**M1.**         (a)     (i)      electrons

**1**

jumper

**1**

(ii)     positive

*accept protons*

*accept +*

**1**

(iii)     positively charged

*accept any clear way of indicating the answer*

**1**

(b)     (i)      copper

**1**

it is an (electrical) conductor

*only accept if copper is identified*

*do* ***not*** *accept it conducts heat*

*accept it conducts heat and electricity*

*accept copper is the best conductor*

*accept correct description of conduction*

**1**

(ii)     current

**1**

**[7]**

**M2.**(a)     (i)      electrons

**1**

a positive

**1**

(ii)      (forces are) equal

*accept (forces are)the same*

*forces are balanced is insufficient*

**1**

(forces act in) opposite directions

*accept (forces) repel*

*both sides have the same charge is insufficient*

**1**

(b)     aluminium

**1**

**[5]**

**M3.**          (a)     switch

*allow answer circled in box*

**1**

(b)     24

**1**

(c)     equal to 0.25 A

**1**

(d)     4

**1**

**[4]**

**M4.**(a)

 

*allow* ***1*** *mark for each correct line if more than one line is drawn from any symbol then all of those lines are wrong*

**3**

(b)     (i)      half

**1**

(ii)     3(V)

**1**

(iii)    V1

**1**

(c)     (i)      potential difference / voltage of the power supply

*accept the power supply*

*accept the voltage / volts*

*accept number of cells / batteries*

*accept (same) cells / batteries*

*do not accept same ammeter / switch / wires*

**1**

(ii)     bar drawn – height 1.(00)A

*ignore width of bar*

*allow* ***1*** *mark for bar shorter than 3rd bar*

**2**

(iii)    as the number of resistors increases the current decreases

**1**

**[10]**

**M5.**(a)     increases

*accept reaches highest value*

*do* ***not*** *accept increases and decreases*

**1**

(b)     (i)       increases

**1**

(ii)      increases

**1**

(c)     18

*allow* ***1*** *mark for correct substitution i.e. 12 × 1.5 provided no subsequent step*

**2**

watt

*accept W
answer may be indicated in the list*

**1**

**[6]**

**M6.**          (a)     (i)      diode

*[Do not accept ‘rectifier’ or LED]*

(ii)     lamp / bulb / light

*each for 1 mark*

**2**

(b)     •        P = voltage / potential difference / p.d. / volts / V

*[Allow ‘Voltmeter]*

•        Q = current / amperes / amps / A

*[Allow ‘ammeter]*

*each for 1 mark*

**2**

**[4]**

**M7.**(a)     25(Ω)

**1**

(b)     (i)      2(V)

*allow* ***1*** *mark for showing a correct method, ie 6 / 3*

**2**

(ii)     equal to

**1**

**[4]**

**M8.**         (a)      (i)     15

**1**

(ii)     4.5 or their (a)(i) x 0.3 correctly calculated

*allow* ***1*** *mark for correct substitution, ie 0.3 x 15/their (a)(i), provided no subsequent step*

**2**

(ii)     decrease

**1**

(b)     **Y**

*accept any correct indication*

*reason only scores if* ***Y*** *is chosen
accept voltage for p.d.*

**1**

(only one that) shows a direct current / p.d.
**or**a battery / cell gives a direct current

*accept both* ***X*** *and* ***Z*** *are a.c.*

**or**a battery/cell gives a constant current/p.d.

*accept it’s a constant current/p.d.
it is not changing is insufficient*

**1**

**[6]**

**M9.**         (a)       (i)     correct symbol ringed



**1**

(ii)     accept any suggestion that would change light intensity, eg:

•        torch on or off

*accept power of torch*

*do* ***not*** *accept watts / wattage of torch*

•        distance between torch and LDR

•        lights in room on or off

•        shadow over the LDR

**1**

(b)     resistance decreases

**1**

from 600 kΩ to 200 kΩ

*accept by 400 kΩ*

**1**

(c)     (i)      no numbers for light intensity
**or**light intensity is categoric / a description / not continuous

*not enough results is insufficient*

**1**

(ii)     YES

*mark is for the reason*

both show that resistance increases with decreasing (light)intensity / brightness

*accept they both get the same results / pattern*

**1**

(d)     A circuit that automatically switches outside lights on when it gets dark.

**1**

**[7]**

**M10.**          (a)     voltmeter

*and no other*

*do* ***not*** *accept voltage*

**1**

(b)     (i)      variable resistor

**1**

(ii)     0.10 – 0.30

*accept 0.1 – 0.3*

*accept 0.3 – 0.1*

*accept 0.30 – 0.10*

**1**

(iii)     3.3 (W)

*allow* ***1*** *mark for correct data choice*

*allow* ***2*** *marks for substitution of correct
data i.e. 0.30 × 11.0*

*the following answers gain* ***2*** *marks
0.10 / 0.30 / 0.80 / 1.75*

*allow* ***1*** *mark for substitution of incorrect
of data incorrectly calculated e.g.
0.20 × 4.0 = 0.6 scores* ***1*** *mark*

**3**

(c)     increases

**1**

**[7]**

**M11.**(a)     3rd  box
The negative charge in the water is repelled by the rod and the positive charge is attracted to the rod.

**1**

(b)     (i)      friction between bottles and conveyor belt / (plastic) guides

*accept bottles rub against conveyor belt / (plastic) guides*

**1**

charge transfers between bottles and conveyor belt / (plastic) guides

*accept specific reference eg electrons move onto / off the bottles
reference to positive electrons / protons negates this mark*

**1**

(ii)     (the atom) loses or gains one (or more) electrons

**1**

(iii)    charge will not (easily) flow off the conveyor belt / bottles

*accept the conveyor belt / bottles is an insulator / not a conductor accept conveyor belt is rubber*

**1**

**[5]**

**M12.**(a)    (i)       to obtain a range of p.d. values

*accept increase / decrease current / p.d. / voltage / resistance*

*accept to change / control the current / p.d. / voltage / resistance*

*to provide resistance is insufficient*

*a variable resistor is insufficient*

*do* ***not*** *accept electricity for current*

**1**

(ii)     temperature of the bulb increases

*accept bulb gets hot(ter)*

*accept answers correctly*

*expressed in terms of collisions between (free) electrons and ions / atoms*

*bulb gets brighter is insufficient*

**1**

(iii)    36

*allow* ***1*** *mark for correct substitution, ie 12 × 3 provided no subsequent step shown*

**2**

watt(s) / W

*accept joules per second / J/s*

*do* ***not*** *accept w*

**1**

(b)     Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](../resources/AG_BL/menus/Markingguidance.pdf), and apply a ‘best-fit’ approach to the marking.

**0 marks**No relevant content.

**Level 1 (1-2 marks)**There is a basic comparison of either a cost aspect or an energy efficiency aspect.

**Level 2 (3-4 marks)**There is a clear comparison of either the cost aspect or energy efficiency aspect**OR**a basic comparison of both cost and energy efficiency aspects.

**Level 3 (5-6 marks)**There is a detailed comparison of both the cost aspect and the energy efficiency aspect.

For full marks the comparisons made should support a conclusion as to which type of bulb is preferable.

**Examples of the points made in the response:**

**cost**

•         halogen are cheaper to buy

*simply giving cost figures is insufficient*

•         6 halogen lamps cost the same as one LED

•         LEDs last longer

•         need to buy 18 / more halogen lamps to last the same time as one LED

•         18 halogens cost £35.10

•         costs more to run a halogen than LED

•         LED has lower maintenance cost (where many used, eg large departmental store lighting)

**energy efficiency**

•         LED works using a smaller current

•         LED wastes less energy

•         LEDs are more efficient

•         LED is 22% more energy efficient

•         LED produces less heat

•         LED requires smaller input (power) for same output (power)

**6**

**[11]**

**M13.**         (a)     (i)      Ends have charge
Which is opposite on each rod

**2**

(ii)     Attracts

**1**

(b)     (i)      Repulsion

**1**

(ii)     Ends have same charge

**1**

(c)     Electrons move between cloth and rod
Where gather is negative
Where move from is positive

**3**

**[8]**

**M14.**          (a)     brown

**1**

(b)     outside / case is plastic / an insulator

*accept is double insulated*

*accept non-conductor for plastic*

*do* ***not*** *accept it / hairdryer is plastic*

**1**

(c)     (i)      (1) S1

*and no other*

**1**

(2) S1 and S3

*both required, either order*

**1**

(ii)     S1 must be ON (for either heater to work)

*do* ***not*** *accept reference to ‘fan’ switch*

**1**

S1 switches the fan on

**1**

(d)     1495

*allow* ***1*** *mark for correct substitution*

*ie, 6.5 × 230*

**2**

watt(s) or W

*an answer of 1.495 kW gains* ***3*** *marks*

*although the unit is an independent mark for full credit*

*the unit and numerical value must be consistent*

*accept joules per second or J/s*

**1**

**[9]**

**M15.**         (a)      (i)     friction between the beads and pipe

*accept beads rub against the pipe*

**1**

(cause) electrons to transfer

*accept electrons are lost/gained*

*do* ***not*** *accept negatively charged atoms for electrons*

*3rd mark point only scores if 2nd mark scores*

**1**

from the pipe

*do* ***not*** *accept from the (negatively) charged pipe*

**or**to the beads

*do* ***not*** *accept to the (positively) charged beads*

*accept negative charge transfer to the beads for* ***1*** *mark provided 2nd or 3rd marking point not awarded*

*mention of positive charge transfer negates last 2 marking points*

***1***

*(ii)     volume of beads*

*accept (75)cm3*

***or****length of pipe*

*accept use the same pipe*

***or****speed the beads are poured*

*poured the same way is insufficient*

***or****angle of pipe*

***1***

*(b)     (i)      the larger the beads the less charge*

*do* ***not*** *accept inversely proportional*

*negative correlation is insufficient*

***1***

*(ii)     (total) charge decrease*

*results would be lower/smaller would be insufficient*

***1***

*beads in contact with pipe (walls) for less time*

*accept less contact (between beads and pipe)*

*accept beads in pipe for less time*

***or****smaller surface area (to rub against)*

*accept less pipe to rub against*

*less friction is insufficient*

***1***

*(c)     (i)      (pumping very) fine powders*

*reason only scores if (very) fine powders given*

*greater charge (build up)*

*accept more static (electricity)*

*accept an answer that correctly relates back to the experimental data*

***or****higher pd/voltage****or****greater energy*

*accept larger surface area to volume (ratio)*

***1***

*(ii)     idea of earthing (the pipe)*

*accept use metal pipes*

*do* ***not*** *accept use larger particles*

***1***

*(d)     to compare (the relative risks)*

*fair test is insufficient*

*you can only have one*

*independent variable is insufficient*

***or****different conditions change the MIE value*

*accept different conditions change the results*

*do* ***not*** *accept avoid bias*

***1***

***[10]***

***M16.****(a)     (i)
 *

***1***

*(ii)     360*

*allow* ***1*** *mark for correct substitution, ie 9 = 0.025 × R*

***2***

*(iii)    sketch graph of correct shape, ie

 *

***1***

*(iv)    An automatic circuit to switch a heating system on and off.*

***1***

*(b)     so ammeter reduces / affects current as little as possible*

*accept so does not reduce / change the current (it is measuring)*

*accurate reading is insufficient*

*not change the resistance is insufficient*

***1***

*(c)     gives a common understanding*

*accept is easier to share results*

*accept can compare results*

*do not need to be converted is insufficient*

*prevent errors is insufficient*

***1***

*(d)     replace Bunsen (and water) with a lamp*

*accept any way of changing light level*

***1***

*replace thermometer with light sensor*

*accept any way of measuring a change in light level*

*datalogger alone is insufficient*

***1***

***[9]***

***M17.****(a)     (i)      P = V × 1*

***or*** *equivalent*

*credit a triangle if part (ii) correctly uses the relationship*

*credit power = volts × amps* ***or*** *watts V × A*

*do not accept C for current*

***1***

*(ii)     (P = 230 × 10 =) 2300*

*credit 2.3*

***1***

*W* ***or*** *J/s*

*kW*

***1***

*(b)     (i)      15 A*

*credit 13 A* ***or*** *amps*

***1***

*(ii)     any* ***three*** *from*

*earth*

*any short (to the metal tank) causes fuse to blow*

*fuse is in the live wire*

*to prevent damage to the heater*

*credit to stop the current*

***3***

*(c)     (i)      V = I × R*

***or*** *equivalent*

*credit a triangle if part (ii) correctly uses the relationship*

***1***

*(ii)     (230 = 10 × R =) 23*

*ohms* ***or*** *Ω*

***2***

***[10]***

***M18.****(a)     (i)      1.7*

***1***

*(ii)     51****or****30 × their (i) correctly calculated*

*allow* ***1*** *mark for correct substitution i.e. 1.7 *

*or their (i)*

***2***

*coulomb / C*

*do* ***not*** *accept c*

***1***

*(iii)    612****or****their (ii) × 12 correctly calculated****or****their (i) × 360 correctly calculated*

*allow* ***1*** *mark for correct substitution i.e. E = 12 × 51*

*or 12 × their (ii)*

*or their (i) × 360*

***2***

*(b)     ions vibrate faster****or****ions vibrate with a bigger amplitude*

*accept atoms for ions throughout*

*accept ions gain energy*

*accept ions vibrate more*

*ions start to vibrate is insufficient*

***1***

*electrons collide more (frequently) with the ions****or****(drift) velocity of electrons decreases*

*electrons start to collide is insufficient*

*there are more collisions is insufficient, unless both electrons and ions are implied*

***1***

***[8]***

***M19.****(a)      (i)     light dependent resistor / LDR*

*accept ldr*

***1***

*(ii)     25 (kilohms)*

*accept 24 - 26 inclusive*

*accept 25 000 Ω*

***1***

*(iii)    5 (V) or their (a)(ii) correctly converted to ohms × 0.0002 correctly calculated*

*allow* ***1*** *mark for converting 25 kΩ /*

*their (a)(ii) to ohms*

***or***

*allow* ***1*** *mark for correct substitution*

*ie 0.0002 × 25(000)*

***or*** *0.0002 × their (a)(ii)
allow an incorrect conversion from kilohms providing this is clearly shown*

***2***

*(b)     (i)     linear scale*

*using all of the available axis*

*must cover the range 4 - 6 v*

***or*** *their (a)(iii) - 6 v and lie within the range 0 - 15 inc.*

***1***

*(ii)     negative gradient line*

*do* ***not*** *allow lines with both positive and negative gradients*

***1***

*passing through 20 lux and their (a)(iii)*

*only scores if the first mark is awarded*

*only scores if line does not go above 6 volts*

***1***

*(c)     (i)     37.5 (kΩ) or their (a)(ii) + 50 % (a)(ii) correctly calculated*

***1***

*(ii)     light intensity value would be unreliable / not accurate*

***1***

*due to variation in resistance value*

*accept because resistance varies by ± 50 %*

*accept tolerance of resistor is too great*

*do* ***not*** *accept results are not accurate*

***1***

***[10]***

***M20.****(a)     electric current
(rate of) flow of (electric) charge / electrons*

*accept *

*with Q and t correctly named*

***1***

*potential difference
work done / energy transferred per coulomb of charge (that passes between two points in a circuit)*

*accept *

*with W and Q correctly named*

***1***

*(b)     metals contain free electrons (and ions)*

*accept mobile for free*

***1***

*as temperature of filament increases ions vibrate faster / with a bigger amplitude*

*accept atoms for ions*

*accept ions/atoms gain energy*

*accept vibrate more for vibrate faster*

*do not accept start to vibrate*

***1***

*electrons collide more (frequently) with the ions****or****(drift) velocity of electrons decreases*

*do not accept start to collide*

*accept increasing the p.d. increases the temperature (****1*** *mark)*

***and***

*(and) resistance increases with temperature (****1*** *mark) if no other marks scored*

***1***

*(c)     7.8*

*allow* ***1*** *mark for obtaining value 1.3 from graph*

***or*** *allow* ***1*** *mark for a correct calculation using an incorrect current in the range 1.2-1.6 inclusive*

***2***

***[7]***

***M21.****(a)     (rate of) flow of charge / electrons / ions*

*accept movement for flow*

*do* ***not*** *accept flow of electricity*

***1***

*(b)     7(.0)*

*accept 6.96 / 6.95 or an answer that would approximate to 6.96 if rounded*

*allow* ***1*** *mark for obtaining correct power and changing to watts ie 1600*

***or***

*allow* ***2*** *marks for correct substitution and transformation
ie 1600 ÷ 230*

*an answer 0.00696 / 0.007 gains* ***2*** *marks*

*allow* ***1*** *mark for 1.6 / 230 or 1.7 / 230*

*an answer 7.39 or 7.4 gains* ***2*** *marks*

***3***

*amp (ere)*

*accept A*

***1***

***[5]***

***M22.****(a)     (i)      symbol for a diode  *

*accept  *

***1***

*symbol for a variable resistor  *

***1***

*(ii)      voltmeter is in series* ***or*** *voltmeter is not in parallel*

***1***

*ammeter is in parallel* ***or*** *ammeter is not in series*

*accept an answer in terms of how the circuit should be corrected*

*voltmeter and ammeter are wrong way around is insufficient*

***1***

*(b)     (i)      0.2 (V)*

*accept any value between 0.20 and 0.21 inclusive*

***1***

*(ii)     37.5*

*allow* ***1*** *mark for I = 0.008****or*** *allow* ***2*** *marks for correct substitution, ie 0.3 = 0.008 × R****or*** *allow* ***1*** *mark for a correct substitution using I = 0.8* ***or*** *I = 0.08****or*** *I = 0.009****or*** *allow* ***2*** *marks for answers of 0.375* ***or*** *3.75* ***or*** *33(.3)*

***3***

*(c)     (i)       25*

*allow* ***1*** *mark for obtaining period = 0.04(s)*

***2***

*(ii)     diode has large resistance in reverse / one direction*

***1***

*so stops current flow in that / one direction*

*allow diodes only let current flow one way / direction*

*allow* ***1*** *mark for the diode has half-rectified the (a.c. power) supply*

***1***

***[12]***

***M23.****(i)* ***either****210 C*

***3***

***or****1260 (joules of energy transferred)*

*unit not required*

***1***

*210*

***1***

*coulomb(s) C*

*allow J/V*

***1***

*(ii)* ***either****0.7 A*

***3***

***or****charge = current × time*

***or*** *210\* = current × 300*

***1***

***or*** *Q = It*

***or****\* same as candidate’s answer to
part (a)(I) provided correct unit given in part (a)(i)****or****\* as follows from above*

***1***

*current = 0.7\*
amp(s)* ***or*** *A*

***1***

***[6]***

***M24.****(a)     each hair gains the same (type of) charge****or****(each) hair is negatively charged*

*do* ***not*** *accept hair becomes positively charged*

***or****(each) hair gains electrons*

***1***

*similar charges repel*

*accept positive charges repel*

*providing first marking point is in terms of positive charge*

***or****negative charges repel****or****electrons repel*

***1***

*(b)     0.000002*

*accept correct substitution and transformation for* ***1*** *mark*

***or*** *2 × 10-6*

*ie 30 / 15 or .03 / 15000 or 30 / 15000 or .03 / 15*

***or*** *2 μ C*

*answers 2 and 0.002 gain* ***1*** *mark*

***2***

*(c)     current*

*do* ***not*** *accept amp / amperes*

***1***

***[5]***

***M25.****(a)     attempt to draw four cells in series*

***1***

*correct circuit symbols*

*circuit symbol should show a long line and a short line, correctly joined together*

*example of correct circuit symbol:*

**

***1***

*(b)     (i)      6 (V)*

*allow* ***1*** *mark for correct substitution, ie*

*V = 3  ×  2 scores* ***1*** *mark*

*provided no subsequent step*

***2***

*(ii)     12 (V)*

*ecf from part (b)(i)*

*18  –  6*

***or***

*18  –  their part (b)(i) scores* ***1*** *mark*

***2***

*(iii)    9 (Ω)*

*ecf from part (b)(ii) correctly calculated*

*3 + their part (b)(ii) / 2*

***or***

*18 / 2 scores* ***1*** *mark*

*provided no subsequent step*

***2***

*(c)     (i)      need a.c.*

***1***

*battery is d.c.*

***1***

*(ii)     3 (A)*

*allow* ***1*** *mark for correct substitution, ie*

*18  ×  2 = 12  ×  Is scores* ***1*** *mark*

***2***

***[12]***

***M26.****(a)     (i)      any* ***six*** *from:*

*•        switch on*

*•        read both ammeter and voltmeter*

*allow read the meters*

*•        adjust variable resistor to change the current*

*•        take further readings*

*•        draw graph*

*•        (of) V against I*

*allow take mean*

*•        R = V / I*

*allow take the gradient of the graph*

***6***

*(ii)     resistor would get hot if current left on*

***1***

*so its resistance would increase*

***1***

*(iii)    12 (V)*

*0.75 × 16 gains* ***1*** *mark*

***2***

*(iv)    15 (Ω)*

***1***

*16 is nearer to that value than any other*

***1***

*(b)     if current is above 5 A / value of fuse*

***1***

*fuse melts*

*allow blows / breaks*

*do* ***not*** *accept exploded*

***1***

*breaks circuit*

***1***

***[15]***

***M27.****(a)     filament bulb*

***1***

*(b)     (i)      6 V*

***1***

*(ii)     3 Ω or their  correctly calculated*

*allow 1 mark for correct substitution ie*

*6 = 2 × R*

*or their (i) = 2 × R*

***2***

*(iii)    1 A*

***1***

*(iv)    6 Ω or their (i) / their (iii) correctly calculated*

***1***

*(v)*

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Decrease*** | ***Stay the same*** | ***Increase*** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

***1***

***1***

***1***

***[9]***

***M28.****(a)     decreases*

***1***

*(b)     a filament bulb*

*allow bulb*

***1***

*an LED*

***1***

*(c)     Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response.*

***0 marks****No relevant content.*

***Level 1 (1−2 marks)****There is a basic description of the method. This is incomplete and would not lead to any useful results.*

***Level 2 (3−4 marks)****There is a description of the method which is almost complete with a few minor omissions and would lead to some results.*

***Level 3 (5−6 marks)****There is a detailed description of the method which would lead to valid results.
To gain full marks an answer including graph, or another appropriate representation of results, must be given.*

***examples of the physics points made in the response:***

*•        read V and I*

*•        read temperature*

*•        apply heat*

*allow hot water to cool*

*•        read V and I at least one other temperature*

*•        determine R from V / I*

*•        range of temperatures above 50 °C*

*extra detail:*

*•        use thermometer to read temperature at regular intervals of temperature*

*•        remove source of heat and stir before taking readings*

*•        details of attaining 0 °C or 100 °C*

*•        last reading taken while boiling*

*•        graph of R against T*

*•        at least 3 different temperatures*

***6***

*(d)     (i)      Q*

***1***

*(ii)     (80, 3.18)*

***1***

*(iii)    any* ***one*** *from:*

*•        measurement of V too small*

*•        measurement of I too big*

*•        incorrect calculation of R*

*•        thermometer misread*

*allow misread meter*

*ignore any references to an error that is systematic*

***1***

*(iv)    any* ***two*** *from:*

*•        not portable*

*allow requires a lot of equipment allow takes time to set up*

*•        needs an electrical supply*

*•        cannot be read directly*

*accept it is more difficult to read compared to liquid-in-glass*

***2***

***[14]***