Neap:

Trial Examination 2016

VCE Physics Unit 1

Written Examination

Suggested Solutions

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Area of study – How can thermal effects be explained?

Question 1 (17 marks)

a. 100 K is equivalent to –173°C so block A is much hotter. 1 mark

Atoms in block A have a higher average kinetic energy since it is directly proportional to temperature. 1 mark

b. The hotter block has particles with a greater average kinetic energy than the cooler block. Thus when they come into contact, the hotter block particles transfer kinetic energy to the cooler block particles, such that eventually the average kinetic energy of the particles in both blocks is the same. Therefore the blocks now have the same final temperature. 1 mark

c. The transfer of energy by conduction is proportional to the temperature difference and the surface area of the blocks. 2 marks

Initially both these quantities are equal for both blocks, so both will receive energy at the same rate. 1 mark

d. The copper block (A) is hotter 1 mark
because copper has a lower specific heat capacity than steel. 1 mark

The same amount of energy will translate to a greater temperature increase in the copper. 1 mark

e. $$m_c \times C_c \times \Delta t_c = m_w \times c_w \times \Delta t_w$$

$$m_c \times 385 \text{ J K}^{-1} \times (227 - 31)^\circ\text{C} = 1 \text{ kg} \times 4180 \text{ J K}^{-1} \times (31 - 26)^\circ\text{C}$$ 1 mark

$$m_c = 0.33 \text{ kg}$$ 1 mark

f. $$\frac{P_1}{P_2} = \left(\frac{T_1}{T_2}\right)^4$$

$$\frac{2400 \text{ W}}{1200 \text{ W}} = \left(\frac{500 \text{ K}}{T_2}\right)^4$$ 1 mark

$T_2 = 420$ K (rounded from 421 K) 1 mark

g. Wien's law:

$$\lambda_{\text{peak}} = \frac{0.0029}{T}$$

$$= \frac{0.0029}{500 \text{ K}}$$ 1 mark

$= 5800$ nm 1 mark

h. The correct answer is **D.** 2 marks

10^{-6} m is in the infrared part of the spectrum.

Question 2 (13 marks)

a. $Q = U + W$

Q is zero since no energy is transferred in or out of the balloon. 1 mark

W is positive since the gas does work by expanding into the balloon. 1 mark

U must therefore be negative; the gas cools. 1 mark

b. Unlike CO_2, H_2 does not absorb infrared radiation, 1 mark
so H_2 will not re-emit radiation back towards the Earth's surface; it is not a greenhouse gas. 1 mark

c. Only half of the Earth's surface is exposed to sunlight at any one time. 1 mark

Only at the equator will the Earth receive the full intensity of the Sun. At higher latitudes, the intensity is less/is more spread out (*or words to that effect*). 1 mark

d. energy in = energy out = 343 W m^2 1 mark

e. Energy used in our homes comes mostly from burning fossil fuels. This produces carbon dioxide that gets released into the atmosphere. 1 mark

Greater levels of carbon dioxide in the atmosphere increase the greenhouse effect and so the Earth must heat up to emit more energy. 1 mark

f. **Thick curtains:** The thicker the material, the less **conduction** there is from the hot windows to the cool room. 1 mark

Light-coloured curtains: The lighter colour will reflect more of the infrared **radiation** from the Sun. 1 mark

Pelmets: These disrupt the **convection** current that causes the hot air next to the window to rise up behind the curtains and enter the room. 1 mark

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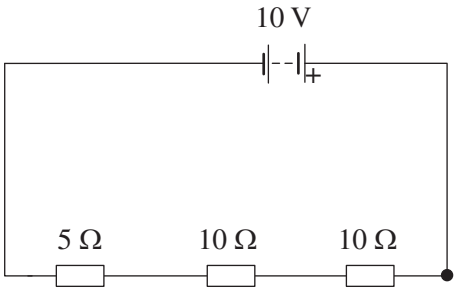
Area of study – How do electric circuits work?

Question 3 (10 marks)

a.



2 marks
1 mark for correct use of symbols.
1 mark for correct set-up.

b. $R_T = 5 + 10 + 10 = 25\ \Omega$, or consequential from drawing. 1 mark

c.

	5 Ω	**10 Ω**	**10 Ω**
***I* (A)**	1	0.5	0.5
***V* (voltage drop) (V)**	5	5	5

Students may show that the parallel section has an effective resistance of 5 Ω, so:

$R_T = 10\ \Omega$ and $I = \frac{V}{R} = \frac{10}{10} = 1.0$ A.

3 marks
1 mark for each correctly filled column.
Note: Consequential on answer to ***Question 1a.***

d. In series: $P = \frac{V^2}{R} = \frac{10^2}{25} = 4$ W. 1 mark

In parallel: The 2 × 10 Ω resistors have an effective resistance of 5 Ω.

$$R_{\text{eff}} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1}$$
$$= \left(\frac{1}{10} + \frac{1}{10}\right)^{-1}$$
$$= 5\ \Omega$$

When combined with the other 5 Ω resistor, the total effective resistance is 2.5 Ω.

$$P = \frac{V^2}{R}$$
$$= \frac{10^2}{2.5}$$ 1 mark
$$= 40\ \text{W}$$ 1 mark

A circuit set-up in parallel will produce maximum power. 1 mark

Question 4 (9 marks)

a. $t = 5$ mins $= 300$ s 1 mark

$$\text{And } Q = \frac{E}{V}$$

$$= \frac{Pt}{V}$$

$$= \frac{6 \times 300}{12}$$

$= 150$ C 1 mark

b. $E = Pt$

$= 6 \times 300$ 1 mark

$= 18\ 000$ J

$= 1.8$ kJ 1 mark

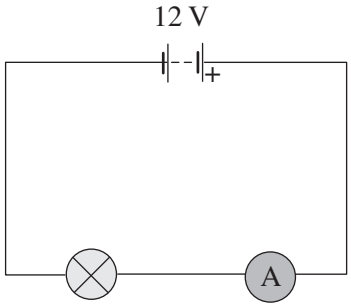
c. The energy changes occurring are electrical to thermal (or heat) energy. 1 mark

d. The ammeter provides little resistance and all the current goes through the ammeter. 1 mark

This bypasses the globe (that is, a short circuit) so it does not light up. 1 mark

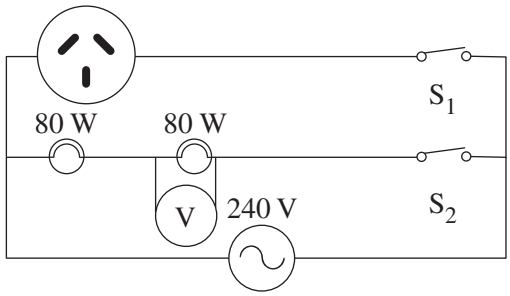
e. The ammeter should be placed in series instead. 1 mark

This will allow the globe to light up. 1 mark



Question 5 (8 marks)

a. The diagram must show the voltmeter placed correctly across either globe, as shown below.



1 mark

b. If one globe goes out then so does the other, since they are in series. 1 mark

The solution is to wire the second globe in parallel. 1 mark

c. $E = Pt$

$= 80\ (\text{W}) \times 1.75\ (\text{hr}) \times 3600 \times 14\ (\text{days})$

$= 7.1442\ \text{MJ}$ 1 mark

Since 1 kW h = 3.6 MJ, then $E = \dfrac{7.1442}{3.6} = 1.98$ kW h. 1 mark

d. Emma is correct – the earth is not needed to run devices. 1 mark

The earth wire connects the metal casing of the device to the ground. 1 mark

This safety feature prevents a faulty 'live' device from potentially electrocuting someone. 1 mark

Question 6 (3 marks)

For example:

One ohmic device is the fixed-value resistor. 1 mark

One non-ohmic device is the LED. 1 mark

An ohmic device maintains a constant resistance (or the $\dfrac{V}{I}$ ratio is constant), whereas a non-ohmic device does not maintain this constant ratio. 1 mark

2 marks for choosing correct ohmic and non-ohmic devices.
1 mark for explanation.
Note: There can be a number of different answers.

Area of study – What is matter and how is it formed?

Question 7 (21 marks)

a. **baryons:** proton, neutron (lambda or sigma for example) 2 marks

leptons: electron, neutrino (muon, tau) 2 marks

b. Electrons can only be held by the nucleus below a certain temperature (about 3000 K). 1 mark

The universe first had to cool (and expand) below this temperature, which took many years. 1 mark

c. The universe became 'transparent'; photons were able to travel freely through space (*or words to that effect*). 1 mark

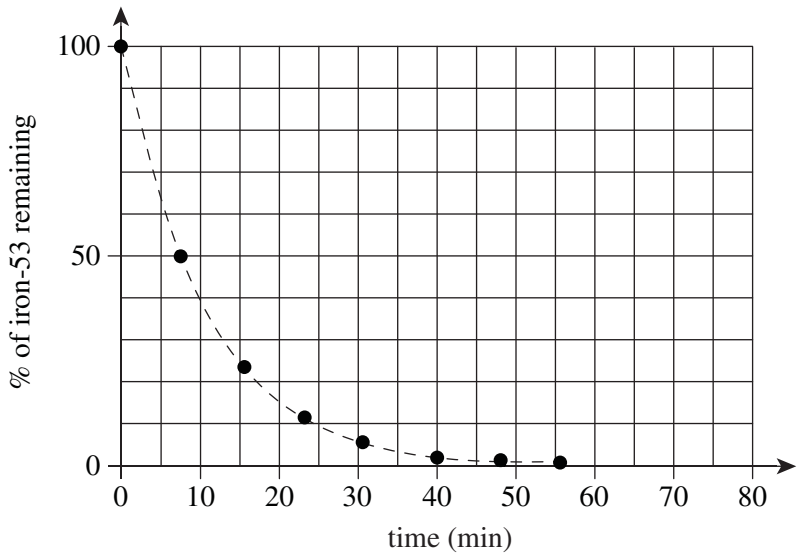
d. The corrrect answer is **C**. 2 marks

e. The nucleus of Fe-56 has the highest binding energy per nucleon in the periodic table, and so is the most stable atom. 1 mark

This means you cannot add more nucleons and grow towards greater atomic mass without adding extra energy. 1 mark

f. An isotope is a species of nucleus that has the same atomic number as a given element, 1 mark
but a different neutron/mass number. 1 mark

g.



3 marks
2 marks for three or four correct points.
1 mark for curve of best fit.
Students are awarded 1 mark for only including two correct points.

h. ${}^{53}_{26}\text{Fe} \rightarrow {}^{53}_{25}\text{Mn} + {}^{0}_{+1}\beta + {}^{0}_{0}\nu$ 3 marks

1 mark for atomic numbers for Fe and Mn .
1 mark for positron (beta+).
1 mark for neutrino.

i. Mn-53 undergoes gamma decay. 1 mark

The nucleus gives out pure energy in the form of EM-radiation/gamma photon. 1 mark

Question 8 (9 marks)

a. The strong nuclear force that holds nucleons together is much stronger than the electromagnetic force that holds electrons in atoms. 1 mark

This means much more work is required to undo those nuclear bonds. 1 mark

b. ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3{}^{1}_{0}n + \text{energy}$ 3 marks

1 mark for incoming thermal neutron.
1 mark for Kr-92.
1 mark for the three neutrons produced.

c. $E = mc^2$

$$m = \frac{3.2 \times 10^{-11}\ \text{J}}{9 \times 10^{16}\ \text{m s}^{-1}}$$ 1 mark

$$= 3.6 \times 10^{-28}\ \text{kg}$$ 1 mark

d. Electrons in such atoms are found in higher (excited) states (levels). 1 mark

When the atoms lose energy, the electrons return to lower states (levels), emitting photons of light in the process. 1 mark

