technical – the security of data transmission between cars and infrastructure has not been fully tested or is not robust – leading to potential threats while driving
- Legal - the legal liability, insurance and accountability laws and regulations have not been fully worked out
- Psychological – the public and the citizens are not emotionally ready/do not trust to be using or driving alongside driverless cars.

Note to examiners:
The reasons to allow fully autonomous vehicles on public roads need to be related to legal, economic, technological, financial, psychological and ethical problems that could be handled by the driverless car on a public road, and vice versa for reasons to not allow the driverless car to be on public roads. The candidate may pair the individual positives and negatives as a contrast or put them into two groups which may not match identically. The difference would be accounted for in the conclusion. As this is a government decision, candidates should develop their arguments based on the impact at a community or country level.

HL paper 3 question 4 markband

Marks	***Level descriptor***
No marks	• *A response with no knowledge or understanding of the relevant ITGS issues and concepts.* • *A response that includes no appropriate ITGS terminology.*
Basic ***1–3 marks***	• *A response with minimal knowledge and understanding of the relevant ITGS issues and concepts.* • *A response that includes minimal use of appropriate ITGS terminology.* • *A response that has no evidence of judgments, conclusions or future strategies.* • *No reference is made to the information in the case study or independent research in the response.* • *The response may be no more than a list.*
Adequate ***4–6 marks***	• *A descriptive response with limited knowledge and/or understanding of the relevant ITGS issues and/or concepts.* • *A response that includes limited use of appropriate ITGS terminology.* • *A response that has evidence of conclusions, judgments or future strategies that are no more than unsubstantiated statements. The analysis underpinning them may also be partial or unbalanced.* • *Implicit references are made to the information in the case study or independent research in the response.*
Competent ***7–9 marks***	• *A response with knowledge and understanding of the relevant ITGS issues and/or concepts.* • *A response that uses ITGS terminology appropriately in places.* • *A response that includes conclusions and/or judgments that have limited support and are underpinned by a balanced analysis.* • *Explicit references to the information in the case study or independent research are made at places in the response.*
Proficient ***10–12 marks***	• *A response with a detailed knowledge and understanding of the relevant ITGS issues and/or concepts.* • *A response that uses ITGS terminology appropriately throughout.* • *A response that includes conclusions, judgments or future strategies that are well supported and underpinned by a balanced analysis.* • *Explicit references are made appropriately to the information in the case study and independent research throughout the response.*