



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2014

Marking Scheme

Technology

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.



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The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable. If you are unsure of the validity of an alternative answer, contact your advising examiner.

Section A - Core (72 marks)

*Answer any twelve questions in the spaces provided.
All questions in Section A carry 6 marks.*

Section A. Answer *any twelve* questions. All questions carry 6 marks.

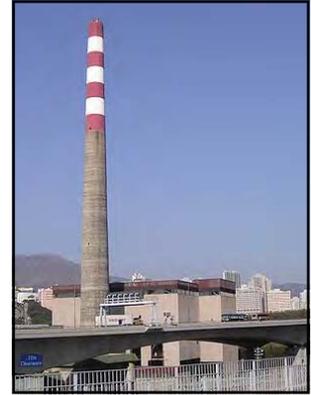
1. In June 2011, An Bord Pleanála refused planning permission for a €60 million twin-incinerator project at Ringaskiddy, Co.Cork.

(i) Outline **one** advantage of incineration.

Efficient method of disposing of large volumes of refuse, can be used to generate heat or electricity, etc.

(ii) Outline **one** disadvantage of incineration.

Health concerns of dioxins released, reduced incentive to recycle, air pollution, ash disposal, etc.



2. 'GORE-TEX®' is classified as a *smart fabric* and is used extensively for all-weather outdoor clothing.

(i) Explain what is meant by a smart fabric.

Smart fabrics are materials whose properties change/react in a controlled fashion to external stimuli such as temperature, moisture, electric field, etc.

(ii) Give **one** other example of a smart material.

Thermo-chromatic materials will respond to changes in heat by changing colour. Photo-chromatic materials respond to changes in light intensity. Polymorphs, muscle wire, etc. are smart materials.



3. Many plastic products have the logo shown embossed or printed on them.

(i) Explain the meaning of the term **HDPE**.

High density Polyethylene

(ii) Outline the main difference between *thermoplastic* and *thermosetting* plastic materials.

Thermoplastics will mould more than once and are recyclable. Polyethylene and polyvinyl chloride (PVC) are examples.

Thermosetting plastics can only be shaped once and are usually harder and will withstand higher temperatures. Polyester resin and phenol formaldehyde are common thermosets.



4. The sprocket on the engine of a scooter has 75 teeth and the sprocket on the back wheel has 150 teeth.

(i) If the engine sprocket revolves at 1500 rpm, what is the rpm of the sprocket on the back wheel?

Calculation:

$$VR = \frac{75}{150} = 1:2$$

$$RPM = 1500 \times \frac{1}{2} = 750 \text{ rpm}$$

(ii) Give two reasons why lubrication is used for this sprocket system.

Prevent build-up of heat by reducing friction, reduce noise, minimise wear, stop rusting, etc.

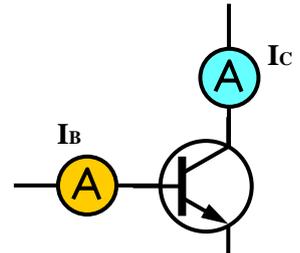


5. Part of a transistor testing circuit which includes two ammeters is shown.

(i) Give two main functions of a transistor.

Electronic switch and current amplifier.

(ii) Calculate the gain (h_{FE}) of the transistor shown if the ammeter readings at $I_B = 250\mu A$ and $I_C = 50mA$. **Note:** $h_{FE} = I_C / I_B$



$$\begin{aligned} h_{FE} &= I_C / I_B \\ &= 0.05 / 0.00025 \\ &= 200 \end{aligned}$$

6. A node used in the construction of a *critical path diagram* is shown below. These diagrams are used to ensure that projects are completed within the specified time.

(i) Explain the terms EST and LST.

EST - Earliest Start Time

LST - Latest Start Time

(ii) Identify the missing terms at X and at Y.

X - EFT - Earliest Finish Time

Y - LFT - Latest Finish Time

EST		X
Activity Name		Duration
LST		Y

7. An *ergonomic* laptop stand is shown in the graphic.

- (i) Explain the term ergonomic.

The study of designing equipment and devices which fit the human form.

- (ii) Outline **two** reasons why laptop stands are now commonly used in the workplace.

Dissipation of heat, providing a better position for screen and keyboard to prevent injury due to prolonged use, etc.



8. Product development can involve learning from other designs which have features similar to those required by the new product.

- (i) Outline **one** method used to analyse an existing product.

Reverse engineering, accelerated tests, bench marking, etc.

- (ii) Explain the purpose of a Quality Control (QC) system in product manufacture.

Quality control (QC) is a procedure intended to ensure that a manufactured product adheres to a defined set of quality criteria or meets the requirements of the client or customer.



9. A hotel elevator has a load carrying capacity of 8 persons (average weight 80 kg). The elevator has a factor of safety of 4. Calculate the design load of the elevator.



Calculation:

$$\text{Capacity} = 8 \times 80\text{kg} = 640\text{kg}$$

$$\begin{aligned} \text{Design load} &= 640 \times 4 \\ &= 2560\text{kg} \end{aligned}$$

10. *Rapid prototyping* is used in the development of new products.

(i) Name **one** rapid prototyping method.

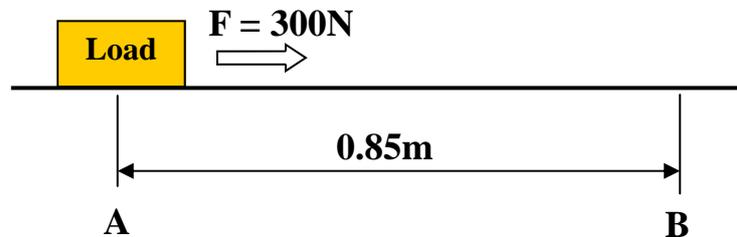
3D printing, additive processes, CNC, etc.



(ii) Outline **two** reasons for manufacturing a prototype of a new product before full production commences.

Identify faults/modifications prior to full production, less expensive to alter prototypes than production parts, visualise the scale/size of a product, potential saving on material costs, etc.

11. Calculate the **power** required to move the load shown in the graphic below from position **A** to position **B** in three seconds.



Calculation:

$$\begin{aligned} \text{Work} &= \text{force} \times \text{distance} \\ &= 300 \times 0.85 = 255 \text{ joule} \quad (\text{Note: } 1\text{Nm} = 1\text{joule}) \end{aligned}$$

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{255}{3} = 85 \text{ watt}$$

12. The European Union aims to generate 20% of its energy from renewable sources by 2020. (*Renewables Directive 2009/28/EC*)

(i) List **three** sources of renewable energy.

Any three renewable sources including solar, wind, tidal, geothermal, biomass, etc.



(ii) Outline **two** factors which contribute to a worldwide increase in the demand for energy.

Increase in global population, greater industrial use for energy, development in use of electronic devices, etc.

13. Make well-proportioned freehand sketches of **two** principal orthographic views of the printer shown.

Any two orthographic views (elevation, plan, either end view)



14. Social networking sites play a significant role in the lives of many people.

Describe the impact of *on-line advertising* and *real-time reporting* as features of social networking.

On-line advertising:

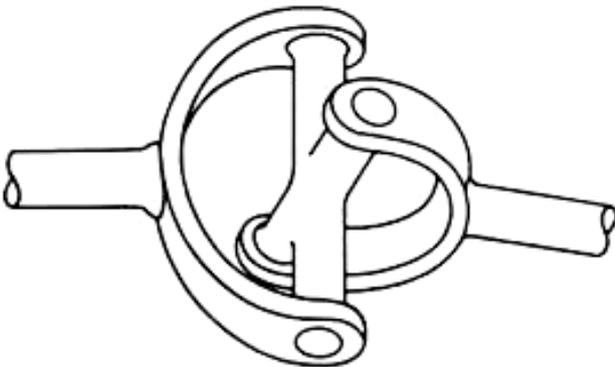
Has the potential to transform methods of advertising as campaigns can be targeted effectively to potential buyers, consumers can have instant access to large volumes of information, consumers have the power to influence large groups of people through recommendation or sharing negative opinion, on-line brand communities are spread by social networking, reduction in sales of print media, etc.

Real-time reporting:

Current trends are captured as they are happening, information and misinformation is instant, popularity of content is instant and collated which will drive succeeding topics, etc.



15. Use **two** graphic techniques to enhance the representation of the universal joint shown.



Two distinct graphic techniques required.

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Section B - Core (48 marks)

Answer both questions.

Each question in Section B carries 24 marks.

Section C - Options (80 marks)

Answer two of the five options presented.

All questions in Section C carry 40 marks.

Section B - Core - Answer Question 2 and Question 3.

Question 2 - Answer 2(a) and 2(b) (a) - 8 marks, (b) - 10 marks, (c) OR (d) - 6 marks

- 2(a) (i) State **two** reasons for creating an emblem for a large sporting or social event.
Create an identity for the event, advertising, merchandising etc.
- (ii) Outline **two** ways in which ideas could be generated in order to develop a design for the emblem.
Brainstorming, product research, mind map, survey, competition, etc.
- 2(b) (i) State **two** advantages of using barcodes.
Speed of operation, track stock, used for automated systems, reduce risk of errors, etc.
- (ii) Explain the term 'biometric'.
The identification of humans by their characteristics or traits. Systems include fingerprint, face recognition, DNA, palm print, iris recognition, etc.
- (iii) Outline **two** Quality Attributes of an effective security system.
Loudness of siren output, reliability of circuitry, type of material, waterproof, etc.

Answer 2(c) or 2(d)

- 2(c) (i) Describe **two** pieces of hardware required for wireless communication.
The key hardware components of a wireless communication are headset, microphone, hub, network card, access point, router, etc.
- (ii) Outline **two** advantages of using a wireless communication system.
Allows flexibility of access, allows multi-users and range of devices to be used, safety - no trailing cables, etc.

OR

- 2(d) (i) List **one** property required of the material used to manufacture the outer shell and **one** property of the material used to manufacture the inner lining.
- Outer shell - **Impact resistant, durable, strong, etc.**
Inner lining - **comfort, mouldable, etc.**
- (ii) Describe, using notes and annotated sketches, a method of fastening the shin guard in place during a match.

Suggested solution:

*Velcro straps are attached to the shin guard.
They are tightened to fit into place.*



Question 3 - Answer 3(a) and 3(b)

(a) - 8 marks, (b) - 10 marks, (c) OR (d) - 6 marks

- 3(a)** (i) Suggest **two** reasons for using radioisotope power rather than solar power systems.
Provides consistent power even in darkness, greater power output, etc.
- (ii) Outline **two** technological benefits accruing to society from the science and engineering developed for space exploration.
Development of efficient power systems, strong lightweight materials, transmission of information across long distances, remote control, etc.

- 3(b)** (i) Name any **two** electronic devices that might be attached to the turret.
Camera system, dust removal tool, rock drill, x-ray spectrometer, laser, etc.
- (ii) A servo motor is used to move the robotic arm. From the data given below calculate the torque of the motor required to move the arm. **Note:** $g = 9.8m/s^2$
- Torque = force x distance = (2.5 x 9.8) x 1.1 = 26.95 Nm**
- (iii) Sketch and label a drive mechanism for the rover wheel and include a means of reducing friction as the wheel rotates.

Any suitable annotated sketch of a drive mechanism – Examples: gearbox system, pulley system, chain and sprocket system, etc.

Means of reducing friction: bearing system, automatic lubricators, nylon inserts, etc.



Answer 3(c) or 3(d)

- 3(c)** (i) Compare *bitmap* and *vector* based images, making reference to quality and sharpness.
Bitmap– made of pixels in a grid, tiny dots of individual colour, resolution dependent e.g., photographs.
Vector– series of geometric objects such as lines and curves. Each object has properties such as colour, width, size, etc. High quality, sharp images are developed.
- (ii) Outline a process of editing to reduce the brightness of a photograph sent back from the Mars rover.
Brightness, colour, contrast, etc. can be edited using photo-editing software.
Colour filtering allows for the selection of a % brightness which can brighten or darken a photo, etc.

OR

- 3(d)** (i) Distinguish clearly, with examples, between *ceramic* and *composite* materials.
Ceramic materials are inorganic, non-metallic materials made from compounds and formed by heat and subsequent cooling. Examples include clay and superconductors.
Composite materials are made from two or more constituent materials with significantly different physical or chemical properties that when combined, produce a material with enhanced properties. Common examples include concrete and fibre-reinforced plastics.
- (ii) Describe a comparison test which could be used to inform the selection of materials capable of withstanding the extremes of temperature expected on Mars.

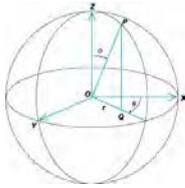
Any suitable test outlined that makes reference to the effects on the properties of various materials due to the extremes of temperature, etc.

Section C - Options - Answer any two of the Options.

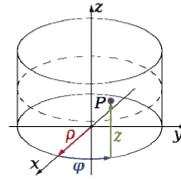
Option 1 - Applied Control Systems - Answer 1(a) and 1(b)

(a) - 10 marks, (b) - 16 marks, (c) OR (d) - 14 marks

- 1(a) (i) Outline the suitability of 3D printing for prototyping a mobile phone.
Design created in CAD, can be edited and reprinted, quick reproduction, tactile, colour and shape can be edited, etc.
- (ii) Explain, using sketches, the terms *polar coordinate system* and *cylindrical coordinate system*.

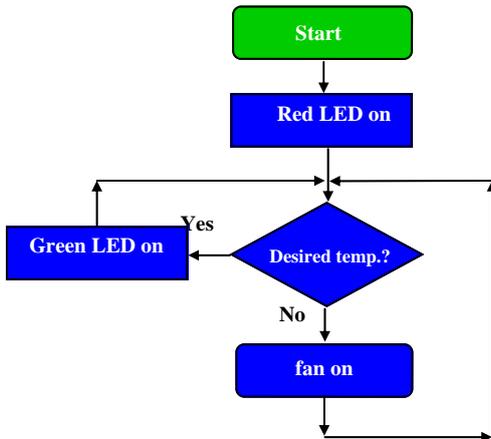


Polar: Radius, angle and longitude/latitude required to specify points in space, etc.

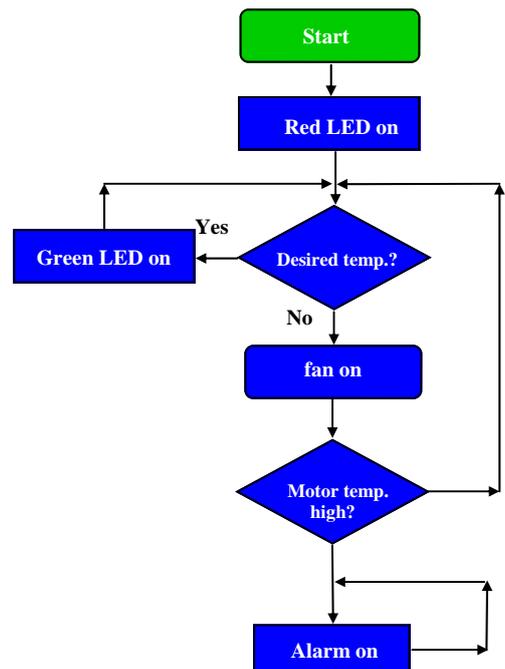


Cylindrical: Radius, height and angle required to specify points in space, etc.

- 1(b) (i) Draw a flowchart for the operation of this air conditioning unit.



- (ii) Modify the flowchart to include an alert for the user if the motor in the air conditioning unit overheats.



Any valid alternative solution accepted.

Answer 1(c) or 1(d)

1(c) (i) Outline the principles of a closed loop system of control.

A closed loop control system monitors its movements through the provision of feedback.

When working with DC motors, shaft encoders are commonly used as accurate feedback can be provided, etc.

(ii) Compare *servo motors* and *stepper motors* as sources of motive power.

Servo motors give smooth control with good torque and precision, 80-90% efficient, quiet without vibration, limited rotation in some servos, etc.

Stepper motors are easy to control using a pulsing sequence, torque is greater at low speeds, can provide a holding torque even when not powered, reasonable cost, continuous rotation, precision, etc.

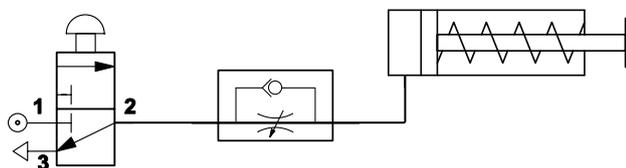
OR

1(d) (i) Describe the main features of a pneumatic control system and give **two** common applications.

Air compressor supplies air that is filtered, pressure regulated and lubricated. Pneumatic cylinders and valves are controlled to convert stored energy into motion, etc.

Used for automatic doors, drills, paint spraying, clamping, etc.

(ii) Draw a suitable pneumatic control circuit to operate the barrier.



Any valid alternative solution accepted.

Option 2 - Electronics and Control - Answer 2(a) and 2(b)

(a) - 10 marks, (b) - 16 marks, (c) OR (d) - 14 marks

2(a) (i) Distinguish clearly, with examples, between *conductor*, *insulator* and *semiconductor* materials.
Conductors allow current to pass e.g. copper. Insulators prevent current flow, e.g. PVC. Semi-conductors allow small amounts of current to flow, e.g. Silicon.

(ii) An electrical heater with a resistance of 24 ohms is connected to a 240V supply for 12 hours. Calculate the cost of operation if electrical energy costs 25 cents per kWh.

$$\begin{aligned} \text{Power} &= V^2 / R &= (240)^2 / 24 \\ & &= 2.4 \text{ kW} \times 12 = 28.8 \text{ kWh} \\ \text{Cost} &= 28.8 \times 0.25 &= \text{€}7.20 \end{aligned}$$

2(b) (i) Describe what is meant by an astable circuit.

The circuit is called an astable because it is not stable in any state. The output is continually changing between 'low' and 'high' which produces output at intervals.

(ii) The soft-glow nightlight stays on continuously while the ultrasonic sound is emitted at intervals. Describe how the given circuit could be modified to achieve this.

The light circuit can be placed in parallel with the 555 timing circuit. The ultrasonic sounder needs to be connected to pin no. 3 and to the zero voltage rail, etc.

(iii) For the given circuit, if the value of C is 10 μ F, R1 is 10k Ω and R2 is 68k Ω calculate the frequency.

$$\begin{aligned} f &= 1.44 / (2R_2 + R_1) \times C \\ f &= 1.44 / (136,000 + 10,000) \times 0.00001 &= 0.99 \text{ Hz} \end{aligned}$$

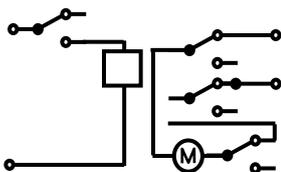
Answer 2(c) or 2(d)

2(c) (i) Name parts A, B and C of the DC motor shown.

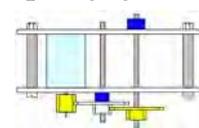
A - Contacts/Brushes, B - Commutator and C - Permanent magnet (stator)

(ii) Describe **one** electrical and **one** mechanical method used to change the direction of rotation of a DC motor.

Electrical: DPDT switch, relay circuit, PIC control, etc.



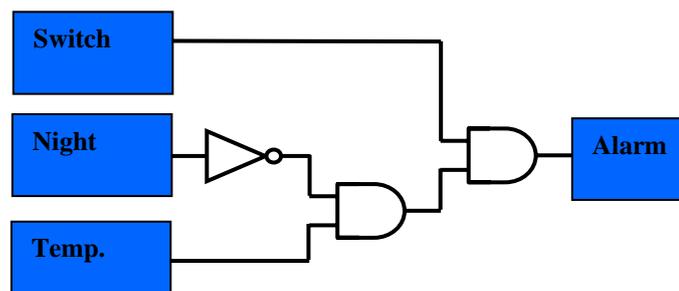
Mechanical: Gearbox, extra gear, cross belt pulley system, etc.



Any valid alternative solution accepted.

OR

2(d) (i) Draw a logic circuit to reflect the given truth table.



(ii) Name any sensor which could be used in the weather station.

Thermistor, LDR, etc.

Option 3 - Information and Communications Technology - Answer 3(a) and 3(b)

(a) - 10 marks, (b) - 16 marks, (c) OR (d) - 14 marks

- 3(a) (i) Describe **two** potential health problems related to the prolonged use of mobile computing devices.
Repetitive strain injury, back problems associated with poor posture, eye strain, etc.
- (ii) Outline **one** method of reducing the potential health impact of using a laptop computer.
Use of a docking device promotes better seating position, take regular breaks, etc.
- 3(b) (i) A large company has a LAN. The IT manager of the company wants to replace it with a WLAN. Explain the differences between a LAN and a WLAN.
LAN is a local area network- this connects computers in a limited area using cables. WLAN is a wireless local area network which allows devices within range to be connected with wire-free interface, etc.
- (ii) Explain the term *ad-hoc* in relation to wireless networking.
Ad-hoc mode is a method for wireless devices to directly communicate with each other. This allows all wireless devices within range of each other to discover and communicate in peer-to-peer fashion without involving central access points, etc.
- (iii) Differentiate between *infrared* and *radio frequency* in relation to wireless transmission.
IR transmit and receive systems are inexpensive and are generally reliable. The carrier frequency of infrared signals is typically in the order of around 38 kHz, etc. Radio Frequency (RF) do not require line of sight and do not have to be aimed at the equipment. RF offers greater range than IR. It is omni-directional and allows the control of devices in other rooms, etc.

Answer 3(c) or 3(d)

- 3(c) (i) Describe the advantages and disadvantages for a company of using *proprietary* software rather than *open source* software.
Proprietary software or "closed source" software has source code that cannot be modified by anyone but the person, team, or organisation who created it and maintains exclusive control over it. Open source is software whose source code is available for modification or enhancement by others. Proprietary software allows the user to create and share files without the need for additional expertise, business users are less prone to infiltration by viruses and will have software vendor support. Open source software will increase control of the user, promote better programming, update quickly and can be free to use.
- (ii) For **each** of the following items of functionality, name a software package which includes that feature.

Feature	Software package
Slide transition	Presentation e.g. PowerPoint, Keynote, Prezi.
Use of counters	Web design e.g. Dreamweaver, Word Press.
Mute, play and pause	Media player e.g. Windows media player, iTunes.
Crop	Graphics or desktop publishing e.g. Publisher.

OR

- 3(d) (i) Distinguish between *voice recognition* and *chip and pin* as methods of verifying data.
Voice recognition involves the use of a computer program to identify/authenticate the speech pattern of an individual voice. The speech pattern is compared against data stored on a computer hard drive. 'Chip and pin' has contact pads on a card which allows electronic access which can be verified by a unique personal identification number.
- (ii) Outline what is meant by **each** of the terms *computer hacking*, *spam* and *data encryption*.
Computer hacking exploits and modifies computer software for access to protected information. Spam is the use of electronic messaging systems to send unsolicited bulk messages (spam), especially advertising, indiscriminately. Encryption means to scramble data in such a way that only someone with access to the code / key can read it.

Option 4 - Manufacturing Systems - Answer 4(a) and 4(b)

(a) - 10 marks, (b) - 16 marks, (c) OR (d) - 14 marks

- 4(a) (i) Outline what is meant by a modular approach to a design.

Modular design is a form of splitting an object into smaller portions such that when they are done, they are joined together to form one complete system.

Modular design is employed when building cars, computers or high-rise buildings, etc.

- (ii) Explain the terms *reverse engineering* and *feasibility study*.

Reverse engineering is the process of discovering the technological principles of an existing device, object, or system through analysis of its structure, function, and operation. It often involves disassembling the device, object or program and analysing its components and workings in detail. Their best features can then be incorporated into a new design.

A feasibility study is an analysis of the ability to complete a project successfully, taking into account legal, economic, technological, scheduling and other factors. It allows project managers to investigate the possible negative and positive outcomes of a project before investing too much time and money.

- 4(b) (i) Explain the difference between a process that is *capable* and a process that is *not capable*.

Capable process means that the normal distribution curve falls within the design specifications– most parts produced would pass an inspection test, etc.

Not capable means it falls outside the specifications/tolerances desired– an unacceptable number of parts would fail an inspection test, etc.

- (ii) Measurement of samples from the manufacturers of the camera lens are given:

Manufacturer **A** standard deviation 0.04077

Manufacturer **B** standard deviation 0.01620

If the lens must have an outside diameter between 7.85mm and 7.95mm:

Calculate the process capability index for each manufacturer

$$\text{A: } C_p = \frac{\text{Tolerance Range}}{6\sigma} = \frac{7.95 - 7.85}{6(0.04077)} = 0.41$$

$$\text{B: } C_p = \frac{\text{Tolerance Range}}{6\sigma} = \frac{7.95 - 7.85}{6(0.01620)} = 1.03$$

- (iii) Which manufacturer should be chosen to manufacture the lens? Justify your selection.

Manufacturer B - tolerances will be met all of the time, no products will have defects, process is capable.

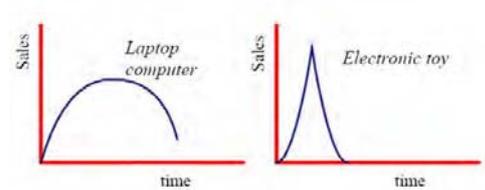
Answer 4(c) or 4(d)

4(c) (i) Name and briefly describe the four stages in the life cycle of a product.

1. Introduction - Design/Research/Testing/Manufacture/Marketing/Distribution/Sales, etc.
2. Growth - Marketing/Acceptance/Sales growth, etc.
3. Maturity - Sales peak/plateau, etc.
4. Decline - Obsolescence/superceded/sales decline, etc.

(ii) Discuss the differences between the life cycle graphs of the electronic devices shown below.

This laptop computer shown exhibits a life cycle with an initially exceptionally strong sales growth and an immediate acceptance of the product. This product is seen as fashionable with a popular style in its market. It also demonstrates a shortened life cycle as sales decline faster than the standard life cycle.



The electronic toy is a 'fad' product that is around for a short period and is generated by hype. Sales peak very quickly and this product has a very short life cycle, etc.

OR

4(d) (i) *Reliability* and *durability* are quality dimensions. Briefly outline what is meant by **each** of these terms.

Reliability – The probability a product operates correctly for a given time frame under specified conditions. This is a key element for users who need the product to work without fail.

Durability – Measures the length of a product's life. The item will be used until it is no longer economical to operate it. This happens when the repair rate and the associated costs increase.

(ii) Suggest **three** important characteristics of the alarm casing.

**Waterproof seal,
Weather resistant material,
Capable of holding circuit,
Heat resistant,
Durable, etc.**

Option 5 - Materials Technology - Answer 5(a) and 5(b)

(a) - 10 marks, (b) - 16 marks, (c) OR (d) - 14 marks

- 5(a) (i) Describe the main properties of *thermosetting plastics*, *ferrous metals* and *softwoods*.
Use specific examples in each case to support your answer.
Thermosetting can only be set once. They are hard and have a high melting point e.g. Bakelite.
Ferrous metal contain iron. Steels are magnetic, malleable and ductile.
Softwoods are generally evergreen, soft and mature quickly e.g. pine.
- (ii) Outline **two** potential hazards when using adhesives to bond materials.
Adhesives can produce dangerous fumes, ventilation is needed.
Care must be taken not to bond skin. Suitable adhesive must be selected to ensure good adhesion.

- 5(b) (i) Suggest **two** reasons why the workstation frame is made from steel.
Ease of fabrication, can be welded, readily available, cost effective, strong and ductile, etc.
- (ii) Outline a manufacturing process suitable for the production of these parts.
Description of a suitable manufacturing process, e.g. injection moulding.
- (iii) Explain, using notes and annotated sketches, a method of attaching the adjustable screens to the steel frame.
Suggestion:



Brackets can be fixed using nuts and bolts. This allows the screens to be replaced if needed.

Answer 5(c) or 5(d)

- 5(c) (i) The seating arrangement was found to be uncomfortable for long term use. Outline, using notes and annotated sketches, a modification to rectify this issue.
Suggestion:
The seating position could be adjusted to tilt backwards, use of pivot joints, height adjustment etc.
Any valid alternative solution.
- 
- (ii) Explain why *accelerated testing* was used to test the hinge and describe how such a test could be carried out.
Accelerated testing is used to test objects when the expected life is too long to capture suitable data.
The test is set up with the hinge to be automatically opened and closed to simulate the operating action of the hinge. The number of movements can be measured or set for the testing process.
An indication of the expected hinge life and degradation can then be ascertained, etc.

OR

- 5(d) (i) Give **two** reasons for the development of technologies such as the hydrogen fuel cell.
Need to seek alternative source of fuels, necessary to investigate sources of cleaner technologies than fossil fuels, effective use of renewable energies, etc.
- (ii) Outline the environmental impact of producing this model car from the production of the initial polymers to it's end-of-life disposal.
Thermoplastics are produced chemically from oil in the process of polymerisation.
The sourcing and refining of oil and chemical processing impacts on the environment and energy use.
Processing into shape by electrically-driven industrial moulding machines.
The model then uses further energy as it must be assembled, packaged, transported and retailed.
At the end of life, the model may be recycled by heating and shaping again.
Alternatively, if disposed in landfill, thermoplastics are slow to decompose, etc.

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