SUPERVISOR TO ATTACH
PROCESSING LABEL HERE

Write your **student number** in the boxes above. **Letter**

# Systems Engineering

## Question and Answer Book

VCE Examination – Friday 14 November 2025

- Reading time is **15 minutes**: 9.00 am to 9.15 am
- Writing time is **1 hour 30 minutes**: 9.15 am to 10.45 am

### Approved materials

- One scientific calculator

### Materials supplied

- Question and Answer Book of 24 pages
- Detachable Formula Sheet in the centrefold
- Multiple-Choice Answer Sheet

### Instructions

- Follow the instructions on your Multiple-Choice Answer Sheet.
- At the end of the examination, place your Multiple-Choice Answer Sheet inside the front cover of this book.
- Detach the Formula Sheet from the centre of this book during reading time.

Students are **not** permitted to bring mobile phones and/or any unauthorised electronic devices into the examination room.

### Contents





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# **Section A** – Multiple-choice questions

## Instructions

- Answer **all** questions in pencil on your Multiple-Choice Answer Sheet.
- Choose the response that is **correct** or that **best answers** the question.
- A correct answer scores 1; an incorrect answer scores 0.
- Marks will **not** be deducted for incorrect answers.
- No marks will be given if more than one answer is completed for any question.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

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**Question 1**

If a circuit has a resistance of 30 Ω and a current of 1.5 A, what is its voltage?

**A.** 450 V

**B.** 45 V

**C.** 20 V

**D.** 0.05 V

**Question 2**

What does LCD stand for?

**A.** light colour diode

**B.** liquid colour display

**C.** light crystal diode

**D.** liquid crystal display

**Question 3**

What is the systems engineering process?

**A.** a three-dimensional (3D) design process

**B.** an assembly line that builds designed parts

**C.** stages and factors that influence the creation and use of integrated and controlled systems

**D.** a document listing the features that must be included in a final design

**Question 4**

A controlled system is a

**A.** system in which the output is controlled by varying the input.

**B.** system that cannot regulate the behaviour of other systems using control loops.

**C.** feedback system with both positive and negative outputs.

**D.** system in which the input is controlled by varying the output.

**Question 5**

Dual solenoids can be applied in various industries and devices due to their versatility.

Which one of the following mechanisms could use a dual solenoid in its operation?

**A.** door lock

**B.** rack and pinion

**C.** manual transmission

**D.** camshaft

**Question 6**

What is the primary function of an input transducer?

**A.** It amplifies signals.

**B.** It converts energy from one form to another.

**C.** It increases pressure.

**D.** It filters signals.

**Question 7**

Which one of the following is the most likely driver of new and emerging technologies?

**A.** aesthetics and ease of use

**B.** cost and commercial reception

**C.** discoveries and new materials

**D.** ease of manufacturing and distribution

**Question 8**

New and emerging technologies can have negative and positive consequences. Managing the potential risks of these technologies is essential.

Which one of the following would **not** be considered when managing the potential risks of new and emerging technologies?

**A.** risk analysis

**B.** risk control

**C.** risk identification

**D.** risk augmentation

**Question 9**

Which one of the following is a possible outcome of technology convergence in engineering?

**A.** decrease in innovation

**B.** surge in integrated systems

**C.** decline in collaboration between industries

**D.** increase in the number of lawsuits because of job losses in factories

**Question 10**

What is a major operational limitation of a reed switch?

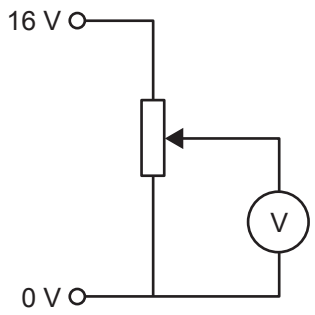
**A.** It is sensitive to external magnetic fields.

**B.** It is sensitive to heat.

**C.** It has a slow response time.

**D.** It is sensitive to the atmosphere.

**Question 11**




The voltmeter shown above is measuring the output voltage regulated by the

**A.** battery.

**B.** fixed value resistor.

**C.** potentiometer.

**D.** thermistor.

**Question 12**

Which one of the following shows the energy transformations in a geothermal power plant?

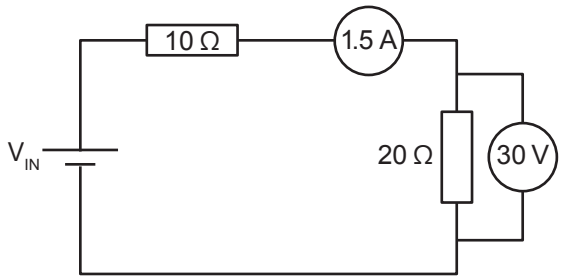
**A.** thermal → chemical → electrical

**B.** thermal → mechanical → electrical

**C.** thermal → electrical → kinetic

**D.** chemical → thermal → hydro

**Question 13**




The amount of power used by the circuit shown above is

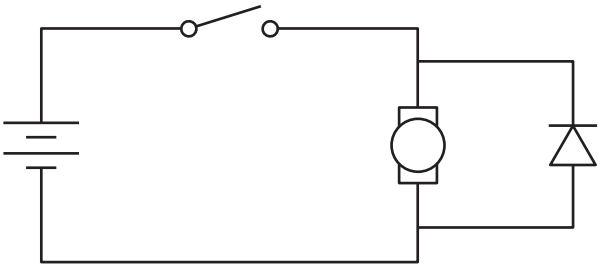
**A.** 67.5 W

**B.** 35.0 W

**C.** 22.5 W

**D.** 15.0 W

**Question 14**



The function of the diode in the diagram shown above is to

**A.** store energy so the motor speed stays constant.

**B.** step up the voltage.

**C.** slow down the motor.

**D.** protect the motor from collapsing coil currents.

**Question 15**

Which one of the following best describes the order of operations in a home solar energy system?

**A.** production, conversion, storage, use

**B.** conversion, production, use, storage

**C.** production, storage, conversion, use

**D.** conversion, storage, production, use

**Question 16**

Which one of the following is the best example of cradle-to-cradle analysis?

**A.** ensuring that electrical components are made from biodegradable materials

**B.** ensuring that wind turbine blades can be dismantled and reused as poles for streetlights

**C.** ensuring that the production of solar cells in a factory has a minimal carbon footprint

**D.** ensuring that no habitats are disturbed during the construction of a dam for the production of hydro-electricity

**Question 17**

Which one of the following examples best demonstrates biomass energy?

**A.** a swimming pool using natural gas to heat water

**B.** a fertiliser promoting the growth of vegetables

**C.** biodegradable plastics releasing oxygen into the atmosphere

**D.** a campfire keeping a group of campers warm

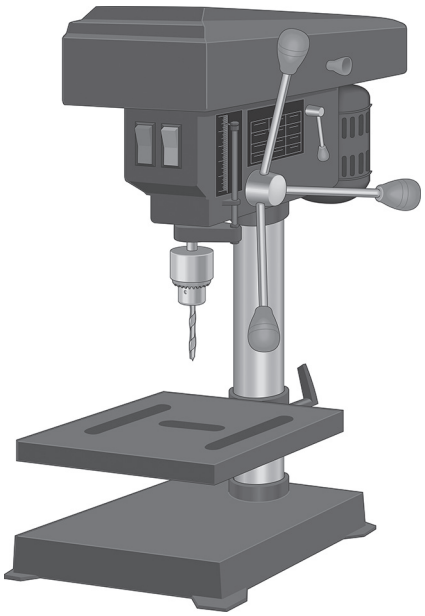
**Use the following information to answer Questions 18 and 19.**

Anthony is building a self-driving car for his Systems Engineering class. In order to successfully meet the criteria set out in his design brief, the car must:

- have a body made entirely of recycled materials; however, the electronic components do not need to be recycled
- be able to autonomously navigate a short course using a very precise steering control.

**Question 18**

Anthony has some scrap sheet metal that he found in a junkyard. He intends to repurpose the metal for the car's body and will use a drill press for this task. A drill press is a power tool used to drill precise holes in materials such as metals.



Source: Allied Computer Graphics/Shutterstock.com

Which one of the following risk management strategies should Anthony use when completing a risk assessment for the use of a drill press to drill through steel?

**A.** Loose clothing should be worn to ensure comfort when using the equipment.

**B.** Safety glasses should be used to protect the student's eyes from metal fragments.

**C.** An extra person should assist the student to hold the piece of sheet metal.

**D.** A large drill bit should be used to reduce the amount of time needed to use the equipment.

**Question 19**

Anthony's original design used a stepper motor to allow the car to steer itself. However, when he went to his local electronics supply store, the item was out of stock. Instead, Anthony was offered a servo motor, which would also allow the car to steer itself.

What is the potential impact of making this design change on the final product?

**A.** The product may not be delivered by the desired due date.

**B.** The product may not be made of recycled materials.

**C.** The product may not be able to navigate the short course as accurately.

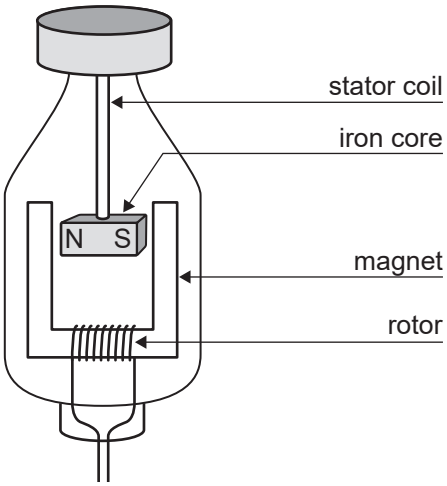
**D.** The product may not be able to meet the weight requirements.

**Question 20**

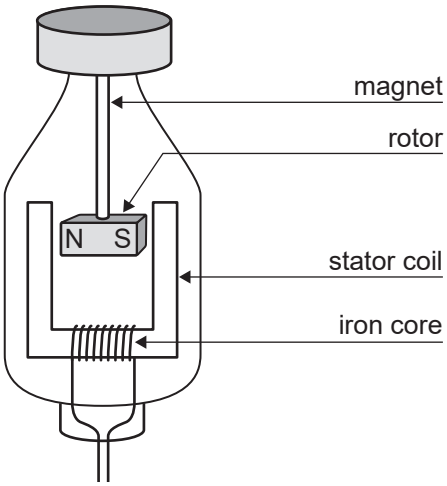
A generator contains a magnet that spins near a coil of wire.

Based on this information, which one of the following diagrams shows the correctly labelled generator?

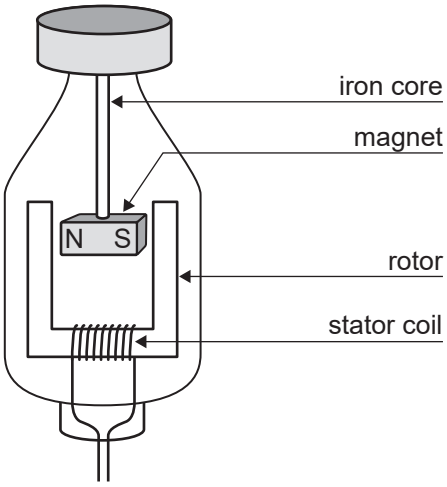
**A.**



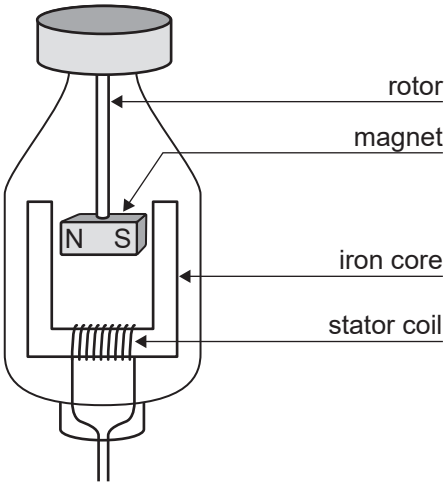

**B.**




**C.**




**D.**




**End of Section A**

# Section B

- Answer **all** questions in the spaces provided.
- Write your responses in English.
- All calculations must show appropriate formulas and working.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

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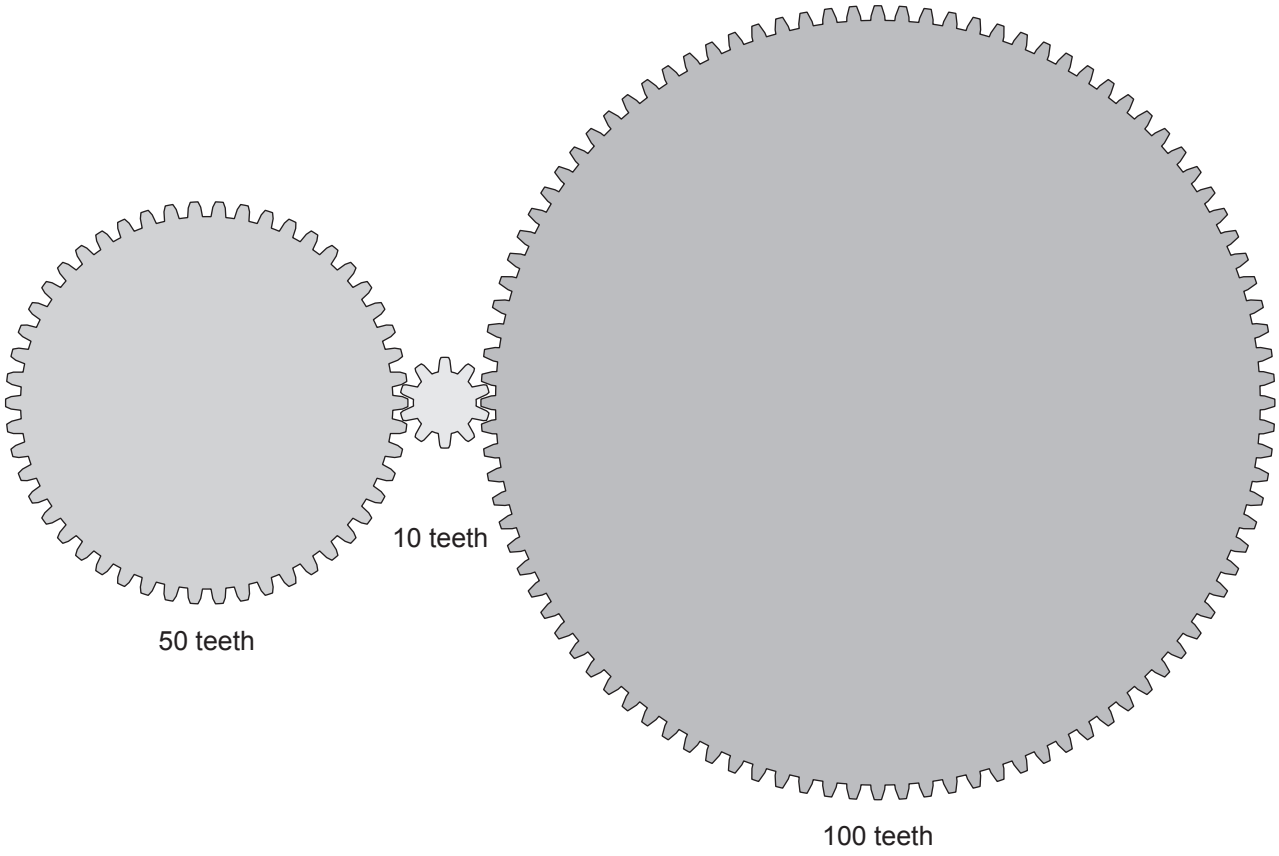
**Question 1** (3 marks)

The diagram below shows a gear train with a mechanical advantage of 5 and an input gear rotating anticlockwise.

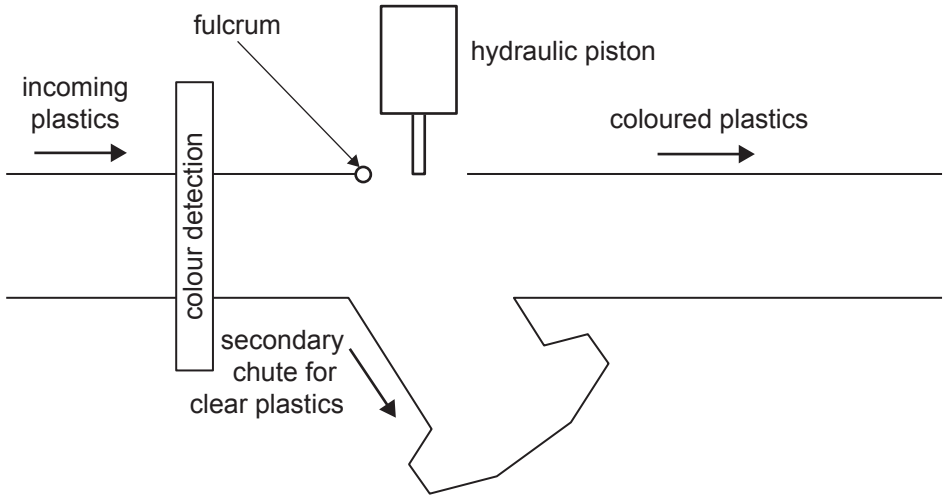
On the diagram provided, identify and label the input gear, the output gear, and the directions in which the three gears are moving.



**Question 2** (17 marks)

A recycling plant is trialling a new method of separating coloured plastics from clear plastics, as shown in the diagram below.

As the materials move along the conveyor belt, a sensor detects whether the materials are coloured or clear, and then activates a lever to alter the path of the clear plastics to the secondary chute, where there is no conveyor belt.



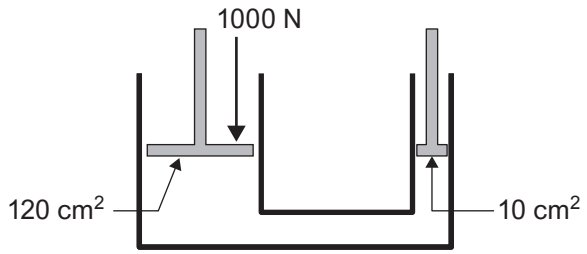

**a.** Draw an appropriate lever on the diagram above. Label the effort and load on the diagram. 3 marks

**b.** Identify the class of lever. 1 mark

**c.** Draw an input-process-output (IPO) diagram to represent the colour-detection operation. 3 marks

Do not write in this area.

**d.** The diagram below shows a hydraulic piston system. The area of the input piston is 120 $cm^2$.




Calculate the output force of the hydraulic piston system using the given values. Show your working. 3 marks

**e.** The output piston moves 0.3 m in 20 seconds.

Calculate the power of the hydraulic piston system. Show your working. 3 marks

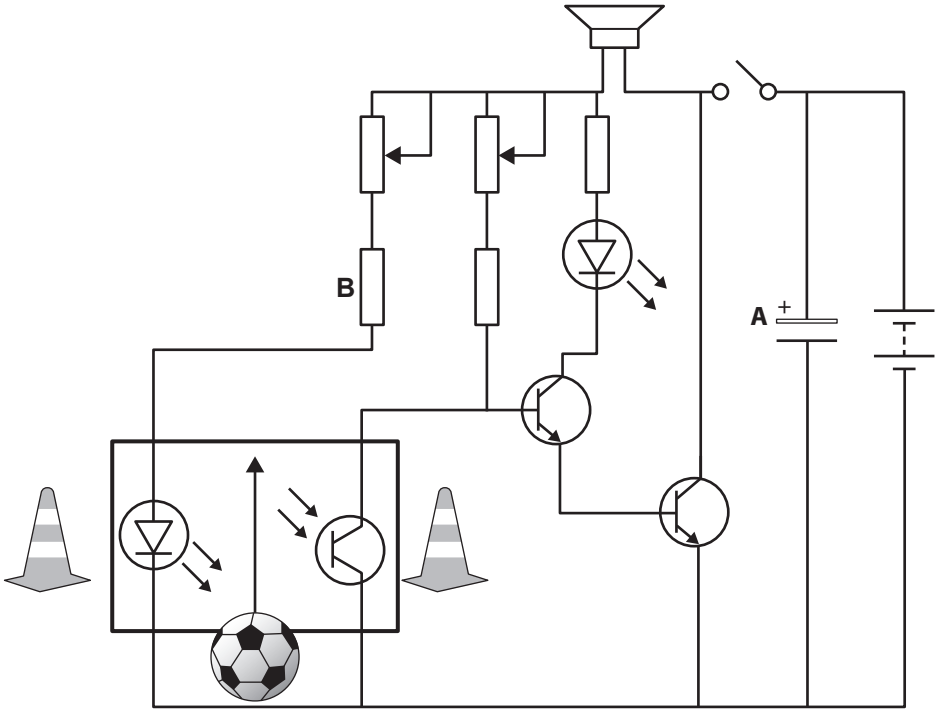
**f.** A worker notes that when clear plastics are redirected to the secondary chute, the clear plastics get stuck and have to be pushed along manually.

**i.** Describe why this might occur. In your response, refer to friction and any **one** of Newton's laws. 3 marks

**ii.** Suggest **one** method for improving the movement of clear plastics through the secondary chute. 1 mark

**Question 3** (9 marks)

The schematic circuit below shows an outdoor training system designed by a soccer coach to play a short celebratory song from a speaker when a player passes the ball between two cones.




Source: Adapted from Chegg <www.chegg.com/homework-help/>

**a.** Identify the **two** components that the ball must pass between to activate the speaker. 2 marks

**b.** Identify and describe the function of component A in the circuit above. 2 marks

**c.** The coach set up the cones and circuit outdoors and observed that the speaker continuously played music regardless of whether the ball passed through the two cones or not.

Explain how the coach could modify the system so that the speaker plays music only when the ball passes between the two cones. 2 marks

**d.** During testing, a fault was identified in component B, the 2400 Ω resistor. The coach does not have another 2400 Ω resistor but has 3600 Ω, 1800 Ω and 1200 Ω resistors.

Sketch a resistor network that the coach could use to replace the faulty component. 3 marks

**Question 4** (10 marks)

A regional city in Victoria is supplied with electricity from a hydro-electric power plant and a small coal-fired power plant. However, its growing population is putting a strain on the energy supply. At a council meeting, community members discussed options for upgrading the energy supply as well as investing in alternative power sources.

Source: AI.geba/Shutterstock.com

**a.** Describe **one** approach that could be used to improve the efficiency of the coal-fired power plant. 2 marks

**b.** During the council meeting, solar and wind were proposed as alternative power sources, and solar was supported by the majority.

Identify one advantage and one disadvantage of using each technology. 4 marks

| | **Solar** | **Wind** |
|---|---|---|
| advantage | | |
| disadvantage | | |

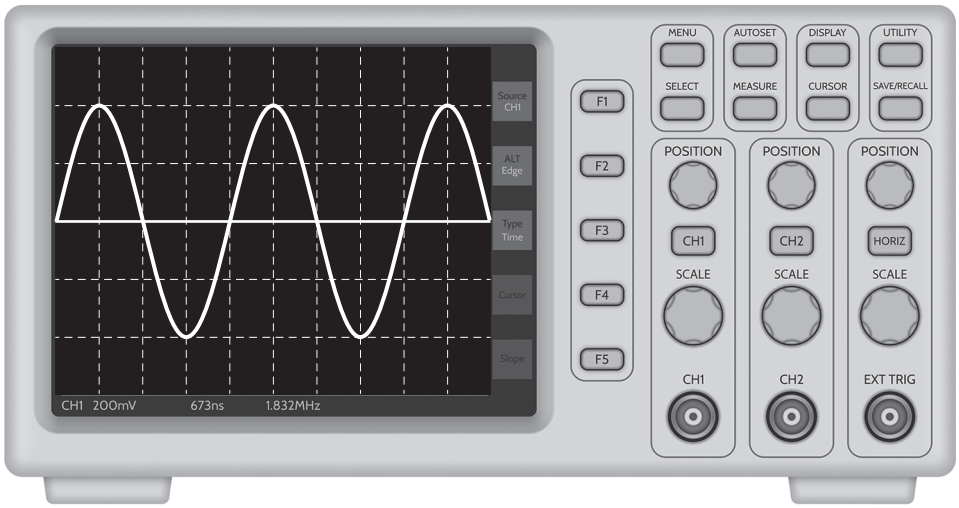
**c.** To provide power during emergencies, the council has installed a rechargeable battery at the local hospital. The battery has a capacity of 140 000 J of electrical energy but only 80 000 J are delivered to the medical equipment.

**i.** Calculate the efficiency of the battery system as a percentage. Show your working. 2 marks

**ii.** Explain why some energy would be lost in the transfer from the battery to the medical equipment. 2 marks

**Question 5** (6 marks)

An oscilloscope is used to measure a waveform from an alternating current (AC) mains power supply.




Source: Adapted from Konstantin Batrakov/Shutterstock.com

**a.** The horizontal scale is 0.02 seconds per division and the vertical scale is 110 V.

Calculate the frequency of the wave. Show your working. 2 marks

**b.** An adaptor is connected to the AC mains power supply to power a 12 V laptop.

Identify any two components within the adaptor that are necessary to deliver the correct power to the laptop, and outline the purpose of each. 4 marks

Component 1

Component 2

Do not write in this area.

**Question 6** (16 marks)

As part of a Systems Engineering project, Alex wants to install a light-emitting diode (LED) light on their bicycle that will power up while they are pedalling. Alex wants to turn on the LED light with either a dynamo or a generator.

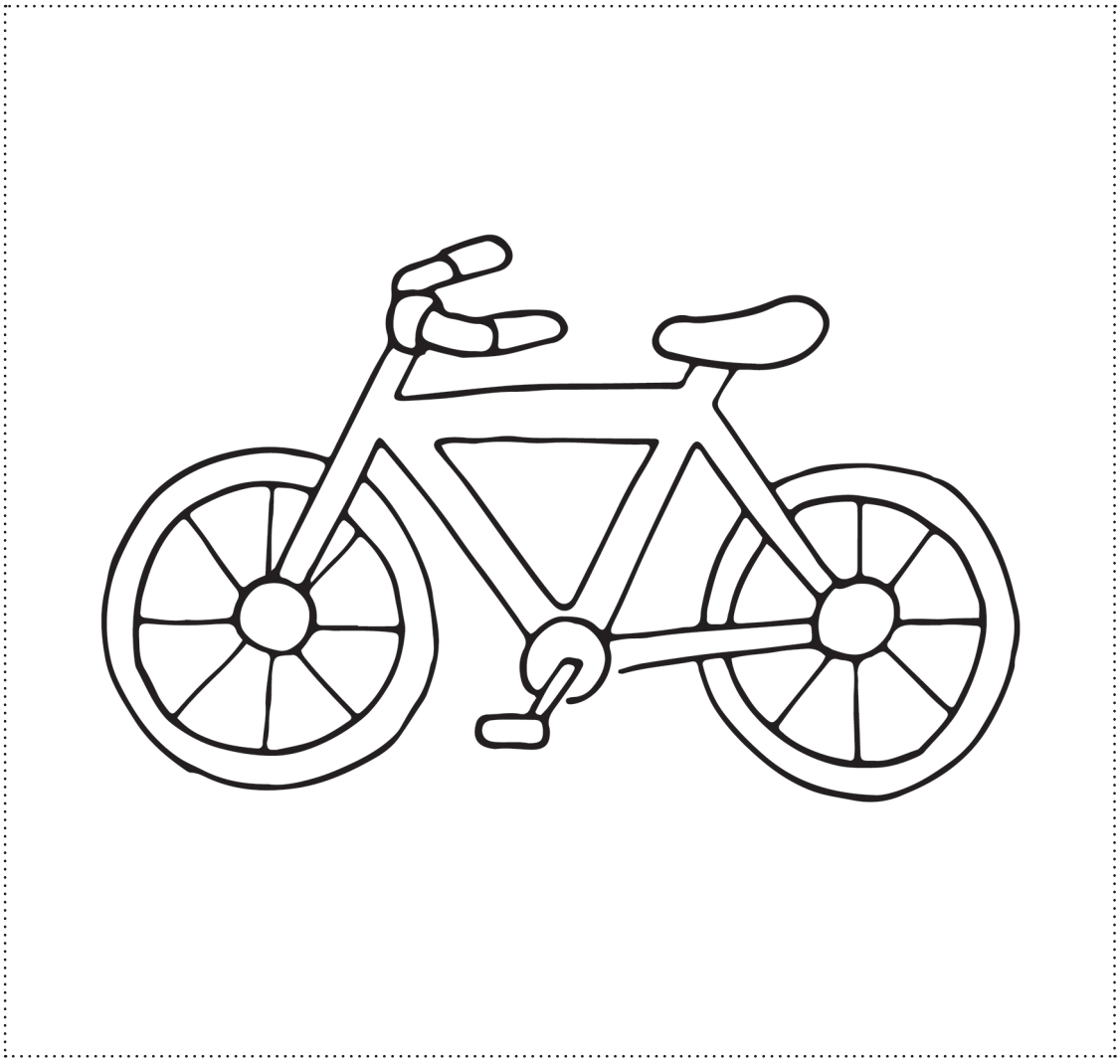
**a.** Which power source should Alex use to turn on the LED light on the bicycle while pedalling? Justify your response. 2 marks

**b.** Describe how the operational system of the power source, identified in **part a**, would turn on the LED light when Alex is pedalling. 2 marks



**Question 6** continues on the next page.

**c.** Alex wants to connect the power source to the bicycle. On the diagram below, indicate where the power source and the LED light should be located, and draw the required wire connections. 3 marks



Source: Sasha Mosyagina/Shutterstock.com

**d.** State and justify two criteria that Alex could use to evaluate the efficiency of the bicycle light system. 4 marks

Criterion 1 _____

_____

_____

_____

Criterion 2 _____

_____

_____

_____

**e.** Alex wants to test the output voltage and current for the bicycle light system with a digital multimeter.

Outline the set-up that Alex requires to test the output voltage and the current, and explain the testing procedure for each. 5 marks

Set-up

Testing procedure – voltage

Testing procedure – current

**Question 7** (5 marks)

Artificial intelligence is a new and emerging technology that focuses on the creation of computer systems to perform tasks that typically require human intelligence, such as analysing large datasets to make predictions based on pattern recognition. The use of artificial intelligence, including in renewable energy systems, has increased exponentially since the early 2020s.

Discuss how artificial intelligence can be used in the operation and maintenance of wind energy systems.

**Question 8** (4 marks)

A group of engineering students want to develop an electronic lock system that can be controlled remotely via an app installed on smart devices. The students want to use an open-source software model in developing the system.

Discuss the effect that the use of an open-source software model could have on the development of the system. In your response, discuss **one** possible positive effect and **one** possible negative effect.

**Question 9** (6 marks)

A Systems Engineering teacher is designing a project for their students that will require the production of a desk lamp with metal parts and wooden arms, as shown in the image below.

Source: VitaminCo/Shutterstock.com

The teacher will provide the students with the required materials, but the students will be responsible for manufacturing all parts and components.

Suggest three production processes that would be required to manufacture the lamp, and describe how each of the suggested processes should be undertaken safely.

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

**Question 10** (4 marks)

Weather stations are systems that collect and record weather-related data via a range of subsystems.

Identify two subsystems that would commonly be used in the operation of a weather station. Outline one maintenance procedure for each subsystem that would ensure its effective and efficient operation.

Subsystem 1 _____

Maintenance procedure _____

_____

Subsystem 2 _____

Maintenance procedure _____

_____

**End of examination questions**

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# Systems Engineering

## Formula Sheet

Please remove from the centre of this book during reading time.

You may keep this Formula Sheet.



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## Mechanical

| | |
|---|---|
| $\text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100\%$ | $\text{efficiency}_{\text{total}} = \text{efficiency}_1 \times \text{efficiency}_2$ |
| $F = ma$ | $\text{force due to gravity} = \text{mass} \times \text{acceleration due to gravity}$ |
| $P = \dfrac{W}{t}$ | $\text{work done} = \text{force in direction moved} \times \text{distance}$ |
| $\text{torque} = \text{twisting force} \times \text{perpendicular distance to pivot point}$ | $\text{moment} = \text{force} \times \text{perpendicular distance to pivot point}$ |
| $F_1 d_1 = F_2 d_2$ | $P = \dfrac{F}{A}$ |
| $\text{speed} = \dfrac{\text{distance}}{\text{time}}$ | $\text{mechanical advantage} = \dfrac{\text{load}}{\text{effort}}$ |
| $\text{gear ratio final} = \text{gear ratio 1} \times \text{gear ratio 2}$ | $\text{gear or pulley ratio} = \dfrac{\text{speed of driver (rpm)}}{\text{speed of driven (rpm)}}$ |
| $\dfrac{\text{Gear A rpm}}{\text{Gear B rpm}} = \dfrac{\text{Gear B number of teeth}}{\text{Gear A number of teeth}}$ | $\dfrac{\text{Pulley A rpm}}{\text{Pulley B rpm}} = \dfrac{\text{diameter of Pulley B}}{\text{diameter of Pulley A}}$ |
| $\text{velocity ratio} = \dfrac{\text{distance moved by effort}}{\text{distance moved by load}}$ | |

## Electrical

| | | | |
|---|---|---|---|
| electrical energy efficiency $= \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$ | | $I = \frac{V}{R}$ | |
| $P = VI$ | | $P = \frac{E}{t}$ | |
| $f = \frac{1}{T}$ | | $V_x = \frac{R_x}{R_{total}} \times V_{supply}$ | |
| $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ | | $V_{peak} = \sqrt{2}V_{RMS}$ | |
| resistors in series | $R_t = R_1 + R_2 + R_3 + \ldots$ | resistors in parallel | $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$ |
| two resistors in parallel | $R_t = \frac{R_1 \times R_2}{R_1 + R_2}$ | capacitors in series | $\frac{1}{C_t} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$ |
| capacitors in parallel | $C_t = C_1 + C_2 + C_3 + \ldots$ | | |

## General

| |
|---|
| area of circle $= \pi r^2$ $(\pi = 3.14)$ |
| circumference of circle $= 2\pi r$ |

## Resistor colour codes

| Colour | Value | Colour | Value | Colour | Tolerance |
|---|---|---|---|---|---|
| black | 0 | green | 5 | brown | 1% |
| brown | 1 | blue | 6 | red | 2% |
| red | 2 | violet | 7 | gold | 5% |
| orange | 3 | grey | 8 | silver | 10% |
| yellow | 4 | white | 9 | | |

**End of Formula Sheet**