VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2016

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | Letter |

VCE VET INTEGRATED TECHNOLOGIES

Written examination

Thursday 10 November 2016

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	10	10	80
			Total 100

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied
- Question and answer book of 24 pages.
- Detachable insert of miscellaneous formulas in the centrefold.
- Answer sheet for multiple-choice questions.

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the detached insert.

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

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
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.

Question 1

A fire is discovered in a rubbish bin in a back storeroom.
The first action of a nearby worker should be to

A. raise the alarm and inform the other workers.
B. run to the corridor and get the fire extinguisher.
C. close the door firmly to reduce the available oxygen.
D. go further into the storeroom to investigate the source of the fire.

Question 2

What is the name of the tool shown above?

A. wire strippers
B. long-nose pliers
C. side-cutting pliers
D. general-purpose electronic pliers

Question 3

When placing components and trimming component leads on a Printed Circuit Board (PCB), the **minimum** personal protective equipment (PPE) required is

A. safety glasses.
B. a full face mask.
C. safety glasses, earplugs and safety boots.
D. safety glasses and a high-visibility vest.

Question 4

Which one of the following represents the smallest capacitance value?

A. 18 μF

B. 1900 nF

C. 21 000 pF

D. 0.0037 μF

Question 5

ELV stands for

A. extra low voltage.

B. elevated level voltage.

C. extremely low voltage.

D. Electrical Licensing Victoria.

Question 6

Which one of the following devices produces non-visible light?

A. a red light-emitting diode (LED)

B. an infra-red LED

C. a filament lamp

D. a compact fluorescent lamp (CFL)

Question 7

Which battery is classed as a secondary cell?

A. lithium battery

B. alkaline battery

C. carbon-zinc battery

D. lithium-ion battery

Question 8

What is the mains voltage supplied from a standard power point in Australia?

A. 230 V_{DC}

B. 240 V_{DC}

C. 230 V_{AC} 50 Hz

D. 240 V_{AC} 100 Hz

Question 9

Which one of the following represents the largest resistance value?

A. 56 MΩ

B. 590 kΩ

C. 5800 kΩ

D. 54 500 000 Ω

Question 10

Power transmission lines deliver high-voltage electricity.

The principal reason for them delivering high-voltage electricity is that the

A. voltages delivered can be used directly in households.

B. losses on the transmission lines are lower at higher voltages.

C. resistance of the transmission lines decreases as the voltage increases.

D. conductivity of the transmission lines increases as the voltage increases.

Question 11

Mains power from electrical distributors is supplied to residential suburbs as

A. single-phase AC voltage.

B. single-phase DC voltage.

C. three-phase AC voltage.

D. two-phase AC voltage.

Question 12

Supercapacitors, also called ultracapacitors, are

A. able to maintain a constant voltage during discharge.

B. made by placing two or more electrolytic capacitors in series.

C. used in battery-powered vehicles and hybrids, as they are cheaper than lithium-ion batteries.

D. used in hybrid vehicle regenerative braking systems to capture energy from the electric motors.

Question 13

Lithium-ion batteries are used extensively in electronic devices such as phones, drones and tablets.

The most likely reason for this is that they

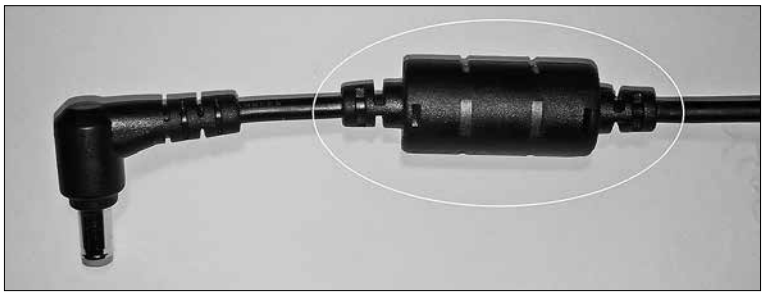
A. have high energy density and tiny memory effect.

B. can be discharged to zero volts with no damage to the battery.

C. can operate safely for long periods in high-temperature environments.

D. are also used in battery-operated vehicles to give recharge times of less than 10 seconds.

Question 14



The device circled in the image above is commonly used on power supply cables.

The device

A. provides strain relief for the power supply cable.

B. contains electronic circuitry that maintains a steady voltage to the connected equipment.

C. prevents high-frequency electrostatic interference from reaching the connected equipment.

D. holds a ferrite core to supress high-frequency electromagnetic interference, both to and from the connected equipment.

Question 15

Which one of the following statements about batteries is correct?

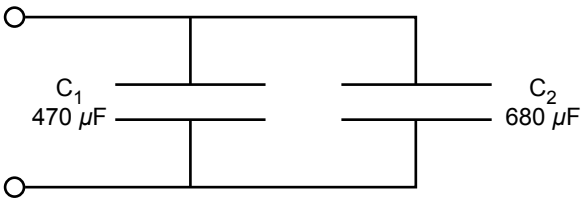
A. Carbon and alkaline batteries are used for off-grid storage in remote areas.

B. Lead-acid and nickel-cadmium batteries are known as primary storage devices.

C. A lithium-ion battery can become warm due to the battery's internal resistance.

D. Nickel-iron batteries are used in laptops due to their high cell density and unlimited recharge capacity.

Question 16



What is the total capacitance of the circuit above?

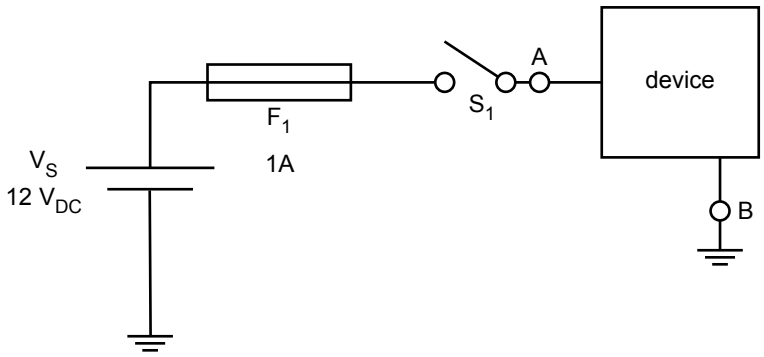
A. 278 μF

B. 1150 μF

C. 1150 mF

D. 2128 μF

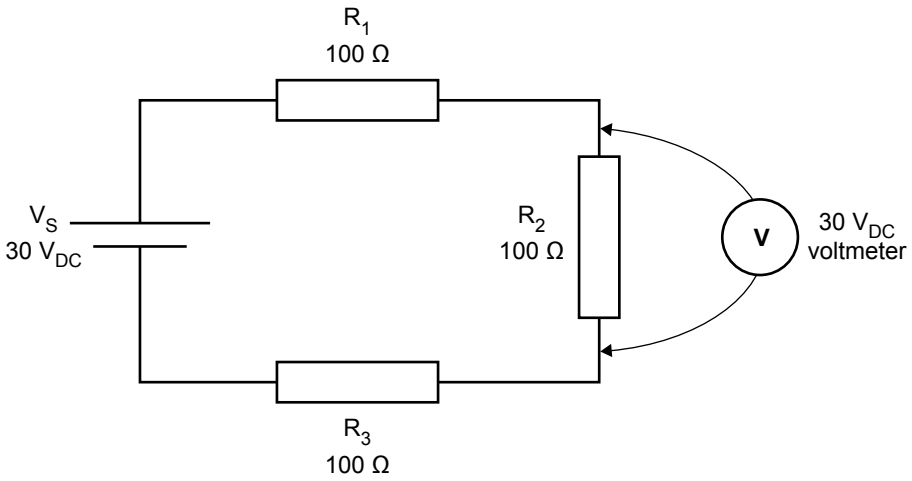
Question 17



When switch S_1 in the circuit above is closed, fuse F_1 blows instantly.
Switching S_1 'off', replacing the fuse and closing switch S_1 again causes the fuse to immediately blow.
Which equipment, test and result would locate the fault while S_1 is open?

	Equipment and test	Test result
A.	insulation-resistance (IR) tester set on 500 V range and test between A and B	2 Ω
B.	multimeter set on ohms range and test between A and B	0 Ω
C.	multimeter set on V_{DC} range to measure the voltage across switch S_1	12 V_{DC}
D.	multimeter set on V_{DC} range to measure the voltage across fuse F_1	12 V_{DC}

Question 18



In the circuit above, the voltmeter reading is 30 V_{DC}.
What does this reading indicate?

A. 100 mA is flowing in the circuit.
B. The circuit is operating as it was designed.
C. The supply voltage V_S has doubled.
D. Resistor R_2 has become an open circuit (OC).

Question 19

An IR tester is set to 500 V IR range.
Which of the following are the correct IR test result and comment for the test being carried out?

	Item under test	Test result	Comment
A.	electronic appliance between active and earth	0 Ω	'test and tag' purposes
B.	flexible extension lead between active and earth	0 Ω	open circuit
C.	flexible extension lead between neutral and earth	0 Ω	short circuit
D.	flexible extension lead between neutral and active	50 MΩ	open circuit

Question 20

What is the Australian standard cable colour for the active wire in a 3-core flexible extension lead?

A. blue
B. black
C. brown
D. green with a yellow stripe

END OF SECTION A
TURN OVER

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SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.
Formulas must be relevant to the calculations. Calculations must be shown.
All units must be specified in correct engineering notations in the answers.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (8 marks)
Figure 1 shows a range of symbols for electrical components.

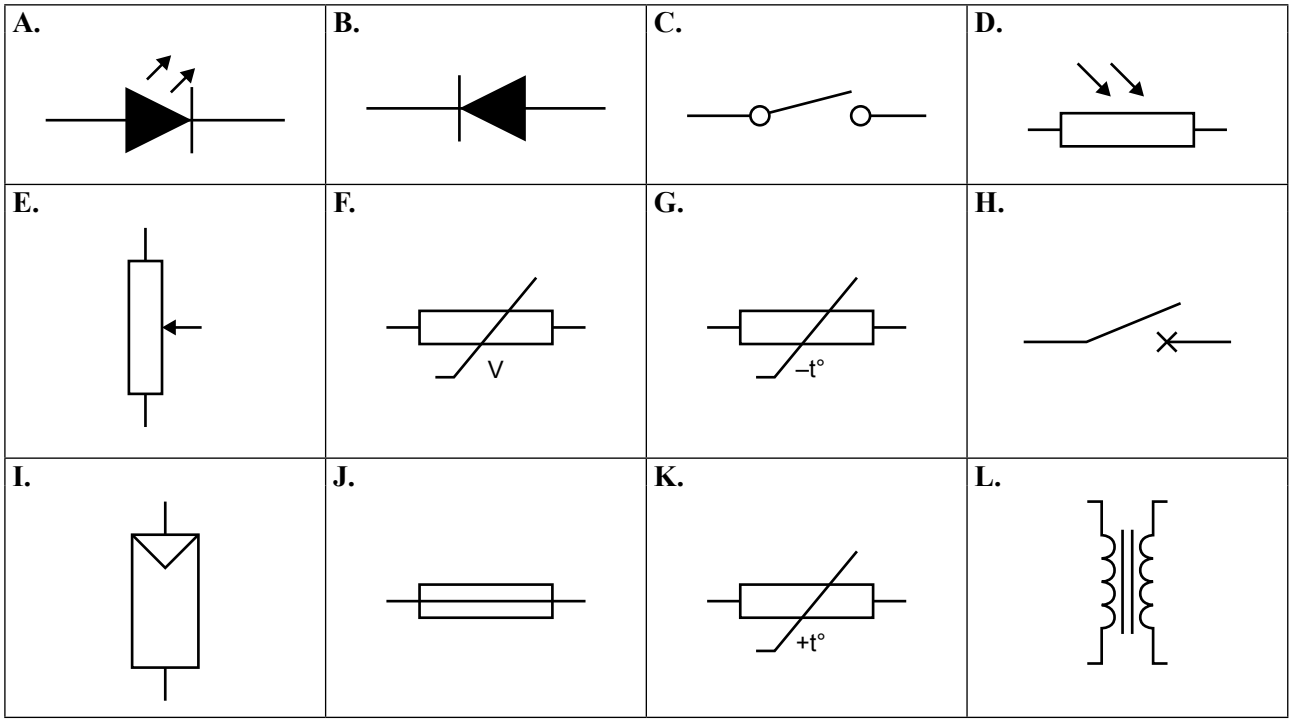

Figure 1

Match eight of the symbols from Figure 1 to the components listed in the table below. Write the corresponding letter for each symbol in the space provided.

Component	Symbol letter	Component	Symbol letter
circuit breaker		potentiometer	
rectifier diode		fuse	
transformer		light-emitting diode (LED)	
SPST switch		PTC resistor	

Question 2 (7 marks)

A factory worker on a job site discovers an apprentice electrician lying on the floor near the main switchboard. The apprentice appears to be unconscious.

The factory worker immediately carries out the basic life support 'DRSABCD' action plan.

In the table below, give the corresponding term for each letter and describe an appropriate action to be taken in each case.

Letter	Corresponding term	Action to be taken
D		
R		
S		
A		
B		
C		
D		

Question 3 (8 marks)

a. Complete the table below by identifying the colour code or value of the resistors A to F. 6 marks

	Band colours				Resistance	Tolerance
Resistor	**First**	**Second**	**Third**	**Fourth**		
A					1 kΩ	10%
B					8.2 Ω	5%
C					100 kΩ	1%
D					6.8 MΩ	5%
E	white	brown	yellow	gold		
F	red	violet	brown	silver		

b. There are many types of resistors available in different wattages and values.

In the table below, name two different types of resistors and describe their usage. 2 marks

Resistor	**Type of resistor**	**Usage**
1		
2		

Question 4 (5 marks)

Railway authorities are becoming increasingly concerned about the theft of copper cables that are used to provide high voltage (HV) to electric trains. The theft of copper cables worth a few hundred dollars can result in shutdowns that cost millions of dollars.

One method of solving this problem is to replace the copper cables with a cheaper alternative that also has good conductive properties.

Table 1 below lists the resistivity of a number of metals.

Table 1

Metal	Resistivity (ρ) Ω.m @ 20 °C
aluminium alloy	2.82×10^{-8}
copper	1.72×10^{-8}
mild steel	1.5×10^{-7}
silver	1.59×10^{-8}

a. Which metal in Table 1 has the lowest resistivity? 1 mark

_____

b. What does the term 'metal alloy' mean? 1 mark

_____

c. Aluminium alloy cables are being used to replace the copper cables.

How might the resistivity of the aluminium alloy cable affect the size of the cables used? Refer to the information in Table 1. 1 mark

_____

d. Mild steel would be a very inexpensive material to use for the cables, but its use would have some major drawbacks.

Provide two reasons why mild steel cables should not be used. 2 marks

Reason 1 _____

_____

Reason 2 _____

_____

Question 5 (8 marks)

Refer to the circuit diagram shown in Figure 2 below.

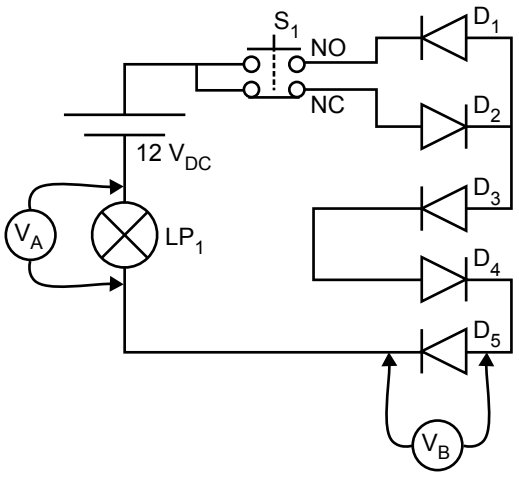

Figure 2

a. How many diodes are conducting in the circuit? 1 mark

_____

b. If each of the diodes has a voltage drop of 0.6 V when conducting, determine the voltage shown on voltmeter V_A. Show your working. 3 marks

_____

_____

_____

_____

c. Push-button switch S_1 is pressed.

i. Describe the effect on lamp LP_1. 1 mark

_____

_____

ii. If the operation of lamp LP_1 is affected, what causes this? 1 mark

_____

_____

iii. What are the readings on voltmeters V_A and V_B? 2 marks

V_A _____

V_B _____

Question 6 (8 marks)

A trailer requires wiring to a 7-pin plug and a vehicle requires wiring to a 7-pin trailer socket.

The diagram in Figure 3 shows a vehicle's rear tail-light system with an unwired 7-pin vehicle trailer socket. Table 2 shows the lighting connection for the vehicle trailer socket and plug.

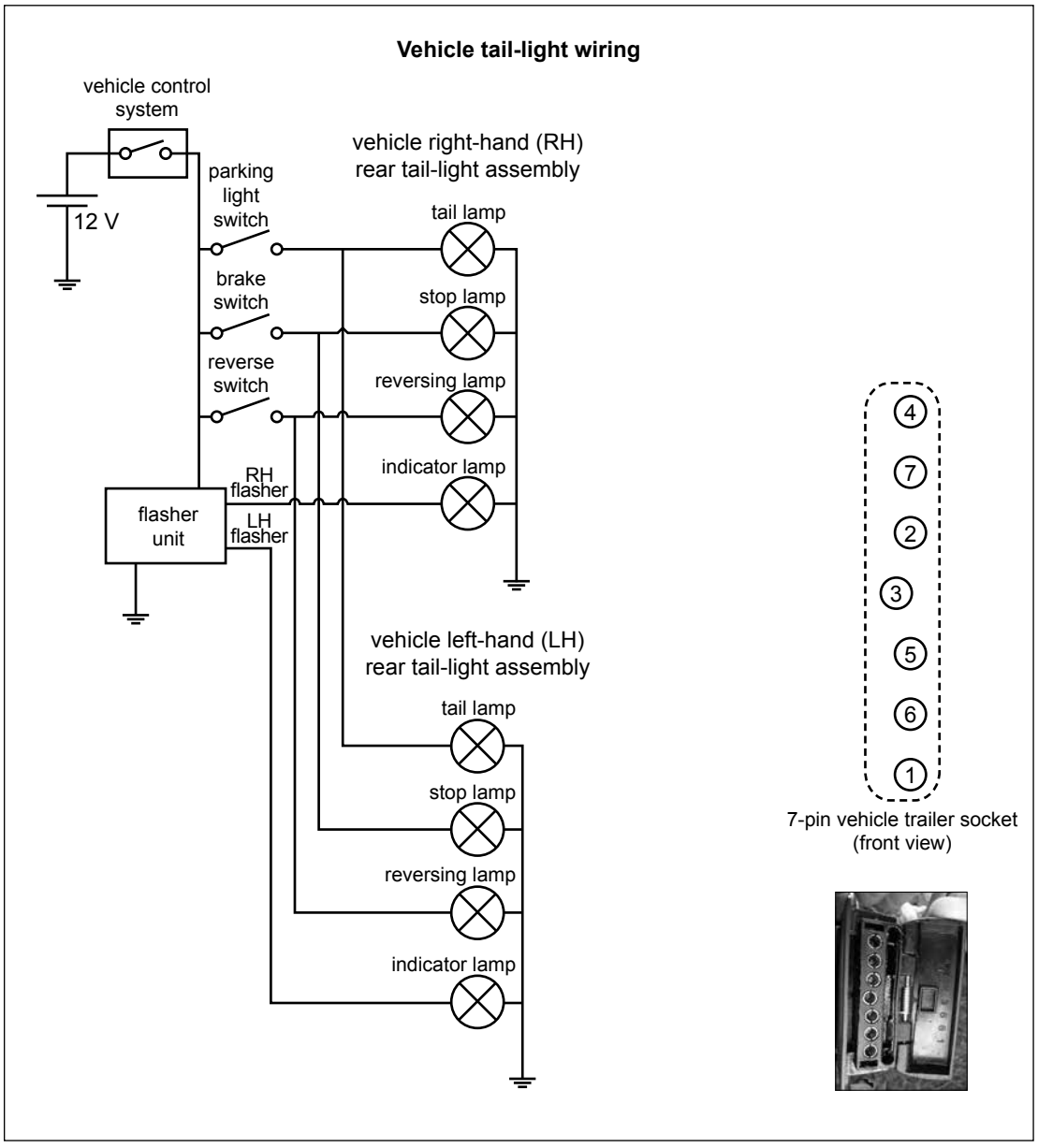

Figure 3

Table 2

Pin	Connection
1	left indicator lamp
2	reversing lamp
3	earth
4	right indicator lamp
5	NC
6	stop lamp
7	tail lamp

a. On the diagram in Figure 3, draw all wiring connections between the vehicle's tail-light assemblies and the 7-pin vehicle trailer socket. 3 marks

b. The diagram in Figure 4 shows an unwired trailer tail-light system and a 7-pin trailer plug.

Referring to Table 2, draw on the diagram in Figure 4 all the wiring connections between the trailer's tail-light assemblies and the 7-pin trailer plug. The trailer lights must operate correctly when the trailer is connected to the vehicle. 5 marks

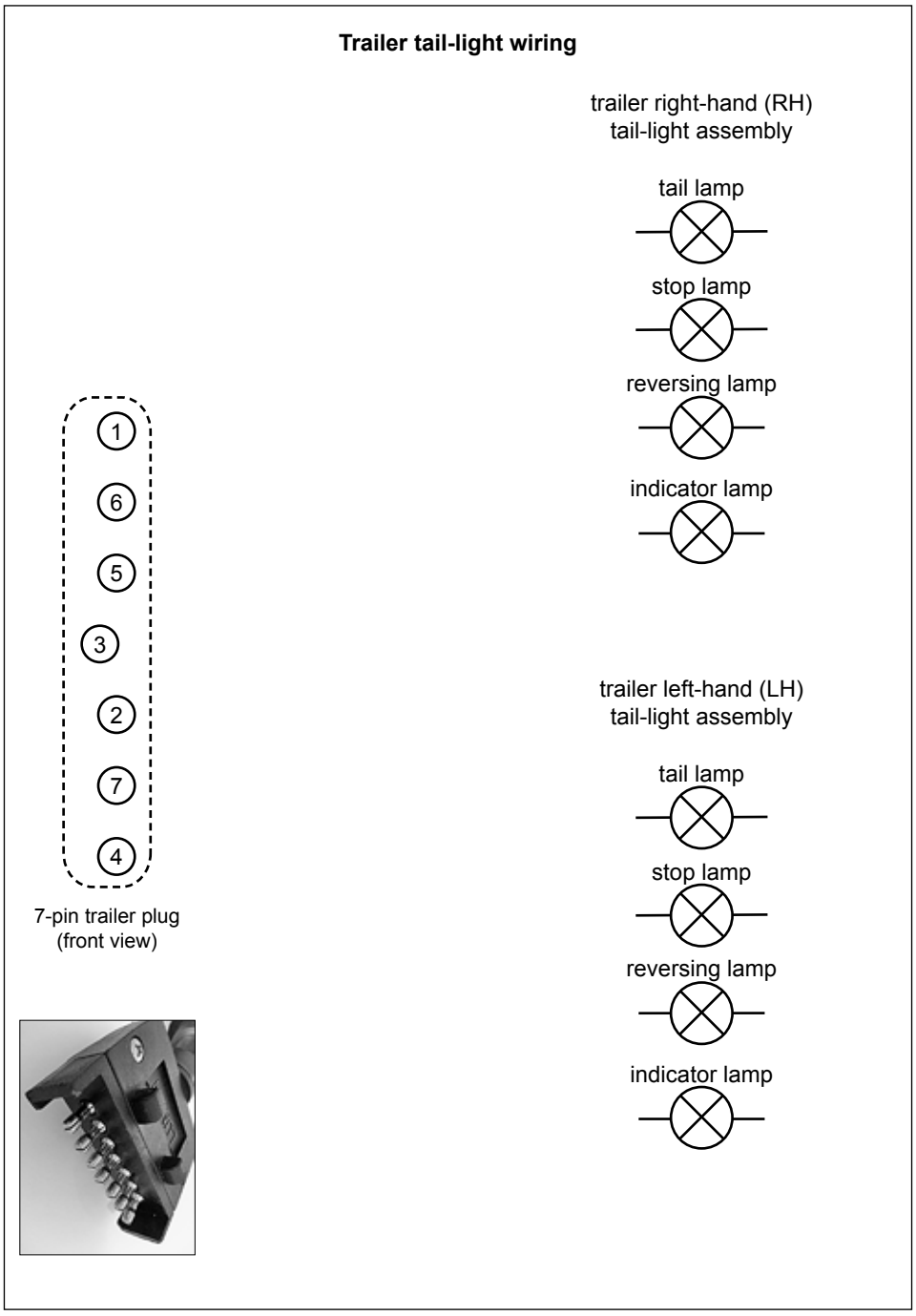

Figure 4

Question 7 (10 marks)

Refer to the circuit diagram shown in Figure 5 below. Note that V_{R2} is 20 V_{DC}.

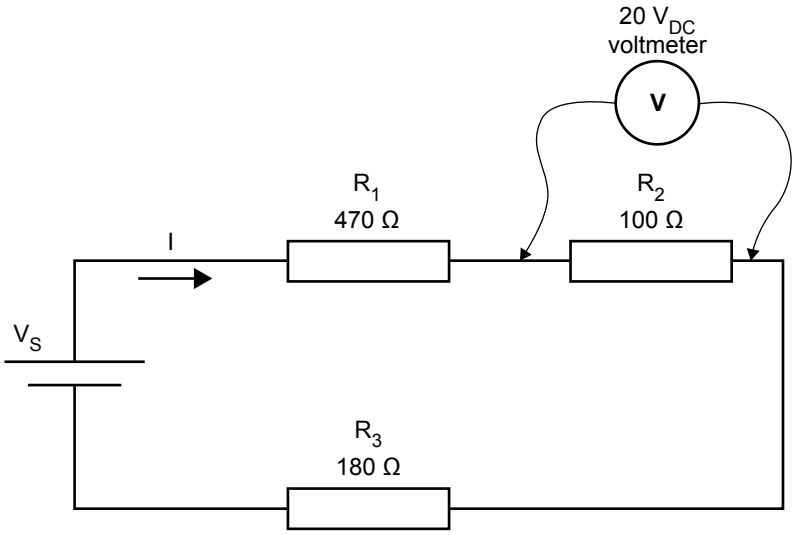

Figure 5

a. Find the supply current I. Show your working. 2 marks

b. Find the total resistance of the circuit (R_{total}). Show your working. 1 mark

c. Find the supply voltage V_S. Show your working. 3 marks

d. Find the total power dissipated in the circuit. Show your working. 2 marks

e. What is the minimum power rating that would be required for resistor R_2 to function correctly in the circuit? Show your working. 2 marks

Question 8 (9 marks)

a. Refer to Figure 6 below. When connected, switch S_1 will turn on lamp LP_1 and switch S_2 will turn on lamp LP_2.

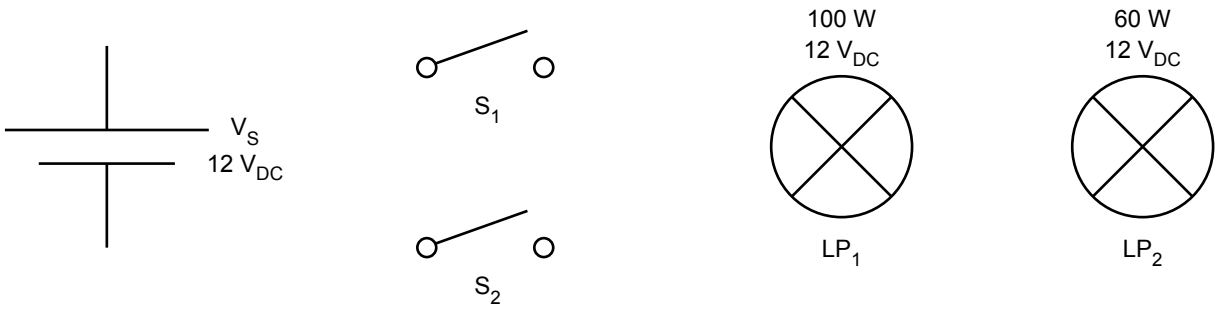

Figure 6

i. Draw the circuit connections on Figure 6 so that each lamp will operate correctly. 3 marks

ii. Calculate the total current when both lamps are on. Show your working. 2 marks

b. In the circuit diagram shown in Figure 7 below, I_1 is 200 mA and the power dissipated by R_3 is 2 W.

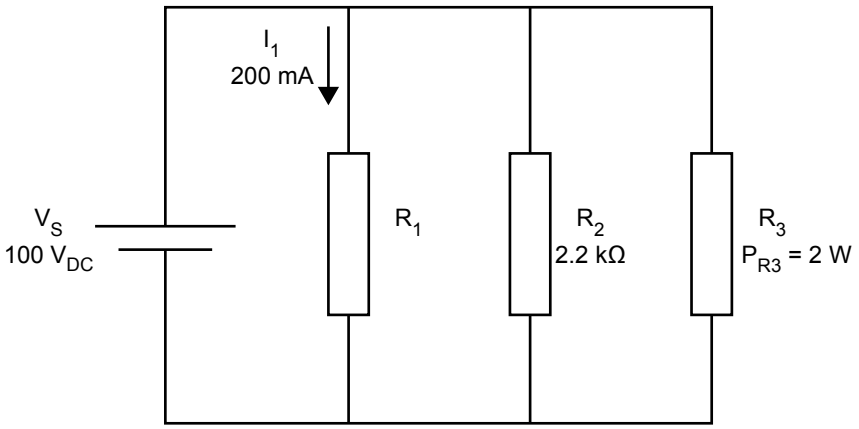

Figure 7

i. Find the resistance of R_1. Show your working. 1 mark

ii. Find the total resistance of the circuit (R_{total}). Show your working. 3 marks

Question 9 (8 marks)

Refer to the circuit diagram shown in Figure 8 below. Note that V_{R5} is 10 V_{DC}.

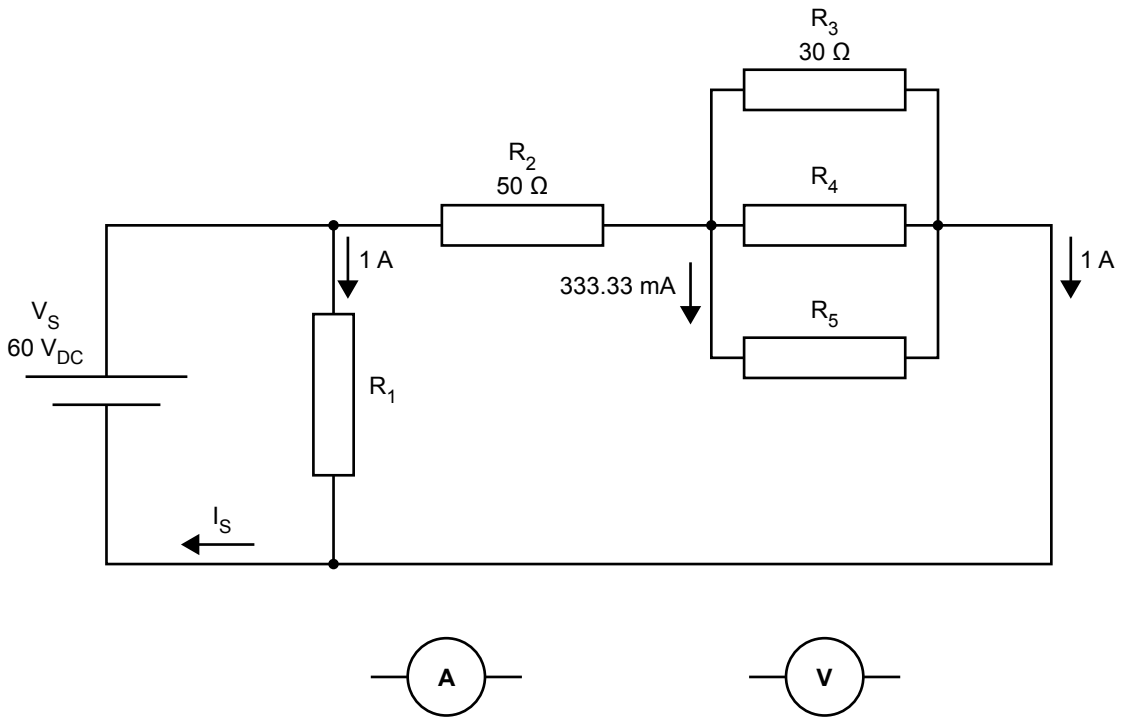

Figure 8

a. Find the resistance of R_5. Show your working. 2 marks

b. Find the resistance of R_4. Show your working. 2 marks

c. Find the total resistance of the circuit (R_{total}). Show your working. 2 marks

_____

_____

_____

d. Draw the voltmeter where it should be in the circuit in Figure 8 to measure V_{R2}. Indicate the meter polarity. 1 mark

e. Draw the ammeter where it should be in the circuit in Figure 8 to measure I_S. Indicate the meter polarity. 1 mark

Question 10 (9 marks)

Michael has recently purchased a small yacht. His intention is to wire a 12 V system with a solar panel and a 150 Ah capacity Absorbent Glass Mat (AGM) battery.

A block diagram of the system is shown in Figure 9.

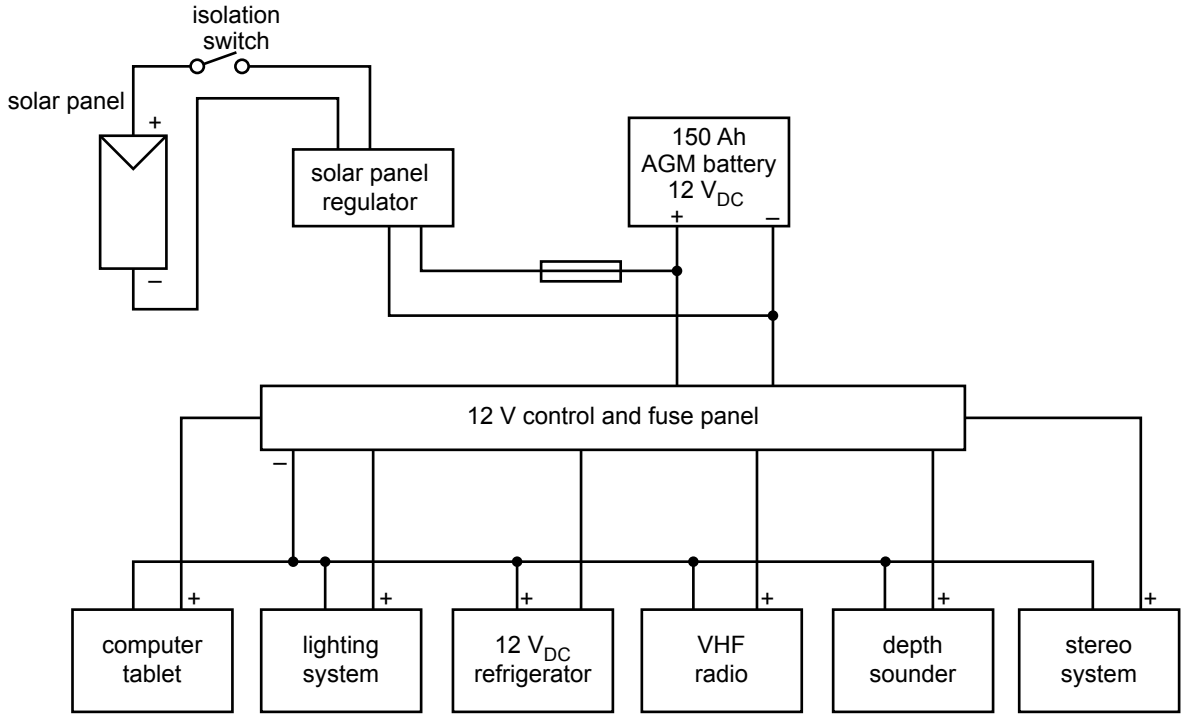

Figure 9

a. Table 3 below lists the average daily usage and current for each device.

i. Complete Table 3 by listing the daily ampere hour requirement for each device and the total daily ampere hour requirement. 3 marks

Table 3

Device	Average daily usage (hours)	Current drawn by device	Daily ampere hour (Ah) requirement
computer tablet	3	1 A	
lighting system	4	400 mA	
12 V_{DC} refrigerator	8	3.5 A	
VHF radio	6	300 mA	
depth sounder	4	1.5 A	
stereo system	8	1 A	
		Total daily ampere hours	

ii. Michael wants to go sailing for up to five days without having to recharge the battery using an external power source (mains power).

Calculate the total ampere hour usage for five days. 1 mark

Total ampere hour usage for five days	Ah

b. The 12 V_{DC} 150 Ah AGM battery can be discharged down to 50% of its capacity without causing it any internal damage. A suitable solar panel is required to supply the current needed.

In the table below, record the five-day ampere hours to be supplied by the solar panel. 1 mark

Total ampere hour usage for five days (from **part a.ii.**)	Ah
Battery ampere hour capacity at 50%	Ah
Five-day ampere hour supply by solar panel	Ah

c. If the solar panel operates for an average of six hours per day (full sunlight), how many amps per hour does the panel need to provide? Show your working. 2 marks

Current to be provided by the solar panel per hour during full sunlight	A

d. **i.** Calculate the minimum power required from the solar panel. 1 mark

ii. The power ratings for three solar panels are given below.

Circle the lowest-power-rated panel that will achieve the task. 1 mark

$12\ V_{DC}$, 60 W $12\ V_{DC}$, 80 W $12\ V_{DC}$, 100 W

END OF QUESTION AND ANSWER BOOK

VCE VET INTEGRATED TECHNOLOGIES

Written examination

FORMULA SHEET

Instructions

Please remove from the centre of this book during reading time.
This formula sheet is provided for your reference.

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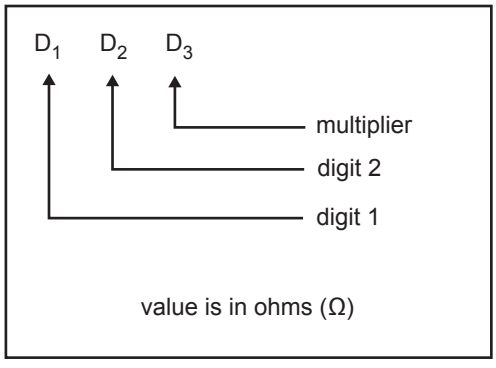
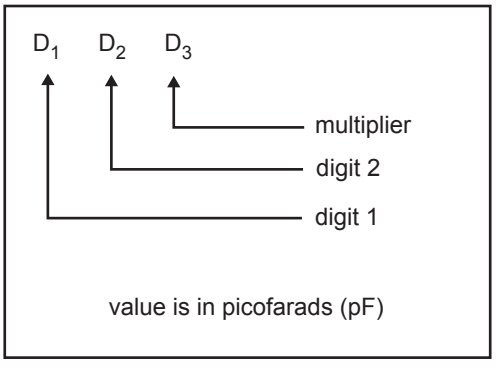
VCE VET Integrated Technologies formulas

$R_T = R_1 + R_2 + R_3$	$f = \frac{1}{T}$
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$\tau = C \times R$
$R_T = \frac{R_1 R_2}{R_1 + R_2}$	$A = \frac{\pi d^2}{4}$
$R = \frac{\rho l}{A}$	$C = \frac{\varepsilon A}{d}$
$V = I \times R$	$C_T = C_1 + C_2 + C_3$
$P = V \times I$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
$V_X = V_S\left(\frac{R_X}{R_T}\right)$	$Q = V \times C$
$V_{PK} = \sqrt{2} \times V_{RMS}$	$W = \frac{1}{2}CV^2$
$\frac{V_{primary}}{V_{secondary}} = \frac{N_{primary}}{N_{secondary}} = \frac{I_{secondary}}{I_{primary}}$	$W = P\,t$
$V_{STEP} = \frac{V_{max}}{2^n - 1}$	efficiency $\% = \frac{output}{input} \times 100$
turns ratio = $\frac{N1}{N2}$	1 ampere hour (Ah) = 1 A of amount drawn for one hour

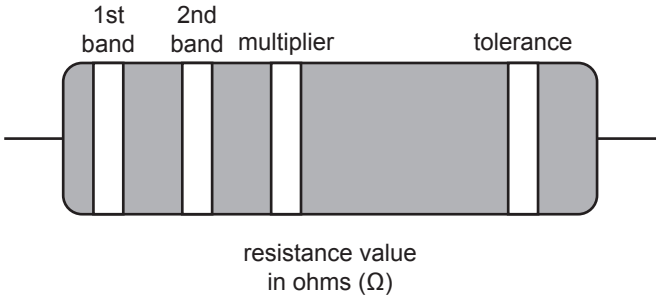
Resistor code



Capacitor code



Resistor colour codes



Colour	Value	Multiplier	Tolerance
black	0	10^0	
brown	1	10^1	1%
red	2	10^2	2%
orange	3	10^3	
yellow	4	10^4	
green	5	10^5	0.5%
blue	6	10^6	0.25%
violet	7	10^7	0.1%
grey	8	10^8	0.05%
white	9	10^9	
gold		10^{-1}	5%
silver		10^{-2}	10%

END OF FORMULA SHEET