2004 Systems and Technology GA 3: Written examination

GENERAL COMMENTS

The 2004 exam was based on all Areas of Study in Units 3 and 4 of the Systems and Technology Victorian Certificate of Education Study Design. The following criteria were used to set the examination:
1. Knowledge of technological concepts and principles associated with integrated systems
2. Knowledge of technological principles associated with the control of integrated systems
3. Understanding of the function of and interrelationships between a system and its subsystems
4. Understanding of the relationship between technological systems and the natural environment
5. Understanding of the role of diagnosis, evaluation and repair
6. Understanding of the role of design in the production of a technological system

Students were required to answer all questions on the paper.

Following are comments about each question and how marks were assigned. Where descriptive answers were required, some sample answers have been supplied.

SPECIFIC INFORMATION

Note: Student responses reproduced herein have not been corrected for grammar, spelling or factual information.
The advice below outlines the details required when answering questions. It should be read in conjunction with the Systems and Technology 2004 examination paper.

Systems and subsystems, system design and control

Question 1
Question 1 required students to demonstrate an understanding of their production work. Statistical analysis shows that a high percentage of students achieved either full or high marks for this part of the exam, indicating that many students were well prepared for this section and had a good knowledge of their project.

Students were asked to name an integrated system, and all answers in Question 1 related to that system. Where a student named a system that was not integrated, assessors marked only the subsystems and explanations that related to the named system.

1a–b

Marks	0	1	2	3	4	5	Average
%	6	8	15	22	23	27	**3.3**

1a. Draw a systems block diagram which describes, in terms of input, process and output, the operation of the integrated system.
Students were expected to write full answers that clearly described the operation of the named system in terms of input, process and output.

Two marks were awarded if the total description of input, process and output was detailed and related to the named system. One mark was added if this was presented as a systems block diagram.

One mark was awarded if part or all of the description of input, process and output was sketchy but related to the named system. One mark was added if this was presented as a block diagram.

No marks were given for the description of input, process and output if it did not relate to the named system; however one mark was given if the description given was presented as a block diagram.

1b. Name two subsystems that made your system an integrated system.
Both answers needed to relate to the named system. For full marks, both answers needed to be in different categories (that is, only one answer was accepted from the mechanical/hydraulic/pneumatic category and one answer from the electrical/electronic category).

1c. Choose one of the subsystems you have named in part b and describe in detail the input, process and output for that subsystem.

Marks	0	1	2	3	4	5	6	Average
%	10	2	8	28	16	14	21	3.7

The answer was to come from one of the two named subsystems.

Each description must have related to the named subsystem in order to achieve any marks. Two marks were given for each full description of the input, process and output where numerically quantified data was specified; only one mark was given for descriptions that lacked detail.

1d–e

Marks	0	1	2	3	Average
%	14	13	25	48	2.1

1d. Name a major component or device that was responsible for control in your integrated system.
The device named must have been related and capable of some form of system control.

1e. Explain how control was achieved in your integrated system.
Two marks were given for fully detailed descriptions of how control was achieved, or one mark for sketchy details that related to the question.

When producing your integrated system you were required to carry out design or modification work. Identify the design or modification work.
This answer was used to determine the validity and continuity of student answers in Questions 1f and g.

1f–g

Marks	0	1	2	3	4	5	Average
%	15	8	15	22	19	21	2.9

1f. What was the intended purpose of the design or modification work?
The answer needed to relate to the nominated design or modification work.

1g. Produce a detailed, labelled sketch and/or explanation of this design or modification work.
Four marks were awarded for a comprehensive, labelled sketch and/or explanation that related to the named design or modification work and to the integrated system named in Question 1. Either a labelled sketch, a full explanation or both was accepted.

Two or three marks were awarded for an answer similar to that described above, but which lacked detail.

One mark was given for any answer that attempted to explain some design or modification work. Students who wrote comprehensive answers that had no relationship to the above mentioned design or named system could not be awarded full marks.

The following is a high-scoring student response to Question 1. The integrated system that the student named was a model vault.

1a

INPUT		PROCESS		OUTPUT
Electrical energy DPOT switches x 2 SPST switches x 4 9v DC steady Current x 6 (battery)	→	Electrical energy travells to circuits through wires and in some subsystems changes energy to mechanical. Circuits start to operate.	→	Door move vertically and horizontally through rotation in powered motor. Alarm system with code entry requirement is active and interior lighting is switched and powered on.

1b
Subsystem 1 *Variable Dual Flasher for interior lighting*
Subsystem 2 *Wormdrive Gearbox for vertical door movement*

1c

Subsystem name *Wormdrive gearbox for vertical door movement*

Input

9V DC steady current from battery connected to terminals of motor.
electrical energy
DPDT switch

Process

electrical energy creates magnetic flux and motor rotates through the change in electrical energy to mechanical.

Output

motor rotates gears which are connected to a rack. Gears mesh with rack attached to door and the door either moves up or down depending of the direction of the DPDT switch.

1d

DPDT Switch

1e

It controlled the movement of the vertical doors and horizontal doors. By operating the switches the direction of current flowing to the motor reverses to change the direction of motor rotation.

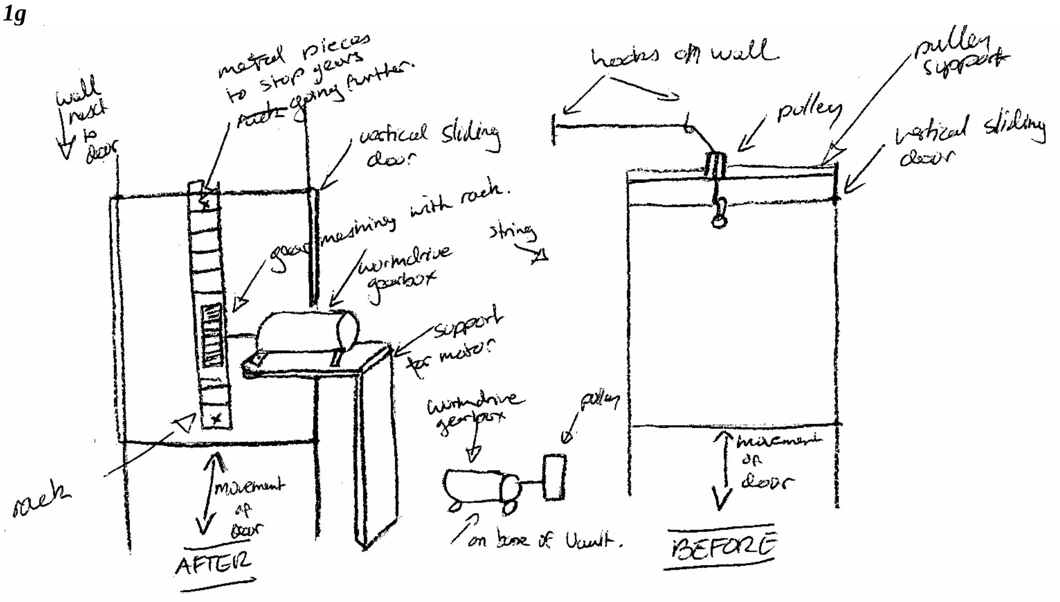
When producing your integrated system you were required to carry out design or modification work. Identify the design or modification work.

Changing the vertical door movement operation from a pulley system to gear.

1f

To minimise further maintenance on the product because the string used for pulley system was weak and eventually wore out

1g



Explanation

Removed the pulley system as seen on right because string wasn't strong enough and the hooks didn't make it easier. So I decided to change to gears and a rack which needed a bit more work in the construction of the support but worked to be less maintenance required.

Diagnostic testing

Question 2

Many students achieved high marks for this section; however, it is of concern that in most parts of this question approximately 20% of students scored no marks.

Name the integrated system on which you conducted a diagnostic or fault-finding test.

The system named here **did not** have to relate to Question 1. This answer was used to mark the validity and continuity of the answers to Questions 2a–g.

2a–b

Marks	0	1	2	Average
%	15	29	57	**1.4**

2a. Name the specific subsystem upon which the test was carried out.
A subsystem was expected to be named here; however, some students may have genuinely tested the whole system. Assessors were asked to read the answers to Questions 2b–g before giving zero marks to students who named the actual system.

2b. Name the specific test that you carried out.
This needed to be a specific test that related to Question 2a.

2c. Explain in detail the purpose of the test.

Marks	0	1	2	Average
%	19	34	47	1.3

Marks were awarded according to the degree of detail given and how well the answer related to the named test.

2d. Name one piece of test equipment that you used to take measurements of the performance of this subsystem.

Marks	0	1	Average
%	20	80	0.8

The test equipment named needed to relate to the specific test undertaken.

2e–g

Marks	0	1	2	3	4	Average
%	20	20	25	17	19	2.0

2e. What is the operating principle for the item of test equipment you used?
The operating principle named needed to be the operating principle of the item of test equipment named in Question 2d.

2f. Explain why you chose this category.
Two marks were awarded to students who provided a comprehensive explanation that detailed the operation of the item of test equipment. Marks were awarded according to the level of accuracy and detail given.

2g. Name the specific unit of measurement that you read from the test equipment that you named in part d.
A specific unit of measurement taken from the test equipment must have been stated (for example, Amps, amperes, volts, kilopascals).

Technological systems and the environment

Question 3
This question required students to answer in very specific terms to obtain marks. Statistical analysis indicates that a large number of students had only a very general understanding of how a system interacts with the natural environment.

As part of your course you studied how a technological system interacts with the natural environment. Name the system.
All answers to Questions 3a–c needed to relate to the system named here.

3a. Name a major specific negative environmental effect associated with the system. You must use specific terminology when referring to any negative effects.

Marks	0	1	Average
%	38	62	0.6

Only answers containing specific terminology were accepted; for example, carbon monoxide into the atmosphere or lead-heavy metal pollution from a battery.

3b. Explain in detail how this effect occurs. You must write full answers with specific details to achieve full marks.

Marks	0	1	2	3	Average
%	22	28	30	21	1.5

Three marks were given for a comprehensive answer that detailed how the system process produces the negative effect when in operation.

One or two marks were given for answers that reflected the above, but which were less detailed or very simple.

3c. Explain in detail how the system design could be, or has been, changed to reduce this negative environmental effect.

Marks	0	1	2	Average
%	27	39	35	**1.1**

Answers should have reflected actual changes or hypothesised about realistic possibilities. Marks were awarded according to the level of detail. Excellent answers included technical terminology about the system.

The following is a high-scoring student response to Question 3.

As part of your course you studied how a technological system interacts with natural environment.
Name the system.
Wind Mill Generator

3a
noise from blades turning create noise pollution.

3b
For a wind mill generator to operate it must generate electricity from the generator which is powered by the turbine. The turbine moves from the blades. When there is enough wind the blades generate lift and start to rotate. The noise of these rotating blades create a significant amount of noise pollution especially when they are producing electricity economically ie at wind speeds of more than 24km.

3c
There has been changes to make noise pollution less effective by relocating these windmill generators to top of cliffs and isolated areas where human habitation is minimal and the impact of noise pollution is significantly less.

Concepts and principles, system design and control on a given system

Question 4
This section had many parts, with Question 4 requiring students to examine a given system from a mechanical aspect.

4a. Describe the operation of the pool blanket roll drum device in terms of its input, process and output.

Marks	0	1	2	3	Average
%	6	5	13	76	**2.6**

- Input: mechanical or human energy is applied to the handle by a person.
- Process: rotary motion occurs through both gears to turn the pool blanket
- Output: the pool blanket is rolled onto the drum.

One mark was given for each correct explanation.

4b–c

Marks	0	1	2	3	4	Average
%	14	6	19	13	47	**2.7**

4b. Calculate how many rotations of the pool blanket roll drum would be required to remove the blanket from the pool. Show all working.

$$\text{Number of revolutions} = \frac{\text{distance moved}}{\text{circum. of roll drum}} = \frac{12}{1.2} = 10$$

4c. Calculate the gear ratio involved in the gear set.

$$\text{Ratio} = \frac{\text{driven gear}}{\text{driving gear}} = \frac{60}{15} = 4$$

One mark was given for formula and/or working, and one mark for the correct answer.

4d. Sketch and label a simple mechanical gear solution that would enable the handle to rotate in the same direction as the pool blanket roll drum when operated.

Marks	0	1	2	Average
%	32	11	58	**1.3**

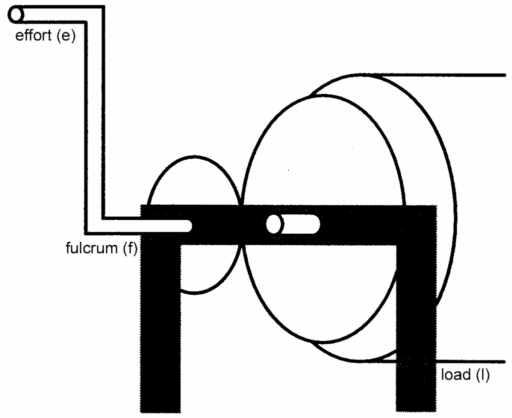
Two marks were given to students who displayed a clear, concise, labelled drawing with two smaller gears driving the larger gear, the number of gear teeth indicated and/or driver/driven and the middle gear labelled idler.

Students who displayed some idea of three gears, with or without labelling, received one mark.

4e–f

Marks	0	1	2	3	4	5	Average
%	8	10	15	32	25	10	**2.9**

4e. Mark on the roll drum handle diagram the fulcrum (f), the load (l) and the effort (e).



One mark was given for each correct answer.

4f. Calculate the torque applied to the 15-tooth gear. Show all working.

torque = force x distance
= 10 x 0.5
= 5

One mark was given for formula and/or working, and one mark for the correct answer.

4g. Suggest a practical solution to reduce the amount of effort required to turn the handle.

Marks	0	1	Average
%	37	63	**0.7**

Make the handle longer, or add more gears to the system.

4h. Draw and label a device that will allow the handle to be disengaged when the pool blanket is being rolled out. The device must allow the handle to be engaged when the blanket is being removed from the pool.

Marks	0	1	2	3	Average
%	38	15	18	29	**1.4**

Three marks were given for well-produced, labelled drawings that clearly showed how this system would work.

One or two marks were given for drawings that were less clear, but where the device illustrated would at least perform the intended function.

4i–k

Marks	0	1	2	3	4	Average
%	8	6	17	32	37	**2.8**

4i. Identify the type of force acting on the pool blanket when it is being removed from the pool.
Tension

4j. Which two motions are not present in the operation of the pool blanket roll drum device?
Reciprocating and oscillating

4k. Which type of motion does the handle use when it is being operated to remove the pool blanket?
Rotary

Question 5
Question 5 required students to examine a given system from an electrical/electronic aspect.

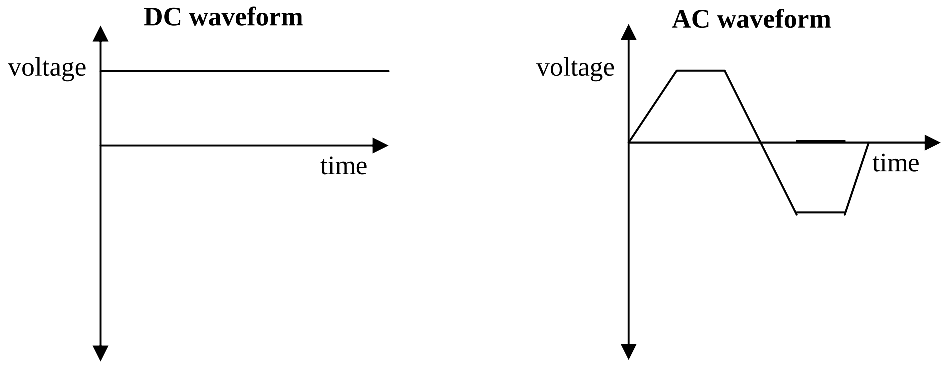
5a. Explain why a 12 volt DC system would be preferred to a 240 volt AC system in this situation.

Marks	0	1	Average
%	33	67	0.7

A 12 volt system is safer than 240 volt, especially around water.

5b. Sketch a typical DC waveform and a typical AC waveform on the graphs below.

Marks	0	1	2	Average
%	22	29	49	1.3



5c–d

Marks	0	1	2	Average
%	61	12	26	0.7

5c. Which type of logic gate would best suit the situation described?
An Or gate.

5d. Explain why you chose this logic gate.
The alarm must sound when either or both inputs are triggered. The Or gate output meets this need.

5e. Complete the truth table for this logic gate.

Marks	0	2	Average
%	57	43	0.9

A	B	Q (output)
0	0	0
0	1	1
1	0	1
1	1	1

The answer must have been as above, no variations were permitted.

5f–g

Marks	0	1	2	3	4	Average
%	33	18	17	19	13	1.6

5f. Explain in detail the operation of the system shown in Figure 8.
If either or both of the motion sensors are triggered by someone or something entering the pool or the pool area, an output high is sent to the Or gate input. This will cause the Or gate output to go high, triggering the timer which will turn the alarm on for 10 minutes.

5g. Why is this system an open loop system?
The system has no feedback loop to allow for the input to influence the output.

5h. Name the following components that have been marked and labelled in Figure 9.

Marks	0	1	2	3	4	Average
%	17	13	15	24	32	2.4

- A: Battery
- B: Resistor
- C: Diode
- D: Transistor

One mark was given for each correct answer

5i–l

Marks	0	1	2	3	4	5	6	7	Average
%	47	6	7	7	10	7	7	10	2.3

5i. What is the major difference between components E and F?
One is polarised and has a positive, the other does not and is electrolytic.

5j. Component E has a value of 10 nF. What does nF stand for?
Nanofarad

5k. Component F has a value of 200 μF. What does μF stand for?
Microfarad

5l. Component C will have an A end and a K end. What do the initials A and K stand for?
- A: anode
- K: cathode

5m–n

Marks	0	1	2	3	4	Average
%	39	16	14	11	21	1.6

5m. Give the resistance between points X and Y.
Two marks were awarded for an answer of 2.88K or 2880.

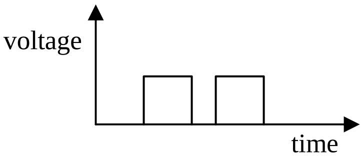
Although available, a formula was not necessary here. Students needed to be able to convert 2K2 into 2200 to achieve the correct answer.

5n. The alarm speaker is rated at 8 ohms and draws a current of 250 mA. Calculate the voltage across the speaker. Show all working.
V = I x R
= 8 X 0.25
= 2 Volts

One mark was given for formula and/or working, and one mark for the correct answer.

5o. The input signal of the alarm is digital. Draw a typical digital signal on the axes below.

Marks	0	1	Average
%	62	38	**0.4**



5p. Complete the sentence below.

Marks	0	1	Average
%	60	40	**0.4**

The relationship between voltage, current and resistance is known as:
Ohms law

The answer must have had the word 'ohms'; 'law' was optional.

Diagnostic Testing

Question 6
Again, students were asked to answer questions concerning diagnostic practices, but this time on a specifically named system. Statistical analysis indicates a polarisation in student marks, with large sections either achieving zero or full marks.

6a–b

Marks	0	1	2	3	Average
%	43	9	12	36	**1.4**

6a. Name the other item of test equipment that is required.
An item of time keeping; for example, a stop watch or watch.

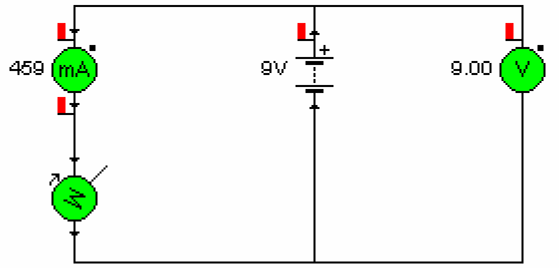
6b. Explain in detail how you would carry out a mechanical test using the 20 litre bucket and the other item of equipment named in part a and give the expected results.
If the pump is operating correctly it will take up to 20 seconds to fill the bucket, or it will pump one litre of water per second.

One mark was awarded for less competent answers that at least indicated some understanding of the process.

6c–d

Marks	0	1	2	3	Average
%	31	19	22	28	**1.5**

6c. Using the components shown below, draw the circuit connections that show the ammeter and voltmeter correctly connected to the motor and battery. Both meters are analogue meters.



One mark was given for each item that was connected correctly.

6d. What will happen to the meter needle if the battery polarities are reversed?
The needle will reverse/go backwards.

Technology and the environment

Question 7
Again students were asked to answer questions concerning technology and the environment, but this time on a specifically named system. Statistical analysis indicates a polarisation in student marks, with large sections either achieving zero or full marks.

7a. Explain briefly why the operation of the heating system shown in Figure 11 is more environmentally friendly than the example shown in Figure 12.

Marks	0	1	Average
%	35	65	0.7

It is a passive system that requires no external energy input.

7b. Explain why the heating system shown in Figure 11 is inefficient in its operation.

Marks	0	1	2	Average
%	36	33	31	1.0

The sun's rays heat only the water surface and it would take a long period of sustained sunshine to heat the whole pool.

One mark was given for less detailed accounts as to why it is inefficient, as long as the student demonstrated some understanding of the process.

7c. State the major negative environmental effect of the operation of the system illustrated in Figure 12.

Marks	0	1	Average
%	50	50	0.5

This system requires an external energy source, and the production of this energy will create some pollution.

7d. Explain why the heating system illustrated in Figure 12 is more efficient in its operation that the system shown in Figure 11.

Marks	0	1	2	Average
%	38	29	32	1.0

The water is being pumped through solar collectors, and over a given amount of time all the pool water will be heated.

One mark was given for answers with less detail but which demonstrated an understanding of the system.