2018 VCE Systems Engineering examination report

General comments

In the 2018 Systems Engineering examination, students found some of the questions relating to resistance of the wires within solar panel circuits to be difficult. Students are reminded that all aspects of the study design are examinable.

Students need to write their answers in the boxes provided. Having multiple answers for a question will not result in marks being awarded. For questions worth two or more marks, clear working showing application of the appropriate formula was essential.

Specific information

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	% A	% B	% C	% D	% No Answer	Comments
1	37	11	43	9	0	Torque is not a force. Torque = force × distance
2	14	38	36	12	0	A worm drive will not work as a driver gear.
3	1	5	19	76	0	
4	6	89	1	4	0	
5	7	13	40	41	0	There are four cables coming from the moving mass. 60/4 = 15 N
6	19	39	15	26	1	On review, it was acknowledged that this question was ambiguous, so students were awarded a mark for any response.
7	16	39	9	37	0	
8	5	60	18	17	0	The driven gear rotates four times for each rotation of the driver.

Question	% A	% B	% C	% D	% No Answer	Comments
9	6	24	64	6	0	One quarter turn. A quarter of two is 0.5 mm (option C).
10	9	26	9	56	0	
11	40	0	2	57	0	A watt is a unit of power, not energy. It is the rate of doing work.
12	42	23	11	24	0	If R_2 is shorted, the voltage drop across it is zero.
13	10	30	57	2	0	
14	33	38	21	7	0	A Zener diode is commonly used to supply a constant DC supply.
15	8	8	31	53	0	Capacitors in parallel add together.
16	26	14	37	23	0	The current is going in one direction only.
17	64	13	10	13	0	All of the current in the circuit needs to flow through the ammeter.
18	14	51	10	25	0	
19	4	4	88	4	0	
20	47	15	19	19	0	The total resistance is 20 Ω. 12/20 = 0.6 or 600 mA (option A)

Section B

Question 1a.

Marks	0	1	2	Average
%	31	39	31	1

Solar hot water and passive solar design are two possibilities. Harnessing of energy includes using windows, so heat energy and light energy can enter the house.

Question 1b.

Marks	0	1	Average
%	79	21	0.2

An answer that included thermal mass was needed.

Question 1c.

Marks	0	1	2	Average
%	15	34	51	1.4

Transport of materials, what the materials were made from, recycling and the impact on fauna

Question 2a.

Marks	0	1	2	Average
%	4	8	88	**1.9**

A: fulcrum

B: effort

Question 2b.

Marks	0	1	Average
%	64	36	**0.4**

Reciprocating

Question 2c.

Marks	0	1	Average
%	29	71	**0.7**

Class 1

Question 2d.

Marks	0	1	2	3	Average
%	23	36	22	19	**1.4**

As the piston rod goes up, Valve 1 closes, causing low pressure below it and Valve 2 opens drawing water up. As the piston rod goes down, Valve 2 closes and the water passes through Valve 1.

Question 2e.

Marks	0	1	2	Average
%	11	14	74	**1.7**

Mechanical advantage = 900/150 = 6

Question 2f.

Marks	0	1	2	Average
%	58	1	41	**0.9**

100 × 6 = 600 mm

Question 2g.

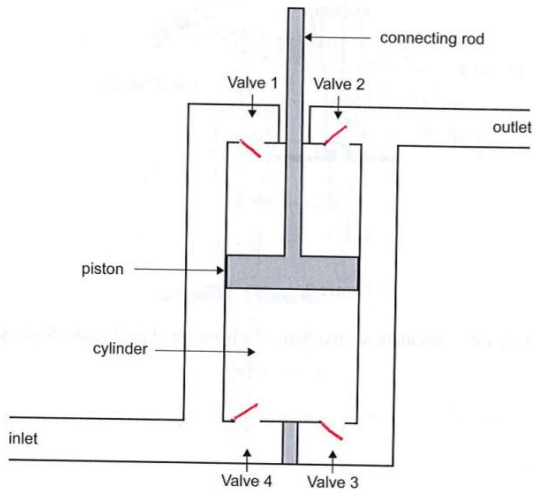| Marks	0	1	2	3	Average
%	39	45	9	7	**0.9**

The force on the end of the handle is 10 N, so the force on the piston rod is 60 N. The diameter of the piston is 50 mm, hence the area is $3.142 \times 0.025^2 = 0.001964$

Pressure $= \frac{force}{area} = 30\,500$ N m^{-2} or 30 500 Pa

Marks were also awarded to students who interpreted the question as 10 N being applied to the piston rod. In this case the answer was $\frac{10}{0.01964} = 5090$ N m^{-2}

Question 3a.

Marks	0	1	2	Average
%	41	13	46	1.1

Question 3b.

Marks	0	1	2	Average
%	6	33	61	1.6

Direction of piston	Valve 1	Valve 2	Valve 3	Valve 4
moving up	closed	open	closed	open

Question 3c.

Marks	0	1	2	Average
%	58	19	24	0.7

$2 \times 3.1415 \times 25^2 \times 50 \times 40 = 7\,854\,000$ mm^3/min

Question 3d.

Marks	0	1	2	3	Average
%	37	22	13	28	1.3

$F = P\,A \qquad P = F/A$

$$= 50/(3.142 \times 0.025^2)$$

$$P = 25.5 \text{ kPa}$$

Question 4

Marks	0	1	2	3	4	5	Average
%	40	25	12	8	7	7	**1.4**

The most common solution is given below. Other operational variations were accepted.
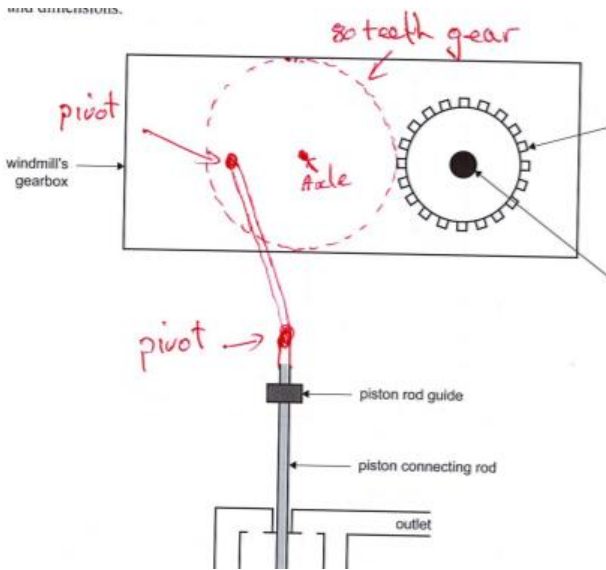
Question 5

Marks	0	1	2	3	4	5	6	Average
%	7	10	14	22	29	11	7	**3.2**

Task	Letter for stage
Find out the volume of water and the height that the water needs to be raised.	G
Cost a windmill and water pump.	E
Trial the operation of the water pump.	B
Generate a parts list and formulate a timeline.	F
Test the operation of the windmill and water pump.	A
Assess the final operation of the windmill against the design criteria.	D

There is a subtle difference between the test of a system and the trial of a system.

This question used the Systems Engineering Process as described on page 12 of the study design.

Question 6a.

Marks	0	1	2	Average
%	26	23	51	1.3

Variables include length, diameter and resistivity on the metal. Temperature and gauge were also accepted.

Question 6b.

Marks	0	1	Average
%	34	66	0.7

The total resistance divided by the resistance per metre gives the distance.

0.15/0.005 = 30 m

Question 6c.

Marks	0	1	2	Average
%	46	13	41	1

With all of the lights on, the circuit draws 20 A. The resistance is 0.15 Ω. Using $V = IR$, the voltage drop across the wires is 20 × 0.15 = 3 V

Question 6d.

Marks	0	1	Average
%	81	19	0.2

If there is 3 V across the wires, there is a 12 – 3 = 9 V drop across the lights.

Question 6e.

Marks	0	1	2	3	Average
%	69	15	9	7	0.1

There is only 1 A through this circuit. Using V = I × R, the voltage drop is 1 × 0.15 = 015 V

12 – 0.15 = 11.85 V. The result of Emma's experiment was correct.

Question 6fi.

Marks	0	1	Average
%	93	7	0.1

From Question 6e., the current through each light was 1 A. There are five parallel branches with 1 A through each. There is a total of 5 A.

Marks were also given if students used information from Question 6a.

Question 6fii.

Marks	0	1	2	Average
%	95	4	2	**0.1**

The resistance of the wire is 0.15 Ω. The current is 5 A. Using V = I × R, the voltage drop across the wires is 0.75 V. Given a 24 V supply, the voltage across the two globes is 24 – 0.75 = 23.25 V. Hence the voltage drop across each globe is 23.25 / 2 = 11.625 V.

If the information from Question 6a. was used, the answer would be 11.25 V.

A 24 V circuit ends up giving a greater voltage across the lights.

Question 6g.

Marks	0	1	2	Average
%	25	6	69	**1.5**

11.85/12 = 0.9875 or 98.75%

Question 6h.

Marks	0	1	2	Average
%	43	31	26	**0.9**

P = V × I = 12 × 20 = 240 W

Question 7a.

Marks	0	1	Average
%	66	34	**0.4**

Exclusive OR or XOR

Question 7b.

Marks	0	1	Average
%	76	24	**0.3**
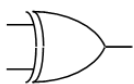
Question 7c.

Marks	0	1	2	Average
%	55	27	18	**0.7**
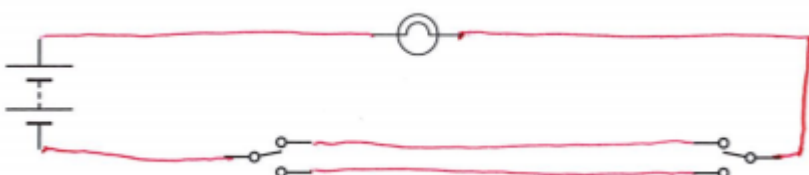
Question 7d.

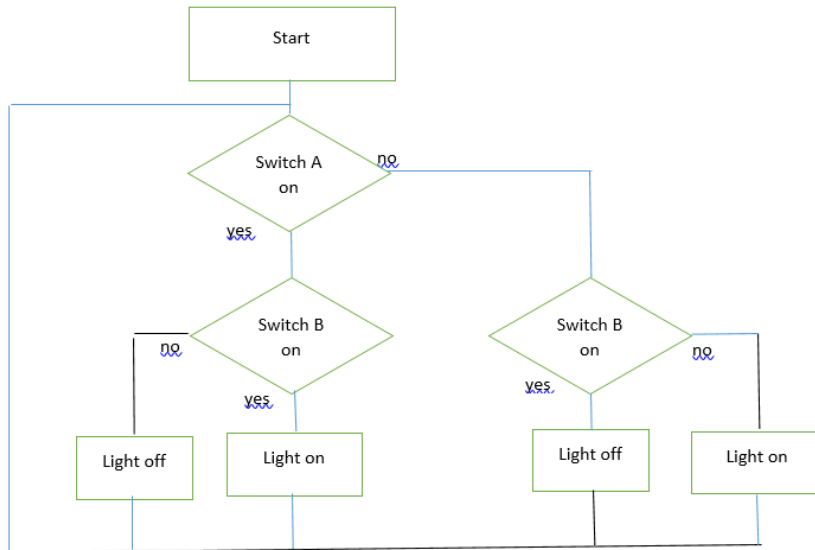| Marks	0	1	2	3	Average
%	40	38	16	6	**0.9**

Most students gave a simple program. The simplest program is:

Repeat

If XOR(A,B)=1, light on

Else light off.

A possible flow chart is given below.

Question 8a.

Marks	0	1	Average
%	70	30	**0.3**

There is no feedback.

Question 8b.

Marks	0	1	Average
%	89	11	**0.1**

Inverter or voltage inverter

Question 8c.

Marks	0	1	2	3	Average
%	21	38	29	13	**1.4**

Subsystem	Purpose
solar panels	to convert solar energy to electrical energy. These panels do not create energy
batteries	to store energy
Block A	to convert DC to 240 VAC

Question 8d.

Marks	0	1	2	Average
%	62	7	30	**0.7**

The units given are kWh. That is, kilowatt × hours = 1 × 0.5 = 0.5 kWh

(30 min = 0.5 h)

Question 8e.

Marks	0	1	2	Average
%	24	12	63	**1.4**

0.8 × 0.9 × 0.45 = 0.324 or 32.4%

Question 8f.

Marks	0	1	2	Average
%	68	6	26	**0.6**

12 kWh / 6 = 2 kWh. There are 10 panels to 2/10 = 0.2 kWh.

Question 8g.

Marks	0	1	2	Average
%	55	4	40	**0.9**

12 × 0.25 kAh = 3 kWh

Emma needs 12 kWh, so 12/3 = 4 batteries.

Question 9

Marks	0	1	2	3	4	5	Average
%	12	6	17	30	19	16	**2.9**

The highest-scoring answers gave an application along with a description of how it worked. The response also gave both positive and negative implications of the application.

A number of students gave public security cameras as their application. They thought of having people of interest stored on a database so they could be excluded from public events. A positive implication is increased safety for the public. A negative implication is the amount and type of information the government would have on each individual and the possible abuse of the system.