



Victorian Certificate of Education 2002

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

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SYSTEMS AND TECHNOLOGY

Written examination

Wednesday 20 November 2002

Reading time: 2.00 pm to 2.15 pm (15 minutes)

Writing time: 2.15 pm to 3.45 pm (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
5	5	100

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, an approved graphics calculator (memory cleared) and/or one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 21 pages including formulas on page 21.

Instructions

- Write your **student number** in the space provided above on this page.
- All calculations must show appropriate formulas and working.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

Instructions

Answer **all** questions in the spaces provided.

Question 1

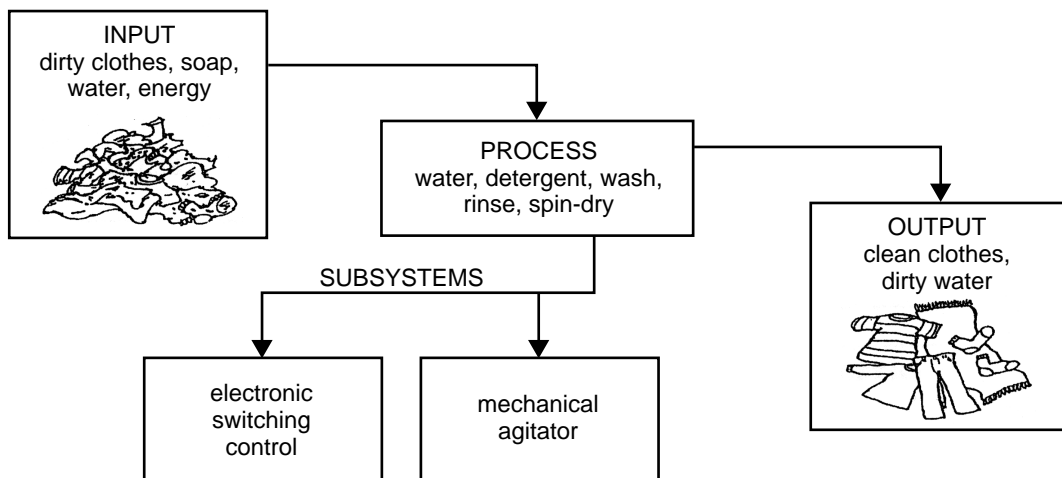
Systems and subsystems

As a part of your course you were required to select/design and construct a controlled integrated system.

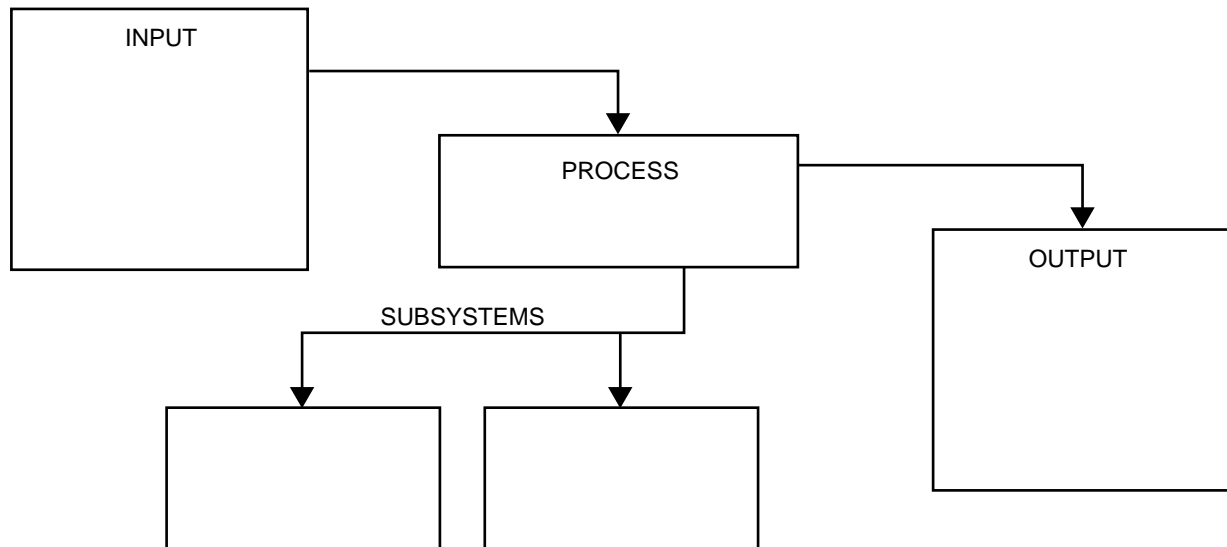
a. i. Name the system _____

Briefly describe the system _____

Figure 1 below is an example of a systems block diagram which illustrates and describes the operation of a domestic washing machine. This will assist you in the next question where you are required to analyse the system you have constructed.



- ii. Using Figure 1 as a reference, describe the operation of the integrated technological system you named in part a.i. on the diagram below. The subsystems listed must include one example from the electrical/electronics category and one example from the mechanical, pneumatic or hydraulic category.



2 + 5 = 7 marks

- b. i. Draw a systems block diagram which describes the operation of the **electrical/electronic** subsystem you named in part a.ii. in terms of the input, process and output. Specific values of measurement must be stated where applicable.
- ii. Draw a systems block diagram which describes the operation of the **mechanical, hydraulic or pneumatic** subsystem you named in part a.ii. in terms of the input, process and output. For the output state the desired output and one undesired output.

5 + 5 = 10 marks

Question 1 – continued

TURN OVER

- c. Select **one** of the subsystems you have named in part **a.ii.** and list two of its main components or component parts.

Name of subsystem _____

1 _____

2 _____

2 marks

- d. The technological system that you named in part **a.i.** required you to perform design or modification work on the system.

- i. Name the design or modification work that you carried out.

- ii. Describe the purpose of the design or modification work.

- iii. Accurately sketch an illustration and/or describe the design or modification work.

1 + 2 + 2 = 5 marks

Total 24 marks

Question 2**Control of integrated systems**

- a. i. Name a control device that you used to control the integrated system you constructed and named in Question 1 a.i.

- ii. Does the system named above operate as an open loop system or a closed loop system? Explain briefly.

- iii. If the control device of your integrated system failed, how would this affect the operation of the system named above? Describe this failure in terms of input, process and output.

Input

Process

Output

1 + 2 + 3 = 6 marks

Most cars have a heating system for the comfort of the people inside the car (in the cabin). Some cars also have a cooling system (air conditioning) for the cabin. The following diagram (Figure 2) shows the heating system of an average car.

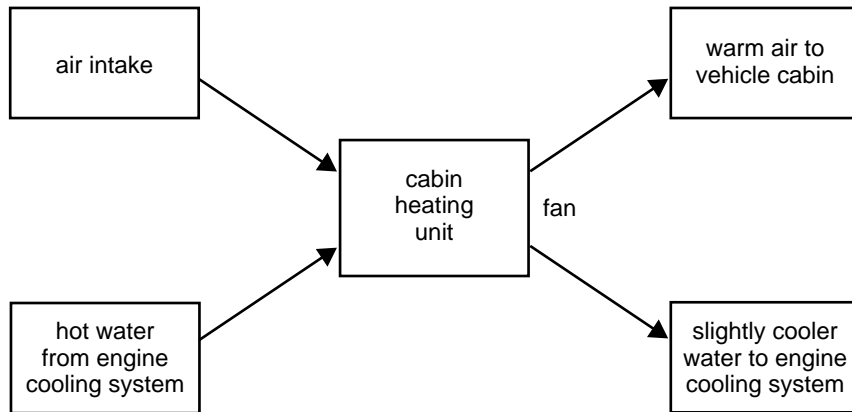


Figure 2

This is an example of an open loop system.

b. i. Explain why this car cabin heating system is an open loop system.

ii. On Figure 3 below, **name** in the space provided at point X, a device which would convert the system to a closed loop system.

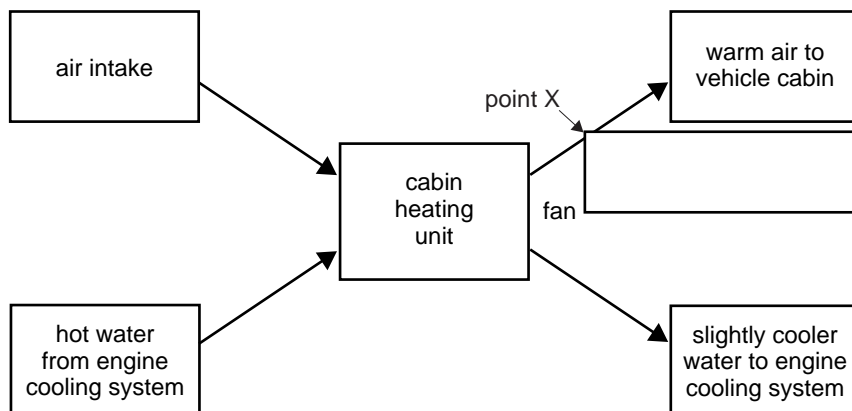


Figure 3

- iii. Explain briefly how the closed loop system would operate.

1 + 1 + 1 = 3 marks

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When an air conditioning (cooling) system is included in the average car, the combined heating and cooling systems can be shown as follows (Figure 4).

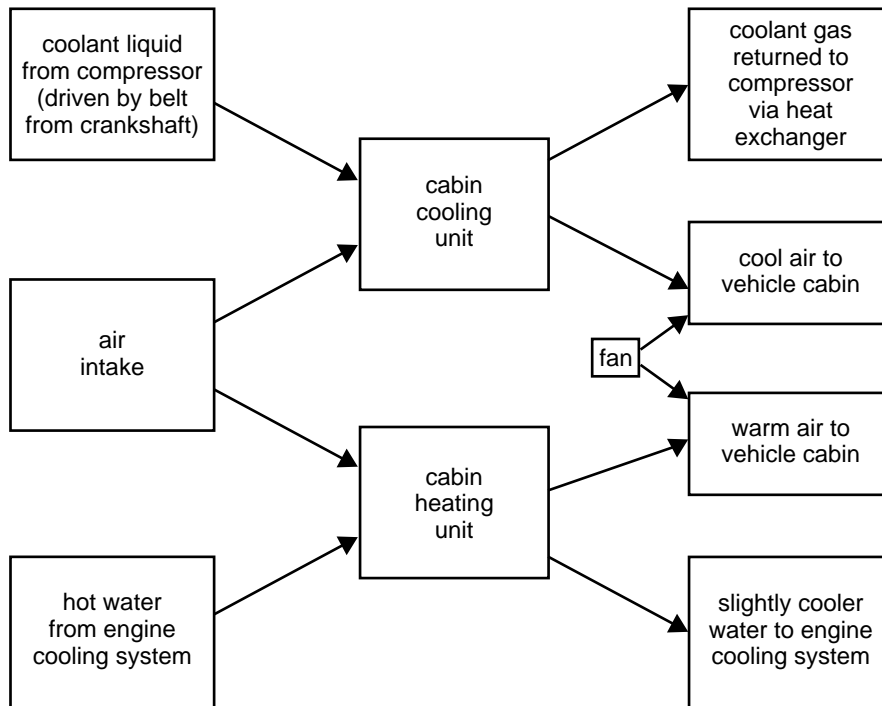


Figure 4

The combined heating and cooling system must never operate with both the heater and cooler working at the same time. The digital exclusive OR gate and its associated truth table (Figure 5) can be used as a control device to prevent the heater and cooler working at the same time.

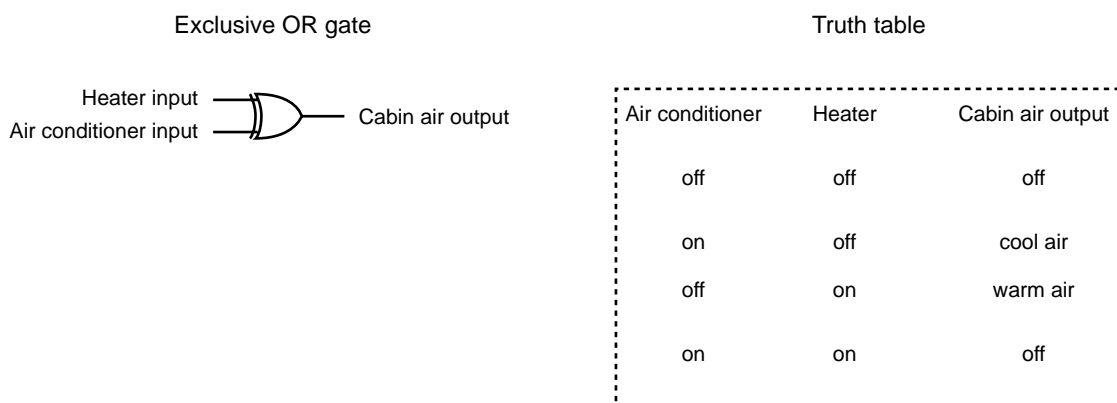


Figure 5

- c. i. The truth table (Figure 5) indicates the operation of the exclusive OR gate. Explain how the exclusive OR gate can be used to ensure that only the heating or cooling system can operate at any one time.

Some modern cars have a climate control system which has at its core a central processing unit. The driver adjusts a dial to set the temperature required in the cabin (for example, 20°C). The system can have the following components.

A central processing unit	
A fan	Air vents into the cabin
A heating unit	Air from the cabin
Air from outside	A cooling unit

- ii. Create a systems block diagram around the central processing unit (Figure 6). Using the above list of components, show how a climate control system functions in terms of input, process and output.

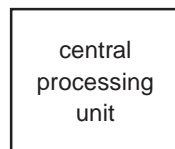


Figure 6

2 + 6 = 8 marks

Total 17 marks

TURN OVER

Question 3**Diagnostic practices****Advanced testing and measurement**

Name the system or subsystem on which you conducted a diagnostic test.

- a. Prepare a plan for a diagnostic test on the system/subsystem you have named above. The plan must be written in a logical sequence and in the order of the work. The following details must be included.
- the type of quantified results you expect to obtain
 - name of the specific type of advanced measuring equipment to be used
 - reason for selecting this type of advanced measuring equipment
 - name and purpose of the diagnostic test
 - setup procedures for the test equipment you have chosen

The above dot points are written in random order.

8 marks

- b. Name the technical publication you used for information about your diagnostic test. Explain how this assisted you in conducting your diagnostic test.
-
-
-

2 marks

Question 3 – continued

- c. At the headings below, list readings that compare one of your expected results with one of the actual results you obtained from your diagnostic test. Explain how this assisted you to interpret your diagnostic test results.
- i. Expected result _____ Actual result _____

- ii. Explanation

2 + 2 = 4 marks

Total 14 marks

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Question 4

Concepts and principles

The four main types of motion that occur in systems are

- linear
- rotary
- reciprocating
- oscillating

a. i. In the space provided name the **two** types of motion illustrated in the drawings in Figure 7.



Figure 7

Figure 8 shows a form of lever designed to create a mechanical advantage.

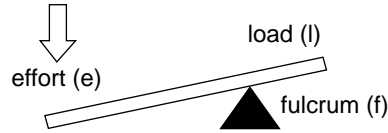


Figure 8

ii. The two examples below (Figure 9) are everyday examples of levers. Mark on the examples below using the letters **f**, **l** and **e**, the fulcrum, the load and the effort.

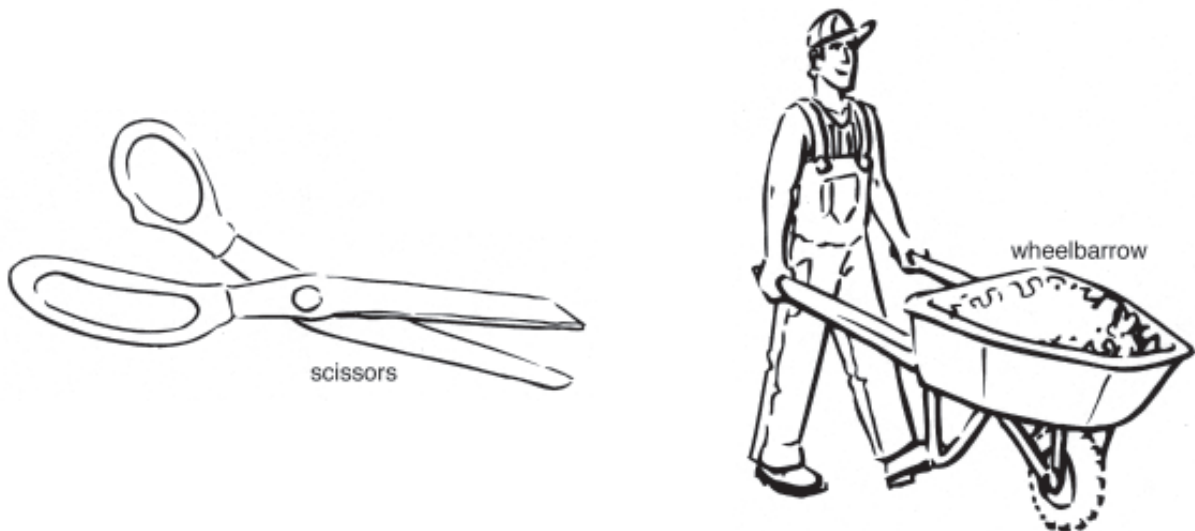


Figure 9

Question 4 – continued

Tension, compression, shear and torsion are different types of force.

- iii. In the space provided below, name the type of force the following two examples (Figure 10) represent.

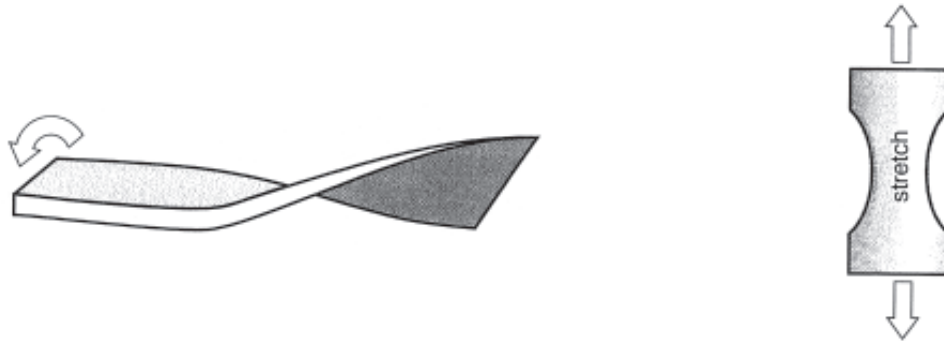


Figure 10

Figure 11 below illustrates two common types of gears. The arrows indicate the direction of rotation of the driver gear.



Rack and Pinion

Figure 11

- iv. Draw an arrow on Figure 11 to show the direction of movement of the driven gear on **each** example.
- v. One gear example in Figure 11 is labelled. Name the other gear example in the space provided.

2 + 2 + 2 + 2 + 1 = 9 marks

Figure 12 below depicts a number of electrical/electronic components.

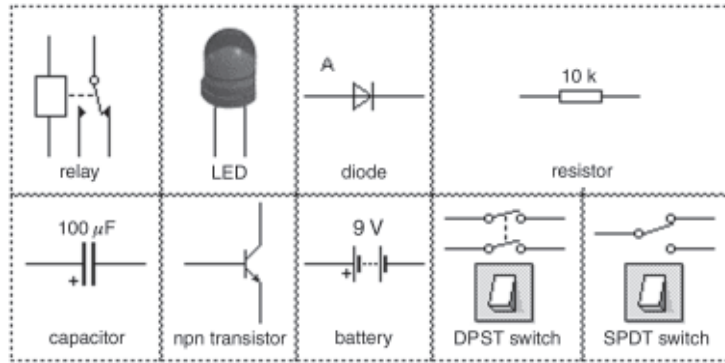


Figure 12

- b. i.** Listed below are **five** functions which can be identified with the specific electronic components pictured in Figure 12.

In the space provided, write the name of the component that correctly matches the function of the component.

limits current in a circuit _____

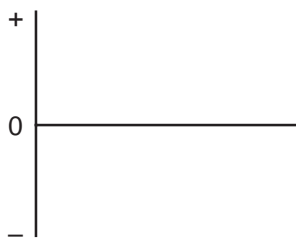
stores electrical charge _____

can switch two poles in one direction _____

acts as an electromagnetic switch _____

can perform as a switch or an amplifier _____

- ii.** On the axes provided draw an example of an AC signal.



- iii.** What do the initials AC and DC stand for?

AC _____

DC _____

- iv.** Name the term which describes the conversion of AC to DC.

5 + 1 + 2 + 1 = 9 marks

Lifting Device

Figure 13 depicts a single pulley device used on a building site to lift mortar.

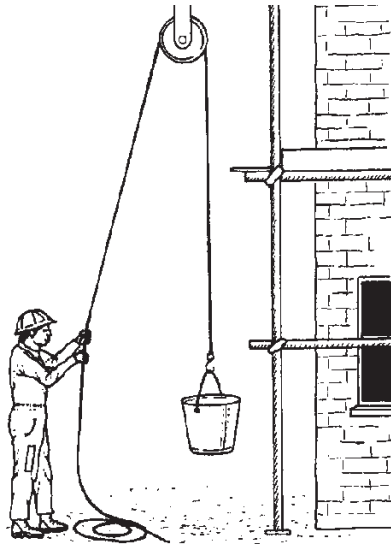


Figure 13

- c. i. State **one** reason why it is safer for the person operating the system to be on the ground pulling downwards rather than off the ground pulling upwards.

Figure 14 depicts a double pulley system which creates a mechanical advantage for lifting a mortar bucket.

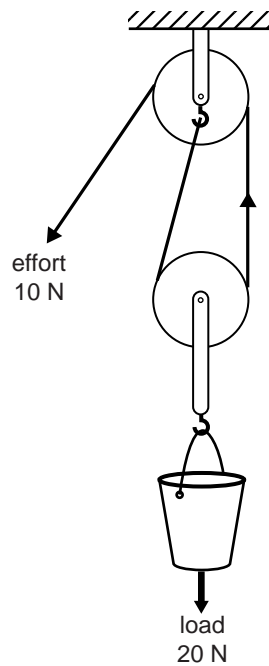


Figure 14

- ii. Express as a ratio the mechanical advantage that the double pulley system creates.

A better system for raising and lowering the bucket uses a hand-operated winch and pulley arrangement as shown in Figures 15 and 16.

hand-operated winch

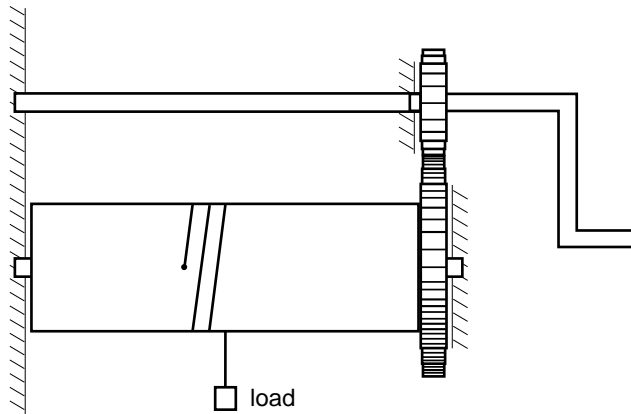


Figure 15

hand-operated winch

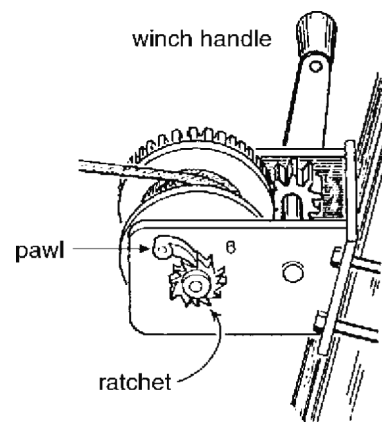


Figure 16

iii. Explain the function of the ratchet and pawl on the hand-operated winch in Figure 16.

iv. What must be done to the ratchet and pawl before the bucket can be lowered?

hand-operated winch

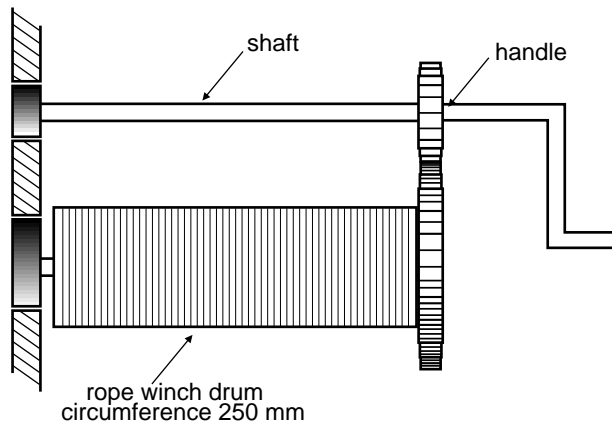


Figure 17

v. The winch rope drum (Figure 17) has a circumference of 250 millimetres. Calculate the number of revolutions the rope drum has to complete to raise the bucket 2.5 metres. Refer to formula on page 21 and show all working.

The hand winch was replaced by a 12 volt electric motor and gear arrangement (Figure 18).

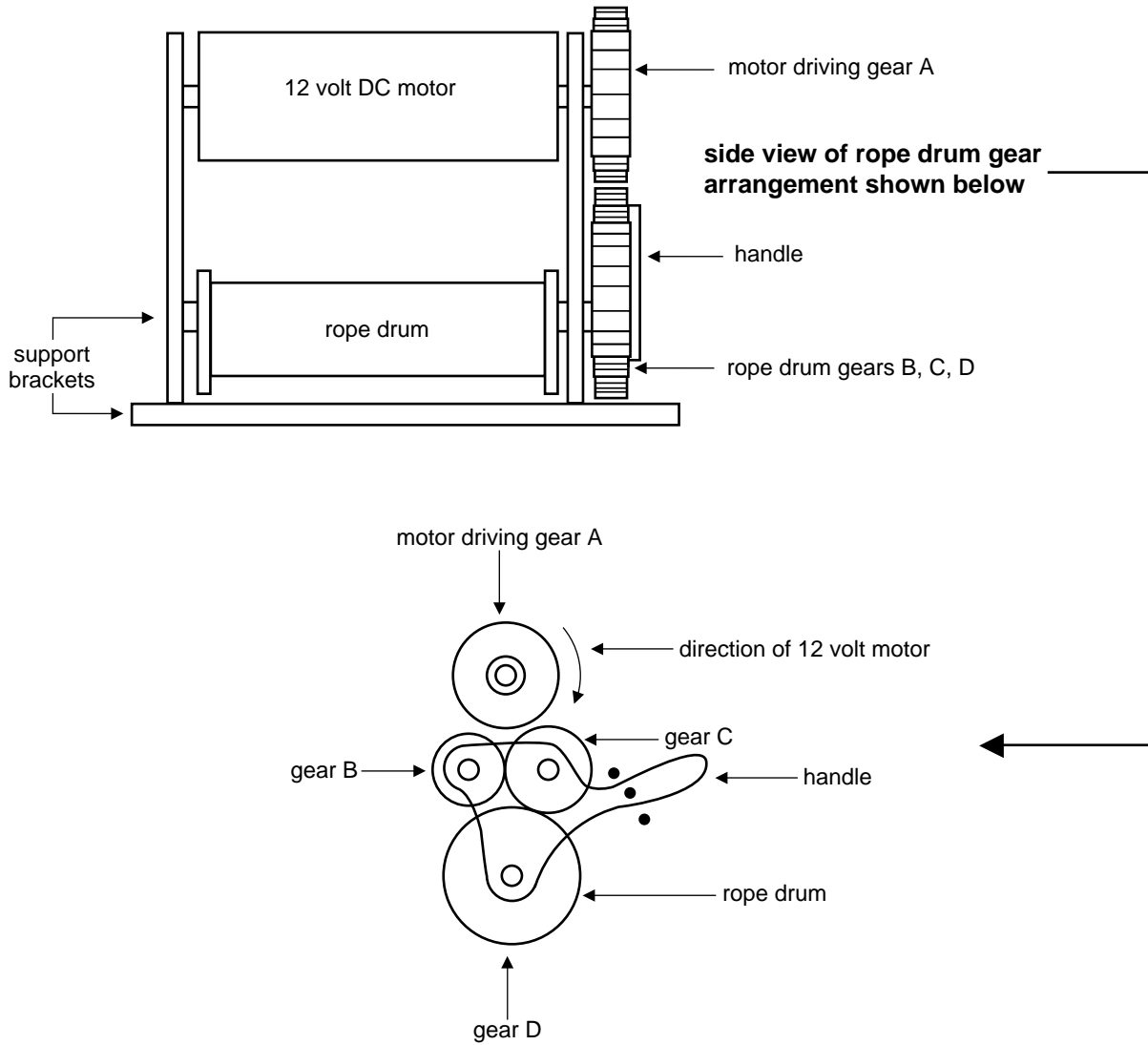


Figure 18

State in the space below which of the gears A, B, C or D will need to be engaged to achieve forward and reverse direction. **Forward direction occurs when gear D turns clockwise.**

vi. Forward direction

gears engaged _____

Reverse direction

gears engaged _____

1 + 1 + 1 + 1 + 3 + 2 = 9 marks

The mortar bucket can also be raised and lowered by driving the electric motor in a clockwise or anticlockwise direction. This is achieved by switching the electric polarity connections from the battery to the motor.

12 volt electric motor and switching arrangement

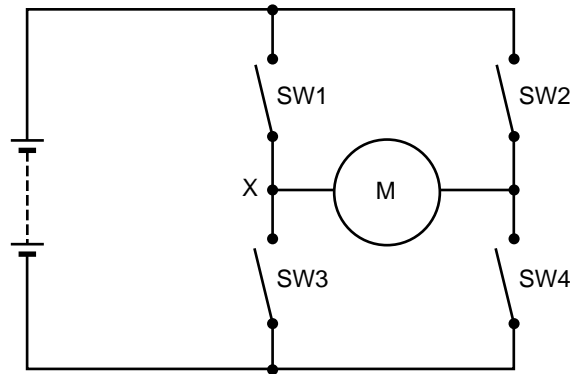


Figure 19

The above schematic diagram illustrates how four SPST switches can run the motor in a clockwise or anticlockwise direction. When the battery negative is connected to X the motor spins clockwise. **When X is connected to the battery positive, the motor spins anticlockwise.**

- d. i. Which **two** switches in Figure 19 are closed to achieve a clockwise direction and which **two** switches are closed to achieve an anticlockwise direction?

clockwise _____

anticlockwise _____

- ii. The motor draws 950 mA from a 12 volt supply. Calculate the power consumption of the motor. Refer to formula on page 21 and show all working.

A flashing light warning system has been included as a safety device for when the bucket is raised or lowered.

Flashing light circuit

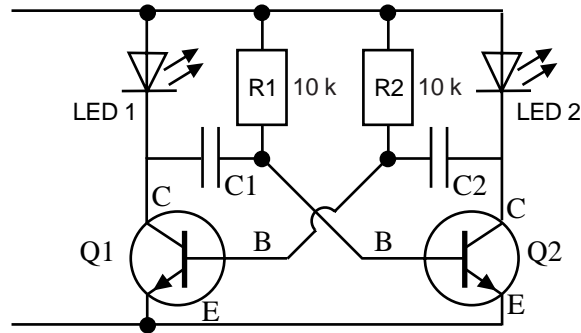


Figure 20

- iii. The electronic circuit shown above in Figure 20 has a digital output signal. Draw, in the space below, a waveform which represents a digital signal.

- iv. What is the function of the transistors in this circuit?

- v. 10 k resistors are not available but you have a large supply of 3 k Ω and 100 Ω resistors. Draw a circuit which will allow you to construct a 10 k resistance from the available 3 k Ω and 100 Ω resistors.

2 + 3 + 1 + 1 + 2 = 9 marks

Total 36 marks

TURN OVER

Question 5

Technology and the environment

Name a specific technological system you studied that has effects on the natural environment.

- a.** List a negative effect and a positive effect that the operation of the technological system named above has on the natural environment. Explain why the effects you identified are negative or positive in their impact on the natural environment.

- i.** Negative effect

Explanation

- ii.** Positive effect

Explanation

3 + 3 = 6 marks

- b.**
 - i.** State one change that has been made to the system named to improve its impact on the environment. Explain how this change has improved the environmental effects of the system's operation.

- ii.** Name one other possible design or management change that could be made to this system to further reduce its negative impact on the environment.

2 + 1 = 3 marks

Total 9 marks

Formulas

$$P = IV \quad V = \frac{P}{I} \quad I = \frac{P}{V}$$

$$\text{number of revolutions} = \frac{\text{distance moved}}{\text{circumference of rope drum}}$$

END OF QUESTION AND ANSWER BOOK