Basic Electricity (2)

AS Physics

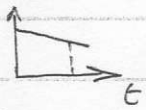
Key formulae...

$I = Q/t$

$E = QV$

$P = IV$

$V = IR$



1. A driver starts her car. The 12 V battery delivers 30 A to the starter motor for 12 sec.

a) What is the charge delivered by the motor? (2)

b) What is the total energy delivered to the motor? (2)

c) What is the motor's electrical resistance? (2)

d) A wire is slightly loose, and slips, so the contact is not so good and has a resistance of 1 Ω. The motor needs a current of 10 A to start the engine. Will the driver be able to start the engine now? (3)

2 My CASIO calculator is marked "3V 0.0004 W"

a) Put the power in (1) standard form (2) milliwatts. (2)

b) What is the current from the cells? (2)

c) What is the resistance of the calculator circuit? (2)

d) If I use the calculator for 2 hours, setting Physics homework, how much energy does the calculator use? (2)

e) Show that power $P = I^2R$ and also that $P = V^2/R$ (2)

3 A kettle element is marked "240 V 20 Ω"

a) What current does it take from the mains? (2)

b) What is the kettle's power? (2)

c) A Science student calculates that it takes half a megajoule to boil water for a pot of tea. How long does it take the kettle to heat the water? (3)

4 A Scientist test a new type of battery for a portable vacuum cleaner. At the start the battery delivered 6V and 1.5 A through the motor. The current fell steadily until after 10 min it was only 1.0 A.

a) Calculate the motor resistance (2)

b) Calculate the initial power delivered by the battery (2)

c) At the end of the test, what was (1) the battery p.d. (2) the power delivered (2+2)

d) Sketch a graph of Current vs. time, and use this to find the total charge delivered by the battery (4)

TN 09.01 +09.04

Basic Electricity (2) — Answer

#s Physics

1. a) $Q = It$ ① $= 30 \times 12 = 360$ C ① (2

b) $E = QV = 360 \times 12 = 4320$ J ① (2

c) $R = V/I$ ① $= 12/30 = 0.4\ \Omega$ ① (2

d) R_{total} now $= 0.4\ \Omega$ motor $+ 1\ \Omega$ (bad contact) $= 1.4\ \Omega$ ①

$V = IR \Rightarrow I = V/R$ ① $= 12/1.4 = 8.6$ ① A Nope ① (4

2. a) (i) $4 \times 10^{-4} = 400 \times 10^{-6}$ W ① (2) 0.4 mW ① (2

b) $P = IV \Rightarrow I = P/V$ ① $= 4 \times 10^{-4}/3 = 133 \times 10^{-6}$ A ① (2

c) $R = V/I$ ① $= 3/133 \times 10^{-6} = 22500\ \Omega$ ① (2

d) Power = energy used / time ① $\Rightarrow$ Energy = Power × time ①

So energy used in 2 hour $= 4 \times 10^{-4} \times (2 \times 60 \times 60) = 2.88$ ① J (2

e) $P = IV$ but $V = IR$ .... also $I = V/R$

So $P = I \times (IR) = I^2R$ ① So $P = \frac{V}{R} \times V = \frac{V^2}{R}$ ① (2

3. a) $I = V/R$ ① $= 240/20 = 12$ ① A (2

b) $P = IV$ ① $= 12 \times 240 = 2880$ ① W (or $P = I^2R = V^2/R$...) (2

c) Energy $E = P \times t \Rightarrow t =$ energy / power ①

So time for a kettle $= 500{,}000$ ① $/2880 = 174$ ① sec (3

4. a) Use data from the start $R_{motor} = V/I = 6$ ① $/1.5 = 4$ ① Ω (2

b) $P_{initial} = IV$ (initial values) $= 1.5 \times 6$ ① $= 9$ W. ① (2

c) End of the test ... (1) $V_{battery} = IR = 1 \times 4$ ① $= 4$ ① V (2

(2) P at the end $= IV = 1 \times 4$ ① $= 4$ ① W (2

d) See graph ⇨

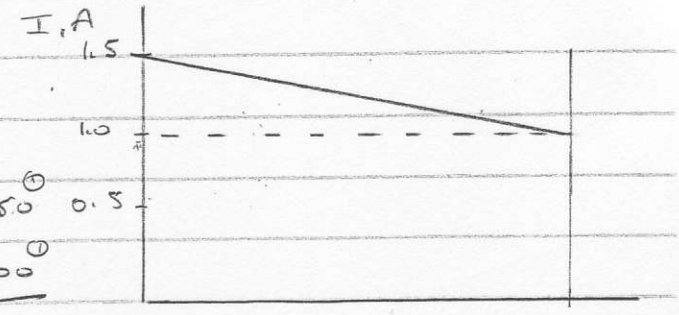
Charge from battery = area under graph

Total area = ◺ $= \frac{1}{2} \times 600 \times 0.5 = 150$ ①

+ ▭ $= 600 \times 1 = 600$ ①

750

Total charge = 750 ① C



axes ① each

graph ①

3

10 min

graph /3

calc. /3

TLN 09.01

Q... 1 /10 2 /10 3 /7 4 /14