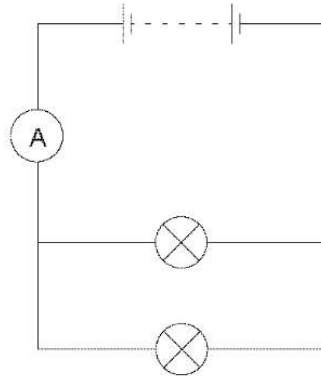


1.

Two identical lamps, each having a constant resistance of 8Ω are connected as shown. In this circuit the lamps each have a power output of 18W .



- (a) (i) Use an equation from page 2 to calculate the current through each lamp. [3]

current = A

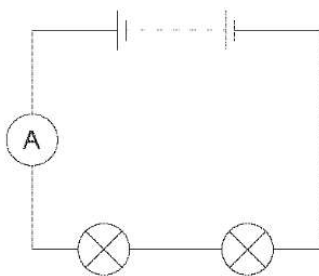
- (ii) Write down the reading on the ammeter. [1]

..... A

- (iii) Use the equation $V = IR$ to calculate the voltage of the battery. [2]

voltage = V

(b) The same two lamps are now connected in series with the same battery.



(i) Explain why the ammeter reading has decreased. [2]

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(ii) Calculate the power dissipated by each lamp in this circuit, given that the current is 0.75 A. [2]

power = W

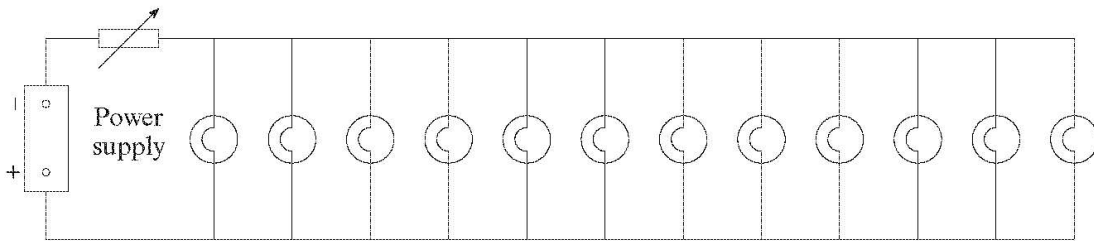
(iii) Give a reason why lamps are connected in parallel rather than in series in domestic circuits. [1]

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2.

A light fitting consists of twelve 40 W lamps connected in parallel. They are connected to the 230 V mains in a circuit in series with a single dimmer switch.



- (a) Use an equation from page 2 to calculate the current through each lamp, when all the lamps are operating at normal brightness. [2]

Current = A

- (b) The lamps are dimmed. At one dimmer switch setting, the resistance of the dimmer switch is 82Ω and the power loss in the dimmer switch is 118 W.

- (i) Use an equation from page 2 to calculate the current through the dimmer switch. [3]

Current = A

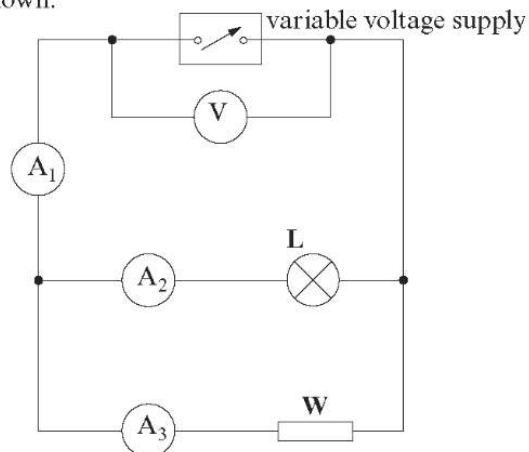
- (ii) Calculate the power produced by each lamp at this dimmer switch setting. [3]

Power = W

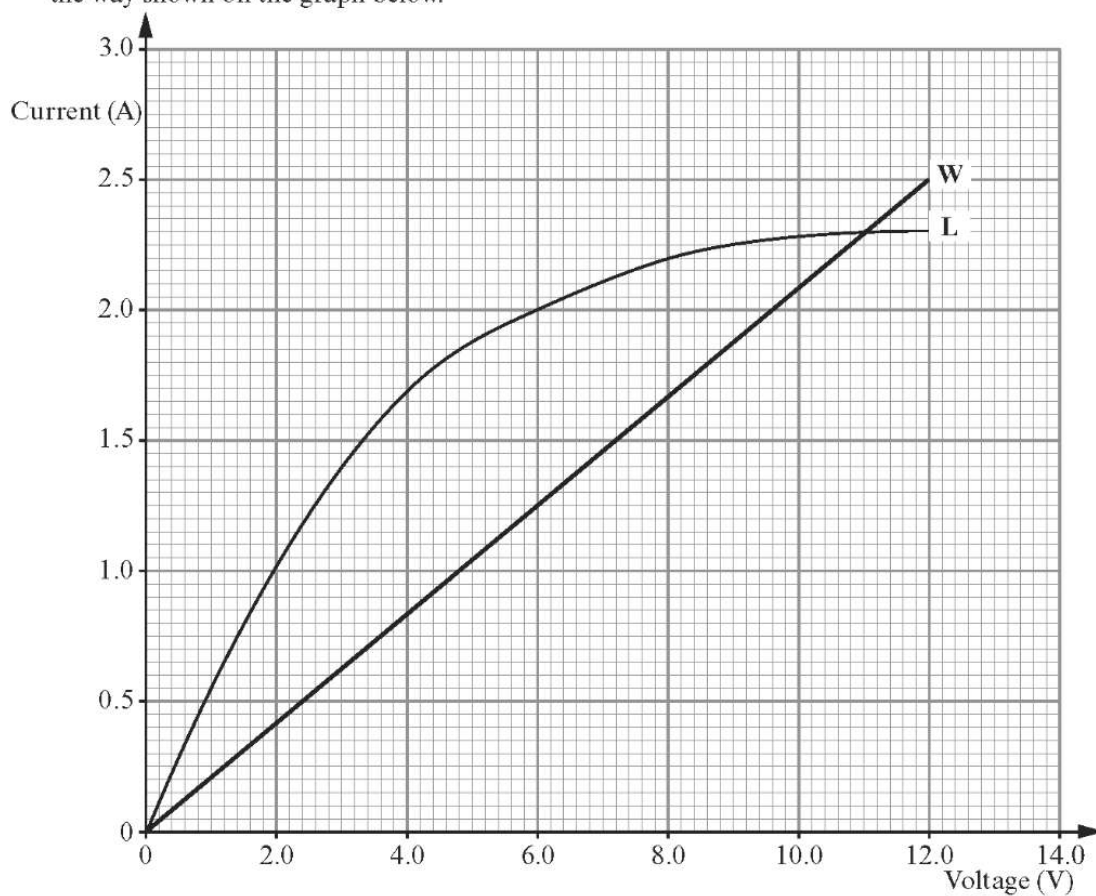
8

3.

The diagram shows a circuit used to investigate currents in a parallel circuit when the voltage is varied. A lamp **L** and a wire **W** are connected in parallel with a variable voltage supply. The circuit has 3 ammeters A_1 , A_2 and A_3 as shown.



The currents through the lamp, **L**, and the wire, **W**, depend on the voltage applied to them in the way shown on the graph below.



- (a) (i) Use the graph to find the current through the lamp when the voltmeter reading is 6 V. [1]

Current = A

- (ii) Using an equation from page 2, calculate the resistance of the lamp at 6 V. [2]

Resistance = Ω

- (iii) Find the current through ammeter A_1 at 6 V. [1]

Current = A

- (b) The voltage supply in the diagram is increased from 6 V to 12 V.

- (i) Compare the resistances of the lamp and wire at 12 V. [1]

.....

- (ii) Give a reason for your answer. [1]

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.....

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- (c) "As the voltage is increased from 0 V to 12 V, the power of the wire is not always less than the power of the lamp." Explain why this statement is true. [2]

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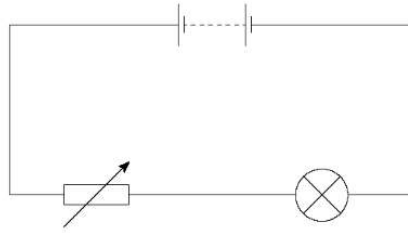
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8

4. The diagram shows a lamp connected to a battery and a variable resistor.



- (a) (i) Describe how the circuit is used to obtain a **series of measurements** of the voltage across the lamp and the current through it. You should add symbols to the circuit of any additional components you would use. [4]

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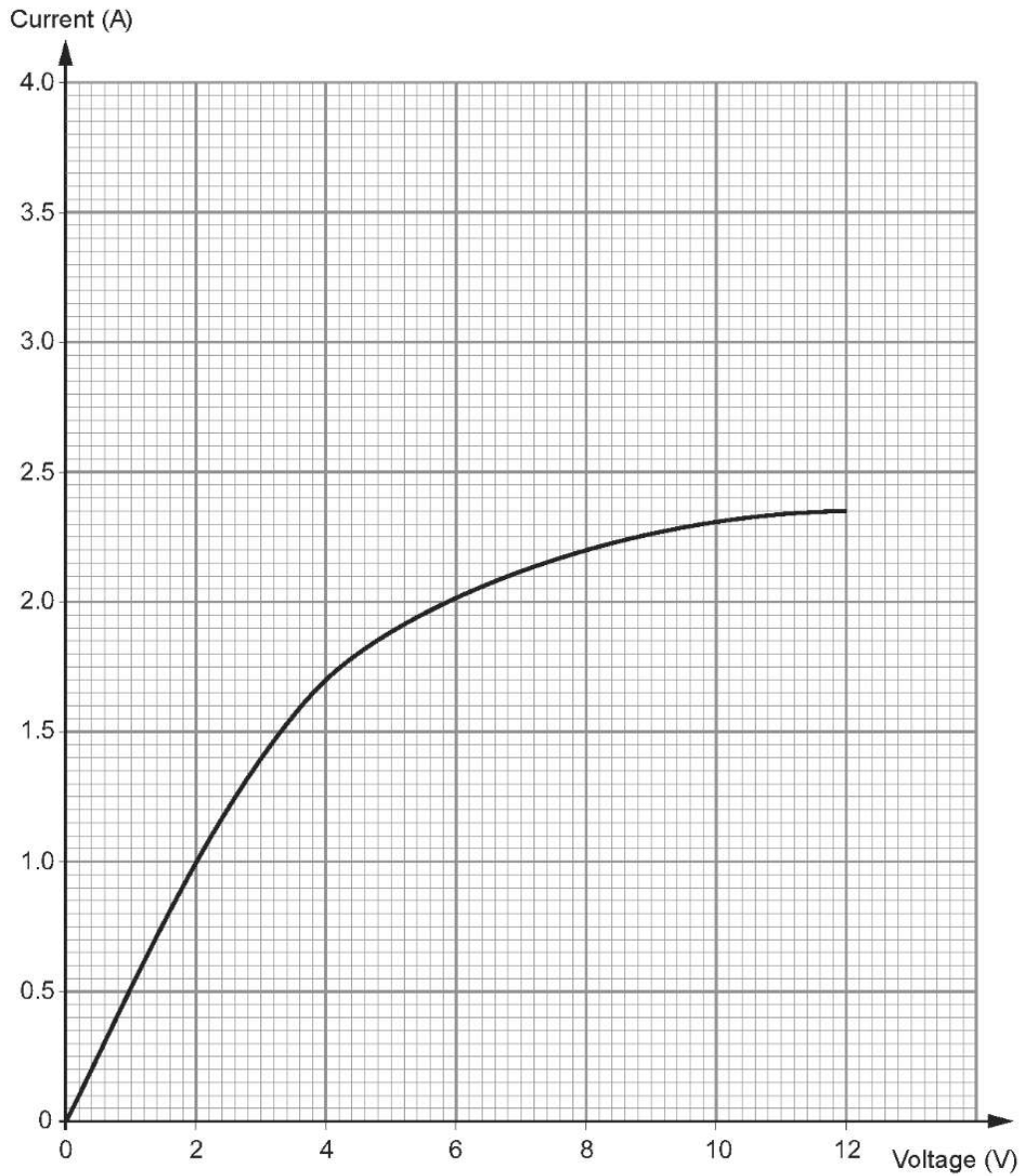
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(ii) The results for the lamp are shown on the graph below.



A resistor has a resistance of 4Ω . Draw a line on the graph above to show the current through it and the voltage across it up to 12 V. [3]

(b) (i) Use the graph and an equation from page 2 to find the power of the lamp when it has the same resistance as the resistor. [3]

..... W

(ii) Compare the resistances of the lamp and resistor when a voltage of 12 V is applied to each. Give a reason for your answer. [2]

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12

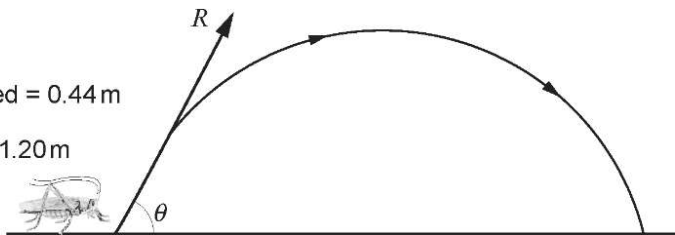
5.

A science student is investigating the jump characteristics of a grasshopper. She makes the following observations when analysing one particular jump.

Maximum vertical height obtained = 0.44 m

Maximum horizontal distance = 1.20 m

Time of flight = 0.60 s



Air resistance can be ignored for parts (a) to (c).

(a) Use the information to calculate:

(i) the horizontal component of the velocity of the grasshopper; [1]

.....

.....

(ii) the initial vertical component of the velocity of the grasshopper. [2]

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(b) Hence calculate:

(i) the magnitude of the velocity at take-off, marked R in the diagram; [2]

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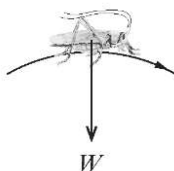
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(ii) the angle of take-off, marked θ in the diagram. [1]

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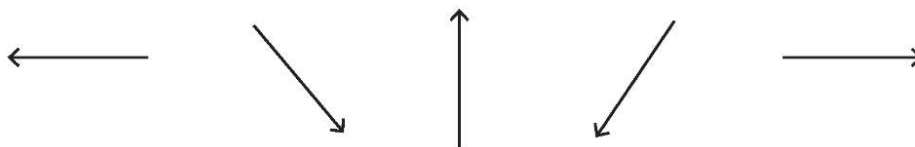
- (c) The diagram below shows the grasshopper of mass 3.0×10^{-5} kg at the instant when it is at its maximum height above the ground.



- (i) The arrow labelled W represents the force of gravity on the grasshopper due to the Earth. Identify the Newton third law 'equal and opposite' force to W . [1]

- (ii) Calculate the magnitude of the force you identified in (c)(i). [1]

- (d) Assume air resistance does act. **Circle the arrow** which correctly shows the direction of the force due to air resistance on the grasshopper at the instant it is at its maximum height. [1]



Marking Scheme

1.

Question			Marking details	Marks
3.	(a)	(i)	$P = I^2 R \quad 18 = I^2 8 \text{ (1-sub), } I^2 = \frac{18}{8} \text{ (1-manip),}$ $I = 1.5 \text{ [A] (1-answer)}$ Award 2 marks for an answer of 2.25 [A] Award 1 mark if substitution precedes manipulation.	3
		(ii)	3 [A] ecf - answer must be double the answer to (i)	1
		(iii)	Either $V = IR \quad V = 1.5 \text{ (ecf)} \times 8 \text{ (1-sub),} = 12 \text{ [V] (1)}$ ecf must be 8 × answer to (i) Or accept $P = VI$ so $V = \frac{18}{1.5} \text{ (ecf) (1-sub+manip)} = 12 \text{ [V] (1)}$ ecf applies to 1.5 the value used must be the answer to (i)	2
	(b)	(i)	Either: Supply voltage is unchanged / current (don't accept amps) has decreased (1) so the circuit resistance must have increased. (1) The 2nd mark must be linked to the 1st mark. OR voltage across each bulb has decreased (1) and so the current (don't accept amps) has decreased / but the resistance of each bulb has not changed (1) The 2nd mark must be linked to the 1st mark.	2
		(ii)	$P = I^2 R = 0.75^2 \times 8 \text{ (1 - sub)} = 4.5 \text{ [W] (1)}$ Or accept $P = VI = 6 \text{ (ecf from (a)(iii))} \times 0.75 \text{ (1 - sub)}$ $= 4.5 \text{ [W] (1)}$ Or accept $P = V^2 / R = 6^2 \text{ (ecf from (a)(iii))} / 8 \text{ (1 - sub)}$ $= 4.5 \text{ [W] (1)}$	2
		(iii)	Lamps are more powerful (brighter) [in parallel] / if one fails then the others will still work / they can be switched independently Accept they have the <u>supply</u> voltage across them	1
				Question total

2.

Question		Marking details	Mark
5.	(a)	Subs+manip 40/230 (1) $I = 0.17[4]$ [A] (1) [Do not accept 0.173 but accept 0.2]	2
	(b)	(i) Subs+manip $I^2 = \frac{118}{82}$ (1) = 1.44 (1), $I = 1.2$ [A] (1) If 1.44 on the answer line then award 2 marks. If 1.43 used, no penalty for rounding I will = 1.19 [A] N.B. $\sqrt{1.4} = 1.18$ (ii) current through each lamp = $\frac{1.2(ecf)}{12} = 0.1$ [A] (1) Either pd across dimmer = $1.2 \times 82 = 98[.4]$ (1) pd across lamps = $230 - 98.4$ ecf = 131.6 (accept 132) power = 131.6 ecf $\times 0.1$ ecf = 13.16 [W] (accept 13.2) (1) OR resistance of each lamp = $\frac{230}{0.174} = 1322$ (1) ecf for 0.174 Power = 0.1^2 ecf $\times 1322$ ecf = 13.22 [W] (1)	3
Question total			[8]


3.

Question		Answer / Explanatory Notes	Marks Available
1.	(a)	(i) 2 [A]	1
		(ii) $R = \frac{6}{2}$ (1 – substitution) = 3 [Ω] (1) ecf from (i) (If found for wire in (i) $R = 4.8 \Omega$)	2
		(iii) 3.25 [A]	1
	(b)	(i) Lamp has bigger resistance or converse argument or values given $W = 4.8 \Omega$ and $L = 5.2 \Omega$	1
		(ii) Smaller current through it or converse argument or calculations shown (allow temperature increase)	1
	(c)	Beyond about 11 V, W has the bigger current (1) hence W has the bigger power (1) Or power calculations at 12 V (1) this is because the current in W is now bigger than in L (1) Or at 11 V the powers are equal (1) because the currents are equal (1)	2
Question total			[8]

4.

Question			Marking details	Marks
4.	(a)	(i)	Voltmeter drawn with correct symbol in parallel with the lamp (allow a line through the voltmeter and allow other voltmeters across other components) (1) Ammeter drawn with correct symbol in series with the resistor (1) The [variable] resistor is altered / changes the resistance / resistor changes the current / resistor changes the voltage (1) Take readings <u>each time</u> (1).	4
		(ii)	Any diagonally upwards straight line from origin [as for a resistor] (1) Diagonal line of correct gradient from origin award 2 marks. Calculation of $I = 3$ A (at foot of page) (1) Point (12, 3) plotted (1) (Point at (12, 3) implies 2 nd mark so can be awarded).	3
	(b)	(i)	$P = IV$ or $P = I^2R$ (1) or implied with correct substitution Substitution (1) Answer = 20.25 [W] (1) to be taken from their graph Expected values are: 9 V (± 0.2), $I = 2.25$ A (± 0.1)	3
		(ii)	Lamp has greater resistance (1) because it has the smaller current through it / allow calculations of 5.1 Ω [and 4 Ω] (1) Accept converse argument for resistor. (Any reference to power treat as being neutral.)	2
			Question total	[12]

5.

Question			Marking details	Marks Available
1	(a)	(i)	Horizontal velocity = $\frac{1.20}{0.60} = 2[.0 \text{ m s}^{-1}]$	1
		(ii)	$0 = u^2 - 2 \times 9.81 \times 0.44$ [correct substitution into $v^2 = u^2 + 2ax$] (1) $u = 2.94 \text{ [m s}^{-1}]$ (1) or $0 = u - 9.81 \times 0.30$ [correct substitution into $v = u + at$] (1) $u = 2.94 \text{ [m s}^{-1}]$ (1) [Other solutions possible]	2
	(b)	(i)	$R = (4 + 8.64)^{1/2}$ (1) [ecf from (a)(i) and/or (a)(ii)] $R = 3.56 \text{ [m s}^{-1}]$ (1)	2
		(ii)	$\theta = 55.8^\circ$ ecf	1
	(c)	(i)	<u>Force of gravity on earth due to grasshopper</u>	1
		(ii)	$F = 3 \times 10^{-5} \times 9.81 = 2.9 \times 10^{-4} \text{ [N]}$ Accept 0.3 m[N]	1
	(d)			1
			Question 1 Total	[9]