Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2010

MARKING SCHEME

TECHNOLOGY

HIGHER LEVEL

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Technology

Higher Level

Marking Scheme

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. The Health and Safety Authority (HSA) has a range of standardised safety signs. For the sign shown:

(i) Identify the hazard.

Corrosive material

(ii) Where is this sign likely to be used?

Used to indicate acid, caustic or solvent hazard, batteries, soldering flux.

Laboratory, storeroom etc.

(3+3 marks)

2. A variety of materials is used in the manufacture of modern sports footwear.

The materials listed below were used in the manufacture in the football boots shown.

Outline **one** property of each material.

Material	**Use**	**Property**
Kevlar	Body of boot	**Tough, hard wearing, won't tear/ good tensile strength etc.**
Foamed polyurethane	Inner lining	**Soft, comfortable etc.**
Moulded polyurethane	Sole of boot	**Impact resistant, mouldable, durable etc.**

(2+ 2+2 marks)

3. Leading mobile phone manufacturers have announced that a standardised universal charger, based on the mini-USB format, will be implemented from 2012. These energy-efficient chargers will result in an estimated 50 per cent reduction in standby energy consumption.

Outline **two** other environmental advantages of the introduction of a standardised universal mobile phone charger.

(i) **Reduced use of raw materials, less energy consumed in manufacture etc.**

(ii) **Reuse of existing chargers when phone is upgraded or make/model changed etc.**

(3+3 marks)

4. The graphic shows a hand-operated winch.

(i) Name a mechanism suitable for use in hand-operated winches to prevent them unwinding under load.

Ratchet and pawl, constricting band brake, worm and worm wheel etc.

(2 marks)

(ii) The large gear of a winch has 120 teeth and the small gear has 12 teeth.
A force of 10N applied to the handle produces 95N at the hook.
Calculate the efficiency of the winch.

Calculation:
Gear Ratio/M.A. = 120/12= 10 *(Formula 2 marks)*
Efficiency = (work output/ work input) * 100
$$\frac{(95/10)}{10} * 100 = 95\%$$ *(Answer 2 marks)*

5. The manager of a tourist heritage site has decided to use ICT to promote the latest attraction.
From the list below, select the most appropriate file format for each output.

mp3 bmp doc tiff gif avi xls odf

Output	File format
Leaflet to outline a history of the site	**doc/odf**
Short video clip to demonstrate the variety of attractions in the local area	**avi**
Colour logo of local tourist area for web use	**tiff/gif**
Sound file for historical commentary	**mp3**

(2+2+1+1 mark)

6. A manufacturer of children's playground equipment specified a 'factor of safety of 5' for the supporting frames of their products.

(i) Explain the term 'factor of safety of 5'

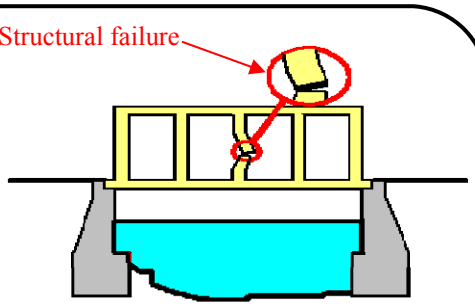
The equipment is designed and manufactured to withstand five times the load that could be expected when in use etc.

(ii) Outline **two** reasons for specifying a factor of safety when designing playground equipment.

Misuse, more than intended number of children/heavier loads etc.

(2+(2+2)marks)

7. A bridge structure, made from solid steel bars of square cross section, has been designed as a prototype. A graphic of the prototype is shown. The point of failure after the structure has undergone destructive testing is highlighted.



(i) Explain the terms:

Prototype

Scale or full-size model of the structure

Destructive test

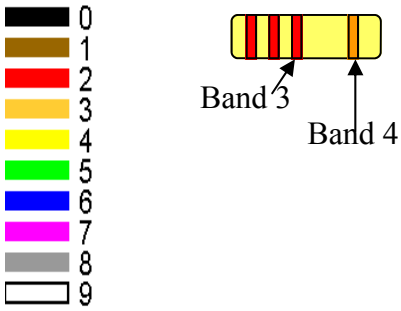
Forces are used to test the structure until it fails or fractures

(ii) Suggest a modification that would eliminate the failure.

Triangulated design etc.

(2+2+2 marks)

8. The resistor colour code table is shown:



(i) Identify the value of the resistor with a colour sequence of Red, Red, Red, Gold. **Value = 2200 ohm**

(ii) Describe the significance of:

Band 3: **multiplier band that determines the number of zero's**

Band 4: **tolerance band determines accuracy of resistor (gold = 5%, silver = 10%)**

(2+2+2 marks)

9. Make well-proportioned freehand sketches of three principal orthographic views of the wind-up torch shown.

Any three well proportioned orthographic views

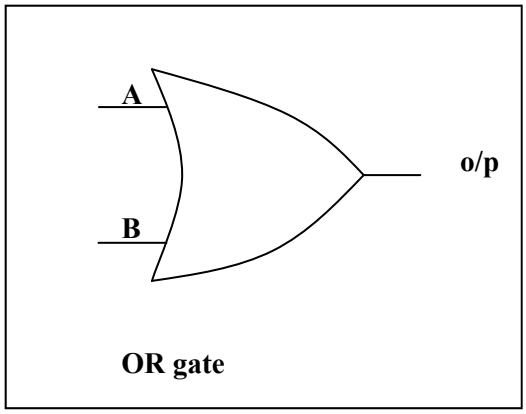
(2+2+2 marks)

10. A domestic garage alarm uses a logic gate system to sound a siren if either of the following occurs:

- the garage door is opened
- the window is opened.

Draw a simple logic gate system and truth table to operate the alarm.

Logic system



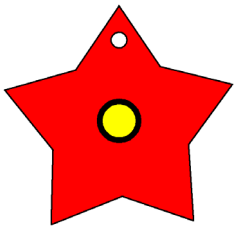
OR gate

Truth table

A	B	O/P
1	1	1
1	0	1
0	1	1
0	0	0

(2+4 marks)

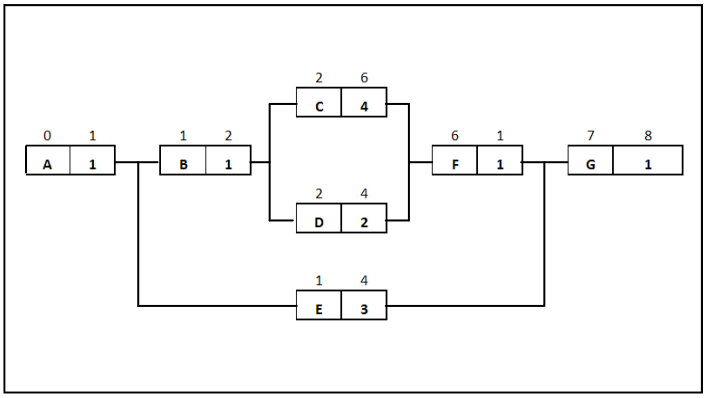
11. An incomplete table of tasks for a school mini-company group that intends to produce flashing stars for the Christmas market is shown below.



(i) Complete the table of tasks and draw a critical path diagram for the project.

Task No.	Task	Time (weeks)	Depends on
A	Design star	1	-
B	Source materials	1	A
C	Team 1—make star	4	B
D	Team 2—build circuit	2	B
E	Team 3—marketing	3	**A**
F	Assembly	1	**C,D**
G	Sell products	1	**E,F**

Critical path Diagram

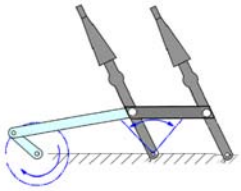


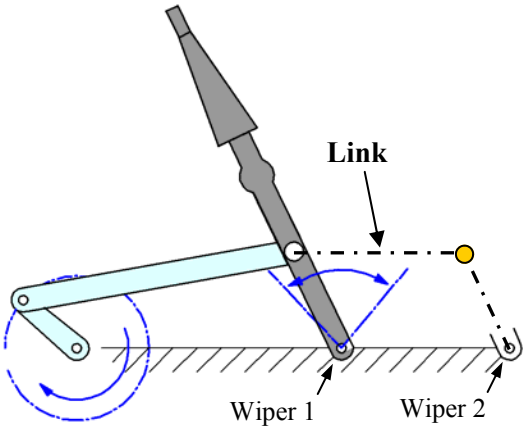
(ii) How many weeks will the project take to complete? **8 weeks**

(3+2+1 marks)

12. A treadle linkage converts rotary motion to *reciprocating motion*.
The graphic shows a treadle linkage which operates a pair of windscreen wipers.

(i) Complete the graphic to show how Wiper 2 could be linked to Wiper 1 so that both wipers remain parallel when in motion.



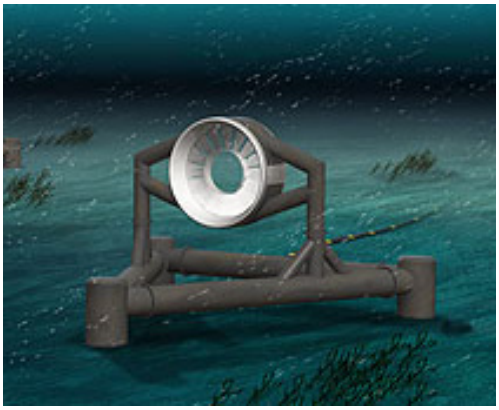


(ii) Explain the term *reciprocating motion*.

Linear motion in a straight line backwards and forwards, e.g. jigsaw blade.

(4+2 marks)

13. The Louth-based company OpenHydro received the 2009 innovation award from Engineers Ireland.
OpenHydro develops turbines for underwater tidal use and has a company motto of:
'silent, invisible, predictable, renewable energy'.



With reference to renewable sources of energy, explain why **each** element of the company motto is important.

Silent - **No noise pollution etc.**

Invisible - **Sited underwater, a minimal impact is achieved, unlike wind or solar farms etc.**

Predictable - **Tidal energy can be harnessed with regularity and predictability and is not dependent on sun shine or wind strength etc.**

Renewable - **Supplies are not exhausted easily or do not need replenishment like biomass etc.**

(2+2+1+1 marks)

14. Skateboards can be produced from a range of materials.

Outline **two** important considerations when selecting a suitable material for:

The deck **A**:

Impact resistant, flexible, easily decorated, high strength to weight ratio, durable, can be formed and machined etc.

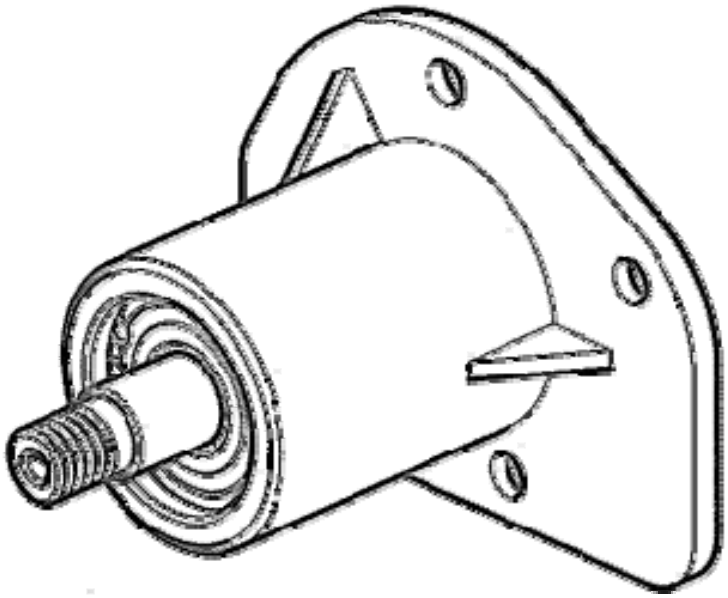
The wheels **B**:

Hard wearing, easily machined, grip, shatter resistant etc.

(2+1, 2+1 marks)

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

Appropriate shading/rendering/colouring etc. *(3+3 marks)*



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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) Early detection and control of fire in the home can prevent loss of life and property.

(i) Suggest **two** ways in which technology can be used to detect or control fire in the home.

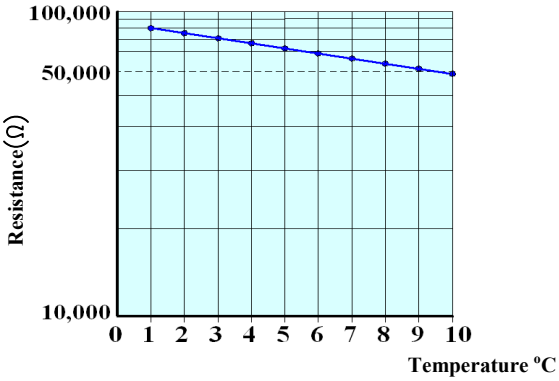
Fire and smoke detectors/alarms, fire doors
Availability of fire extinguishers, fire blankets etc.

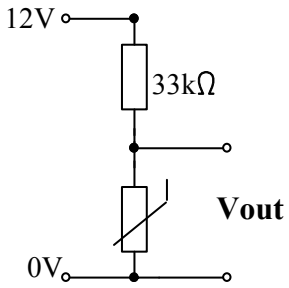
(ii) In designing household products, heat and fire resistance can be important design considerations. Identify a household product which is heat or fire resistant and outline how this resistance is achieved.

Saucepan handle– thermosetting plastic/Bakelite
Sofa/ couch– flame retardant materials (polyurethane foam)
Table– choice of materials (metals/glass) etc.

(8 marks)

2(b) Different types of thermistors are manufactured and each has its own characteristic pattern of resistance change with temperature. Part of the characteristic curve for a thermistor is shown.





(i) Identify, from the graph, the approximate resistance of the thermister at 4°C.

66,000Ω or 66kΩ

(ii) Using the value from (i), Calculate the **Vout** for this thermistor at 4°C.

$$V_{OUT} = \frac{R2}{R1 + R2} \times V$$

$$= \frac{66{,}000}{33{,}000 + 66{,}000} \times 12$$

$$= 8V$$

(iii) Name a household appliance or consumer electronic product which uses a thermistor and outline the reasons for its inclusion in the product you have chosen.

Oven– control cooking temperature
Room thermostat– control heating level
Electric iron– control ironing temperature etc.

(10 marks)

Answer 2(c) ***or*** *2(d)*

2(c) In the manufacture of thermistors, it is essential that each component is 'fit for purpose'.

(i) Distinguish between the factors of: *reliability, aesthetics and conformance.*

Reliability is the probability a product operates correctly for a given time frame under specified conditions etc.

Aesthetics allow the user to judge how the product looks, feels, smells or tastes etc.

Conformance is the ability of performance and physical characteristics to meet established standards etc.

(ii) Describe **two** consequences of non-conformance for a manufacturer of thermistors.

The materials cost of rejects and scrapping finished products.
Possible warranty claims for high quality items used in heat sensors.
Loss of customers and damage to reputation.
Cost of replacement parts, delivery, repackaging, etc.

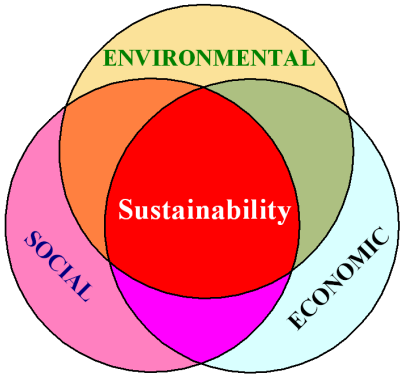
(6 marks)

OR

2(d) Sustainability is a key consideration in controlling the amount of waste created by society.

Explain, with examples, the impact of **each** of the three overlapping 'spheres of sustainability' shown:

- Environmental sustainability
- Social sustainability
- Economic sustainability



Environmental sustainability:
Using renewable sources of energy, prevention of pollution of air, water, land and waste, natural resources will eventually run out etc.

Social sustainability:
An understanding of the needs of society through the development of a reasonable standard of living, education, community and equal opportunity etc.

Economic sustainability:
Provides for profit, cost saving, economic growth with research and development etc.

(6 marks)

3(a) Modern cars are designed to maximise the protection available to passengers in the event of an accident. Injuries can be reduced by dissipating and absorbing much of the energy of an impact while, at the same time, other devices restrain and protect passengers.

In designing for improved car safety, describe:

- **One** way in which the energy of an impact is absorbed.
  A safety zone is created in the car structure to minimise damage to passengers in the event of an car impact.
  Car bumpers absorb minor impacts, collapsible steering columns etc.

- **Two** devices that restrain or protect passengers.
  Seat belts, airbags etc.

(8 marks)

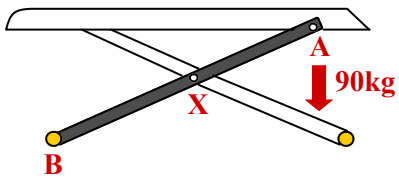
3(b) The graphics show a lifting platform for motorcycle maintenance.

(i) Describe in detail, using annotated sketches, a safe and reliable method of raising and lowering the platform.

Hydraulic ram

Hydraulics, worm/worm wheel, scissors jack etc

(ii) If the motorcycle exerts 90kg at link **A** of the platform and the link is 1600mm in length, calculate the force in Newtons at **B** if the distance from **B** to the pivot **X** is 900mm.



90KG x **10 = 900N**
700mm = 0.7M
900mm = 0.9M **F** x **BX = F** x **AX**

F x 0.9m = 900N x 0.7m

F = 700N

(iii) The platform is designed to have a maximum safe working height of 1200mm.
Outline a suitable means of providing a warning to the user if the platform exceeds this height.

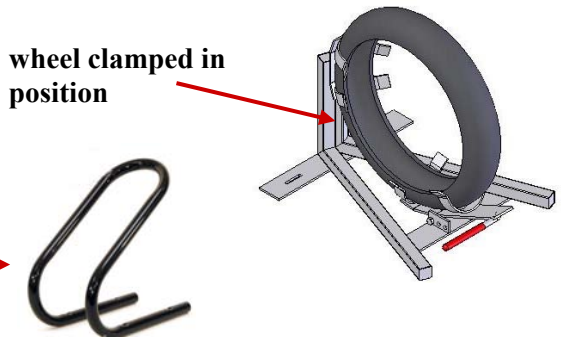
Limit switches on legs wired to a buzzer/output device
Any appropriate warning method etc.

(10 marks)

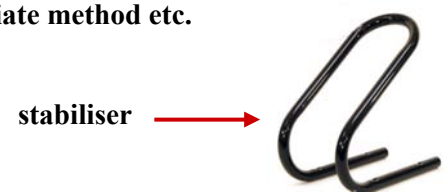
Answer 3(c) ***or*** *3(d)*

3(c) While on the lifting platform, it was found that the motorcycle could become unstable.

(i) Using annotated sketches show how the design of the platform could be modified to include a suitable structure to improve the stability of the motorcycle.



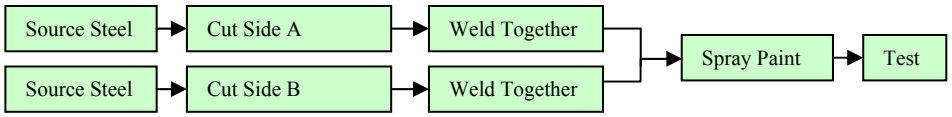
Wheel stabiliser or any appropriate method etc.



(ii) Draw up a work breakdown structure (WBS) for the manufacture of this new structure.

Task	Activity	Time`(weeks)
A	Design clamping structure	2
B	Source steel	1
C	Cut to size	2
D	Weld together	1
E	Spray paint	1
F	Test and attach to platform	1

Example of a WBS:



(6 marks)

OR

3(d) (i) Name **two** computer technologies that are used for the design or production of graphics for motorcycle helmets.

Graphics or CAD software to design decoration.
Printing technology.
Vinyl cutter or similar etc.

(ii) A motorcycle helmet protects the wearer by using a hard outer shell and a soft, thicker inner lining.
Outline why a single material is not used and suggest suitable materials for the shell and lining of motorcycle helmets.

Outer shell: **Hard to absorb impact.**

Inner Lining: **Soft to cushion head.**

Materials for the shell include polycarbonate, carbon fibre and Kevlar etc.

Expanded polystyrene foam can be used for the lining material etc.

(6 marks)

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) It is common to see electronically controlled warning signs and traffic lights near schools. Outline **three** electronically controlled devices that improve road safety.

Automated traffic lights at road works.
Warning signs on motorways to inform motorists of congestion.
Vehicle safety design - anti-lock braking.
Sensored street lighting, speed cameras etc.

(ii) As microelectronic equipment gets more complex and price reduces with volume, there is a tendency for products to get obsolete quickly and be replaced by a newer versions. Outline **two** environmental issues that arise out of such 'built-in' obsolescence.

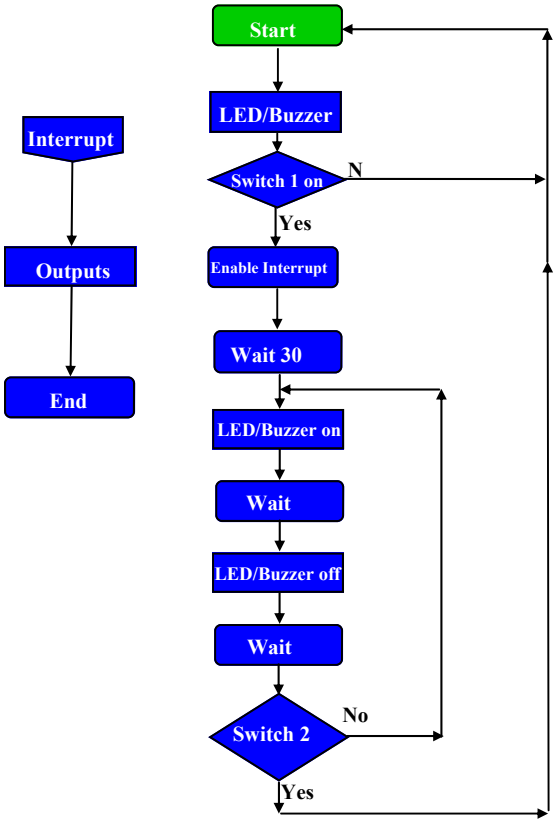
More electronic waste/landfill.
Recycling waste.
Difficulty of disposing of batteries and circuit boards.
They are largely manufactured from long life plastic materials.
The energy invested in manufacturing these items etc.

(10 marks)

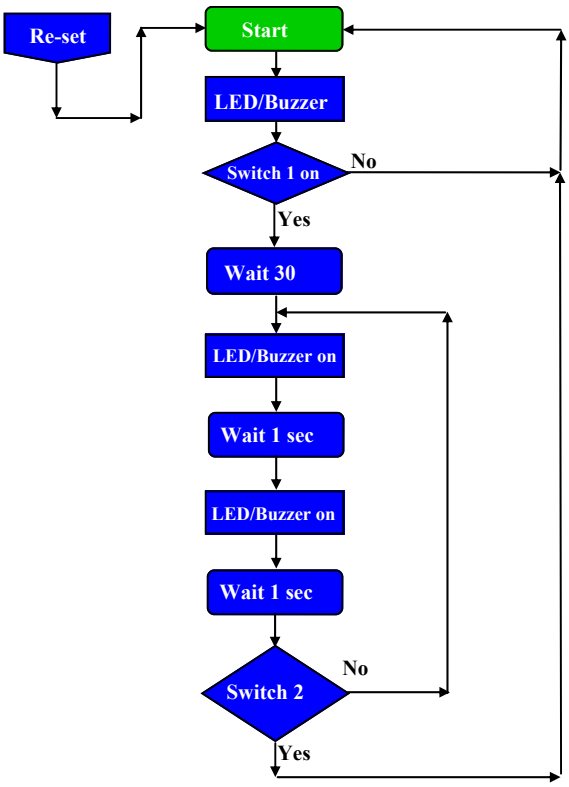
1(b) A time controller is required for a quiz show. Each contestant is allowed a maximum of 30 seconds to answer a mathematical question. A LED and buzzer are activated until a contestant presses switch 2 at the end of the time period.

(i) Complete the programme sequence so that the LED and buzzer continue to be activated once per second until switch 2 is pressed.

(ii) Modify the flowchart to allow for the sequence to be re-set if a contestant is finished in less than the 30 second period.



Possible Solution



Possible Solution

(16 marks)

Answer 1(c) ***or*** *1(d)*

1(c) (i) Compare the use of servo motors with the use of stepper motors for the following aspects of robotic control:

- Accurate driving of a conveyor belt

  The stepper motor can rotate and be controlled with accuracy. The operation of a stepper motor requires pulsing to the correct sequence to move in a particular direction etc.

- Precision, smooth movement of robot arm up to 45^{o}.

  The servo motor gives smoother control with good torque and control for part of a revolution. Not all servo motors are suitable for full revolution applications but they can rotate to precise angles etc.

(ii) Explain the term *electro-pneumatic control* and give **two** advantages of its use.

Using electrical current to pilot operating valves e.g., solenoids to operate pneumatic valves.

Advantages: Can be linked to electric sensing circuits, can be PIC controlled etc.

(14 marks)

OR

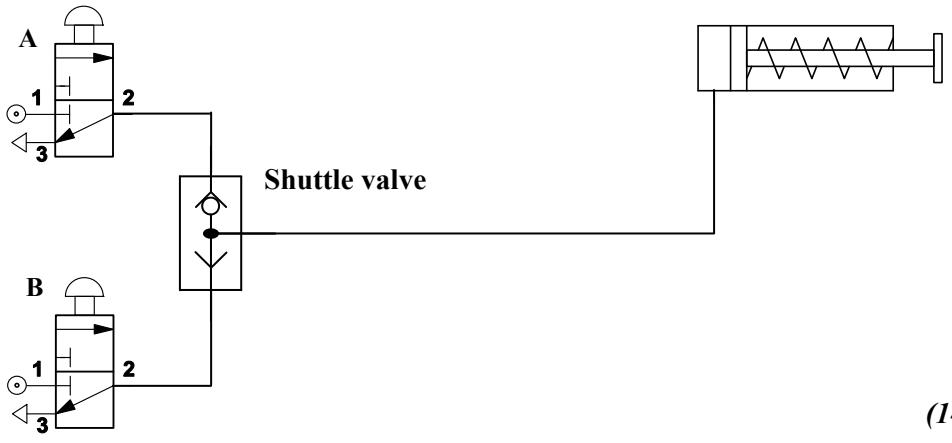
1(d) (i) Discuss **two** possible reasons for the use of a pneumatic control system in preference to an electronic control system.

Powerful system capable of exerting great force

Can be used in hazardous places where sparks could cause explosions

Can provide fast speeds e.g. dentist drills can rotate at 500,000rpm etc.

(ii) A pneumatically controlled energy conserving door is used at a reception office.
Draw a pneumatic circuit using the given components which allows the cylinder to open the door if either **A** *or* **B** is operated.
Include any extra components if needed.



(14 marks)

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) The use of rechargeable batteries in electronic equipment has increased in recent years. Outline **two** benefits of this trend.

Less wastage of materials used to manufacture batteries, less disposal of batteries, reduced environmental impact of corrosive materials used in batteries, reduced packaging etc.

(ii) Printed circuit boards (PCBs) are commonly used in a range of electronic equipment. Outline the main advantages of using PCBs.

Improved reliability, circuits can be made more intricate and complex, circuit manufacture is generally automated with components placed and soldered robotically etc.

(10 marks)

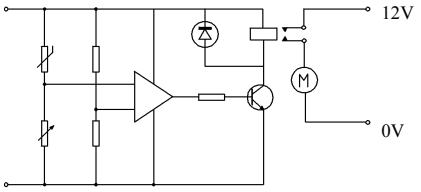
2(b)

The temperature sensing circuit shown uses a LED as an output.

(i) Explain in detail the sequence of operation of the circuit as the temperature changes.

R1 and R2 are of equal resistance, therefore feeding 4.5V into pin 2. A second potential divider consisting of a variable resistor and thermistor is connected at pin 3. If the thermistor is heated, resistance falls and so does the voltage across it. This causes a rise in voltage across the variable resistor. When the voltage at pin 3 rises above 4.5V, the output of the Op Amp goes high turning on the LED etc.

(ii) Redraw the circuit to include a 12V fan which switches on above a set threshold temperature.



(iii) Explain **each** of the following terms:

- Astable configuration **No stable mode, changes state continuously, e.g. flashing LEDs etc.**
- Monostable configuration **One mode, will stay in this mode until triggered or pulsed, e.g. LED on until triggered to go off etc.**

(16 marks)

*Answer 2(c) **or** 2(d)*

2(c) (i) The circuit at ***2(b)*** above could be made more effective by including a Schmitt trigger. Outline **two** benefits of the Schmitt trigger configuration.

Smoother changeover as the Schmitt trigger retains its output value until the input value changes sufficiently to trigger it.
Eliminates problems caused by electrical noise.

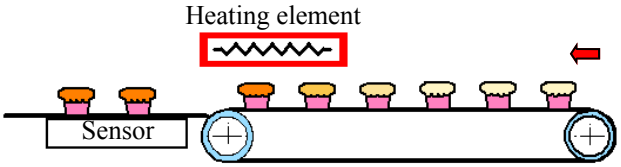
(ii) A DC motor consumes 2 watts of power and delivers 1.6 watts of power at the output shaft. Calculate the efficiency of the motor and explain why this efficiency is not 100%.

Efficiency $= \frac{P_o \times 100}{P_i} = \frac{1.6 \times 100}{2.0} = 80\%$

It is less than 100% due to loss of energy through heat, friction in motor, back emf, etc. ***(14 marks)***

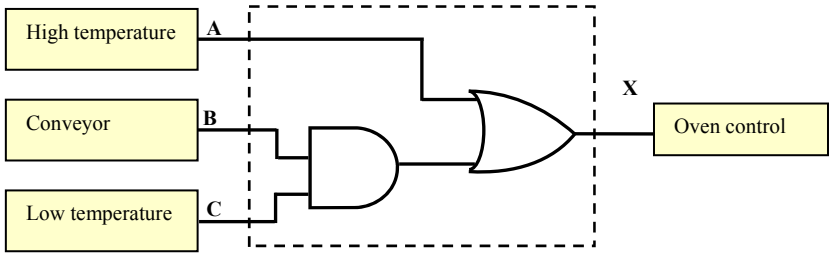
OR

2(d) Heat control is critical in an industrial oven. In the oven shown, the heating element needs to be turned off when the temperature exceeds an upper limit **or** when the conveyor is off and the temperature falls below a lower limit.



(i) Sketch a combination of logic gates to control the oven.

Alternatively: NOT/NOR gates may be used to solve the solution etc.



Possible solution

(ii) Draw the truth table for output X.

A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

High output from the OR gate activates the oven control. The oven control turns off the oven.

(iii) Suggest sensor components for the inputs at A and B.

A - thermistor
B - micro switch, motion sensor, LDR etc.

(14 marks)

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) In the management of prescriptions and general patient welfare, the medical profession has recognised the increased use of ICT as a positive development.
Outline **three** ways in which ICT could be used by doctors and other medical professionals.

Database with general patient information, word processing to compile prescriptions accurately, linking with other parts of the Health Service to access patient records electronically, video-conferencing to update skills, internet research for new techniques, reduce paper by storing records electronically etc.

(ii) Many multi-national companies make extensive use of ICT to support the sharing of ideas and resources.
Give **two** advantages of using video conferencing rather than email or telephone communication.

Allows large groups to communicate at the same time, participants are more likely to concentrate without distractions on the task, ideas can be discussed and debated quickly, products can be analysed and evaluated by interested groups etc.

(10 marks)

3(b) (i) An international computer games company, HARPOON® Ltd., have installed a LAN (Local Area Network) with connections for the network server, 15 office computers and 5 wireless laptops in their new office. Outline **three** functions of the server on the network.

File sharing, Printer sharing, quicker access to files, maintains tight security, tracking of activity etc.

(ii) HARPOON® Ltd. has appointed one of its employees as a system administrator who works closely with the branch manager.
Describe **two** important tasks for which the system administrator would have responsibility.

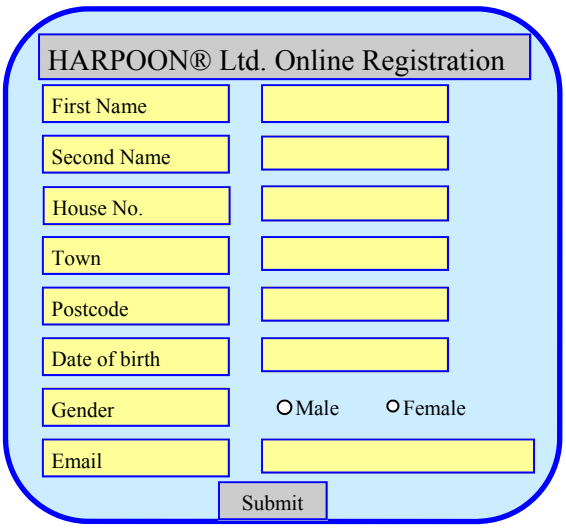
Installing and setting up of hardware and software, allocates degree of access to individual employees, creates and maintains password accounts, organises individual software requirements etc.

(iii) How could HARPOON® Ltd. make use of an *intranet*?

Innovations can be shared electronically by company personnel with no access to others, relevant working information can be dispersed quickly and easily, work information is kept separate from outside interests etc.

(16 marks)

Answer 3(c) ***or*** *3(d)*



3(c) HARPOON® Ltd. decided to make the first addition of a popular game available to play online. In order to access the game, the registration form shown had to be completed and submitted.

(i) Outline **two** reasons why HARPOON® Ltd. collected such information from game users.

Market research, customer profiling, ability to target future advertising etc.

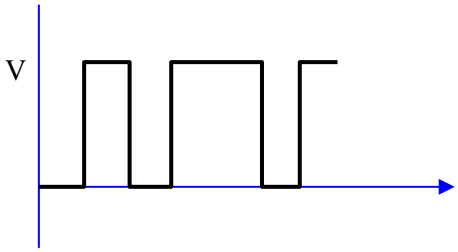
(ii) Parents complained about the nature of the information collected.
Discuss **two** issues that might have arisen.

Unnecessary collection of personal information from young people who may not be aware of dangers of sharing data on age and gender, security issues with clear identification of address, option not to forward information, no choice on unwanted advertising etc.

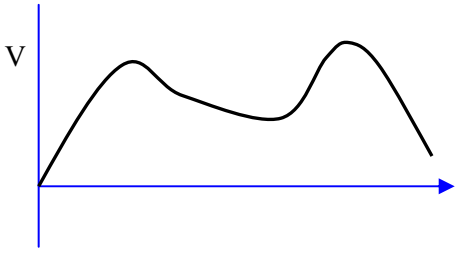
(14 marks)

OR

3(d) (i) Many audio devices convert analogue sound waves to a digital format. Redraw the axes shown and use them to distinguish between digital and analogue signals.



Digital signal only recognises on or off states

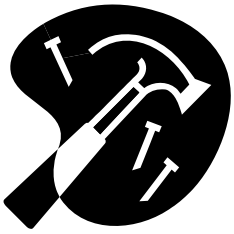


Analogue signal can have different levels

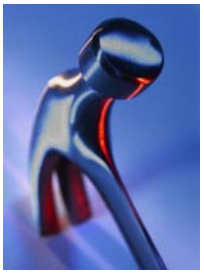
(ii) A construction company is changing its logo from image **A** to image **B**.
Discuss **two** factors that could account for the increase in file size of the image from 3KB to 128KB.

The introduction of colour, the increase in resolution, additional detailing, file formats etc.

A



B



(14 marks)

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

4(a) (i) Design for Environment (DfE) is a set of guiding principles in environmentally responsible design and manufacturing.
Outline the meaning of **each** of the three main DfE considerations of:

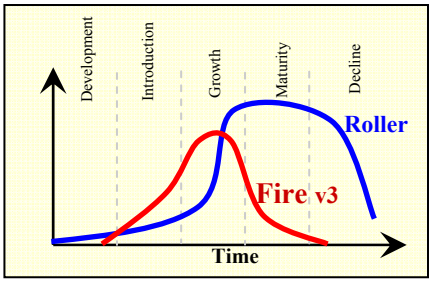
- Manufacture
  Reduce to minimum possible areas such as energy use, emissions and waste products. Materials and processes should be non-toxic, less packaging etc.
- Consumption
  Packaging materials be minimal, reuse and bio-degradable. Use little energy etc.
- Disposal.
  Select materials that recycle, design products to be serviceable rather than disposable, reuse etc.

(ii) In the design of electric motors, consideration should be given to the eventual recycling of parts.
Describe **two** motor design features to facilitate recycling.

Non permanent assembly methods, Windings can be unwound and reused, recycling of materials, e.g. housing etc.

(10 marks)

4(b) (i) The product life cycle profile of two electronic toys, 'Fire v3' and 'Roller', are shown.
'Fire v3' is the upgraded version of the company's best selling product. 'Roller' is a totally new product.

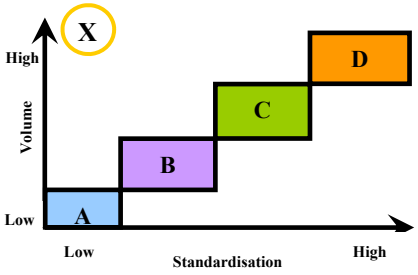


Discuss the life cycle of **each** of these products.

The new product 'Roller' progressed through the development and introduction phases as it was presented to the market. Sales grew as the product proved to be popular and gained market share. This reduced after a period of time when new strategies might boost sales.

'Fire v3', the upgraded product, had a loyal consumer base that snapped up the new version quickly. It did not need a significant development phase and reached maximum sales quickly. However, the product soon exhausted and sales reduced significantly after this initial success.

(ii) The Product Process Matrix illustrates the relationship between standardisation and volume levels of product.



- Name and describe production processes corresponding to A, B, C and D.

  A - Once-off projects: tend to produce single or low number of items, can be expensive etc.
  B - Batch production: products produced over a particular period of time as demand for the items may fluctuate, low volume, used for sporting items that may change each year etc.
  C - Mass production: standard products are produced in large volumes, demand is high and stable, used for household electrical items etc.
  D - Continuous production: Generally factories are dedicated to single number of products with high volume, systems are highly standardised and automated, used to produce products such as sugar etc.

- Outline the impact for a business of a manufacturing strategy positioned at X.

  A policy of trying to produce high volume products with low standardisation techniques. This would be highly inefficient demanding a large workforce and unlikely to succeed etc.

(16 marks)

*Answer 4(c) **or** 4(d)*

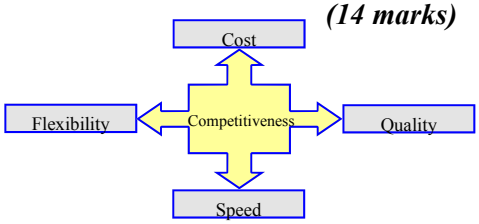
4(c) (i) Explain the principles and advantages of Just-in-time (JIT) as an inventory strategy.
Suppliers are coordinated with the manufacturing company, products/parts are delivered in line with market demand etc.
Advantages: quick response to demand, less investment in storage, quick turnaround of products, increased workforce flexibility, reduces waste, etc.

(ii) Concurrent engineering uses a collaborative approach to product development.
Explain the following techniques associated with this approach:

- Benchmarking
  Uses the most effective product in the market as a basis for developing new improvements.
  It hopes to create new products with the market leader as a starting point for design etc.
- Reverse engineering.
  Competitor products are dismantled and inspected with the best features incorporated into a new design etc.

(14 marks)

OR



4(d) (i) Key factors in competitiveness are:
Cost, Quality, Flexibility and Speed

Use specific examples to explain **three** of these factors.

Cost: processes are likely to be high volume, standardised and automated, try to eliminate all waste and production processes, E.g. Aldi, Lidl and Ryanair etc.

Quality: customers are often prepared to pay more for a product that they believe to be of higher quality with reliability and additional features a factor in the choice of cars, e.g. Toyota/ reliability and Mercedes/Quality etc.

Flexibility: the ability to adjust to changes in the type of product being manufactured allows items such as computers to be customised without excessive cost, e.g. Dell computers etc.

Speed: the efficiency of the manufacturing is influenced by close contact with customers and suppliers as component parts are delivered quickly then assembled and tested without delay.
The preparation of food in fast food outlets could be considered to illustrate this, e.g. McDonalds etc.

(ii) A sports equipment company is to manufacture a face guard for a new helmet. The guards can be manufactured for €2.50 each using skilled labour or production can be automated for an initial set-up cost and then €0.50 per face guard.

From the graph, determine the set-up cost for automation and the quantity of face guards required to justify the decision to automate (Break Even Quantity).

Set-up cost = €500

(4+4 marks)

$$\textbf{BEQ} = \frac{\textbf{Setup cost}}{\textbf{Manual cost/item - Automated cost/item}} = \frac{500}{2.5 - 0.5} = \textbf{250 units}$$

(14 marks)

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

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

5(a) (i) In the case of **any two** of the following material categories, describe the primary properties of the material. Use specific examples to support your answer.

- Ceramic materials
  Hard, brittle, E.g., glass, heated clays used in pottery, heat-resistant carbides and nitrides used for cutting tools etc.
- Glass reinforced plastics
  Strong, lightweight, flexible, e.g., canoes, chairs, vehicle parts etc.
- Native hardwoods.
  Slow growing, hard, strong, shed their leaves each year, oak, ash, beech, sycamore are common native hardwoods etc.

(ii) In classifying materials, distinguish between electrical *conductors,* and electrical *insulators*.

Electrical conductors, such as copper and aluminium, allow electric current to flow etc.
Electrical insulators, including PVC, prevent electrical current from flowing etc.

(10 marks)

5(b) Professional musicians often use custom-built instruments such as the guitar shown at **A**. Computerised interactive music games use instruments which are mass-produced such as the guitar shown at **B**.


Guitar A

(i) Select a suitable material for the body of **each** type of guitar and in **each** case justify your selection.

Guitar A: **Hardwoods (beech, mahogany, walnut) polycarbonate, composite etc.**
Strong, durable, tactile material, easily shaped etc.


Guitar B

Guitar B: **Polypropylene, PVC, ABS etc.**
Withstand impact, cheap, easily moulded etc.

(ii) Describe in detail, using annotated sketches, **three** manufacturing process used to produce the customised guitar shown at A.

- **The shape of the guitar is developed by template and transferred onto the wood and then cut out with a band saw.**
- **The guitar is planed and sanded to a smooth contoured finish.**
- **The neck and hardware spaces are routed.**
- **Neck and body of the guitar are joined, usually glued.**
- **It can then be primed and painted, customised graphics can be added.**
- **The guitar fixings are added,**
  or any appropriate manufacturing processes related to specific materials chosen etc.

(iii) Both *composite materials* and *alloys* are often used in guitars.
Distinguish between a composite material and an alloy.
A composite material is a combination of two or more chemically distinct materials which takes advantage of the favourable properties of each. Plastic laminates provide a waterproof layer on chipboard for kitchen counters, GRP, Steel reinforced concrete etc.

An alloy is a mixture of two or more metals that will form a new metal with enhanced properties, e.g. Brass (alloy of copper and zinc) etc.

(16 marks)

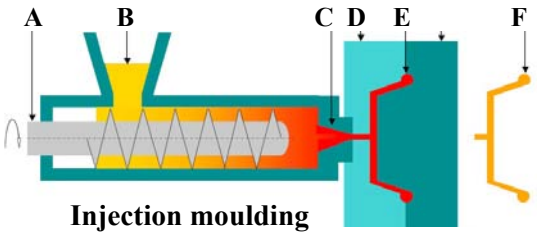
Answer 5(c) ***or*** *5(d)*

5(c) A special 'limited-edition' of the computer-controlled guitar, shown at **B**, is to be batch produced to coincide with a farewell tour.

(i) Explain why batch production is suitable for this limited edition of the product.
The use for this guitar will span the duration of the farewell tour and will mean that the product will have limited appeal after the tour is finished. The methods of manufacturing should be suitable for a limited time production etc.

(ii) Describe, using annotated sketches, a process which could be used to manufacture this product.
Plastics: Injection moulding, (Alternatively: Vacuum Forming, Press Moulding) etc.

Description: The rotating screw (A) drives the plastic pellets in the hopper (B) through a heated chamber into the injection nozzle (C). This plastic is forced into the mould (D) and the shaped cavity (E). The mould is split to reveal the finished product (F). Or any description relevant to the manufacturing process chosen etc.



Injection moulding

OR

(14 marks)

5(d) (i) Describe, using annotated sketches, **one** of the following material processing tools:

- Orbital sander
- Pillar drilling machine.

Highlight **two** safety features integrated into the tool you have described.

Orbital sander:

Description:
A machine that uses sanding disks to produce smooth surfaces on wood prior to applying a finish. A random orbit is produced by spinning the sanding disk and moving it in an elliptical fashion- this reduces the incidence of swirl marks. The sanding action is not sensitive to grain direction.

Safety:
The sander is designed to be used by a single operator.
A dust extraction system is usually incorporated into the machine.

Pillar drilling machine:

Description:
The drill cuts holes in materials with a suitable drill bit. The work is securely held in place on the table with a vice. An electric motor drives the chuck with speed varied by a pulley or gear system. The drill is feed into the work via the feed lever.

Safety:
The gear or pulley is enclosed to avoid accidents.
The chuck has a guard to minimise swarf and cuttings flying off the machine.
Switches are designed to be operated by a single user.

(ii) Repak Ltd. is an organisation which promotes recycling of packaging. Companies are charged on the type and amount of packaging produced. The rates for 2009 are given in the table shown.

Material	Cost (cent per kg)
Aluminium	8.4
Metal composite	11.1
Glass	0.9
Paper/cardboard	2.3
Plastic	8.9
Steel	7.9
Wood	1.1

With reference to this data given, outline **two** reasons for using cardboard instead of foamed polystyrene for packaging items such as guitar B.

Both materials are reasonably light but cardboard is easy to recycle while expanded polystyrene does not recycle easily. Cardboard is levied at a rate of 2.3 cent per kg and plastic materials are charged 8.9 cent per kg by Repak, making it more attractive - if the packaging is necessary!

(14 marks)