|  |  |
| --- | --- |
|  |  **HARRISDALE SENIOR HIGH SCHOOL** **Year 11 Semester 1 2023** |

PHYSICS – MARKING GUIDE

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Student number: | In figures |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |

 |
|  | In words |  |
|  |  |  |

**Time allowed for this paper**

|  |  |
| --- | --- |
| Reading time before commencing work:Working time: | Ten minutesTwo hours and thirty minutes |

**Materials required/recommended for this paper
*To be provided by the supervisor***
This Question/Answer booklet
Formulae and Data booklet

***To be provided by the student***

|  |  |
| --- | --- |
| Standard items: | pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters |
| Special items: | calculators which do not have the capacity to create or store programmes or text and are permitted in ATAR course examinations, drawing templates, drawing compass and a protractor |

**Important note to students**No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Suggested working time(minutes) | Marks available | Percentage of exam |
| Section One:Short answer | 10 | 10 | 50 | 50 | 33 |
| Section Two:Problem Solving | 6 | 6 | 80 | 82 | 55 |
| Section Three:Comprehension and data analysis | 1 | 1 | 20 | 18 | 12 |
|  |  |  | **Total** | 150 | 100 |

**Instructions to candidates**

1. Write your answers in this Question/Answer booklet, preferably using a black/blue pen. Do not use erasable or gel pens.
2. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
3. When calculating or estimating answers, show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning.

In calculations, give final answers to three significant figures and include appropriate units where applicable.

 In estimates, give final answers to a maximum of two significant figures and include appropriate units where applicable.

1. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate in the original answer where the answer is continued, i.e. give the page number.
2. The Formulae and Data booklet is not to be handed in with your Question/Answer booklet.

**Section One: Short response 33% (50 Marks)**

This section has **ten (10)** questions. Answer **all** questions. Write your answers in the space provided. Suggested working time for this section is 50 minutes.

**Question 1 (4 marks)**

On the diagram below, indicate the charge on each ball. In the space below, explain how you arrived at this answer.

Ball D

Ball C

Ball A

Ball B

+

+

-

-

|  |  |
| --- | --- |
| Ball D loses electrons = positive charge. | 1 mark |
| Ball A attracted to Ball D = negative charge.  | 1 mark |
| Ball B repelled by Ball A = negative charge.  | 1 mark |
| Ball C attracted to Ball B = positive charge.  | 1 mark |

OR – if initial answer for Ball D is incorrect (ie – is assigned a negative charge), a maximum of three (3) marks can be achieved as per table below:

|  |  |
| --- | --- |
| Ball A attracted to Ball D = positive charge.  | 1 mark |
| Ball B repelled by Ball A = positive charge.  | 1 mark |
| Ball C attracted to Ball B = negative charge.  | 1 mark |

**Question 2 (7 marks)**

1. Identify the missing particle. Include its chemical symbol; mass number; atomic number.

(2)

|  |  |
| --- | --- |
| Symbol: Ba | 1 mark |
| Mass number: 141; Atomic number: 56 (must get both) | 1 mark |
| NOTE: if the particle’s chemical symbol and atomic number are incorrect BUT match – 1 mark maximum can be given.  |  |

1. Convert the energy released in this fission reaction to a ‘mass equivalence’ in atomic mass units (u). Give this answer to five (5) significant figures.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Use your answer from part b) and the particle masses listed to calculate the mass of the missing particle.

(2)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

**Question 3 (6 marks)**

1. Calculate the power consumed by the heater when it is operating. Place the value in the table; show working below.

(2)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

1. By use of a calculation, determine if the circuit breaker will be tripped when all appliances are operating.

(4)

|  |  |
| --- | --- |
|  | 1-2 marks |
|  | 1 mark |
| Yes, it will open.  | 1 mark |

**Question 4 (4 marks)**

|  |  |
| --- | --- |
| Trapped air is a poor conductor and reduces heat loss via conduction. | 1 mark |
| Trapped air is also unable to move - reduces heat loss via convection. | 1 mark |
| Reflective ‘wall wrap’ will is a good reflector of thermal radiation.  | 1 mark |
| Hence, this wrap will reduce heat loss via this method. | 1 mark |

**Question 5 (5 marks)**

1. There are three wires in the household circuit: active, neutral and earth. On which wire(s) must the RCD be placed? Explain.

(2)

|  |  |
| --- | --- |
| Must be placed on both the active and neutral wires. | 1 mark |
| The RCD needs to be able to detect and measure any differences in the currents carried by both of these wires.  | 1 mark |

1. The picture below shows a situation where an RCD will protect a consumer. In this situation, a person is accidentally touching an active heating element with a metal knife as they try to extract some toast that has become stuck in the toaster. The toaster is NOT turned off.

Explain why an RCD will protect the consumer here, but a safety switch or fuse will not.

(3)

|  |  |
| --- | --- |
| When a person connects themselves to the ‘live’ element in the way shown, a small current will flow through the person to the earth. | 1 mark |
| This will increase the current in the active wire, but not enough to exceed the rating on the safety switch or fuse and open these. | 1 mark |
| The RCD remains closed if the currents in the active wire and the neutral wire are equal. In this case, the current in the active wire will be slightly higher than that in the neutral wire and the RCD will immediately open and cut off current to the toaster. | 1 mark |

**Question 6 (4 marks)**

Explain what would happen to the power output of the fission reactor if:

1. the control rods are extracted from the reactor core.

(2)

|  |  |
| --- | --- |
| Power output INCREASES. | 1 mark |
| Less excess neutrons absorbed increasing the rate of the chain reaction.  | 1 mark |

1. the heavy water moderator accidentally completely drains out of the reactor core via a leak.

(2)

|  |  |
| --- | --- |
| Power output DECREASES. | 1 mark |
| The neutrons will be moving too quickly for neutron capture.  | 1 mark |

**Question 7 (5 marks)**

Use the above data to calculate an experimental value for the specific heat capacity of the glass.

(5)

|  |  |
| --- | --- |
|  | 1-3 marks |
|  | 1 mark |
|  | 1 mark |

**Question 8 (4 marks)**

As more ice was added to the glass in Question 8, a layer of water formed on the outside of the glass. Name this phenomenon and briefly explain how it happens.

(4)

|  |  |
| --- | --- |
| Condensation. | 1 mark |
| Water vapour in the atmosphere collides with the glass. The water vapour is at room temperature; the glass is at a lower temperature – the same as the iced water. | 1 mark |
| Heat is transferred from the water vapour to the glass.  | 1 mark |
| Heat transfer continues until the water vapour changes into a liquid which forms on the glass. | 1 mark |

**Question 9 (6 marks)**

1. Draw a circuit diagram using standard circuit symbols for the fuel gauge assembly above.

(2)

A

|  |  |
| --- | --- |
| All three circuit symbols are correctly drawn (ie – source of potential difference; variable resistor; ammeter).  | 1 mark |
| All three components are connected in series.  | 1 mark |

1. Using Physics concepts from the Electricity Topic, describe how the fuel gauge assembly works.

(4)

|  |  |
| --- | --- |
| As the fuel is consumed and the level drops, the float moves downwards causing the sliding contact to rotate in an anticlockwise direction.  | 1 mark |
| This causes the length of wire in the variable resistor connected in the circuit to increase.  | 1 mark |
| This increases the overall resistance in the circuit which, in turn, decreases the overall current in the fuel gauge/ammeter.  | 1 mark |
| The reduced current registers as a reduced fuel level reading on the fuel gauge.  | 1 mark |

**Question 10 (5 marks)**

1. Write a balanced nuclear equation for the above fusion reaction.

(2)

|  |  |
| --- | --- |
|  |  |
| Correct symbols. | 1 mark |
| Mass and atomic numbers are balanced correctly.  | 1 mark |

1. Calculate the energy released (in Joules) by one of these fusion reactions.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Section Two: Problem-solving 55% (82 Marks)**

This section has **eight (8)** questions. You must answer **all** questions. Write your answers in the space provided. Suggested working time for this section is 80 minutes.

**Question 11 (13 marks)**

1. State the potential difference range within which the globe acts a non-ohmic conductor. As part of your answer, define what is meant by an ohmic conductor.

(2)

|  |  |
| --- | --- |
| An ohmic conductor has a constant resistance for all currents and potential differences.  | 1 mark |
| Hence, the light globe is non-ohmic between 0.400 V and 0.700 V (accept 0.800 V).  | 1 mark |

1. Calculate the electric power consumed by the globe when it carries a current of 0.250 A. Show clearly how you did this.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Calculate the resistance (in Ohms) of the globe when it has a potential difference of 0.600 V applied to it. Show working.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. Calculate the number of electrons that flow through the light globe in one (1) minute when it has a potential difference of 0.240 V applied to it.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1. mark
 |

e) Calculate how much electrical work is done on each electron when the light globe has a potential difference of 0.500 V applied to it.

(2)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

**Question 12 (13 marks)**

1. With clear working shown, calculate the current drawn from the 12 V power supply when:
2. S1 is closed and S2 is open.

(4)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

(ii) both S1 and S2 are closed.

(4)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

1. The 4.00 Ω resistor has a power rating of 4.00 W. Is this exceeded when S1 and S2 are closed? Show via a calculation.

(5)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
| YES – power rating is exceeded.  | 1 mark |

**Question 13 (9 marks)**

1. Use the data above to determine the binding energy per nucleon for a Cl-36 nuclei.

(4)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

d) Using the information from part c) about the Cl-36 to Chlorine ratio, estimate the age of the groundwater in the Eastern Desert.

(5)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
| OR |  |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 14 (21 marks)**

a) In terms of the kinetic particle model, explain why a metal bar expands as it is heated.

(3)

|  |  |
| --- | --- |
| As thermal energy is added to the metal bar, the average kinetic energy (ie – temperature) of its particles increases.  | 1 mark |
| The extra kinetic energy causes the metal’s particles to move faster and further. | 1 mark |
| Hence, the metal occupies a greater volume and appears to extend in length.  | 1 mark |

b) Explain why the coefficient of expansion is the same value for the metal bar no matter what dimension it’s change in length is measured in.

(3)

|  |  |
| --- | --- |
| The metal bar expands in all dimensions – not just along its length.  | 1 mark |
| ‘α’ is dependent on the ratio ∆L/L0. | 1 mark |
| No matter in which dimensions the lengths ‘L0’ and ‘∆L’ are measured, this ratio (and, hence, ‘α’ will be the same).  | 1 mark |

c) Complete Table 2 by calculating the missing values. Use the space below for any working out.

(2)

|  |  |
| --- | --- |
| Missing ∆T = 40.0 – 10.0 = 30.0 °C | 1 mark |
| Missing Tf = 50.0 + 10.0 = 60.0 °C | 1 mark |

d) The units for ‘α’ are missing from the table at the top of the second column in Table 2. Write down the units for this quantity in the space provided.

(2)

|  |  |
| --- | --- |
| m °C-1 m-1  | 1 mark |
| Simplifies to °C-1. | 1 mark |

e) On the grid on page 25, plot ‘∆L’ against ‘∆T’. Place ‘∆L’ on the y-axis. Draw a line of bets fit for this data.

(4)

∆L (x 10-3 m)

∆T (°C)

|  |  |
| --- | --- |
| Axes correctly labelled – ‘∆T’ on x-axis; ∆L on the y-axis.  | 1 mark |
| Units correctly labelled.  | 1 mark |
| Points correctly plotted.  | 1 mark |
| Line of best fit correctly drawn.  | 1 mark |

f) Calculate the gradient of the line of best fit. Include units in your answer.

(4)

|  |  |
| --- | --- |
| Uses line of best fit: (80.0, 10.5 x 10-3) and (15.0, 2.0 x 10-3) | 1 mark |
|  | 1 mark |
|  | 1 mark |
| m °C-1 | 1 mark |

g) Hence, use the information provided in table 2 to identify the metal in the experiment.

(3)

|  |  |
| --- | --- |
| Gradient of line of best fit = coefficient (α)/Length = 1.31 x 10-5 °C-1. | 1-2 marks |
| Steel. | 1 mark |

**Question 15 (10 marks)**

1. Describe how the paper gains a negative charge as it rubs against the machinery.

(3)

|  |  |
| --- | --- |
| Certain materials become electrically charged when they are separated after they come into contact with each other (triboelectric effect). | 1 mark |
| This effect is enhanced by the rubbing of two surfaces as it increases the contact between them. | 1 mark |
| In this case electrons are transferred to the paper from the machinery, causing it to gain a net negative charge.  | 1 mark |

1. Write the decay equation for Polonium-210.

(3)

|  |  |
| --- | --- |
|  |  |
| Correct symbols. | 1 mark |
| Atomic numbers balanced. | 1 mark |
| Mass numbers. | 1 mark |

1. Explain why alpha particles are able neutralise the paper. As part of your answer, explain why beta and gamma radiation would be unable to perform this task.

(4)

|  |  |
| --- | --- |
| Alpha particles have a positive charge (+2) and electrons have a negative charge.  | 1 mark |
| Hence, when alpha particles are near the charged paper, they can attract the excess electrons from its surface with an electrostatic force.  | 1 mark |
| Beta particles have a negative charge – they will repel the excess electrons and will not be able to remove them from the paper’s surface.  | 1 mark |
| Gamma rays have no charge – they will neither attract nor repel the electrons.  | 1 mark |

**Question 16 (5 marks)**

250 g of water at 80 °C is added to a 50 g copper calorimeter at the same temperature, and 40 g of crushed ice at 0 °C is added. If the system is properly insulated, find the final temperature of the calorimeter and the water. Take the specific heat capacity of copper as 385 J kg-1 K-1.

|  |  |
| --- | --- |
| OR  | 1 mark |
|  0.25 x 4180 x (80 – Tf) + 0.05 x 385 x (80 – Tf) = 0.04 x (3.34 x 105) + 0.04 x 4180 x (Tf – 0) | 1 mark |
| 83600 – 1045Tf + 1540 – 19.25Tf = 13360 + 167.2Tf  | 1 mark |
|  71780 = 1231.45Tf  | 1 mark |
|  | 1 mark |

**Question 17 (5 marks)**

A 240 V electric kettle is used to heat 280 mL of water initially at 22 0C. The heating element draws a current of 1.8 A, and is left on for 3 minutes. Determine the final temperature of the s

|  |  |  |
| --- | --- | --- |
| Correctly using the concept of power |  | 1 mark |
| Correctly using the concept of specific heat capacity and change in temperature | 1 mark |
| Correctly using the concept of efficiency Correct use of multiply by 0.85 OR appropriate use of efficiency question | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Question 18 (6 marks)**

1. Explain why alpha particles are able neutralise the paper. As part of your answer, explain why beta and gamma radiation would be unable to perform this task.

(2)

|  |  |
| --- | --- |
|  |  |
|  | 1 mark |
|  | 1 mark |

1. The coolant has a specific heat roughly halfway between the values for water and ethyl glycol. Given this, estimate the mass of coolant required to cool a typical aluminium engine from 104 °C to 93 °C. Assume that the coolant starts at an ‘optimal’ temperature of 91 °C and extracts all the heat energy lost by the engine.

(4)

|  |  |
| --- | --- |
|  | 1 mark |
|  |  |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

**Section Three: Comprehension 12% (18 Marks)**

This section contains **one (1)** question. You must answer this question. Write your answers in the spaces provided. Suggested working time for this section is 20 minutes.

**Question 19 (18 marks)**

* 1. Write the symbol (include both atomic and mass numbers) for the daughter isotope resulting from the beta-decay of Iodine-131.

(2)

|  |  |
| --- | --- |
|  |  |
| The isotope ‘Xe’ and the atomic number (54) are both correctly identified. | 1 mark |
| The mass number (131) is correctly identified. | 1. mark
 |

b) RAI is a beta-emitter. This property makes this radioisotope suitable for this type of therapy. Explain why.

(3)

|  |  |
| --- | --- |
| Beta particles have a lower penetration though to tissue – but more than alpha particles.  | 1 mark |
| Hence, very few beta particles will escape from the human body. | 1 mark |
| However, many beta particles will be absorbed by tissue in the thyroid gland for therapy to occur.  | 1 mark |

c) Use your Physics knowledge to explain this statement: “RAI therapy is considered safe if the absorbed dose in the blood is <2 Gy.”

(3)

|  |  |
| --- | --- |
| ‘2 Gy’ represents the maximum absorbed dose of beta radiation in the blood that is considered safe during RAI therapy.  | 1 mark |
| 2 Gy = 2 J kg-1.  | 1 mark |
| Hence, every kilogram of blood in the human body can absorb a maximum of 2 Joules of ionising energy and be considered safe during RAI therapy.  | 1 mark |

d) Calculate the absorbed dose required **for an alpha emitter** so that it causes the same dose equivalent (in Sv) as the RAI when the absorbed dose in the blood is 2.00 Gy.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
|  | 1 mark |

e) If the activity of RAI in the human body is 4.4 GBq for a total of one (1) minute, calculate the number of beta decays that occur during this time.

(2)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |

f) “In most cases, normal activities can be resumed by patients after 72 hours.” Explain this statement with the use of a calculation.

(3)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |
| Hence, the activity of the sample will have reduced to a very low and safe level.  | 1 mark |

g) One particular patient has a measured radiation activity of RAI in their body equal to 4.4 GBq. Calculate the activity of RAI in their body 48 hours earlier.

(2)

|  |  |
| --- | --- |
|  | 1 mark |
|  | 1 mark |