YEAR 11 PHYSICS

PRACTICE EXAM A – MARKING GUIDE

Time allowed for this paper:
Reading time before commencing work 10 minutes
Working time for paper 3 hours

SECTION ONE

Question 1 **(4 marks)**

- Conduction and convection require matter in order to allow the transfer of heat energy.
- In conduction the particles cause a transfer of vibration by contact with neighbouring particles.
- In convection localised heating in fluids causes expansion which will see a less dense region created. As particles in a fluid can flow the less dense region will rise and cooler more densely packed particles will move into the heating region.

Radiation requires no particles and is simply that region of the EM spectrum that causes molecular motion – namely IR and microwaves. As all EM radiation can travel through vacuum heat energy may be transferred via radiation without particular involvement.

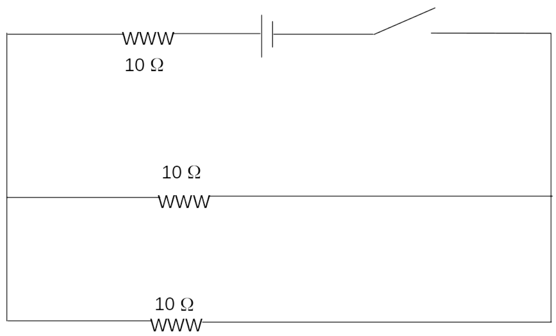
Question 2 **(3 marks)**

$m = 0.01$ kg
$l_{vap} = 2.25\times10^{6}$ K kg^{-1}
$c_{water} = 4180$ J kg^{-1} K^{-1}
$\Delta T = 100 - 37 = 63$ K

$Q = m\,L + m\,c\,\Delta T$
$= (0.01) \times (2250000) + (0.01) \times (4180) \times (63)$
$= 25\ 133.4$
$= 2.51 \times 10^{4}$ J

Question 3 **(4 marks)**

(a)



(2 marks)

(b) $V = I\,R$
$V = 1.5 \times 15 = 22.5$ V (2 marks)

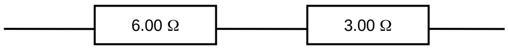
Question 4 **(4 marks)**

(a) Sample B. There is the same amount of particles initially, though it has a shorter half life. (2 marks

(b) Sample A. It deposits in greater concentration in bones, and although it has a lower activity a higher concentration should see a greater effect given that both samples emit beta radiation, and it is also of higher energy. The length of time spent in the body is indeterminate as a reason in this question so is not marked as incorrect. (2 marks)

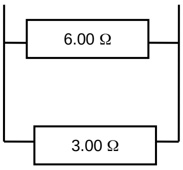
Question 5 **(4 marks)**

Series



(2 marks)

Parallel



(2 marks)

Question 6 **(3 marks)**

$Q = m c \Delta T + m L_f$

$= (0.01) (850) (8) + (0.01) (1640)$

$= 84.4$ J

Question 7 **(5 marks)**

Explain each of the following:

(a) *CHAIN REACTION* is a self sustaining process that may be controlled to produce thermal energy (1 mark)

(b) *NUCLEAR FUSION* is a reaction in which light nuclides combine to form a heavier nuclide. (1 mark)

(c) *MORE ENERGY* is released per nucleon in nuclear fusion that in nuclear fission. (1 mark)

(d) Each species of radio nuclide has a half life which indicates the rate of *DECAY.* (1 mark)

(e) Neutron - induced nuclear fission is a reaction in which a heavy nuclide captures a neutron and then splits into smaller *RADIOACTIVE* nuclides with the release of energy. (1 mark)

Question 8 **(4 marks)**

(a) Either - average KE of water reduced is by high energy particles escaping from the towel in thermal contact with air and leads to heat transfer .

Or

Energy for latent heat of vaporisation is transferred from the head to the towel to evaporating water. (2 marks)

(b) In high humidity the spaces in atmospheric air have been filled by water vapour molecules, which reduce opportunity for other water molecules to fill this space by evaporation

(1 mark)

(c) Increase air flow, increase surface area. (only one required) (1 mark)

Question 9 **(4 marks)**

A = 8 Bq A_0 = 242 Bq $t_{½} = 5 \times 10^4$ years

$$A = A_o(\tfrac{1}{2})^n \qquad \log(0.28125) = n\log(\tfrac{1}{2})$$

$$8 = 242(\tfrac{1}{2})^n \qquad \frac{\log(8/242)}{\log(\frac{1}{2})} = n$$

$$\frac{8}{242} = (\tfrac{1}{2})^n \qquad n = 4.92$$

$$t = n \times t_{½}$$

$$\log(\frac{8}{242}) = \log(\tfrac{1}{2})^n \qquad t = 4.92 \times 5 \times 10^4 = 2.46 \times 10^5$$

time taken = 2.46×10^5years

OR use the following method:

242 > 121 > 60.5 > 30.25 > 15.125 > 7.5625= 5 half lives,
so a little less than 5 half lives = approx $5 \times 5 \times 10^4$ yrs
= approx. 2.50×10^5 yrs

Question 10 **(3 marks)**

Current is a measure of the flow (drift) of charge per second past a point.
A potential difference is established between two locations and an electric field is formed.
Charge that is free to move is induced to flow through the electric field. (across the potential difference).

Question 11 **(3 marks)**

(a) When current flowing through a non-ohmic resistor is measured against changing potential difference, the relationship is not linear. (which is the case with an ohmic resistor.)
(2 marks)

(b) 1.3 A (1 mark)

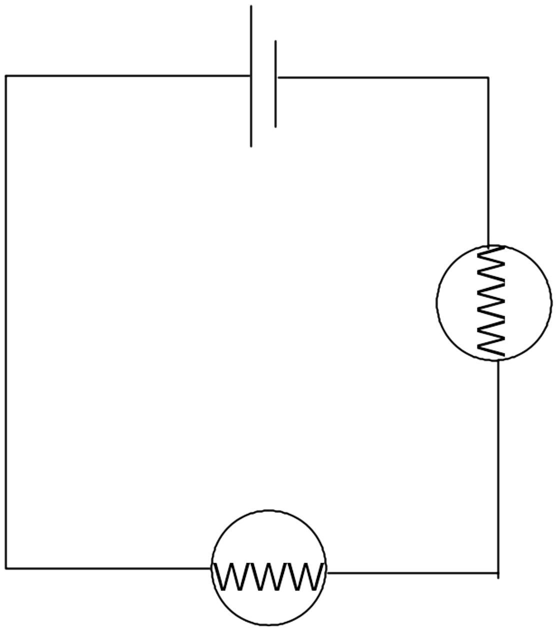
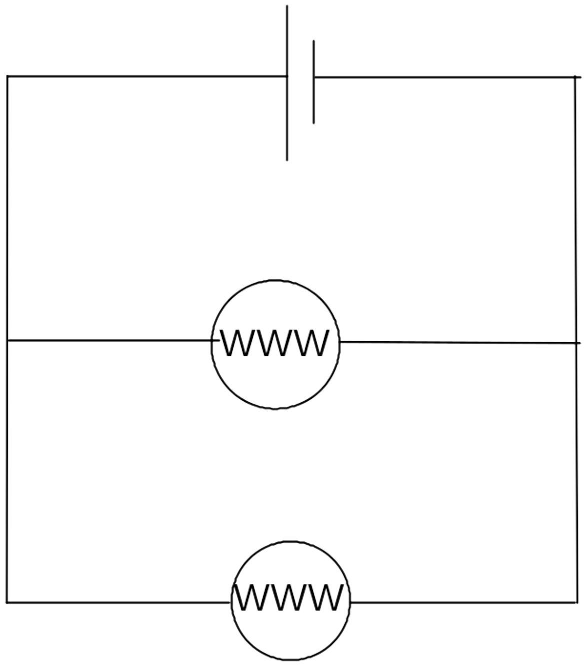
Question 12 **(3 marks)**

The student did not take into account the following:
The molten rock would undergo a change of phase as it solidified.
The bucket would have a different specific heat to water.
There would be a loss of water from the bucket due to vaporisation as the rock cooled and the water boiled.

Question 13 **(2 marks)**

absorbed dose = energy / mass
energy = absorbed dose x mass
energy = 2500 x 2 = 5000 J

Question 14 **(5 marks)**

Circuit 1: Series circuit (1 mark)	Circuit 2: Parallel circuit (1 mark)
	

(b) Circuit 2 (parallel) (1 mark)

(c) Power dissipated in the globes determine how bright they will be. Power depends upon resistance. $P = V^2/R$. Resistance in the parallel circuit is half that of the series circuit so in the formula $P = V^2/R$, the power will be greater in the parallel circuit. (2 marks)

Question 15 **(3 marks)**

(a) ${}_{53}I^{131} \rightarrow {}_{54}Xe^{131} + {}_{-1}e^{0}$ (2 marks)

(b) Because of the isotope's short half life the radiation will not be residual in the body for a long period of time so it is safe to use in this application. (1 mark)

SECTION TWO

Question 16 **(14 marks)**

(a)

$V = I R$ so $I = V/R = 240/300 = 0.80$ A (2 marks)

$V = I R$ so $I = V/R = 240/800 = 0.30$ A (2 marks)

(b) Total current = 0.80 + 0.3 = 1.10 A A (2 marks)

or if students need to calculate it:
Total resistance in the circuit
$1/R_{total} + 1/R_X + 1/R_Y = 1/R_{total} = I/300 + 1/800$
$R_{total} = 218.18$ W
$V = I R$
$I = V/R = 240/218.18 = 1.10$ A

(c) No. It is unlikely there would be a problem. Household lighting circuits are typically able to carry currents of 8 to 10 A before they become overloaded. (2 marks)

(d) Total resistance in the circuit
$1/R_{total} + 1/R_X + 1/R_Y = 1/R_{total} = I/300 + 1/800$
$R_{total} = 218.18$ W (2 marks)

(e) $P = V I = 240 \times 1.1 = 264$ W
$= 0.264$ kW

The number of hours = 2.0 hours
The number of kWh = 2.0 x 0.264 = 0.528 kWh
Cost = 0.528 x 22.36 = $11.81 cents (4 marks)

Question 17 **(10 marks)**

(a) Energy released in 1 second = $10 \times 10^{3} \times 1.55 \times 10^{-13} = 1.55 \times 10^{-9}$
Energy released in 1 year = = $1.55 \times 10^{-9} \times 365 \times 24 \times 60 \times 60 = 0.04888$ J (2 marks)

(b) Energy absorbed per kg = 0.048888/55 = 8.89×10^{-4} J/kg (2 marks)

(c) A gray is measured in J/kg therefore the radiation dose in grays is 8.89×10^{-4} Gy
(2 marks)

(d) (i) The quality factor for alpha radiation is 20
dose equivalent = absorbed dose x quality factor = $8.89\ 10^{-4} \times 20 = 0.01778$ Sv
= 17.78 mSv (2 marks)

(ii) No. The research student is lucky. Absorbing a radiation dose of 17.78 mSv is within the recommended safe range for workers in the radiation industry, (50 mSv), so there would be no major concerns about his health. (2 marks)

Question 18 **(7 marks)**

(a) (i) A-B (1 mark)
(ii) E-F (1
mark)

(b) (i) A-B, C-D and E-F (1 mark)

(ii) B-C and D-E (1 mark)

(c) Time = 1.1 min = 66 s
mass = 1.0 kg
Rate of heating = 20 J/s
Quantity of heat to convert 0.75 kg of solid to liquid = 20 x 66 = 1320 J
Quantity of heat to convert 1.0 kg of solid to liquid = 1.0/075 x 1320 = 1.76×10^3 J
(3 marks)

Question 19 **(13 marks)**

(a) stirring, choosing suitable mass of liquid,
temperature rise and appropriate time for heating. (2 marks)

(b) Q = 0.50 x 4180 x (57 – 23) = 71 060 J (1 mark)

(c) Heat produced per second = 71 060 / 260 = 273.21 watts (3 marks)

(d) Any two

- Some heat goes into heating the glass beaker and the gauze.
- Not all heat from Bunsen heats the beaker, some heat escapes sideways.
- Thermometer accurate to only 1 degree in 34 => 3 % error. (2 marks)

(e) two conditions,
- Bunsen in same position relative to the beaker.
- Bunsen flame same colour
- Gas supply the same (2 marks)

(f) $Q = m\,c\,\Delta T$
$273.31 \times 120 = 0.41 \times c \times (66 - 23)$
$32\,797.2 = 17.63 \times c$
$c = 1.860 \times 10^{3}\ \mathrm{J\,kg^{-1}K^{-1}}$ (4 marks)

Question 20 **(10 marks)**

(a) Control rods are used to absorb neutrons to control the nuclear chain reaction that occurs with the fissile fuel.
In order to do this they are raised and lowered between the fuel “bundles” and by doing so absorb more or less neutrons allowing a degree of control over how much of the fuel undergoes decay and releases energy by controlling how many of the neutrons in a decay event go on to initiate another decay event. (2 marks)

(b)

$${}^{137}_{55}Cs \rightarrow {}^{137}_{56}Ba + {}^{0}_{-1}e$$ (1 mark)

$${}^{137}_{56}Ba^{*} \rightarrow {}^{137}_{56}Ba + {}^{0}_{0}\gamma$$ (1 mark)

(c) If the process is 40% efficient and the eventual output is 950 MW,
then 950 / 0.40 = 2375 MW is required to be produced from the U-235.
1 decay releases 200 MeV = 200 x $1.6\text{x}10^{-13}$ J = 3.2 x 10^{-11} J per decay.

If 2375 x 10^{6} J are required every second the amount of decays per second required is:

2375 x 10^{6} ÷ 3.2 x 10^{-11} = 7.422 x 10^{19} decays per second.

In one day there are 60 x 60 x 24 = 86 400 seconds, therefore the number of atoms

undergoing decay in one day: 7.422 x 10^{19} x 86 400 = 6.413 x 10^{24} decays

If the mass of one U-235 nucleus is $3.90625\text{x}10^{-23}$ kg, then the total mass of U-235 consumed in one day = $3.90625\text{x}10^{-23}$ x 6.413 x 10^{24} = 250.5 kg. (6 marks)

Question 21 **(8 marks)**

(a) V = 1.00 x 10^{9} V
q = 40.0 C

E = qV

= 40 x 1.00 x 10^{9}

= 4.0 x 10^{10} J (3 marks)

(b) q = 40.0 C
t = 1.11 x 10^{-2} seconds

I = q ÷ t

= 40 ÷ 1.11 x 10^{-2}

= 3.60 x 10^{3} A (3 marks)

(c) Any action that would mean you are not the highest point in an otherwise exposed area.
For example: not in the sea, not holding aloft an umbrella or metal object such as a golf club, not standing under a tree. (2 marks)

Question 22 **(11 marks)**

(a) Mass of reactants = 13.999234 + 1.00728 = 15.006514
Mass of daughter products = 14.998677

Δm = 15.006514 - 14.998677 = 0.007837 u
E (MeV) = Δm (u) × 931
E = 0.007837 × 931 = 7.30
E = 7.30 MeV (2 marks)

(b) Kinetic energy of the daughter products
Energy associated with the gamma radiation
Increased particle vibration of the daughter products (heat energy) (2 marks)
Any 2 acceptable examples

(c) Binding energy is the (mechanical) energy required to disassemble a whole into separate parts. In this case the energy required to separate a nucleus into the individual nucleons that it comprises. (2 marks)
Or
The energy released to the surroundings when a nucleus is formed from individual nucleons.

(d) Mass of individual nucleons = (8 × 1.00728) + (8 × 1.00867) = 16.12760

Δm = 16.12760 - 15.990526 = 0.137074 u

E (MeV) = Δm (u) × 931
E = 0.137074 × 931 = 127.615894 MeV
BE per nucleon = 127.615894 / 16 E = 7.98 MeV per nucleon (3 marks)

(e) If the student calculated the BE correctly then their answer would be something like:
“Yes the value of about 8 MeV per nucleon agrees with the graph because a mass number of 16 (oxygen) shows a value of about 8 MeV on the graph”.
If the student calculated a value different to 7.98 MeV then their answer would be something like; “ No. The values do not agree. The correct value is about 8 MeV because oxygen has an atomic number of 16, which shows a BE per nucleon of about 8 MeV. My value is different to that!
Both answers should be marked correct because they demonstrate an understanding of the concept.
(2 marks)

Question 23 **(11 marks)**

(a) The compressor subjects the gas to a rapid increase in pressure. As a result the gas begins to condense, transferring its latent heat to the warm outside air. (2 marks)

(b) Outside the house. (1 mark)

(c) Air is fed through the condenser to extract heat energy. (2 marks)

(d) It is placed just before the evaporator. It feeds the refrigerant into a low pressure region. (2 marks)

(e) The low pressure region induces a phase change from liquid to gas. This requires energy, the latent of vaporisation, which is taken from air inside the house by passing it through the evaporator. This reduces the air temperature. (2 marks)

(f) Volatility- its ability to easily change phase with pressure variation.
Boiling point at around room temperature.
Whether it is a chemical hazard.
Environmental impacts if released. (2 marks)

Any 2 reasonable points

Question 24 **(6 marks)**

(a) For the 60 Ω lamp
$P = V^2 / R = 240^2 / R$
$R = 240^2 / 60$
$R = 960\ \Omega$ (2 marks)

For the 75 Ω lamp
$P = V^2 / R = 240^2 / R$
$R = 240^2 / 75$
$R = 768\ \Omega$ (2 marks)

(b) The ‘smart” lamps are operating with much less power cf 18 W versus 75 W and so are consuming less electricity, so cost less to run.
They have a longer life because they are operating with a different technology which does not rely upon fragile filaments with high resistances. (2 marks)

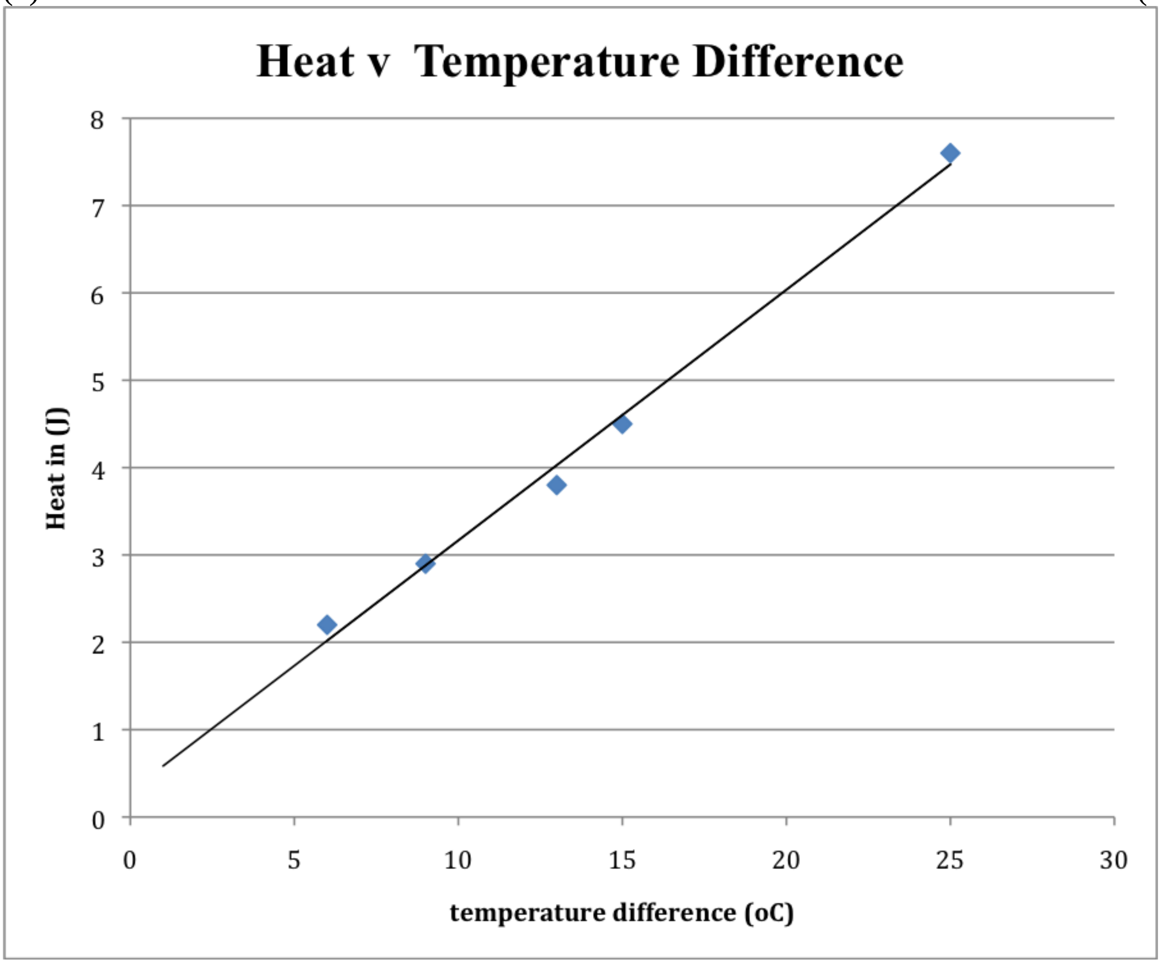
SECTION THREE

Question 25 **(18 marks)**

(a) (2 marks)

Heat in (Q) ($J \times 10^5$)	Temperature T_2 (°C)	Temperature T_1 (°C)	$T_2 - T_1$
7.6	80	55	25
3.8	70	57	13
2.2	55	49	6
2.9	40	31	9
4.5	35	20	15

(b) (4 marks)



gradient of graph is 0.2706

(c)

$$Q = \frac{k\, A\,(T_2 - T_1) \times t}{L}$$

k = L x [Q / (T_1-T_2)] / [A x t]
k = 0.75 x 0.2706 /(0.035 x 120)
k = 4.83 x 10^{-2} W m^{-1} $^{o}C^{-1}$

The coefficient of thermal conductivity (k) = 4.83 x 10^{-2} W m^{-1} $^{o}C^{-1}$ (7 marks)

(d) The major consideration is to insulate the rod so all the heat produced is transferred in the metal and does not escape to the surroundings.
Keeping the conditions identical between each trial. (2 marks)

(e) By repeating multiple trials any errors in measurements are reduced due to an averaging process. (2 marks)

(f) Polymers usually have lower melting temperatures so would melt during high temperature experiments. (1 mark)

Question 26 **(18 marks)**

(a) Zero emissions (non-polluting)
Efficient in terms of energy transformations from power source.
Not using oil which is still a valuable resource elsewhere.
Quiet operation
Convenient to recharge at home(any 4 appropriate responses) (2 marks)

(b) Limited range (up to 300 km) and several hours to recharge make long distance driving slow and fragmented and drivers rely on being able to obtain access to an electrical power point. (2 marks)

(c) On a conventional ICE car the kinetic energy of motion is transformed to heat energy (via the force of friction on brake pads). This energy cannot be reused by the vehicle.

On an EV the kinetic energy of motion is transformed into chemical potential energy in the Lithium-ion battery.
This energy can be re-used for propulsion. (2 marks)

(d) $P_{electrical}$ = 50 000 W   t = 7 $\times$ 60 = 420 s
Electrical energy offered by motor   E = P $\times$ t
$E_{electrical}$ = 50 000 $\times$ 420 = 2.1 $\times$ 10^7 J

Efficiency = energy taken / energy offered (%)
Efficiency = 1.90 $\times$ 10^7 / 2.1$\times$ 10^7
Efficiency = 90.5 % (3 marks)

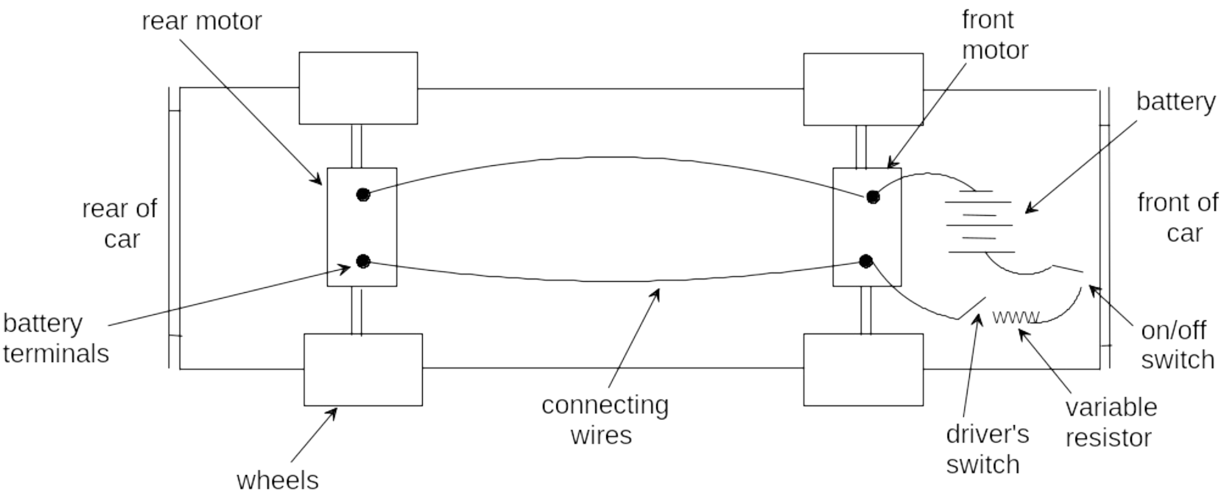
(e) $E_{electrical}$ = 56.1 kW hours time = 8 hours
$E = P \times t$
$P_{electrical} = E / t = 56.1 / 8 = 7.0125$ kW

$P_{electrical} = V \times I$
$I = P_{electrical} / V$
$I = 7012.5 / 240$
$I = 29.2$ A (3 marks)

Or students can convert
56.1 kW hr = $56.1 \times 3.6 \times 10^6 = 2.0196 \times 10^8$ J
8 hours = $8 \times 60 \times 60 = 2.88 \times 10^4$ s
$P = E / t = 2.0196 \times 10^8 / 2.88 \times 10^4 = 7.0125 \times 10^3$ W

(f) Cost ($) = price per kW hr × number of kW hrs (2 marks)
Cost = 0.2236 × 56.1 = $12.54

(g)



(4 marks)