



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle 2022

Marking Scheme

Engineering

Common 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.



Coimisiún na Scrúduithe Stáit
State Examinations Commission

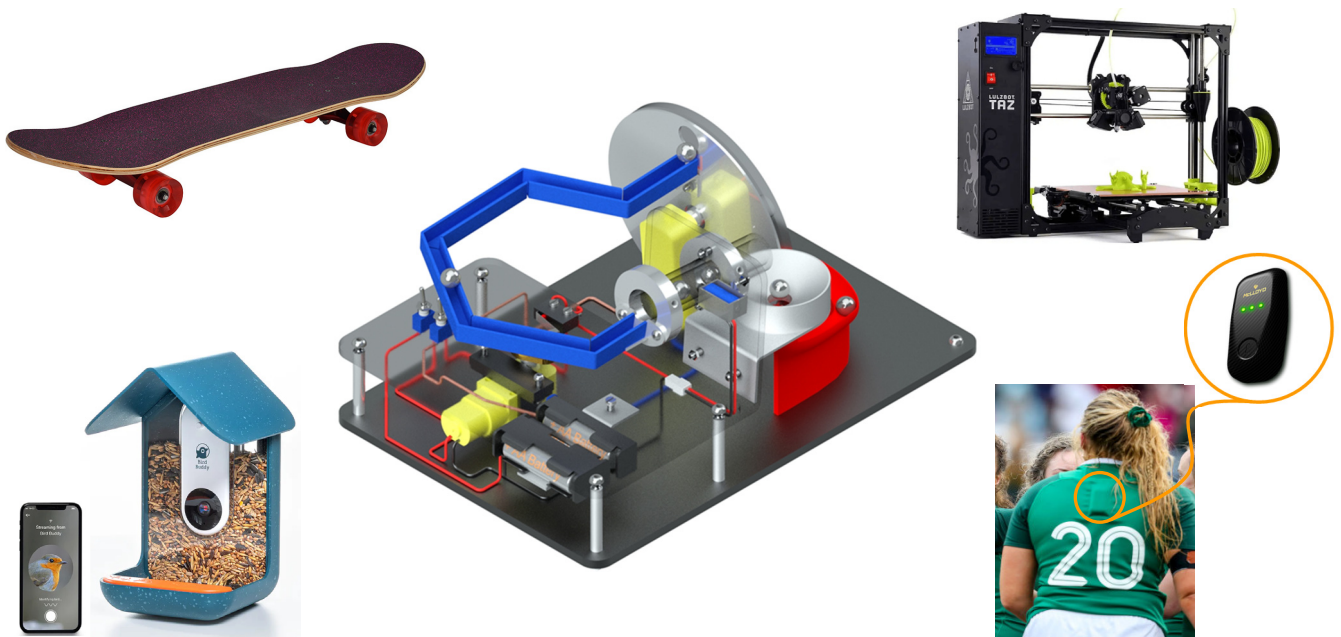
Junior Cycle Final Examination, 2022

Engineering

Common Level

MARKING SCHEME

Written Examination and Project



Written Examination - Marking Scheme and Sample Solutions

120 Marks - Answer all questions

Note: The solutions presented are examples only.

All other valid solutions are acceptable and are marked accordingly.

Question 1 (25 marks)

- (a) (i) Description @ 3 marks
(ii) Use @ 2 marks
- (b) (i) Reason @ 2 marks
(ii) Draw @ 3 marks
- (c) (i) Explanation @ 4 marks
(ii) Two reasons @ 2 + 1 marks (3 marks)
(iii) Two reasons @ 2 + 1 marks (3 marks)
- (d) (i) Description @ 3 marks
(ii) Two uses @ 1 mark each (2 marks)

Question 3 (37 marks)

- (a) (i) Explanation @ 2 marks
(ii) Description @ 3 marks
(iii) Explanation @ 4 marks
- (b) (i) Explanation @ 2 marks
(ii) Name @ 1 mark
(iii) Symbol @ 1 mark
Complete table @ 3 marks
- (c) (i) Explanation @ 2 marks
(ii) Two sources @ 1 mark each (2 marks)
- (d) Design @ 3 marks
Rendered sketch @ 3 marks
- (e) (i) Match six components @ 1 mark each (6 marks)
(ii) Draw symbol @ 2 marks
(iii) Two safety precautions 2 + 1 marks (3 marks)

Question 2 (32 marks)

- (a) Match two @ 1 mark each (2 marks)
- (b) (i) Two impacts @ 1 mark each (2 marks)
(ii) One advantage @ 1 mark
One disadvantage @ 1 mark
(iii) Two features @ 1 mark each (2 marks)
- (c) (i) Correct material @ 1 mark
(ii) Advantages @ 1 + 1 mark (2 marks)
(iii) Explanation @ 2 marks
- (d) (i) Correct classification @ 2 marks
(ii) Name one property @ 1 mark
(iii) Explanation @ 2 marks
- (e) (i) Explanation @ 1 mark
(ii) One property @ 1 mark
(iii) Description @ 3 marks
(iv) Name @ 2 marks
(v) Explanation @ 3 marks
- (f) One positive impact @ 2 marks
One negative impact @ 2 marks

Question 4 (26 marks)

- (a) Complete the table @ 3 marks
- (b) Two properties @ 1 mark each (2 marks)
- (c) (i) Explanation @ 3 marks
(ii) One reason @ 2 marks
(iii) One advantage @ 2 marks
(iv) Three processes @ 1 mark each (3 marks)
- (d) (i) Explanation @ 3 marks
(ii) Two Thermosetting @ 1 mark each (2 marks)
- (e) Description @ 3 marks; Diagram @ 3 marks

Question 1 (25 marks)

(a) Global Positioning System (GPS) technology is widely used in sport.

(i) Describe one use for GPS technology in sport.

Description: GPS trackers are used in sport to track a player's movement on the pitch and to collect vast amounts of data on their performance such as their running speed, distance covered on the pitch as well as the number and frequency of impacts during a Match.
--

Description @ 3 marks



Rugby player fitted with GPS tracker

(ii) State one other use for GPS technology, apart from sport.

Use: GPS technology is used to determine a precise location, navigating from one location to another (satnav in cars), tracking or monitoring the movement of objects or people (tracking a parcel), mapping by creating maps of the world (google maps) and timing by bring precise timing to the world. (timing for high speed sports use GPS timing).
--

Use @ 2 marks

(b) **(i)** The fork shown has been specifically designed for people with a disability. Why is the handle of the fork made from foam?

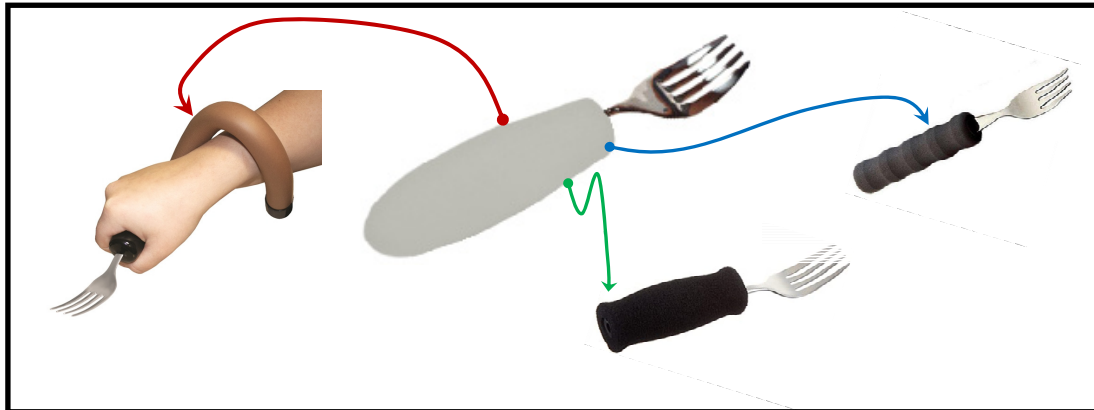
Reason: The foam handle is designed to provide extra grip for those with limited dexterity. The thick, soft foam is non-slip and it fits comfortably and securely in the palm of the hand of the user.
--

Reason @ 2 marks



Fork with contoured foam handle

- (ii) Draw an additional feature which may improve the design of the fork shown below.



Draw @ 3 marks

- (c) (i) Explain why the stainless steel water bottle shown is double walled.

Explanation: A double walled structure keep the water cool as it insulates the water from external temperature changes. Leakage is also prevented if the bottle is dropped or if the outer wall is accidentally pierced.

Explanation @ 4 marks

- (ii) State two reasons why stainless steel is suitable for the manufacture of a water bottle.

Reason 1: The presence of chromium in the alloy stainless steel ensures a high resistance to attack from corrosion, making it suitable for use as a vessel to hold water and other liquids.

Reason 2: Stainless steel is stain resistant. This helps to prevent a build up of bacteria and helps to prevent the formation of mould.

Reason 1 @ 2 marks, Reason 2 @ 1 mark



Double walled stainless steel water bottle

- (iii) The aluminium tumblers shown are anodised.
State two reasons for anodising aluminium.

Reason 1: Anodising produces a hard, wear resistant layer that protects the aluminium making it more durable and long lasting.

Reason @ 2 marks

Reason 2: Anodising can be done in a variety of colours which can make aluminium products more attractive in appearance.

Reason @ 1 mark



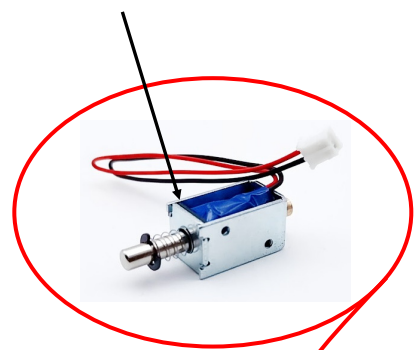
Anodised aluminium tumblers

- (d) (i) The solenoid shown is used in the operation of the Junior Cycle Engineering Project 2022, Model Marble Machine. Describe the operation of a solenoid.

Description: A solenoid consists of a coil of wire wound around a moveable core. When an electrical current is induced magnetic field forms around the coil. This magnetic field causes the plunger (armature) in the core to move, thus converting electrical energy to mechanical energy. The movement of the armature may be used to push, pull or release another object.

Description @ 3 marks

JSO - 0420L Solenoid



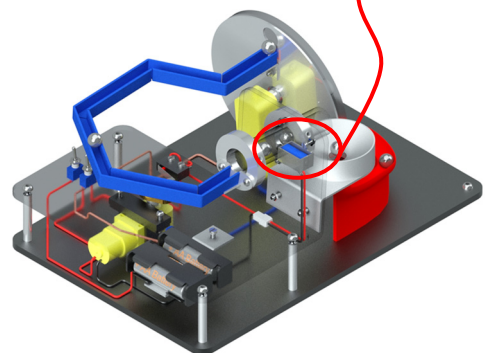
- (ii) Identify any two other uses for a solenoid.

Use 1: Hotel door locks operate using an electromagnetic solenoid in its mechanism.

Use @ 1 mark

Use 2: Hot drink machines that dispense tea, coffee and other beverages use solenoid valves to control the movement of liquid.

Use @ 1 mark



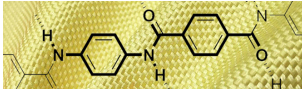
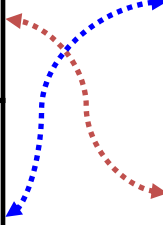
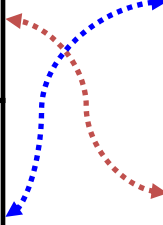
Junior Cycle Engineering Project 2022, Model Marble Machine

Question 2 (32 marks)

For centuries, engineers have used innovative engineering solutions to solve problems for society and to improve the quality of life for people.



- (a) Three of the five inventors shown below have been matched to their invention. Match the remaining two inventors to their inventions.

 Stephanie Kwolek		an American chemist who is known for inventing Kevlar a synthetic fibres with exceptional strength and stiffness. 
 Rev. Nicholas Callan		an Irish scientist and Professor of Natural Philosophy at Maynooth College who is best known for his work on the induction coil. 
 John P. Holland		an Irish engineer who developed the first commercially built submarine which was formally commissioned by the US Navy. 
 Henry Ford		was an Irish-American who founded a Motor Company in his name, which developed the assembly line technique of mass production for his Model T automobile. 
 Steve Jobs		an American inventor, designer and entrepreneur who was the co-founder Apple Computers who developed the iPod, iPhone and iPad. 

Match @ 1 mark + 1 mark

- (b) (i) State two impacts of automobiles (cars) on society.

Impact 1: *Automobiles (cars) have given greater freedom of movement and mobility to societies, particularly those in remote settings.*

Impact @ 1 mark

Impact 2: *Automobiles generate increased rates of environmental pollution, resulting in increased incidence of ill-health in society.*

Impact @ 1 mark

- (ii) Outline one advantage and one disadvantage of mass production in engineering.

Advantage: Mass production increases efficiency of production and reduces costs.

Advantage @ 1 mark

Disadvantage: High set-up costs, increased pollution from over production and increased unemployment .

Disadvantage @ 1 mark



Mass production of cars

- (iii) Identify two features in the design of modern cars to reduce their impact on the environment.

Feature 1: Improved engine design and fuel efficiency help to reduce the impact of cars on the environment.

Feature 2: The move to design and develop hybrid and electric cars will lower the environmental impact of cars.

Features @ 1 mark + 1 mark

- (c) (i) Circle the correct material alloyed with iron to make steel.

Aluminium	Silicone	Carbon	Lead
-----------	----------	--------	------

1 mark

- (ii) Alloy steel is used in many engineering applications.
Explain two advantages of using alloys in engineering.

Advantage 1: Alloying materials improves the properties of such a materials.

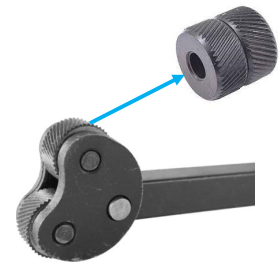
Properties like strength, hardness and resistance to corrosion are improved by alloying.

Advantage 2: Alloying increases the range of uses for such materials.

Advantages @ 1 mark + 1 mark

- (iii) Explain why the wheels of a knurling tool are made from high speed steel (HSS).

Explanation: High speed steel is a tool steel with high hardness, high wear resistance and high heat resistance. These properties ensure that the knurling tool wheel will be capable of cutting into other materials and keep a good cutting edge over a long period of time.



Knurling tool with HSS wheels

Explanation @ 2 marks

- (d) (i) Circle the correct metal group for copper.

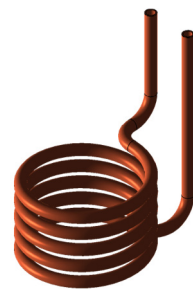
Ferrous metal	Non-ferrous metal
---------------	-------------------

2 marks

- (ii) Copper wire is used in the manufacture of an induction coil as shown. Name one property of copper which makes it suitable for wire manufacture.

Property: Copper is a ductile material.

Property @ 1 mark



Induction coil

- (iii) The sculpture shown is made from bronze which is an alloy of copper and tin. Explain why bronze is suitable for the manufacture of this sculpture.

Explanation: Bronze is widely used for the manufacture of both indoor and outdoor sculptures. Bronze has a relatively low melting point making it easy to melt and sculpt into attractive shapes. Bronze does not rust or corrode which makes it suitable for use in an outdoor setting. Bronze is a shiny attractive material which also makes it suitable as a sculpture material.



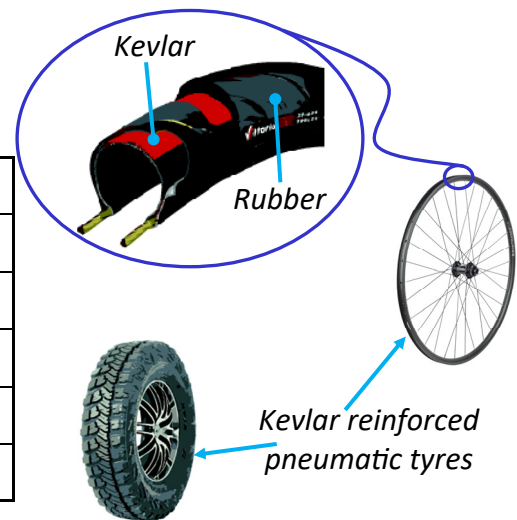
The 'Pomodoro Sphere'
Trinity College Dublin

Explanation @ 2 marks

- (e) (i) Kevlar reinforced pneumatic tyres are used on bicycles and cars.
Explain the term *pneumatic*.

Explanation: <i>Pneumatic is the term that refers to systems that use compressed air. Tyres that are inflated with compressed air are called pneumatic tyres and are used on the majority of modern vehicles.</i>

Explanation @ 1 mark



- (ii) State one property of Kevlar which makes it suitable as a material for pneumatic tyres.

Property: <i>Exceptional strength and stiffness</i>

Property @ 1 mark

- (iii) A Kevlar pedal crank which has been 3D printed is shown opposite.
Describe the additive manufacturing process of 3D printing.

Description: <i>3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced cross-section of the object. 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods. 3D printing is used to produce consumer products like eyewear, footwear and furniture, industrial products, prosthetics and prototypes.</i>

3D printed Kevlar pedal crank



Description @ 3 marks

(iv) Name the bicycle drive mechanism shown.

Name: *The mechanism shown is a chain and sprocket*

Name @ 2 marks



Bicycle drive mechanism

(v) Explain why oil is applied to this drive mechanism.

Explanation: *Oil is applied to a chain and sprocket mechanism to reduce wear between parts that make contact when moving. Oil also helps to reduce noise generated by these moving parts.*



Oil being applied to a bicycle chain

Explanation @ 3 marks

(f) Outline one positive and one negative impact of personal mobile devices on society.

Positive impact: *Personal mobile devices enable people from opposite sides of the world to remain connected virtually online.*

2 marks

Negative impact: *Misuse of personal mobile devices by some people can lead to situations of online bullying.*

2 marks



Question 3 (37 marks)

The *Bird Buddy* is a smart bird feeder that includes features such as a high resolution camera and built-in microphone to identify bird species and stream live video to a mobile app.



- (a) (i) The *Bird Buddy* is made from recycled polypropylene.

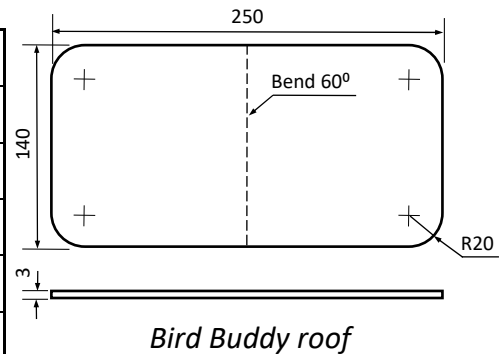
Explain why polypropylene is a suitable material for the bird feeder.

Explanation: Polypropylene is a relatively cheap material which can be easily shaped. Polypropylene is available in a range of attractive colours. Polypropylene is suitable for outdoor use in a variety of types of weather.

Explanation @ 2 marks

- (ii) Describe the steps required to accurately mark out and shape the *Bird Buddy* roof shown.

Description:
Mark out: Measure in from each edge a distance equal to the corner radius (20mm) to locate the centre of each arc in each corner.
Using the located centre and draw the radius.
Mark a vertical fold line equal distance from the left and right hand ends of the material.



To Shape: Cut, file edges & round the R20 curves.
Drawfile all edges to a high finish.
Bend along centre line at 60° using strip heater.

Description @ 3 marks

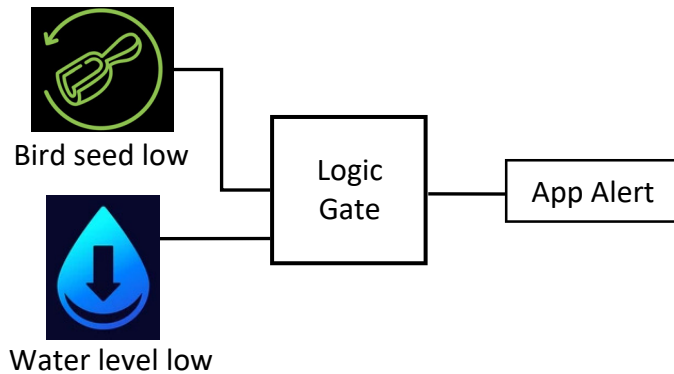
- (iii) Explain how the *Bird Buddy* roof may be accurately bent into shape.

Explanation: Heat the polymer material along the fold line using a strip heater.
When soft, the material can be bent to the required shape.
The accuracy of the bend is checked using an engineers protractor.

Explanation @ 4 marks

- (b) (i) The *Bird Buddy* uses digital logic gates and smart technology to alert the user when the feed containers need refilled. Explain the meaning of the term smart technology.

Explanation: *Self-Monitoring, Analysis, and Reporting Technology* is where a smart device (electronic device), can be connected to other devices or networks, using e.g. Bluetooth or WiFi, to operate interactively.



Explanation @ 2 marks

The following information is relevant to activate the feed refill alert.

Bird seed full = Logic Level 0

Bird seed low = Logic Level 1

Water level full = Logic Level 0

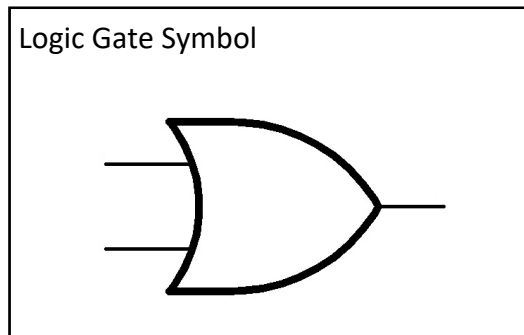
Water level low = Logic Level 1

- (ii) Name the logic gate which is most suitable to activate the app alert when either feeding system is depleted.

Name: *OR gate*

1 mark

- (iii) Draw the symbol for this Logic Gate and complete the Truth Table.



Symbol @ 1 mark

Input 1	Input 2	Output
1	0	1
<i>0</i>	<i>1</i>	<i>1</i>
<i>1</i>	<i>1</i>	<i>1</i>
<i>0</i>	<i>0</i>	<i>0</i>

Complete @ 3 marks

- (c) (i) A solar panel attachment for the *Bird Buddy* is shown. Describe how the solar panel is used to provide power to an electronic circuit.

Explanation: *Solar panels convert light energy to electrical energy. They work by allowing photons (light particles) to knock electrons free from atoms and in doing so generate electrical energy. The energy generated is used to supply power to a product.*



Solar panel attachment

Explanation @ 2 marks

- (ii) Identify two other sources of renewable energy.

Source 1: *Wind power / energy*

1 mark

Source 2: *Tidal power / energy*

1 mark

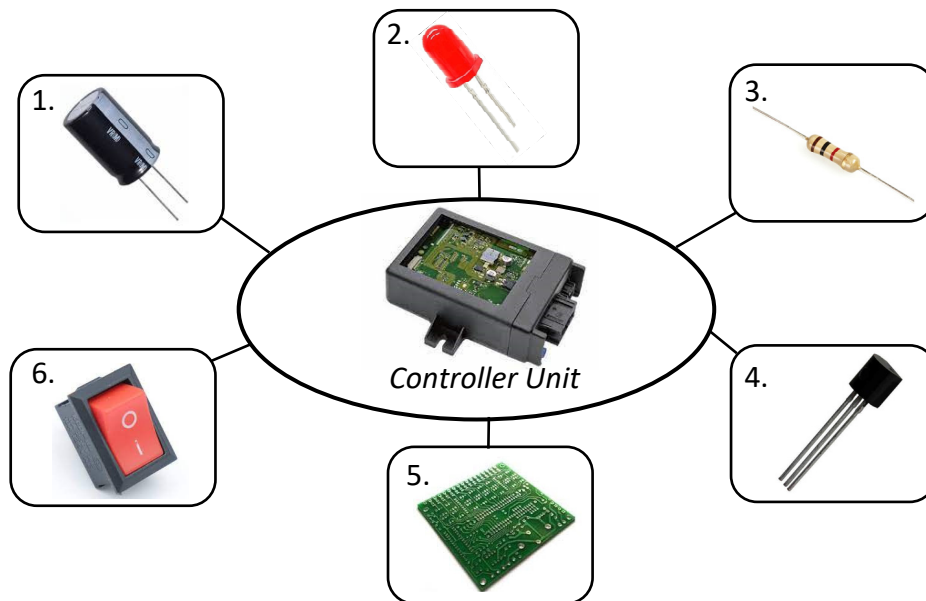
- (d) Using rendered sketching, draw a design for a wall mounted bracket on which the *Bird Buddy* can be placed.

Rendered sketch of your design



Design @ 3 marks, Rendered sketch @ 3 marks

- (e) The electronic components shown may be included in a controller unit circuit.

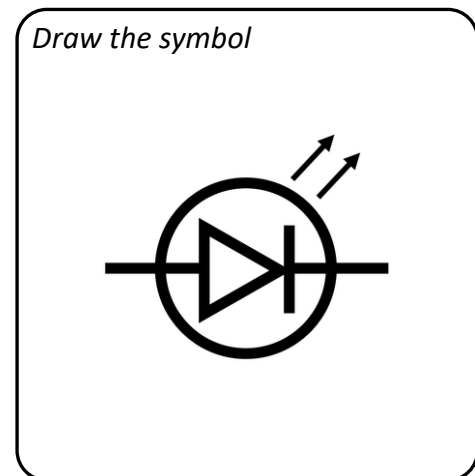


- (i) Match the number to the correct electronic component in the table below.

Electronic Component	Number
On/Off Switch	6
Capacitor	1
LED	2
Transistor	4
Resistor	3
Printed Circuit Board	5

1 mark each

- (ii) Draw the electronic symbol for an LED.



Symbol @ 2 marks

- (iii) State two safety precautions to be observed when soldering electronic components on a Printed Circuit Board.

Safety precaution 1: Always return the soldering iron to its stand when not in use.

2 marks

Safety precaution 2: Keep the cleaning sponge wet during use.

1 mark

Question 4 (26 marks)

Modern engineering techniques play an important role in the world of leisure and recreation.



- (a) The following three engineering terms are associated with skateboard design:

Washer	Lamination	Bearing
--------	------------	---------

Complete the table below by inserting the most suitable term next to the description of the term.

Term	Description of Engineering Terms
Lamination	Is the process of manufacturing a material in multiple layers, creating a material with improved properties.
Bearing	A device that supports moving parts and allows them to move more smoothly by reducing friction.
Washer	A small flat metal, rubber or plastic ring placed over a bolt before a nut is applied.

Complete correctly @ 3 marks

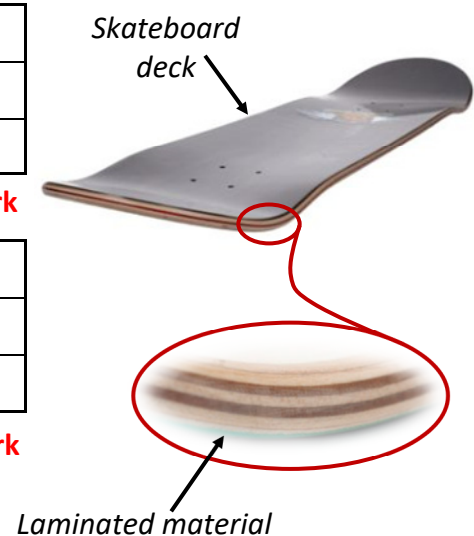
- (b) State two properties of the skateboard deck which are improved by the process of lamination during manufacture.

Property 1: Lamination can increase the strength of a material in the manufacture of a product.

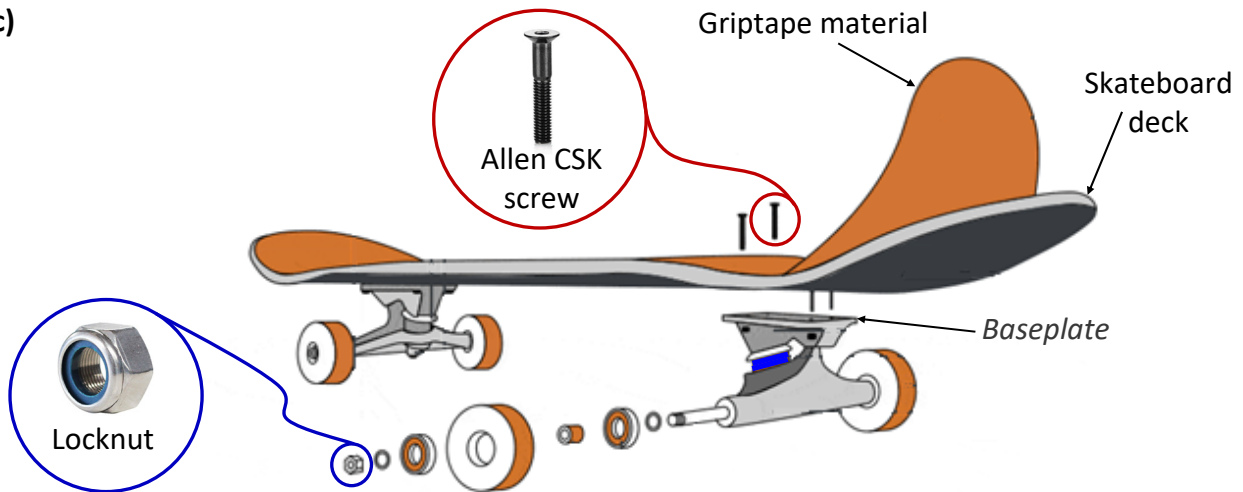
1 mark

Property 2: Lamination can improve the stiffness and flexibility of a material in a product.

1 mark



(c)



- (i) Explain why adhesive is the most suitable method for attaching the griptape material to a skateboard deck.

Explanation: Adhesive is used as it covers the entire area of each surface to be joined thus ensuring even bonding of the griptape to the skateboard deck.

Explanation @ 3 marks

- (ii) State one reason for the use of a locknut in the wheel assembly of a skateboard.

Reason: Skateboards are subject to persistent vibration and impacts. The nylon insert in the locknut will ensure that the wheel assembly will not come apart from such vibration and impacts.

Reason @ 2 marks

- (iii) Outline one advantage of using an Allen CSK screw for the assembly of the skateboard deck to the baseplate.

Advantage: The hexagonal socket ensures the Allen screw is easily tightened, without slippage, using an Allen Key. The CSK head ensures that the screw will be flush (level) with the surface of the skateboard deck.



Allen CSK screw

Advantage @ 2 marks

- (iv) List three lathe processes used to produce the skateboard bushing shown.

Lathe process 1: Facing

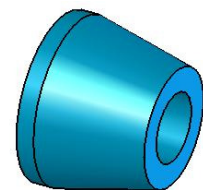
1 mark

Lathe process 2: Parallel turning

1 mark

Lathe process 3: Taper turning

1 mark



Skateboard bushing

(d) The skateboard wheel shown is made from the thermosetting polymer polyurethane.

(i) Explain the term thermosetting.

Explanation: A thermosetting plastic is a polymer that irreversibly becomes rigid when heated. Any subsequent heating will not cause the plastic material to change shape or soften.



Skateboard wheel

Explanation @ 3 marks

(ii) Circle the two plastic products which are made from thermosetting plastics.



1 mark

1 mark

(e) Upcycling is the process of transforming by-products, waste materials, or unwanted products into new products of higher quality.

Describe, with the aid of a diagram, one upcycled use for a skateboard deck.



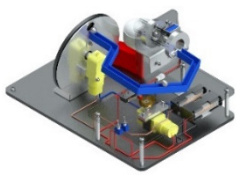
Description: Skateboards may be upcycled to a variety of new products or products of greater quality with the ability to have new life applications such as seating, shelving light fixtures and stairs as shown opposite.

Diagram



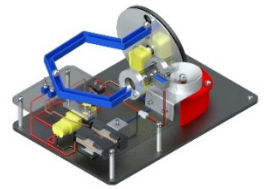
Description @ 3 marks

Diagram @ 3 marks



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle Engineering Project - Model Marble Machine - Marking Scheme 2022



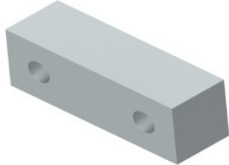
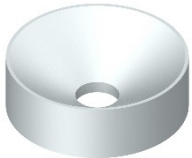
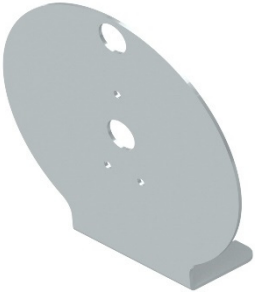
Section 1: Complete Model ('Design Element' not included)

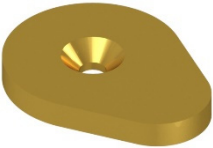
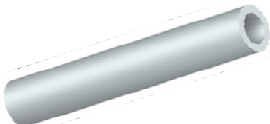
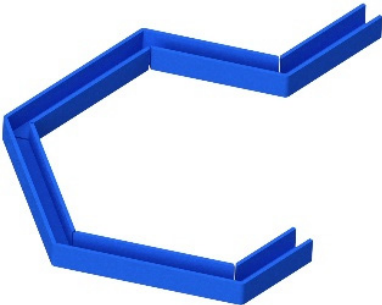
Headings	Description	Marks
Assembly	Subjective Grade 1 – 20	20
Finish	Subjective Grade 1 – 20	20
Mechanical Function	Subjective Grade 1 – 15	15
Electrical Function	Subjective Grade 1 – 15	15
Section 1 - Total		70

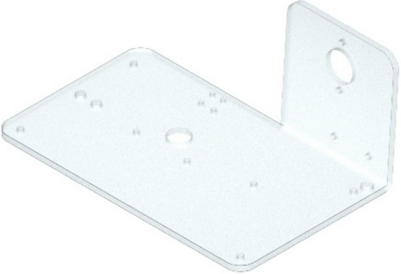
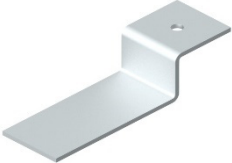
Section 2: 'Design Element' (Not required for 2022)

Section 2 - Total	--
-------------------	----

Section 3:

Headings	Description	Marks
Part 1 - Elevator Motor Spacer 	Mark out, Drill & Shape	5
Part 2 - Track Support 	Mark out, Drill, Shape & Bend	5
Part 3 - Hopper Bracket 	Mark out, Drill, Shape & Bend	5
Part 4 - Hopper 	Machining internal taper	5
	Mark out, Drill & Tap	5
Part 5 - Elevator Support 	Mark out & Drill	5
	Shape, Slots & Bend	10

Part 6 - Marble Elevator 	Mark out, Drill & Shape	10	10
Part 7 - Outer Ring 	Mark out, Drill and Tap	5	10
Part 10 - Platform Ring 	Mark out, Drill and Tap	5	
Part 8 - Tunnel 	Mark out, Machining & Drill	5	10
Part 9 - Outer Ring Bracket 	Mark out, Drill, Shape & Bend	5	
Section 3 - Total			70
Section 4:			
Headings	Description	Marks	
Part 11 - Cam 	Mark out, Drill, CSK & Shape	5	10
Parts 12 - Platform Support × 4 	Machining & Drill	5	
Part 13 - Track 	Mark out & Drill	5	20
	Shape & Bend	15	

Part 14 - Base 	Mark out, Drill, Tap & Shape	10	10
Part 15 - Platform 	Mark out & Drill	10	20
	Shape & Bend	10	
Part 16 - Battery Holder 	Mark out, Drill, Shape & Bend	5	10
Part 17 - Cam Motor Spacer 	Mark out, Drill & Shape	5	
Section 4 – Total			70
Overall Total			210