2015 VCE Systems Engineering examination report

General comments

Most students made a good attempt to complete the 2015 Systems Engineering examination. In questions that required a formula, students needed to show correct application of the formula to gain a method mark rather than just stating the relevant formula. For example, while calculating the force on a piston, the formula Force (F) = pressure (P) × area (A) would be used. If a student then substituted in the circumference for A, they did not gain any marks for the question.

In the solutions given in this report, only one possible method of working out has been given. Other correct methods were accepted.

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

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	1	2	1	96	0	Everyone who works in a workshop should be aware that they cannot use a device marked as unsafe.
2	13	84	2	1	0	
3	84	12	0	4	0	To 're-evaluate, modify and document' (option D) is a continual process and should happen throughout the construction and not just while building. Once a system has been built, the next step is to 'test and diagnose' (option A).
4	18	15	60	7	0	The relay, solenoid and transformer all use an inductor.
5	5	10	9	76	0	Half of 1 mm is 0.5 mm (180° is half a circle).
6	8	38	22	32	0	6 divisions times 3 is 18 volts.

Question	% A	% B	% C	% D	% No Answer	Comments
7	36	13	31	20	0	The period is 4 divisions, 4 ms or 0.004 s. The frequency is then 1/0.004 = 250.00 Hz.
8	17	24	40	19	0	The second AND gate circuit simplifies to a NOT gate. A NAND gate and a NOT gate gives an AND gate.
9	2	65	9	24	0	0.3 × 0.9 = 0.27 or 27%
10	4	2	84	9	0	
11	4	26	49	21	0	Batteries in series simply add together. Those in parallel cause many problems unless they are of the same voltage.
12	12	39	29	20	1	Each battery can effectively run for one hour at 4 amps. So each battery can supply 12 × 4 = 48 watts for an hour. Two batteries can then supply 96 watts for an hour. Four batteries should last for two hours.
13	76	14	0	9	0	Users of the workshop must wear glasses and comply with other guidelines within a workshop. In some industries, employees are given three warnings. If they fail to comply, then they are fired.
14	75	9	10	6	0	Fire requires oxygen for combustion.
15	5	63	13	19	0	If two resistors are taken in parallel, $\frac{12\times12}{12+12}=6\text{R}$. Take the 6R and the third 12R resistor in parallel $\frac{12\times6}{12+6}=4\text{R}$. (Other methods exist.)
16	8	21	37	34	0	For every metre the cable is moved, the 6 kg mass would go up 0.5 m.
17	8	89	2	2	0	
18	23	11	47	19	0	Many students used the diameter and not the radius in the calculations.
19	4	33	56	7	0	The concepts of rounding correctly and significant figures were assessed in this question.
20	19	18	22	42	0	

Section B

Question 1

Marks	0	1	2	3	Average
%	4	9	0	87	**2.7**

Load, effort, fulcrum

Question 2

Marks	0	1	Average
%	63	37	0.4

Students needed to show an understanding of the concept of momentum. Labelling the wheel as a flywheel was accepted.

Question 3

Marks	0	1	2	Average
%	12	31	57	1.5

The wheel has circular motion. Rotational motion was also accepted.

Both reciprocating and oscillating motion were accepted for the foot pedal.

Question 4

Marks	0	1	Average
%	73	27	0.3

The device indicated is a crank.

Question 5a.

Marks	0	1	2	Average
%	63	8	29	0.7

Students needed to understand that the force × distance of the load equals the force × distance of the effort. The following formula can be then used. Another approach would have been to equate the torque for the load and the torque for the effort.

0.8 m × 100 N = 1 m × force on load

Force on load = 80 N

Question 5b.

Marks	0	1	2	Average
%	51	26	23	0.7

Mechanical advantage = load/effort

80 N/100 N = 0.8

Many students had the correct formula but exchanged the value for the load with the value for the effort.

Question 6a.

Marks	0	1	2	Average
%	36	10	54	1.2

0.45/0.15 = rpm lathe/300

rpm of lathe = 900

The pulley with the smallest diameter should rotate the fastest. A recurring incorrect answer was 100 rpm.

Question 6b.

Marks	0	1	Average
%	39	61	0.6

5 rps

The most frequent error was to multiply by 60 rather than divide by 60.

Question 6c.

Marks	0	1	2	Average
%	73	10	17	0.5

The speed of the belt is the circumference multiplied by the revs per second.

C = 2 × 3.14 × 0.225 = 1.41

1.41 × 5 = 7.07 ms^{-1}

Different values of pi were accepted. Any value of pi from 3.140 to 3.142 was allowed. The formula sheet suggested 3.14.

Question 7

Marks	0	1	Average
%	66	34	0.4

To reverse the direction of the lathe the simplest solution is to make a figure of eight in the belt.

Question 8

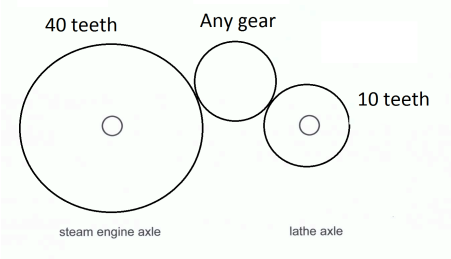
Marks	0	1	Average
%	16	84	0.9

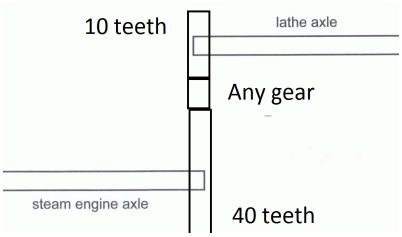
Safety glasses and boots were common correct answers. ‘Gloves’ was not accepted because big leather gloves would be a liability. More information was needed since latex gloves should be used in the application of stain.

Question 9

Marks	0	1	2	3	4	Average
%	32	12	16	25	16	1.8

Two possible answers are given below.





Question 10a.

Marks	0	1	Average
%	67	33	0.4

Possible answers included:

- design the clutch so that a power source can be detached
- the belts can slip off the drill and get jammed.

Question 10b.

Marks	0	1	Average
%	28	72	0.7

The most common answers were:

- the belts have a tendency to break
- an exposed pulley system is a liability.

Question 11

Marks	0	1	2	Average
%	50	28	22	0.7

The highest-scoring answers mentioned marking the axle, counting the revolutions in one minute. This gives the revs per minute.

Question 12

Marks	0	1	Average
%	21	79	0.8

Given that the high pressure steam is forcing the piston to the right, the wheel must be turning clockwise.

Question 13

Marks	0	1	2	3	Average
%	62	13	8	18	0.8

Force = pressure × area

F = 10000 × 0.070685 = 706.5 Newtons

Many students wrote the correct formula but they often substituted the circumference instead. Other students calculated the force on the piston as it was moving to the left and hence deducted the area of the cross-sectional area of the piston rod.

Slight variations in answers due to different values of pi being used were accepted.

Question 14

Marks	0	1	Average
%	53	47	0.5

The cross-sectional area of the rod needs to be considered.

Question 15a.

Marks	0	1	2	Average
%	13	32	56	1.4

Possible answers included:

- the effect of the smoke
- whether the wood used was from a sustainable source.

Question 15b.

Marks	0	1	2	Average
%	32	43	25	1

Issues could include the source of the energy and visual pollution of the tension wires.

Question 16

Marks	0	1	2	3	Average
%	22	22	27	28	1.6

- Dry wood is a source of chemical energy.
- Steam is thermal or heat energy.
- Spinning wheel is kinetic or rotational energy.

Question 17

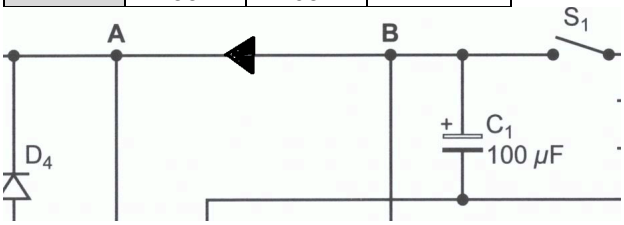
Marks	0	1	2	Average
%	39	7	55	1.2

I = P / V = 1200/240 = 5 A

Some students did not change 1.2 kW to 1200 W. Others calculated 240/1200.

Question 18

Marks	0	1	Average
%	35	65	0.7



Question 19

Marks	0	1	2	3	4	Average
%	10	28	27	22	13	2

- LED: light-emitting diode
- IC: integrated circuit
- POT: potentiometer
- μF: microfarad

Question 20

Marks	0	1	Average
%	57	43	0.4

Reverse the direction of the motor.

Question 21

Marks	0	1	Average
%	55	45	0.5

Brown, black, red and gold

Question 22

Marks	0	1	2	Average
%	40	12	48	1.1

A current of 10 mA or 0.01 A through a resistor of 1k or 1000 ohms gives:

V = IR

V = 0.01 × 1000 = 10 V

Question 23

Marks	0	1	Average
%	65	35	0.4

As the polarity of the motor is changed, due to the DPDT switch, the polarity of the diodes will also change.

This question assessed students' ability to see the underlying function of this part of the circuit.

Question 24

Marks	0	1	2	Average
%	39	42	20	0.8

Across pins 1 and 8 there will be 12 V.

Pins 2 and 6 are connected by a wire so the potential difference will be 0 V.

Question 25a.

Marks	0	1	2	Average
%	33	45	22	0.9

All the following responses were accepted: dry solder joints, the fuse was blown, the DPDT switch was faulty, S_1 was in the off position.

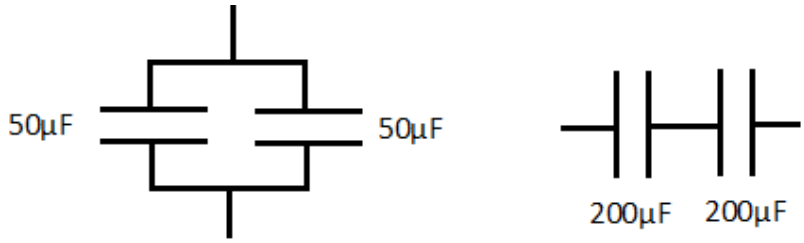
Question 25b.

Marks	0	1	2	Average
%	49	38	13	0.7

A good understanding of components was needed for this question. If C_4 is in short circuit, the voltage across it would be 0 V. Therefore, the motor and the LEDs will not operate. The fuse would blow. There should be no damage to any other part of the circuit.

Question 26

Marks	0	1	2	3	Average
%	41	19	10	30	1.3



$50\mu F + 50\mu F = 100\ \mu F \quad OR\ \frac{200\mu F \times 200\mu F}{200\mu F + 200\mu F} = 100\mu F$

Most students chose the series version rather than the parallel version. Both were correct.

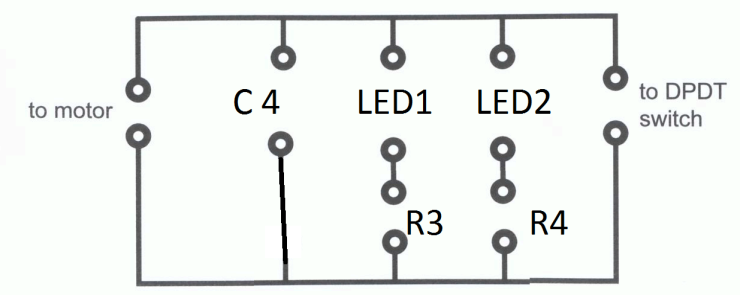
Question 27

Marks	0	1	2	3	Average
%	27	26	23	24	1.4

- Diode: Allows current through in one direction only.
- Transistor: Acts as a switch or amplifier.
- Capacitor: Stores electric charge.

Question 28

Marks	0	1	2	3	Average
%	55	9	8	27	1.1



A circuit board, not a circuit diagram was needed.

Question 29

Marks	0	1	Average
%	60	40	0.4

A closed-loop system requires a feedback loop.

Question 30a.

Marks	0	1	Average
%	6	94	1

4000 rpm needs 5 V

Question 30b.

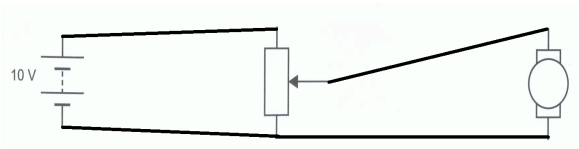
Marks	0	1	2	Average
%	15	18	67	1.5

The minimum speed of 800 rpm requires 1 V and the maximum speed of 4800 rpm requires 6 V.

Students were required to read these values from the graph.

Question 31

Marks	0	1	2	Average
%	24	67	9	0.9



There were several possible correct circuits.

Question 32

Marks	0	1	2	3	4	Average
%	22	30	32	13	4	1.5

identify and document problem/need/ opportunity/situation design brief	research feasibility and alternatives costs	design and model the system flow diagrams	plan, build and fabricate/integrate subsystems materials list

Question 33

Marks	0	1	2	3	4	5	Average
%	9	7	19	33	19	13	2.9

Most students made a reasonable attempt at this question. Some students gave a list of issues but the question asked students to discuss them. High-scoring responses were those that identified the issues and discussed the relative pros and cons.