CHAPTER 5 TEST REVIEW -- MARKSCHEME

1. D
2. D
3. C
4. A
5. A
6. B
7. C
8. D
9. B
10. C
11. C
12. C
13. A
14. D
15. B
16. A
17. D
18. B
19. D

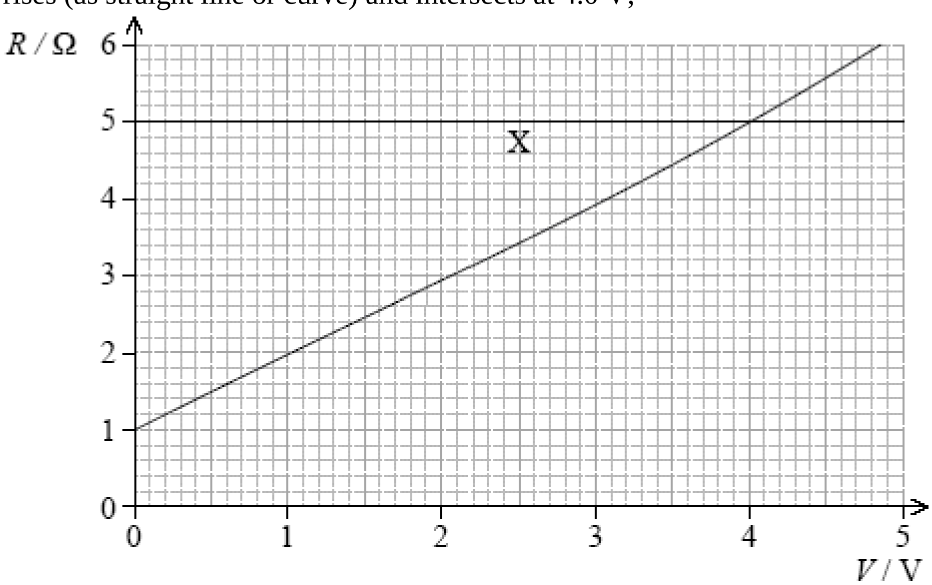
20. (a) (i) the work done per unit charge in moving a quantity of charge completely around a circuit / the power delivered per unit current / work done per unit charge made available by a source; 1

(ii) the ratio of the voltage (across) to the current in the conductor; 1

(b) (i) emf × current; 1

(ii) total power is $V_1I + V_2I$;
equating with EI to get result;
or
total energy delivered by battery is EQ;
equate with energy in each resistor $V_1Q + V_2Q$; 2

(c) graph X: horizontal straight line;
graph Y: starts lower than graph X;
rises (as straight line or curve) and intersects at 4.0 V; 3



Do not pay attention to numbers on the vertical axis.

(d) (i) realization that the voltage must be 4.0 V across each resistor;
and so emf is 8.0 V; 2

(ii) power in each resistor = 3.2 W;
and so total power is 6.4 W;
or
current is 0.80 A;
so total power is 8.0×0.80 = 6.4 W; 2

21. (a) use of $l = \frac{RA}{\rho}$; *(allow if correct substitution seen – watch for use of circumference in place of area)*

$= \left(\frac{1.5 \times \pi \times [1.8]^2 \times 10^{-8}}{1.7 \times 10^{-8}} = \right) 9.0\text{m}$ 2

(b) (i) the resistance of a conductor/copper/metal increases with increasing temperature;
increased power (dissipation) leads to higher temperature in the resistor/ resistor heating up; 2

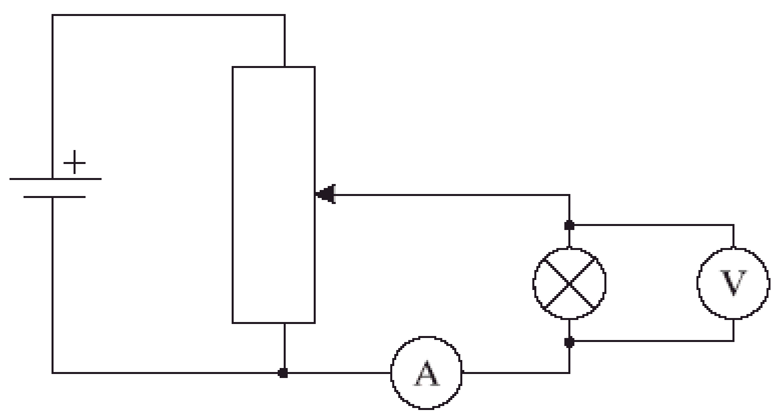
(ii) $I = \left(\sqrt{\frac{P}{R}} = \right)\sqrt{\frac{1.0}{1.5}}$;
(= 0.82 A) 1
Allow working using 0.82 A to show that power is 1.0086 W, in this case final answer must be to 2 sig fig or better.

(iii) total resistance = [R + 3.3];
6.0 = 0.82[R + 3.3];
to give R = 4.0 Ω; (*allow use of 1.65 Ω leading to 3.9 Ω)* 3

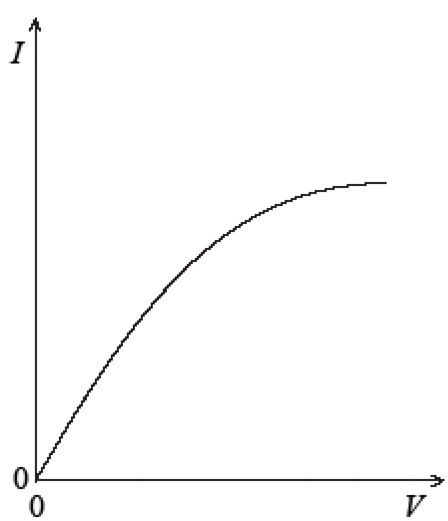
or

total resistance in circuit = $\frac{6.0}{0.82}$ = (7.3 Ω);
internal resistance + fixed resistance = 3.3 Ω;
to give R = 4.0 Ω;

22. (a) any circuit in which the current will flow through the lamp;
variable resistor connected as a potential divider;
voltmeter across lamp;
ammeter in series with lamp;



(b) correct shape;
through origin;



(c) 0.24 A; 1

(d) resistance calculated = 5.2(Ω);

$A = \left(\frac{\rho l}{R}\right) = 6.2 \times 10^{-8}\ m^2$;

radius = $\sqrt{\frac{A}{\pi}}$ seen/used;

$= 1.4 \times 10^{-4}$ m; 4

(e) calculates resistance of lamps in parallel (2.6 Ω);
$V = \varepsilon - Ir$ used to give $V = 1.0$ V;
1.0 V is lower than 1.25 V / power available to each lamp is 192 mW lower than 300 mW;
(terminal pd/power lower) hence not operating normally; *Award **[0]** for only stating this bald answer.* 4
Watch for ECF from (d).
*Award **[4 max]** for any correct numerical argument involving energy or power calculations.*

23. (a) there are no positions;

the lamp is effectively in series with 100 kΩ no matter what the position of S;

this means that the pd across it will always be close to zero (very small) / never reach 6 V;

or

the resistance of the filament is much smaller than 100 kΩ;

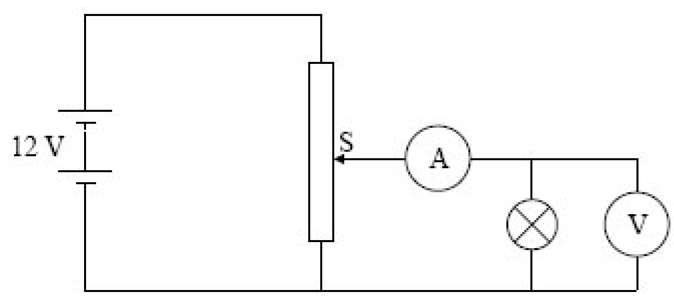
so (nearly) all the potential of the battery appears across the variable resistance; 3

*Award **[0]** for incorrect argument or just the answer without any explanation.*

(b) $I = \frac{V}{R}$;

$= \frac{12}{10^5} = 1.2 \times 10^{-4}$ A;

(c)



correct position of ammeter;

correct position of voltmeter (either to the right or left of the lamp);

24. Domestic shower

(a) (i) the amount of energy/heat required to raise the temperature of 1 kg of a substance through 1K / 1°C; 1

(ii) energy supplied by heater in 1s = 7.2×10^3 J;

energy per second = mass per second × sp ht × rise in temperature;

7.2×10^3 = mass per second × 4.2×10^3 × 26;

to give mass per second = 0.066 kg; 4

(iii) energy is lost to the surroundings;

flow rate is not uniform; 2

Do not allow "the heating element is not in contact with all the water flowing in the unit".

(iv) $P = VI \quad I = \frac{P}{V}$;

$= \frac{7.2\times10^{3}}{240} = 30\,\text{A}$; 2

(v) when operating at 7.2 kW the element is at a higher temperature/ hotter than when first switched on;

therefore, resistance is greater (and so current is smaller) / *OWTTE*;

or

element is cold / *OWTTE* when first switched on;

therefore, smaller resistance than when hot (and so current is larger); 2

(b) $P = \frac{V^2}{R}$;

$\frac{240^2}{R_{240}} = \frac{110^2}{R_{110}}$;

$\frac{R_{110}}{R_{240}} = \left(\frac{110}{240}\right)^2$;

= 0.21

or

from $P = VI$

$240I_2 = 110I_1$ to give $I_2 = \frac{11}{24}I_1$;

$I_2^2 R_2 = I_1^2 R_1$;

$\frac{R_1}{R_2} = \frac{I_2^{\;2}}{I_1^{\;2}} = \left(\frac{11}{24}\right)^2$;

= 0.21 3

25. (a) (i) $v = \sqrt{\frac{2eV}{m}}$;

$v = \sqrt{\frac{2\times1.6\times10^{-19}\times250}{9.1\times10^{-31}}}$

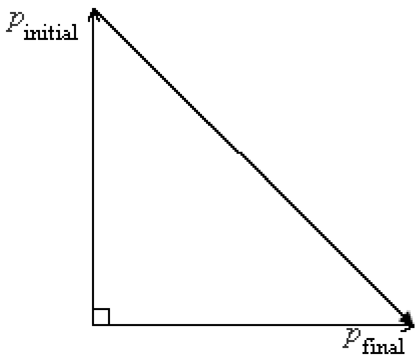
$= 9.4 \times 10^6$ m s^{-1} 2

(ii) $evB = m\frac{v^2}{r}$;

$r = \frac{9.1\times10^{-31}\times9.4\times10^{6}}{1.6\times10^{-19}\times0.12}$

$= 4.5 \times 10^{-4}$m 2

(b) (i) vector as shown; 1



(ii) $\Delta p = \left(\sqrt{[8.6\times10^{-24}]^2 + [8.6\times10^{-24}]^2}\right)$;

$= 1.2 \times 10^{-23}$ N s 1

(iii) $F \left(= \frac{\Delta p}{\Delta t} = \frac{1.2\times10^{-23}}{7.5\times10^{-11}}\right) = 16 \times 10^{-13}$ N; 1