Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2009

MARKING SCHEME

TECHNOLOGY

HIGHER LEVEL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2009

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. Describe **three** ways of improving the Building Energy Rating (BER) of a new home at the design or building stage.

(i) **Windows - large on south, small on north, double/triple glazed, low e glass.**

(ii) **Insulation - walls, roof, floor to match/exceed current regs.**

(iii) **Airtightness/draft sealing. No open flue.**

Solar Panels, renewable forms of energy, lighting CFC's,

contolled heating etc.
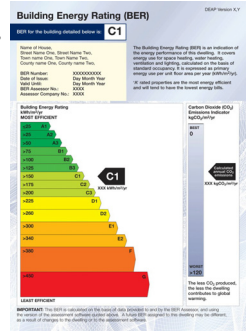
(3 x 2 marks)

2. Modern digital cameras often use lithium-ion (Li-ion) batteries.
Under the WEEE directive such batteries cannot be disposed of to landfill with household waste.

(i) What is the WEEE directive?

Waste Electrical and Electronic Equipment Directive, directive to reduce the Waste from electrical/electronic equipment.

(ii) How should such batteries be disposed of when they have reached the end of their useful life?

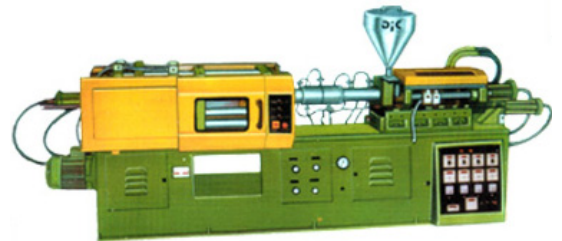**Return to collection box at retailer**

Deposit at local waste transfer station/recycling centre etc.

(2 + 4 marks)

3. The injection moulding machine shown will only operate when the door guard is closed and the switch is turned on.

(i) Name a suitable logic gate to control the machine.

AND gate.

(ii) In the box below, draw a truth table for the logic gate named at (i).

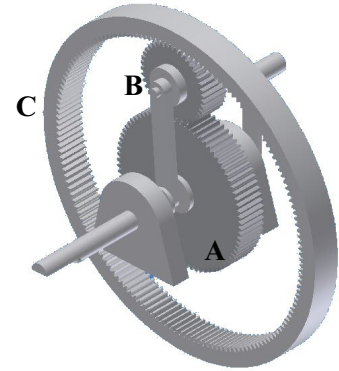| Switch	Guard	Output
0	0	0
1	0	0
0	1	0
1	1	1

(2 + 4 marks)

4.

(i) Using the following information, calculate the gear ratio of the gear train shown.
*Note: The position of gear **B** is fixed.*

Teeth - **A**: 36 **B**: 18 **C**: 72.

Calculation: **Formula- Driven/Driver**

72/36 = 2:1 *(1 mark for formula)*

(ii) If the speed of gear **A** is 40 rev/min, calculate the speed of gear **C**.

Calculation:

40/2 = 20 rev/min

(3 + 3 marks)

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5. Control Systems may be either *open loop* or *closed loop*.
What is meant by the terms open loop and closed loop?

(i) Open loop:
No feedback to determine if the input has achieved its desired goal, self monitoring.

(ii) Closed loop:
Feedback given from sensors to controller to ensure correct/accurate operation of machine.

(3 + 3 marks)

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6. (i) What is the difference between a DVD-R and a DVD-RW disc?
DVD-R   - Can be written to once
DVD-RW - Can be written and then overwritten many times

(ii) Which type of disc would be more suitable for the distribution of a software application?
Give **one** reason for your answer.

Type: **DVD-R**

Reason: **Prevent loss/corruption of data by accidental/deliberate overwriting etc.**

(2 + 2 + 2 marks)

7. Describe **two** specific safety precautions that should be observed when:

Using an adhesive to join acrylic parts:

   (i)   Good Ventilation

   (ii) Avoid skin contact, wear safety goggles etc.

Using a drilling machine:

   (i)   Material securely held/clamped

   **(ii) No loose clothing. Wear eye protection, select correct speed, emergency stop
           button etc .**

(2 + 1, 2 + 1 marks)

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8. What is meant by **each** of the following terms in describing the properties of materials?

(i) Elasticity: **The ability of a material to return to its original shape or form following
                 deformation by an external force.**

(ii) Plasticity: **The ability of a material to bend, stretch or assume a new shape or form without
                  breaking.**

(3 + 3 marks)

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9. The graphics below show a resistor colour code table and two resistors **R1** and **R2**.

Brown	0	
Black	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Violet	7	
Grey	8	
White	9	
Gold	0.1	

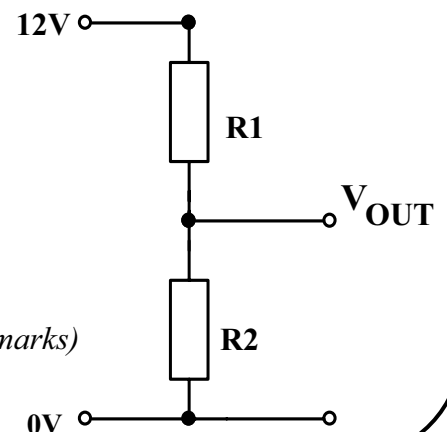(i) Calculate the values of resistors **R1** and **R2**.

R1 - Brown, Black, Red, Gold.   Value = **0100 +/- 0.1%**

R2 - Brown, Yellow, Red, Gold. Value = **0400 +/- 0.1%**

(ii) **R1** and **R2** are used to complete the circuit shown.
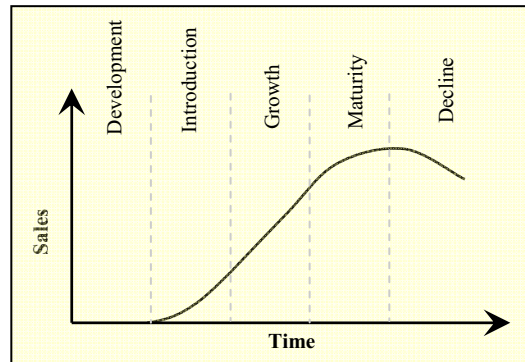
Calculate the value of V_{OUT} in this circuit.

12V

R1

V_{OUT}

R2

0V

Calculation:

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

$$= \frac{400}{100 + 400} \times 12 \quad = \quad 9.6 \text{ V}$$

(2+ 4 marks)

(Formula- 2 marks)

10. The graph shows the sales of a typical product over its life cycle. The graph is divided into five stages from Development to Decline as shown.

Describe **any three** of these stages of product life cycle.

1. **Design/Research/Testing/Manufacture etc.**

2. **Marketing/Distribution/Sales etc.**

3. **Marketing/Acceptance/Sales growth etc.**

4. **Sales peak/plateau etc.**

5. **Obsolescence/superceeded/sales decline etc.**

(3 x 2 marks)

11. (i) Describe the operation of the relay shown making reference to the coil, contacts and iron core.

When a small current flows through the coil, a magnetic field is produced to magnetise an iron core. This attracts the armature which forces the switch contacts to touch. A circuit can be controlled in this way, relays often switch on higher voltage circuits.

1/2 description– 2 marks
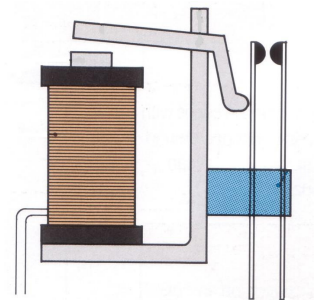
(ii) Give an example of where a relay could be used.

Intercom/radio controlled electric gates - 12V intercom/buzzer controlling 220V gate motors, spotlights for cars etc.

(4 + 2 marks)

12. The graphic shows the *machine heads* of a guitar. The machine heads allow the guitar to be tuned.

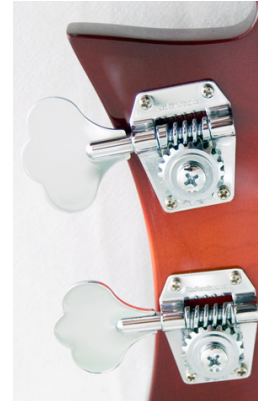(i) Name the mechanism used in the machine heads.

Worm gear/Worm and wheel

(ii) Explain why this mechanism is suitable for this purpose.

No slip/maintains setting

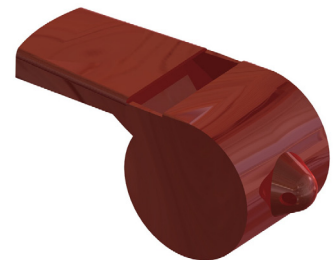**Fine adjustment possible/speed reduction**

Compact size etc.

(2 + 4 marks)

13. Make a well-proportioned freehand sketch of three principal orthographic views of the whistle shown.

Correct view placement/alignment - *2 marks*
Correct proportions - *2 marks*
Detail - *2 marks*

14. Tennis rackets are produced from a range of materials.

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

A

B

The frame **A**:

    (i)   Lightweight

    (ii) Strong, comfortable to hold, stiffness etc.

The strings **B**:

    (i) Tough/Elastic/flexible- to allow "threading" of frame

    (ii) Strong/lightweight/resilient etc.
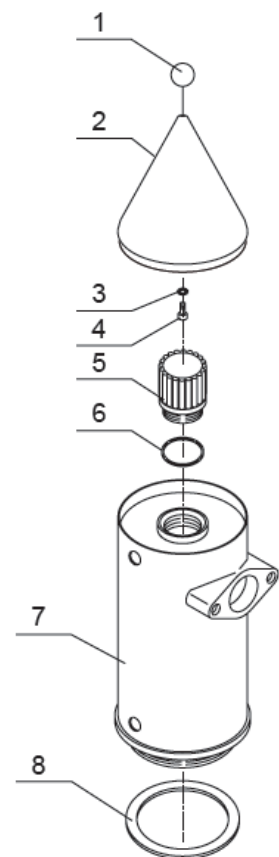
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15. The graphic shows an extract from the manual supplied with a coffee machine.

(i) Name the type of pictorial representation used.

    Exploded view/ Exploded Isometric

(ii) Use **two** graphic techniques to enhance the graphic representation of the parts labelled **2** and **7**.

    Appropriate shading/rendering/colouring

(2+2+2 marks)

1
2
3
4
5
6
7
8

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2009

Technology
Higher Level

Marking Scheme

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) The personal safety of elderly people is an important issue in modern society.

   (i)   Describe **two** situations where elderly people may be particularly vulnerable and state why.
Alone in the home - falls, medical emergency, intruders. Using public transport - falls, disorientation, attack etc.

   (ii)   In **each** case suggest an application of technology which could contribute to making their environment safer.
Personal alarm, Panic button, mobile phone. GPS Tracker, Personal alarm, Mobile phone etc.

2(b) A design for a personal alarm project is shown. The two push-buttons are bought in.
All other parts are to be manufactured in the Technology Room.

   (i)   Draw up a Work Breakdown Structure (WBS) for the project.
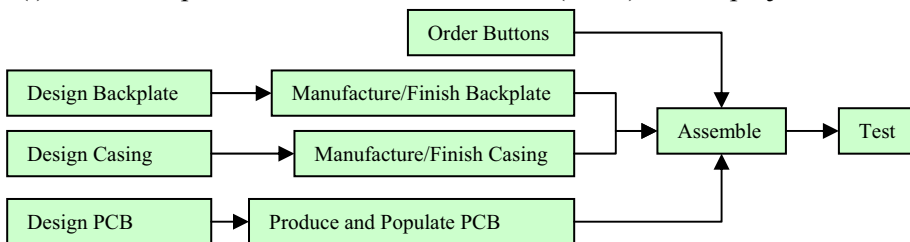
   (ii)   Suggest a suitable means of joining parts **A** and **B**.
An engineered "snap", Countersunk screws, gluing etc.

   (iii)   For **each** part, choose a material and describe the steps you would take to manufacture:

- **The outer casing A - Modelling foam, CNC, Fill, Sand, Paint**
  Rigid polystyrene (HIPS)/PVC - Vacuum Forming
  Acrylic - Press Forming.
- **The backplate B - Acrylic - Laser Cutter, 2D CNC, Manually**

   (iv)   Describe how the PCB could be produced.
Isolation routing (CNC)/Etching on copper clad board, populate, solder.

Answer 2(c) or 2(d)

2(c)

   (i)   The personal alarm needs to be easily accessible at all times to the person carrying it.

Using neat, well-proportioned, annotated sketches propose a design improvement that would address this requirement.
Hanging Loop/Ring/Tag   Belt Clip/Pocket Clip etc.

   (ii)   The personal alarm may need to be activated in darkness or in poor visibility.
Propose a design modification which would make the alarm easier to use in such circumstances.
Tactile/Raised buttons   Backlit buttons   etc.

<div align="center">

OR

</div>

2(d) It is important that the alarm be both reliable and of high quality.

   (i)   Name **three** quality characteristics and specify **three** related quality attributes for the alarm.
Tough/durable - strength of plastic used
Waterproof - manufacturing tolerances
Loud - battery power, speaker spec
Reliable - component quality, manufacturing processes
Portable-size and weight etc.

   (ii)   Explain how the manufacturing processes and the material choices for the project affect the quality attributes of the alarm.
Tighter manufacturing tolerances and better quality materials/components give better quality Attributes etc.

Question 3 - *Answer 3(a) and 3(b)*   (a) - 12 marks, (b) - 8 marks, (c) OR (d) - 4 marks

3(a) (i) Show using sketches **three** different classes of lever.

(ii) A mechanical lifting device allows a weight of 95 N to be raised using an effort of 10 N on a lever.
If the load moves 1 mm for every 10 mm travel of the lever, calculate the mechanical advantage, velocity ratio and efficiency of the device.
MA - load/effort = 95/10 = 9.5:1
**VR - dist. moved by effort/dist. moved by load = 10/1 = 10**
Efficiency = MA/VR = 9.5/10 x 100 = 95%

3(b) The graphic shows a student's design of a robotic arm. The arm is powered using a DC motor (**A**) and reduction gear as shown.

(i) The torque available from the motor is 0.6 Nm. The distance from the pivot to the end of the gripper (end effector) is 150 mm.
Assuming the robotic arm is balanced when unloaded, calculate the maximum load the arm can lift.

Torque = Force x Distance.
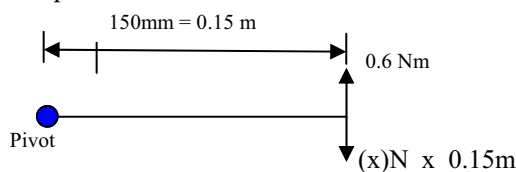
0.6 = (x) 0.15 where (x) is Newton's.
0.6 = (4) 0.15
4 Newton is the maximum lift.

(ii) The robotic arm was found to deflect when used.
Using annotated sketches show how the design of the arm could be modified to increase its rigidity.
**Triangulation or other means.**

Answer 3(c) or 3(d)

3(c)

(i) Using annotated sketches show a suitable mechanism for opening and closing the gripper (end effector) of the robotic arm to allow it to pick up the block shown in the graphic.
Gears, rack and pinions, smart wire, solenoid, other

(ii) In order to achieve equilibrium the gripper must be counterbalanced at the opposite side of the pivot.
The gripper exerts a moment of 0.4 Nm about the pivot.
Calculate the distance from the pivot to the point at where a counterbalance with a mass of 400 g should be positioned to achieve equilibrium.
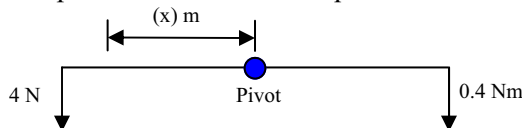
Force = mass x gravity   (mass = 400g = 0.4kg)
Force = 0.4 x 10
Force = 4N
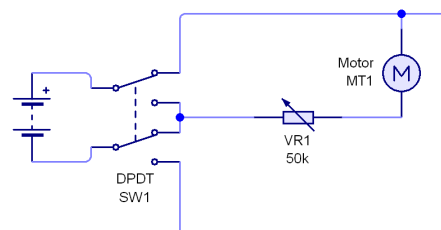
4N x (x)m = 0.4Nm
(x) = 0.4/4 = 0.1m
(x) = 100mm
OR Taking gravity as 9.8, (x) = 102mm

OR

3(d)

(i) A circuit is required to control the movement of the motor at **A**. Both forward and reverse motion are required and the circuit should allow the speed of the motor to be varied. Draw the required circuit diagram.

DPDT - 1, VAR - 1,

(ii) Propose an appropriate sensor to detect the presence of an object in the jaws of the gripper of the robotic arm.
Justify your choice of sensor and describe how it works.
LDR, limit switch, proximity sensor etc.
Appropriate explanation.

# 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)   Using **three** examples, outline how the use of microprocessors has improved our daily lives.
PC's, Kitchen appliances, Traffic Lights, Cars etc.
Appropriate description

(ii) Microcontrollers in the form of Peripheral Interface Controllers (PIC) are widely used for project work.
Outline **three** advantages in using PICs for students' projects in Technology.
Reduce circuit complexity, increase reliability, increase flexibility (programmable) etc.

1(b) A program sequence for a student's steady hand game is shown in the flowchart.
When a metal ring touches a wire track a LED illuminates and a buzzer sounds to show
that the game is over.

(i)   Draw a modified program flowchart to allow the player **two** touches of the wire track before the game
is over. The LED should illuminate after ONE touch and the buzzer should sound and the game finish
after the SECOND touch.

(ii) Input 2 on the PIC is used to detect when a player has successfully completed the game. Modify the
program flowchart to output a simple tune consisting of three tones when this occurs.

(iii) A transistor driver is required to operate the buzzer. Draw a circuit diagram to show how the transistor
and buzzer are connected to the PIC and explain why the transistor driver is required.

(i)

(ii)

(iii)
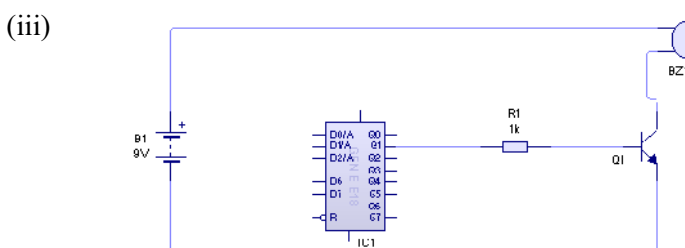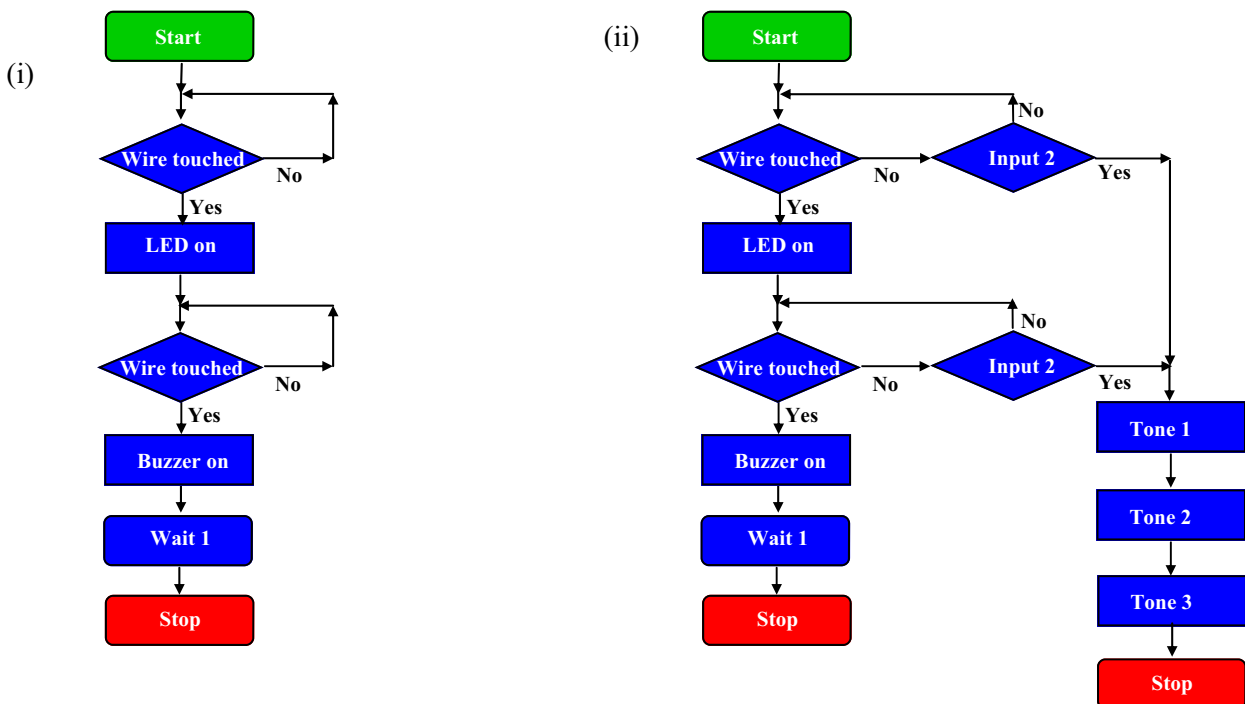
The transistor is needed to act as a current amplifier as the output from the PIC is insufficient to drive the buzzer.

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

1(c) Robotic systems are used in many applications in both industry and society.

     (i)   Outline **one** application of robotic control in **each** of the following areas:

- Space exploration **- Loading arms with "live" control, collect rock samples, repair satellites etc.**
- Mechanical assembly **- Positioning/Attaching components e.g car parts etc.**

     (ii)   A robot is used to spray paint car bodies as part of an assembly line process. Describe in detail how the robot would be programmed to spray paint the cars.

The robot control is switched off and the robot is put in record mode. An expert human operator (spray painter) sprays the car by guiding the robot arm. The robot is enabled to replay the recorded motion (walk through method of programming).

Explain why accurate and consistent positioning of the car bodies is essential for the spray painting process.

The robot uses a closed loop feedback encoder and will replay the same motion regardless of the position of the car - so the car body must be in the exact same position as it was during the learning/recording mode if the spraying process is to work well.

OR

1(d)   (i)   Name any **three** of the pneumatic symbols shown below.

A - Single acting cylinder

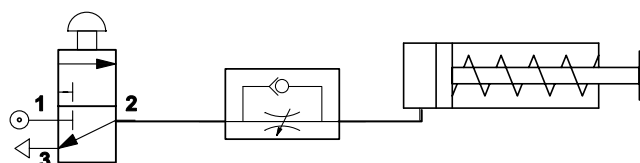**B - 3 /2 way port valve**

C - Throttle valve/ Flow regulator

D - Shuttle valve/ OR Valve

E - Double acting cylinder

(ii)   By selecting from the given symbols, sketch a pneumatic circuit to achieve the following:

- The cylinder extends fully when the button is pressed
- The cylinder retracts at a controlled rate when the button is released.

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)   Electronic waste is a valuable source of secondary raw materials.
Identify **two** parts of a computer monitor which may be recycled.

Glass screen, plastic casing, electronic components etc.

(ii)   Many EU countries have banned the disposal of electrical and electronic equipment to landfill.
Outline **two** reasons for the introduction of this ban.

Promote the reuse/recycling of electronic equipment, reduce pollution, dispose of hazardous waste correctly etc.

2(b)   The bedside lamp shown stays on for a period of time when the switch is pressed.
The monostable circuit below controls the lamp.
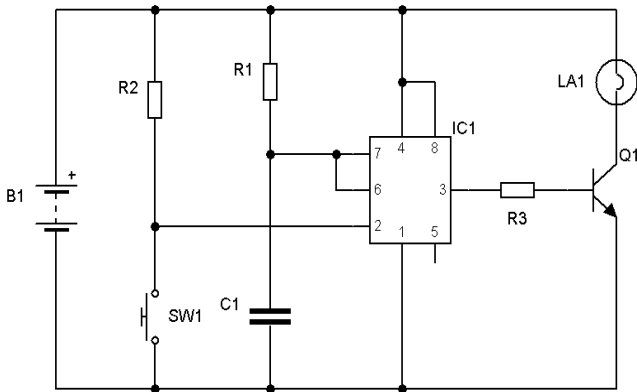
(i)   Name component IC1.

555 Timer.

(ii)   Name **two** components in the circuit that control the Time delay of the circuit and state how to increase the length of time that the lamp stays on.

R1 and C1. Increase size of resistor or capacitor.

(iii)   Explain in detail the sequence of events which occur in the circuit when SW1 is pressed.

When SW1 is pressed, the voltage to pin 2 drops to less than 1/3 of the supply voltage– this starts the timing cycle. The duration of cycle depends on the size of resistor and capacitor. When the voltage at pin 6 has reached 2/3 of the supply voltage, the time on period will end and the lamp goes off. Pin 7 is used to discharge the capacitor.

(iv)   If the value of C1 is 100µF and the value of R1 is 1MΩ, calculate the delay in seconds.

Formula T= 1.1 R1 x C1
R (ohms)
C (Farads)

Answer   T = 1.1 (1,000,000) x 0.000100
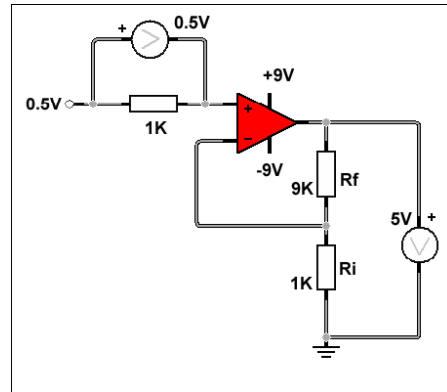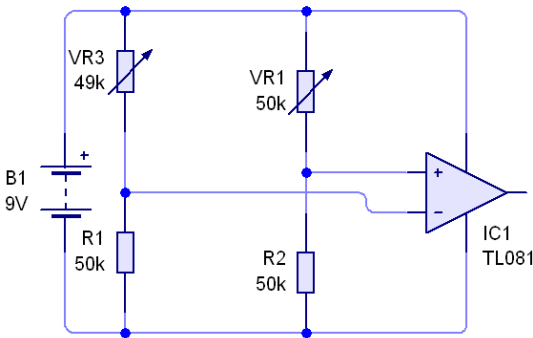
T = 110 seconds

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

2(c) The operational amplifier (op-amp) is a versatile and widely used electronic component.

(i) Describe **two** common configurations for an operational amplifier (op-amp).
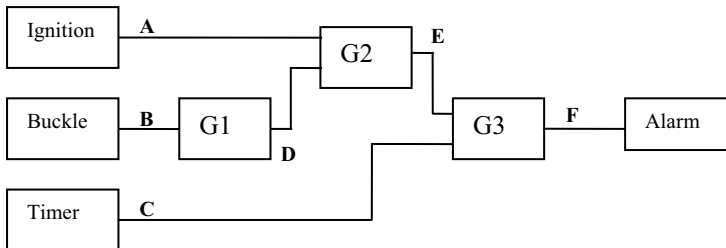**Comparator**
Current amplifier.

(ii) Sketch a circuit diagram to show how an op-amp can be configured to act as either of the configurations described at (i) above.

OR

2(d)

The graphic shows an alarm system for the seat belt of a car. The alarm is designed to activate for 30 seconds when the ignition is on and the seatbelt is unbuckled.

(i) Identify the logic gates required at G1, G2 and G3.
G1– Not Gate, G2 - And Gate, G3 - And Gate.

(ii) Draw the truth table for output F.

(iii) Give **three** examples where electronic control is used in automotive safety.

ABS breaking, burglar alarms, break pad wear indicator, service indicator etc.

A	B	C	D	E	F
0	0	0	1	0	0
0	0	1	1	0	0
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	0	0	0

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) The misuse of Communications Technology is of growing concern to many people.
Discuss **two** ways of protecting yourself from the possibility of *'Cyber bullying'* when online.
Firewall protection, delete suspicious emails without opening, never reveal passwords
or real name online etc.

(ii) Explain what is meant by the term URL.
Uniform Resource Locator, global address of documents and resources on WWW.

Identify **two** elements of the following URL and explain the purpose of **each**.

Http– Hypertext Transfer Protocol– system used to find info. From internet
www.rte.ie - address/domain of the computer where the webpage/resource is located
/arts/ - specific webpage requested

3(b) (i) State **two** benefits that a company would gain from networking their computer system to form a LAN.
**Share hardware/software, central storage of files, security**

(ii) Explain the function of **each** of the following in a computer network:

- Network switch
  A device that joins multiple computers within a LAN. It differs to a hub in that it
  only sends data to the specific computer addresses, faster speeds.
- Network card
  A piece of hardware that allows a computer to communicate with other computers
  on the LAN.
- IP address
  Unique number that every computer connected to the internet or network is assigned,
  e.g, 192.168.0.3.
- File server.
  Computer responsible for the storage and management of data in a central location
  on a LAN.

(iii) The owner of a small transportation company has decided to set up a computer network. At present the company uses one computer for word processing and taking orders. This computer is connected to a printer. It uses another three computers for processing orders and coordinating deliveries.
The company wants to achieve the following:

- All important data to stay on one computer but be available to other computers when needed.
- All computers to be able to use the printer.

(a) Draw a block diagram of a network to make this possible.
(b) Describe how the printer can be shared over the network.
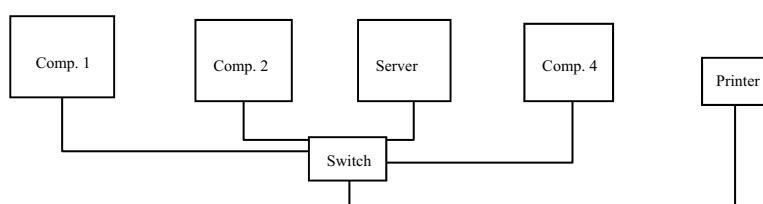
- **Connect printer to network switch.**
- **Install printer software on server.**
- **Select printer sharing on control**
  panel.

3(c) (i) Distinguish between *bitmap* and *vector* based representations of graphical data and suggest a suitable application for **each**.
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., resolution independent e.g., used for tech. drawings/ logo creation

(ii) The graphic shows the logo for a delivery company. The logo is to be used on all printed documents the company uses and on its website. Select a suitable file format for **each** of the following uses of the logo and justify your selection in **each** case:

- Printed on company notepaper and letterheads
  Tiff– if high quality is required
  Jpeg - if quality is not an issue
- Included in the company's email signature
  GIF– 256 colours, transparent, good where few colour/shades/tints are required

- On the homepage of the company's website.
  JPeg– file size, PNG– Transparent, portable

OR

3(d) (i) Distinguish between *shareware*, *freeware* and *trial software*.
Shareware– copyrighted software that is available free of charge on a trial basis
Freeware– completely free software, usually made available over the internet.
Trial Software– contains all functionality of full version but can only be used for a limited time period, try before you buy.

(ii) A sound wave is an analogue signal. Describe how such an analogue signal can be converted to a digital format making reference to *amplitude*, *sampling rate* and *sample format*. Support your answer with a labelled diagram.
An analogue signal can be converted to digital using a sound card with ADC.
Amplitude– height/loudness of the wave
Sampling Rate– No. of times that measurements are taken every second
Sample Format—No. of bits used to represent each sample. Audio CD– 16 bits per sample
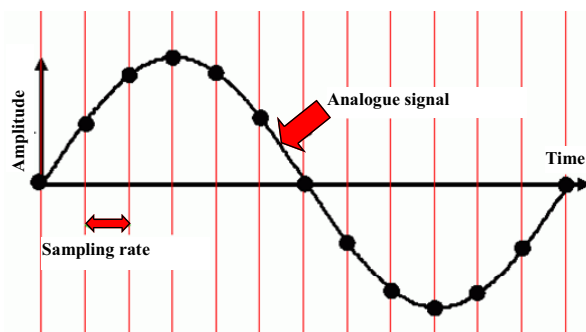
Option 4 - Manufacturing Systems - *Answer 4(a)* ***and*** *4(b)*

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

***4(a)*** **(i)**   Why is accelerated testing sometimes used on a product? Describe **two** types of accelerated wear tests.
   Used when expected life is too long to capture life data. Qualitative and Quantitative

(ii)   A hairdryer as shown is designed to have a life of three years before it wears out.
   If the average usage is 4 hours per week, calculate the total life in hours required of
   the hairdryer.
   Suggest a suitable type of accelerated test to measure the life of the hairdryer.
   4hrs/wk x 52 wks/yr x 3 yrs = 624 hours. Quantitative test is required.

4(b) **(i)**   Describe **one** main difference between *Quality Control* and *Quality Assurance*.
   **Q.C– Checks the quality of the product after manufacture. Q. A– checks the quality of all systems in
   place to produce a quality product.**

(ii)   Draw a diagram to show how the quality costs of conformance and the costs of non-conformance relate to
   one another.

Cost of non-conformance > cost of conformance
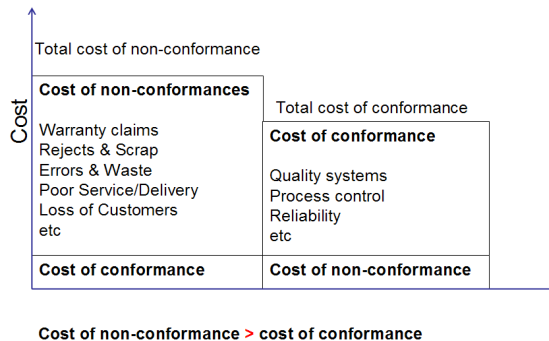
(iii)   A company employs the following people in its production process:

Description	Number	Salary per year
Managers	2	€60,000 each
Customer Service	1	€40,000
Maintenance	2	€45,000 each
Finance	1	€50,000
Quality Assurance	1	€55,000

During the previous year:
- A quarter of one manager's time was spent on quality improvement
- Half of the customer service time was spent dealing with customer complaints
- Half of the maintenance time was spent reworking defective products
- One fifth of the finance time was spent checking for mistakes in billing of customers
- One quarter of the quality assurance time was spent on inspection
- A sales contract worth €40,000 was lost due to a problem with the product.

(a) Evaluate the cost of quality to this company in the previous year.

Description	Cost of Quality
1/4 of manager's time on quality improvement	€15,000
Customer complaints	€20,000
Maintenance on reworking defective products	€45,000
Mistakes in billing customers	€10,000
Q.A time spent on inspection	€13,750
Loss of sales contract	€40,000
Total	**€143,750**

(b) Propose how the company could make savings by improving their quality procedures.

Spend more time on Q.A, use computer system for billing, staff re-training, any relevant procedure etc.

Answer 4(c) or 4(d)

4(c) (i) Explain the difference between a process that is *capable* and one 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.
Not capable means it falls outside the specifications/tolerances desired– an unacceptable number of parts would fail an inspection test.

Enlarged view of cap

H

In order to fit the pen properly, the diameter of the hole **H** must lie between 8.05 / 7.95 mm.

The type of plastic used to make the cap affects the accuracy of the hole.

The manufacturer wishes to choose a suitable plastic. Tests were carried out using two different plastics and the sizes of hole **H** were recorded in the table below.

Hole Sizes in mm	
Plastic **A**	Plastic **B**
8.04	7.99
8.02	7.98
8.05	8.02
7.95	7.98
8.04	7.99
8.02	8.01
7.96	8.01
0.0401	0.0160

Standard
deviation (mm)

(a) Use the information in the table to calculate the process capability index when using each of the plastics **A** and **B**.

Cp = Upper size limit - Lower size limit/6 σ(sigma)

Plastic A: 8.05– 7.95/ 6(.0401) = 0.416

Plastic B: 8.05 - 7.95/ 6(0.0160) = 1.042

(b) Which material should the company choose to make the part? Justify your answer.
Plastic B is the most suitable as its process capability is > 1. This shows that fewer defects were found using this material.

OR

4(d) (i)   Explain what is meant by a *Break Even Quantity* (BEQ) when choosing between two manufacturing processes for a product.
This quantity determines which manufacturing system is best to use in the production of a product, depending on the number (quantity) of the product which is required.

(ii)   A limited edition of 500 pens is to be packaged in presentation boxes.

A decision is to be made whether to package them manually using a skilled operator or to automate the packaging using an automated process.

Skilled labour costs €2.50 per unit to package the pens on a one-off basis.

The automated process costs €0.10 per unit to package the pens.

The setup cost of an automated packaging machine is €1000.

(a)   Draw a graph to show the cost of each method of packaging.
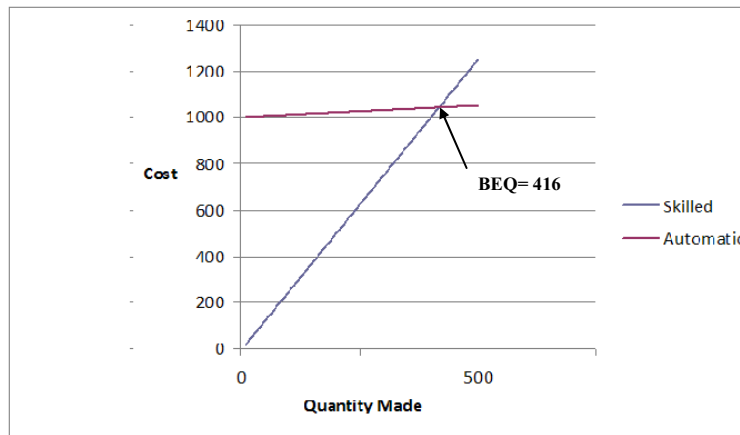
(b) Use the graph *or other means* to determine which method is more economical for packaging a batch of 500 pens.

Formula for BEQ = Set up cost/(manual cost per item - automated cost per item)

= 1000/2.50 - 0.1 = € 416

Calculations:

Automated Cost = €1000 + (500 x 0.1) = €1050

Skilled Labour Cost = €2.50 x 500 = € 1250

Answer: Automated is more economical (alternatively, this could be taken from the graph)

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 pairs of material categories, outline the differences between the two types of materials listed in them. Use examples to support your answer.

- Hardwoods *and* softwoods

Hardwoods: Broadleaves, deciduous, durable slow to mature. Oak, Ash, Beech, Teak etc.
Softwoods: Needleleaves, conifers, evergreen, fast to mature, soft. Pine, Spruce, Fir, Cedar etc.

- Ferrous *and* non-ferrous metals

Ferrous: contains iron (will rust). Steel, Stainless Steel, Cast Iron etc.
Non Ferrous: Does not contain iron (won't rust). Aluminium, Brass, Copper, Bronze etc.

- Thermoplastics *and* thermosetting plastics.

Thermoplastic can be shaped again with heat (strong primary covalent bonds with weak

adjacent bonds). Acrylic, PVC, polystyrene, polythene etc.

Thermosetting can only be set once (strong primary and adjacent bonding, cross linking)

Phenolic Resin, Polyester resin, bakelite etc.

(ii) Describe *malleability*, *ductility* and *toughness* as properties of metals.

Malleability: Ability of material to be stretched out in all directions without breaking e.g, Lead
Ductility: Ability of a material to be drawn out/stretched into wire e.g, copper
Toughness: Ability of a material to resist shocks/sudden blows e.g, toughened glass

5(b) The use of implant and assistive technologies, such as the arm prosthesis shown, greatly improves the quality of life for many accident victims.

(i) Name **one** material commonly used in implant technology.
Silicone, titanium, Ceramics, elastomers, stainless steel etc.

(ii) Select suitable materials for the following components used in an arm prosthesis and justify your selection in **each** case:

- Gripper   **Titanium– hard, strong, aluminium– lightweight**

- Toothed pulley wheels **Nylon-lightweight, less noise, aluminium**

- Printed Circuit Board. **Copper clad with green solder mask**
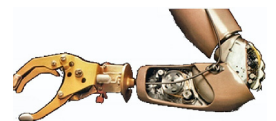
(iii)
"Developments in *composite materials* have allowed better prosthetic limbs be designed and built."

(a) What is meant by a *composite material*?

A material consisting of two distinct constituents which takes advantage of the favourable characteristics of each.

(b) Name a composite material and give an example of a specific use which exploits its main properties.
Glass Reinforced plastic (GRP): boats, good strength to weight ratio
Concrete: Foundations, good compressive properties, easily poured
Kevlar: Bullet proof vests, very high resistance to penetration

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

5(c) (i) Materials can be subjected to different types of stress. Outline what is meant by:

- Compressive stress **Pushing force**
- Shear stress **Slicing force (scissors)**
- Torsional stress. **Twisting Force**

(ii) Describe, with labelled diagrams, **one** of the following material processing tools:

- Bandsaw **Appropriate sketch**
- Vacuum former. **Appropriate sketch**

Give **two** health and safety guidelines to be observed when using the tool you have described.

Bandsaw: Use guidestick, dust extraction, safety goggles etc.

Vacuum Former: Ventilation, Gloves, do not leave unattended etc.

OR

5(d) (i) Describe a simple test to compare the hardness of the following materials:

- Oak
- Steel
- Acrylic.

Indentation comparative test

The plunger is dropped from a given height on to the three different materials.

The size of the indentation from the ball bearing on each material indicates the degree of hardness for that material.

Heavy Plunger

Clear Acrylic Tube

Specimen to be Tested

Steel Ball Bearing
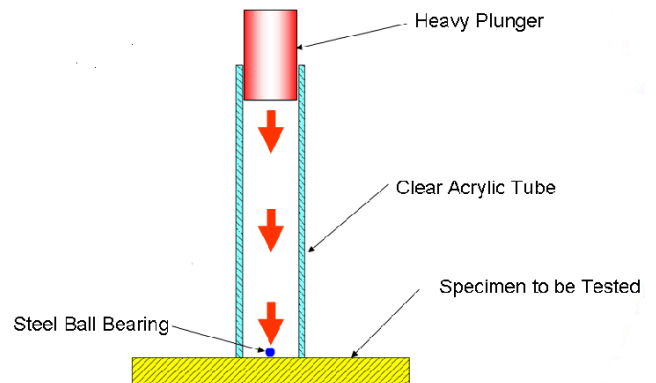
OR description of "Scratch Test" acceptable.

What results would you expect from such a test?
In order of hardness: Steel, Acrylic, Oak

(ii) Explain the advantages of using Computer Aided Manufacture (CAM) techniques in the production of high volume products.
Repetitive and fast, accuracy and high quality finish, low in labour cost.

Give an example of such a product and describe a CAM technique which could be used in its manufacture.
Printed circuit board (PCB). CAM could be used to router circuit boards continously.
Steps: Design board
Set up tool parameters
Place copperclad board
Router the board   (or any other relevant application)