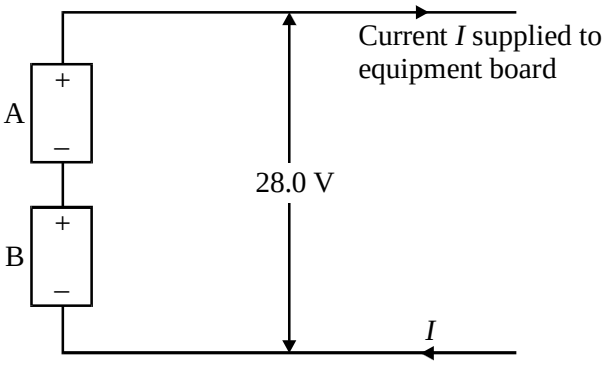
Internal resistance practice questions

1. The power system of a spacecraft must provide a constant 28.0 V for the equipment on board, independent of the current supplied.

This can be achieved using two separate power supplies A and B connected in the series as shown in the diagram below.



Power supply A has an e.m.f. of 20.0 V and an internal resistance of 0.40 Ω.

Power supply B provides a variable voltage and has negligible internal resistance. Its voltage varies automatically to maintain the constant 28.0 V.

Explain carefully why the voltage output of B must increase as the current supplied rises.

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(2)

When the current is 10.0 A,

(i) show that the voltage output of B is 12.0 V

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(2)

(ii) calculate the power supplied to the equipment on board.

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Power supplied = ……………………………………

(1)

(iii) calculate the power wasted in heating the internal resistance.

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Power wasted = ……………………………………

(1)

(iv) calculate the efficiency of the power system.

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Efficiency = ……………………………………

(2)

Many spacecraft are fitted with solar cells. Give one advantage and one disadvantage of their use.

Advantage ……………………………………………………………………………………

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Disadvantage …………………………………………………………………………………

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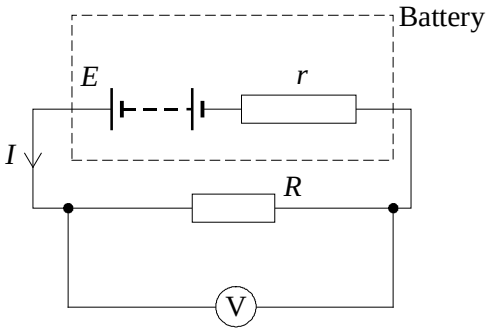
(2)
(Total 10 marks)

2. Melanie is using a spreadsheet to model the behaviour of the circuit shown below.



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	A	B	C	D	E	F
1	Calculations for a Battery Delivering Power					
2						
3	e.m.f.	internal resistance	load resistor	current	p.d. across load	power in load
4	*E*	*r*	*R*	*I*	*V*	*P*
5	(volts)	(ohms)	(ohms)	(amps)	(volts)	(watts)
6						
7	12.0	2.00	0.00	6.00	0.00	0.0
8	12.0	2.00	0.50	4.80	2.40	11.5
9	12.0	2.00	1.00	4.00	4.00	16.0
10	12.0	2.00	1.50	3.43	5.14	17.6
11	12.0	2.00	2.00	3.00	6.00	18.0
12	12.0	2.00	2.50	2.67	6.67	17.8
13	12.0	2.00	3.00	2.40	7.20	17.3
14	12.0	2.00	3.50	2.18	7.64	16.7
15	12.0	2.00	4.00	2.00	8.00	16.0

To calculate a value for cell D7, Melanie entered this formula:

= A7/(B7 + C7)

Explain why this is correct.

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(1)

What would be an appropriate formula for cell E9?

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(1)

What would be an appropriate formula for cell F11?

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(1)

What is the short-circuit current obtainable from this battery?

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(1)

Explain why the p.d. across the load resistor increases as the current falls.

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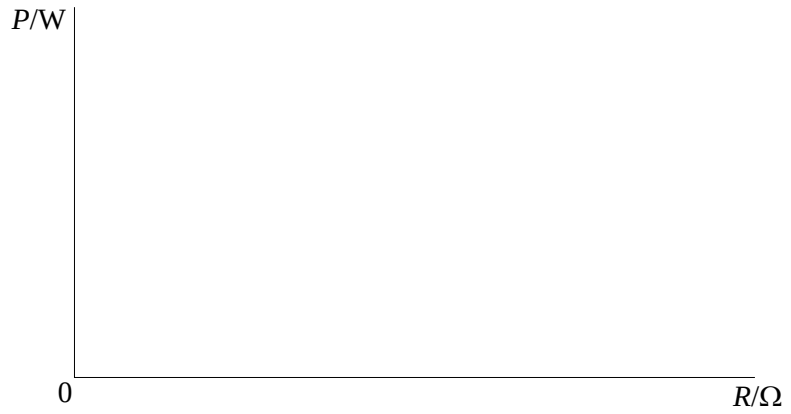
(2)

Sketch a graph on the axes below to show how the power in the load would vary for load resistors in the range 0–9 Ω (marking values where appropriate).



(3)

Comment on *one* key feature of the graph.

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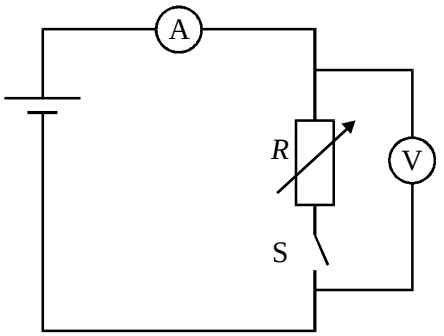
(2)

(Total 11 marks)

3. A student read that a lemon could be used to power a clock. He made an electrical cell using a lemon and placed it in this circuit. The table shows the readings he obtained. The first reading was taken with switch S open. To obtain the others he closed S and varied the resistance *R*.



Reading	Current/nA	Voltage/mV
1	0	110
2	90	83
3	150	74
4	210	57
5	310	35
6	350	20

The prefix n, as in nA, means "$\times 10^{-9}$".

What does the prefix m, as in mV, mean?

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(1)

Calculate the value of *R* for reading 3.

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Resistance = ...

(2)

Calculate the power being supplied by the cell to resistance R for reading 4.

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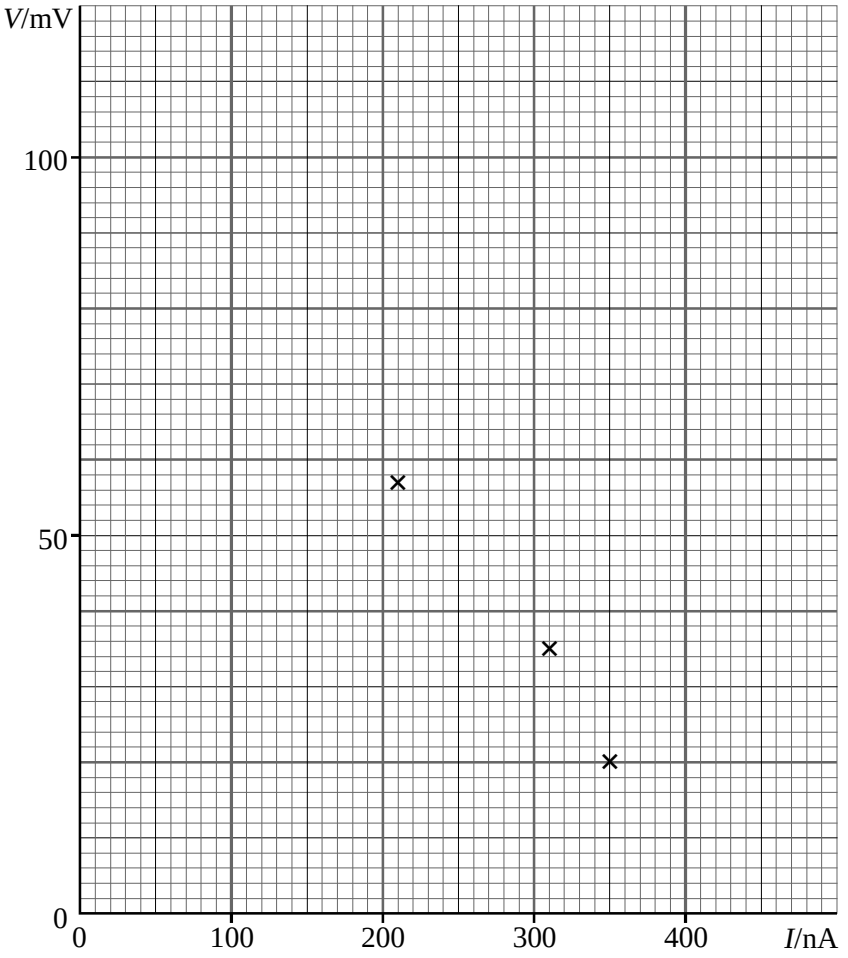
Power = ...

(2)

The student plotted his results on a graph like the one shown. Points for readings 4, 5 and 6 have already been plotted. Complete the graph.



Predict the current that would flow from the cell if it were short-circuited, that is, if *R* were reduced to zero.

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(1)

State what the experiment suggests for the value of the e.m.f. of the cell.

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(1)

Explain why the voltage across the cell falls as *R* is reduced.

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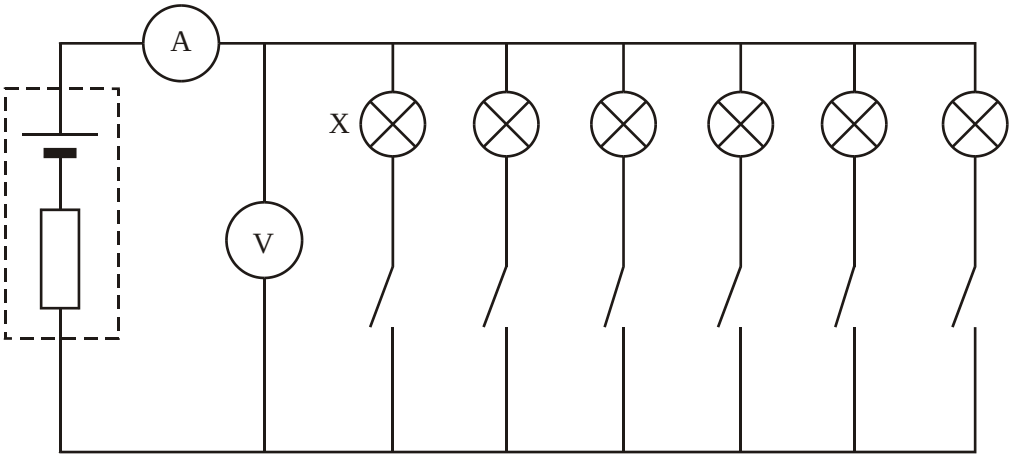
(2)

(Total 12 marks)

4. A student models a stage lighting system using a circuit-drawing computer package and a spreadsheet. He starts with a power supply of e.m.f. 120 V, and internal resistance 15 Ω. He assumes that each lamp has fixed resistance 60 Ω. He is interested in the effect of turning on the lamps one at a time, so that the number of lamps switched on increases from one to six. His circuit and part of his spreadsheet are shown below.



	A	B	C	D	E
1	Number of lamps switched on	Net resistance of lamps/Ω	Total current from supply/A	p.d. across lamps/V	Power to all lamps/W
2					
3	1	60	1.6	96	154
4	2	30	2.7	80	213
5	3	20	3.4	69	235
6	4	15	4.0	60	240
7	5	12	4.4	53	
8	6	10	4.8	48	230

The student has assumed that the voltmeter would have no effect on any of the values he has calculated. Explain why this is an appropriate assumption.

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(1)

When 6 lamps are on (row 8), how much current flows through lamp X?

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Current through X = ...

(1)

Calculate the value missing from cell E7.

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Value = ...

(1)

The lamp marked X is the first to be switched on. Explain how lamp X would appear as successive lamps are switched on.

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(3)

What would be a suitable formula for calculating cell C6?

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(2)

Comment on how the internal resistance of the power supply affects the way in which the values in column E vary.

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(2)

(Total 10 marks)