2022	HIGHER SCHOOL CERTIFICATE **TRIAL**

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A data sheet, formulae sheet and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations
- Write your Student ID at the bottom of this page and at the top of page 12

Total marks: 100

Section I — 20 marks (pages 2–11)
- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II — 80 marks (pages 12–28)
- Attempt Questions 21–34
- Allow about 2 hours and 25 minutes for this section

STUDENT ID: ____________________________________

Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section.

Use the multiple-choice answer sheet for Questions 1–20.

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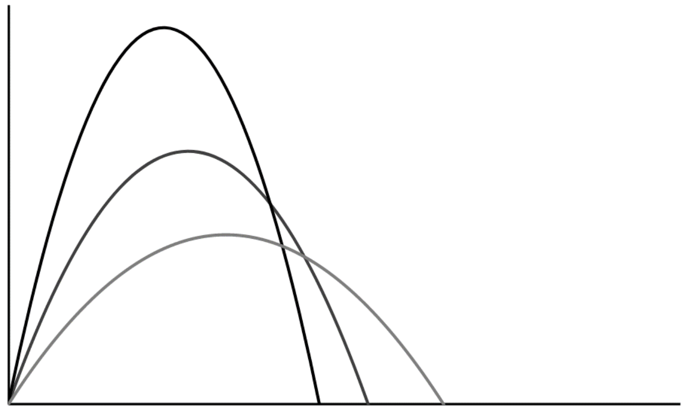
1 Three projectile paths are compared to identify what factors make them similar.



Which statement demonstrates the most correct understanding?

A. The projectiles all share a symmetrical path.

B. All the projectiles have the same time of flight.

C. The initial velocity of each projectile is the same.

D. Each projectile is launched with an identical trajectory angle.

2 A car was investigated as it drove different circular paths at a constant speed in a car park.

Using different sensors, calculations were made about the car's centripetal force (F_c), mass (M_c), velocity (V_c) and the radius (R_c) of the circular path.

Which relationship would the results most closely indicate?

A. F_c is proportional to $\frac{1}{Mc}$

B. R_c is proportional to M_r

C. V_c is proportional to $\sqrt{F_c}$

D. $(V_c)^2$ is inversely proportional to F_c

3 A device was designed using the following components.

Design	*Component 1*	*Component 2*
W	Commutator	DC input
X	Permanent magnets	Split rings
Y	Handle to move coils	Slip rings
Z	Squirrel cage rotor	Rotating magnetic fields

Which design would most likely represent a DC generator?

A. W

B. X

C. Y

D. Z

4 Which classification is used for subatomic particles known as *up*, *down*, *charm* and *strange*?

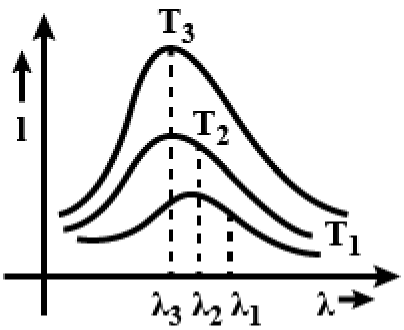
A. Quarks

B. Bosons

C. Leptons

D. Hadrons

5 These curved graphs were drawn to display results observed in blackbody experiments.



Which classical physics' inconsistency does this experiment best relate to?

A. The Twin Paradox

B. The Photoelectric Effect

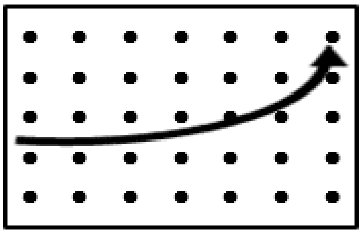
C. The Ultraviolet Catastrophe

D. Unification of Electricity and Magnetism

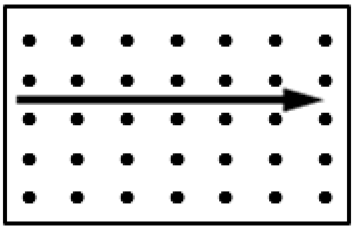
6 Charged particles are often identified as they move through magnetic fields.

Which diagram best represents an alpha particle being detected?

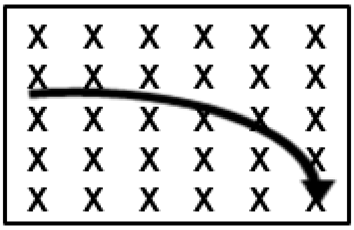
A.



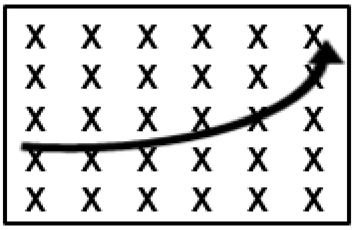
B.



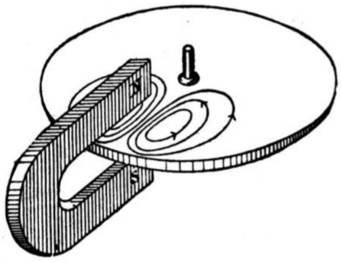
C.



D.



7 A hypothesis is tested using the following lab set up which involves spinning a metal disc in-between a set of magnetic poles created by a horseshoe magnet.



Which hypothesis can be tested with the device?

A. Does constant magnetic flux induce eddy currents?

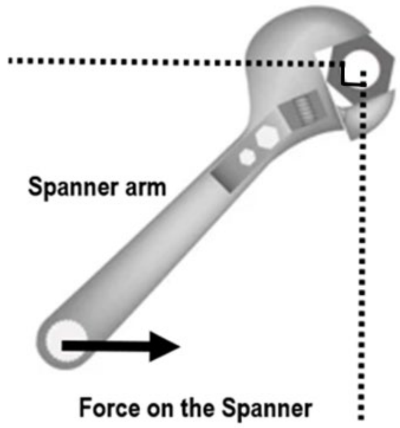
B. Does the circular electric field create the motor effect?

C. Does the induced emf counteract the change in magnetic flux?

D. Does the direction of the poles on a magnet create circular magnetic fields?

8 The diagram shows the equipment used to investigate the factors that affect torque.

Two spanner positions were used, one at 45° to the horizontal line as shown. The second position was set on the 90° vertical line.



Which would have been found to allow the spanner to achieve a maximum torque?

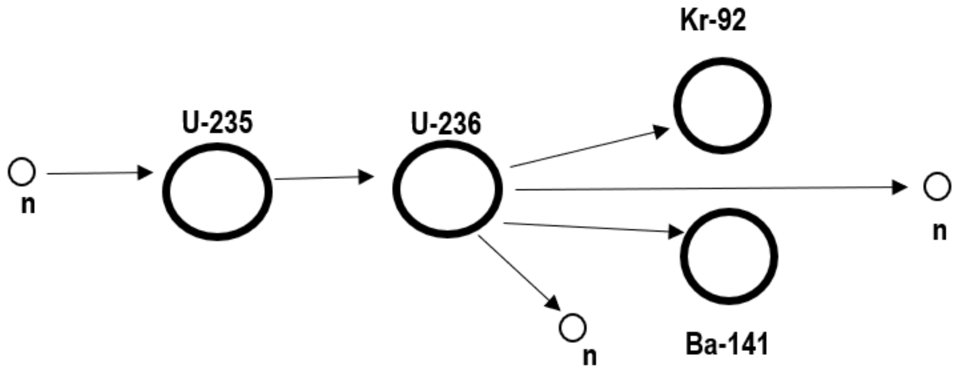
A. A spanner arm of length 0.5L with a force 2F and a starting angle of 45°

B. A spanner arm of length 0.5L with a force 2F and a starting angle of 90°

C. A spanner arm of length 2L with a force 2F and a starting angle of 45°

D A spanner arm of length 2L with a force 2F and a starting angle of 90°

9 This nuclear reaction was drawn by a student but was later discovered to be incorrect.



What essential aspect of the reaction needs to be corrected?

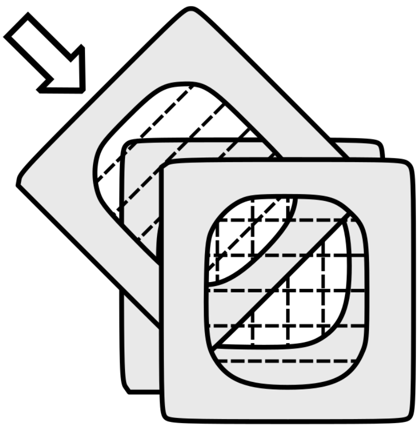
A. U-235 does not react to form U-236

B. One neutron is missing in the products

C. Kr-92 and Ba-141 are incorrect products

D. The symbol ‘n’ should be labelled ‘neutrino’

10 An experiment was performed to further understand an aspect of physics.



What Law can this experiment test?

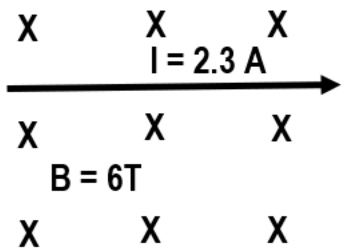
A. Lenz’s Law

B. Malus’s law

C. Wien’s Law

D. Faraday’s Law

11 The diagram shows a current carrying wire suspended in a magnetic field.



Which formula best calculates the value of 1.4 kg/m for the current carrying wire?

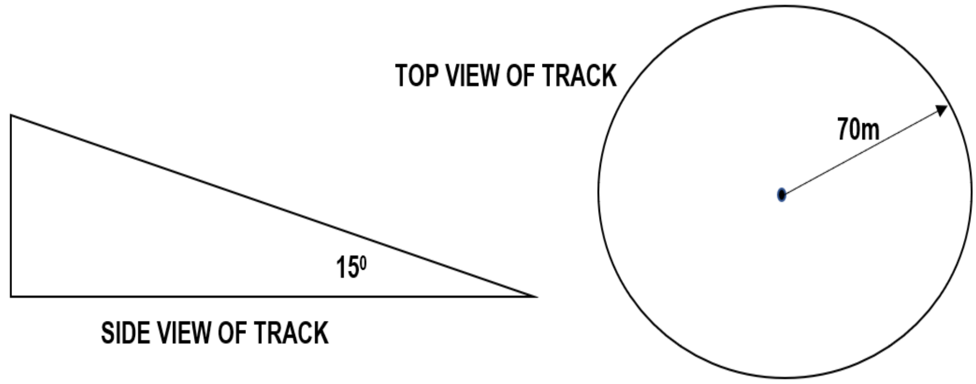
A. F = qvB

B. mg = BIL

C. mg = BIA

D. τ = FL = mg

12 A car travels around a 70 m circle banked at 15° as shown on the track views.



What is the car's maximum safe velocity to maintain this path on the track?

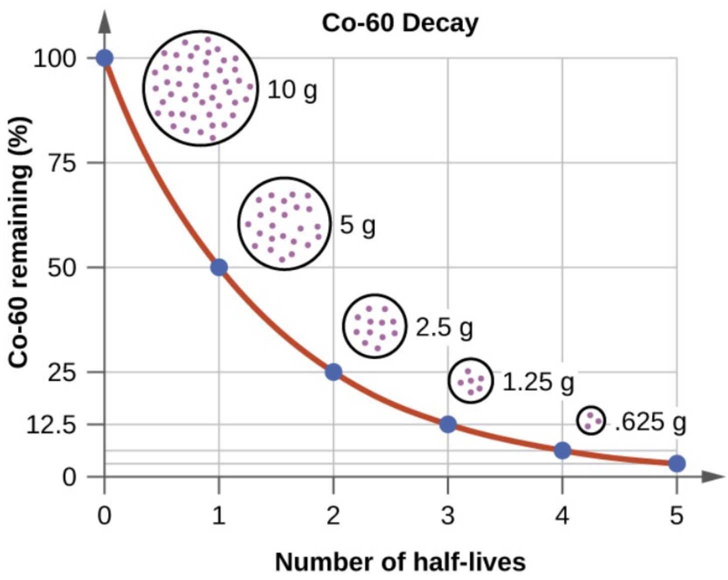
A. 9.5 ms^{-1}

B. 12.9 ms^{-1}

C. 13.6 ms^{-1}

D. 15.2 ms^{-1}

13 The graph displays how Co-60 decays over time.



What trend is clearly shown in this graph?

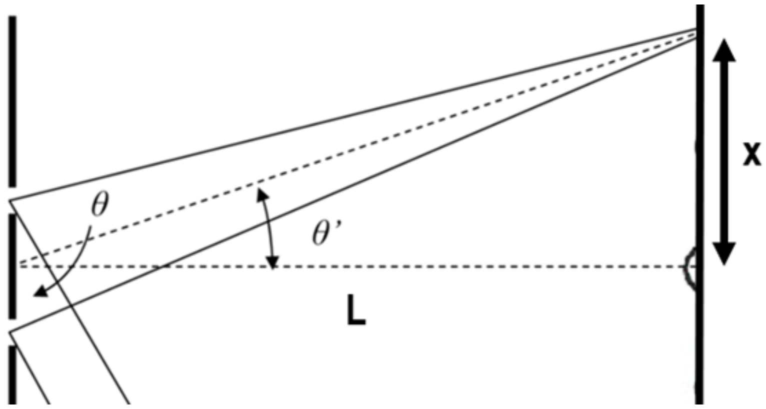
A. The half-life of Co-60 is one year.

B. 10 g of the Co-60 exists after one half-life.

C. After five half-lives, Co-60 will completely decay.

D. 75% of the Co-60 has decayed after two half-lives.

14 The diagram represents Young's double slit experiment.



Which formula was Young's double slit experiment used to determine?

A. $d \cos\theta = \frac{n}{\lambda}$

B. $\frac{d}{\sin\theta} = n\lambda$

C. $\sin x = Ld$

D. $x = \frac{Ln\lambda}{d}$

15 A current balance is often used to investigate the following relationship.

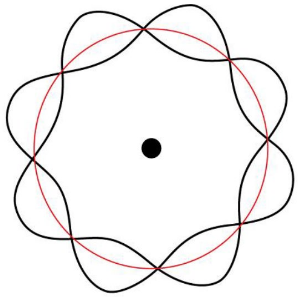
$$\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$$

Which two conditions support the relationship?

	Condition 1	*Condition 2*
A.	Opposing currents	Repulsive force between wires
B.	Like magnetic fields	Moving the wires towards each other
C.	Opposing currents	Attractive force between wires
D.	Unlike magnetic fields	Moving the wires away from each other

16 Simple diagrams are often used to denote models of atoms.

Which model of the atom is best represented by this diagram?



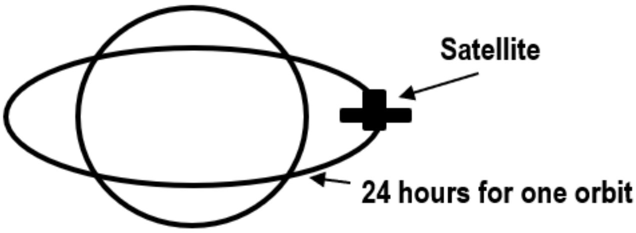
A. Bohr's model of the atom

B. Rutherford's model of the atom

C. de Broglie's model of the atom

D. Schrodinger's model of the atom

17 A communication satellite takes 24 hours to perform one orbit of Earth as shown in the diagram below.



At what altitude above the Earth would the satellite need to be placed to achieve this orbit?

A. 15 500 km

B. 25 600 km

C. 35 800 km

D. 42 300 km

18 The table shows five metals which were exposed to blue incident light.

The following data was gathered during this experiment.

Metal	*Threshold Energy* (eV)
A	4.2
B	3.5
C	2.2
D	5.1
E	1.8

Which metals will begin to emit photoelectrons when the incident blue light has a frequency of 6×10^{14} Hz?

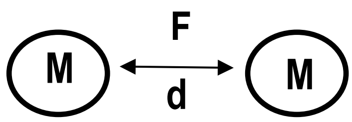
A. Metals B, C and E

B. Metals A and D only

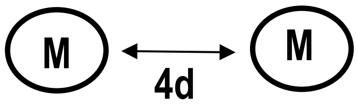
C. Metals B and C only

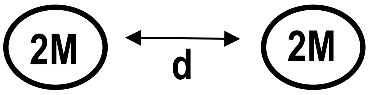
D. Metals C and E only

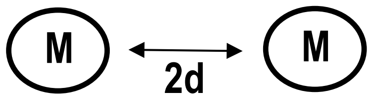
19 The diagram demonstrates a gravitational force concept where M = mass, d = distance and F = gravitational force.

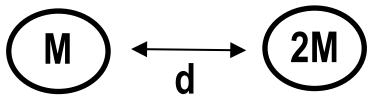


Which diagram below is most likely to create 4F?

A.


B.


C.


D.


20 The following secondary data of Mars was sourced from an authoritative website.

Radius of Mars = 3390 km
Mass of Mars = 6.4 x10^{23} kg

Which method correct substitutes the data for calculating the acceleration due to gravity on Mars?

A. $$g = \frac{G(6.4\ x\ 10^{23})}{(3390\ x\ 10^3)^2}$$

B. $$g = \frac{\sqrt{}(2G)\ (6.4\ x\ 10^{23})}{(3390\ x\ 10^3)}$$

C. $$g = \frac{\sqrt{}(2G)\ (3390\ x\ 10^3)}{6.4\ x\ 10^{23}}$$

D. $$g = G(3390\ x\ 10^3)(6.4\ x\ 10^{23})^{\ 2}$$

Student ID: ____________________

2022

HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

Physics

Section II
Answer Booklet

80 marks
Attempt Questions 21–34
Allow about 2 hour 25 minutes for this part

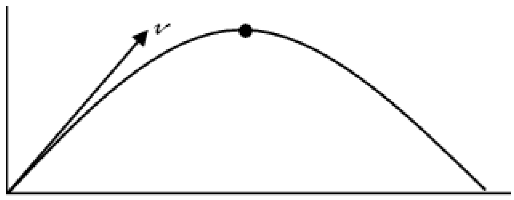
Instructions

- Write your Student ID at the top of this page
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Please turn over

Question 21 (6 marks)

A projectile was sketched as it was fired from the ground.



(a) State TWO quantitative features of the projectile which can be predicted as it reaches the dot marked on its path? **2**

(b) Predict TWO aspects of the path that would change if the same projectile was fired with the same parameters on the Moon. **2**

(c) Describe a method which could be used to calculate the landing angle of this projectile. **2**

Question 22 (4 marks)

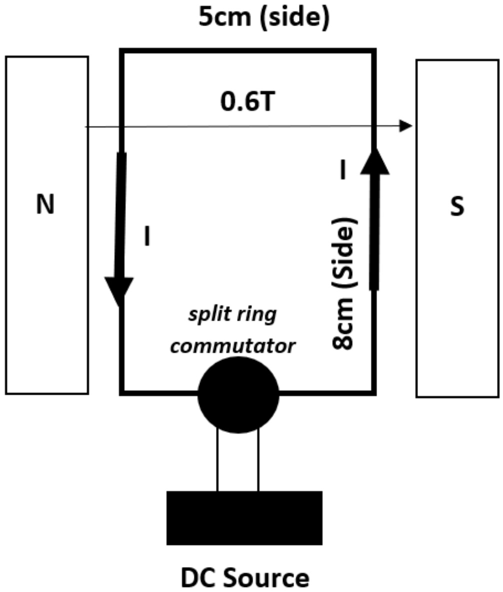
A proton moving with a velocity of $6 \times 10^{6}\ ms^{-1}$ moves into an electric field created by parallel plates which have a length of 80 mm and are 40 mm apart. The potential difference between the plates is 200 V.

(a) Draw a diagram which clearly shows how this proton moves in this electric field. **2**

(b) What is the acceleration experienced by this electron when it enters the field? **2**

Question 23 (5 marks)

A DC motor is constructed using the design below.



(a) The maximum torque is 0.25 Nm on one side of the motor. **2**

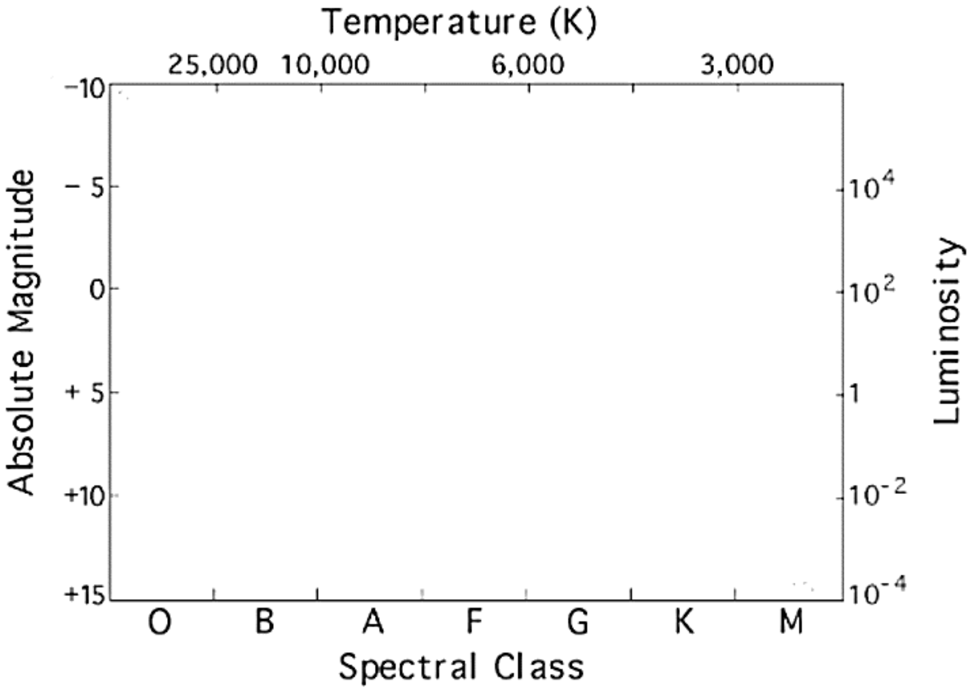
Calculate the current in the coil.

(b) A lift uses this motor to raise a 2 kg mass. **3**

Show how $\frac{\tau}{d}$ is equal to 19.6 m^2s^{-2}.

Question 24 (5 marks)

This an incomplete drawing of the Hertzsprung-Russell (H-R) diagram.

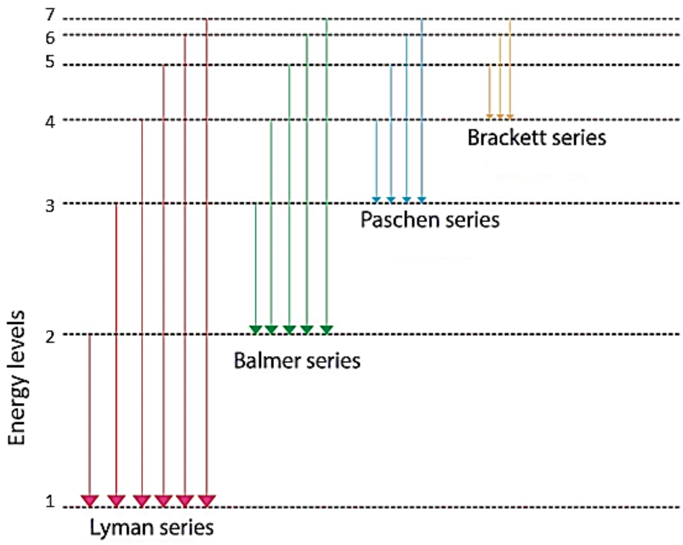


(a) Identify the Sun's position on the H-R diagram above and explain TWO features of the Sun that relate to this position. **3**

(b) Plot the predicted evolutionary path of the Sun by drawing this path on the H-R diagram above. **2**

Question 25 (5 marks)

This diagram was created when observing hydrogen spectra as hydrogen gas was excited in as discharge tube.

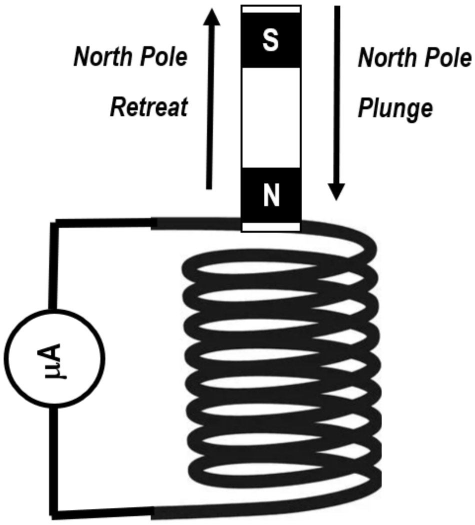


(a) Describe what the Balmer series measures in the hydrogen spectra. **2**

(b) Calculate the longest wavelength of light created by the Balmer Series. **3**

Question 26 (5 marks)

A magnet was plunged into a solenoid and the reading on the ammeter was recorded as 2μA. The ammeter then recorded a zero reading when the magnet stopped moving. The magnet was then moved up. As the north pole of the magnet retreated from the coil, the reading on the ammeter was recorded at -2μA. After this, the magnet left the coil recording a reading of zero on the ammeter. **5**



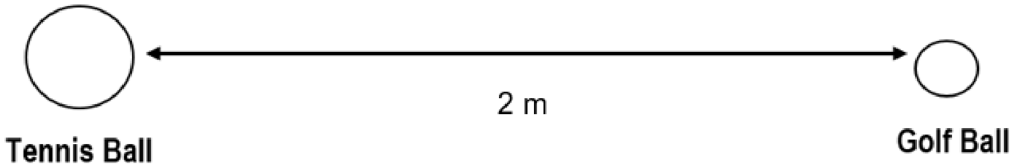
Use your understanding of physics to explain what factors and principles caused these readings to be recorded on the ammeter.

Question 27 (5 marks)

The following simulation is used to model the Geiger-Marsden experiment.

A golf ball is placed on an even surface, a tennis ball is rolled towards the golf ball from a distance of 2 m, as shown in the diagram.

Sometimes the tennis ball missed the golf ball completely, sometimes it just hit it, and other times rebounded back off the golf ball.

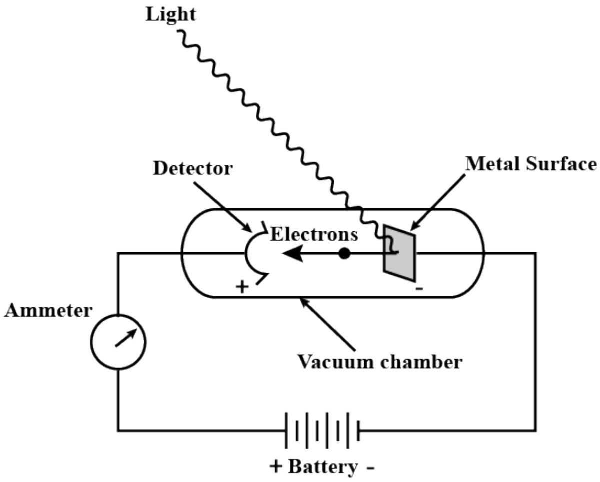


(a) Explain how this simulation could model the evidence achieved by the Geiger-Marsden experiment about the model of the atom. **4**

(b) Outline the feature of the atom that is modelled by the 2 m distance between the balls? **1**

Question 28 (7 marks)

Phillip Lenard was one of the scientists who used the following experiment to observe aspects of light as it was directed towards a metal surface. The frequency of the light (f) was altered and compared to the intensity of light produced (I) and the stopping voltage ($V_{Stopping}$) required to stop these electrons passing through the vacuum chamber.

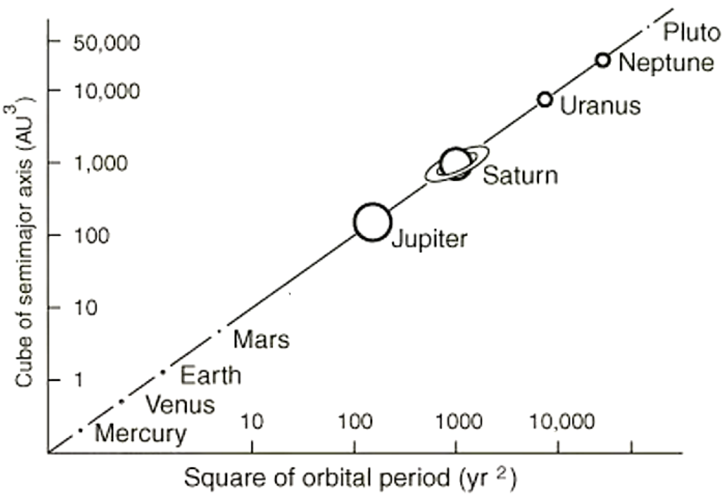


(a) Describe how the results from this experiment provided new evidence which changed classical wave theory. **4**

(b) Use the grid to graphically represent this 'new evidence'. **3**

Question 29 (6 marks)

This graph is used to explain a specific law in physics.



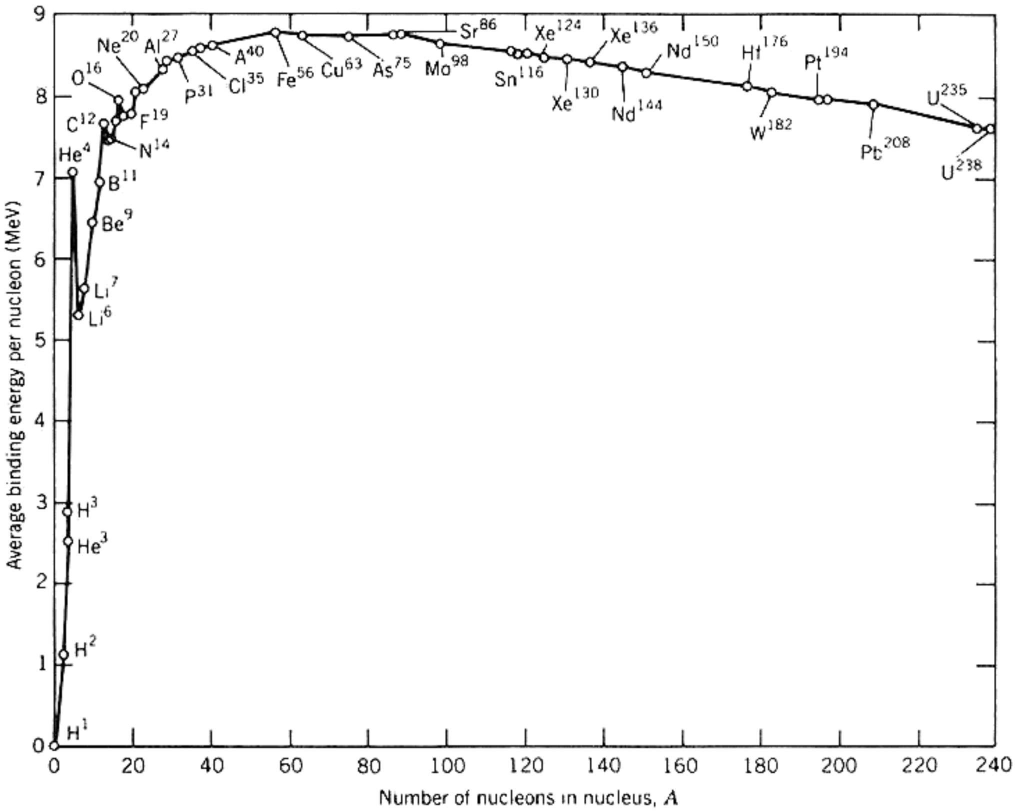
(a) Explain the law this graph relates to when studying the planets in our Solar System. **3**

(b) Using data from the graph, explain how all the planets in the solar system are linked to this Law. **3**

Question 30 (6 marks)

This graph shows the binding energy per nucleon for nuclides up to mass number 238.

A student commented on the plots in this graph. She predicted that the differences in binding energy per nucleon of U-238 and He-4 could be used to determine the type of nuclear reaction these two nuclides will undergo.



Use calculations and your understandings to determine if this student's predictions are correct. **6**

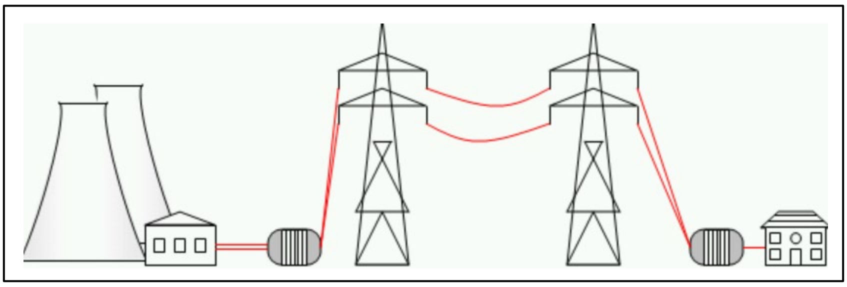
Question 30 continues on page 23

Question 30 (continued)

End of Question 30

Question 31 (6 marks)

Transformers are used in all the electrical power grids in Australia which supply electricity to domestic and household consumers.



(a) Modern transformers are now designed to operate more efficiently. **4**

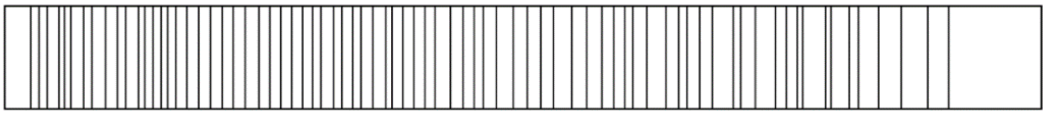
Explain TWO ways that transformers can be improved to operate more efficiently.

(b) Explain how a 5000 KW power station can best use transformers to transmit electricity to a substation using transmission wires which have a 3050 V safety limit and a 4Ω/km resistance value. **2**

Question 32 (8 marks)

Source A and Source B were observed in a spectroscope and their corresponding spectral lines were recorded.

SOURCE A



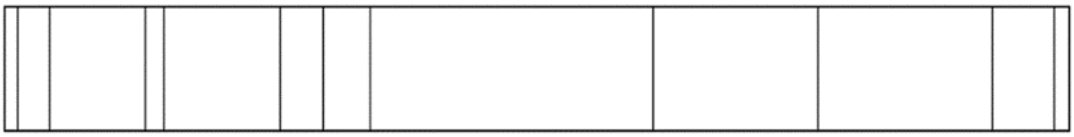
SOURCE B

Diagram displays: Black spectra lines against a full coloured spectrum

(a) Describe ONE way this type of spectrum can be produced. **2**

(b) Source A depicts a stationary source of light. **2**

Redraw Source A to display a star which is situated in a galaxy moving away from an observer who is located on Earth.



SOURCE A

SOURCE A

Question 32 continues on page 26

Question 32 (continued)

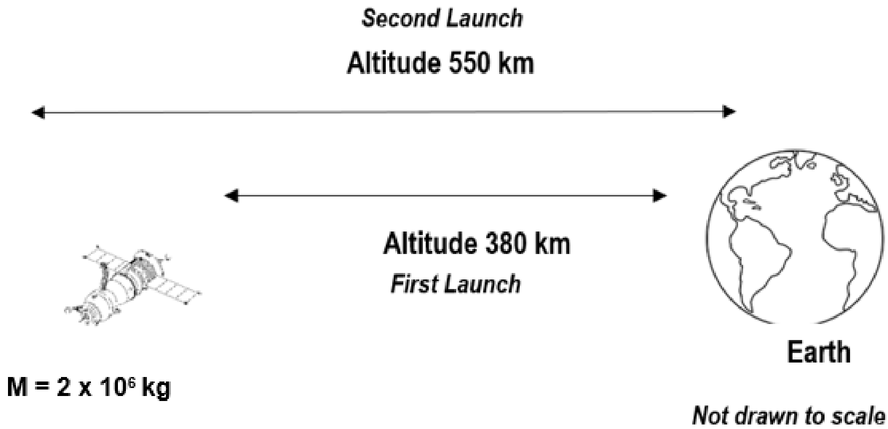
(c) Explain how spectra created in the laboratory can be used to verify THREE other features of stars. **4**

End of Question 32

Question 33 (6 marks)

A satellite has a mass of 2×10^6 kg and orbits Earth at an altitude of 380 km as shown.

It was then returned to Earth and relaunched and placed into a new orbit of 560 km.

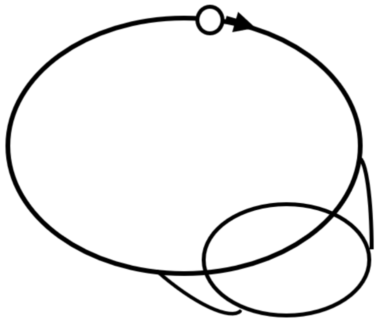


(a) Calculate the gravitational potential energy of the satellite in the 380 km orbit. **3**

(b) Calculate the work done by the satellite to move from the 380 km orbit back to Earth and then into the 560 km orbit. **3**

Question 34 (6 marks)

Scientists study the relativistic effects of many subatomic particles in particle accelerators. A particle accelerates through the circular track as shown below. As it nears the speed of light relativistic effects occur.



Electrons are allowed to travel at 2.6×10^8 ms^{-1} and their relativistic mass is determined and compared to their original mass.

Meanwhile, other particles are allowed to travel with a relativistic mass five times more than their rest mass and their velocities are recorded.

(a) Electrons are accelerated to a velocity of 2.60×10^8 ms^{-1}. **3**

Calculate their relativistic mass and compare it to their original mass.

(b) Other particles when accelerated achieve a relativistic mass five times more than their rest mass. **3**

Calculate the velocity these particles must have achieved.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 ms^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^{8} m s^{-1}
Electric permittivity constant, ϵ_o	8.854×10^{-12} $\text{A}^2\text{s}^4\text{kg}^{-1}\text{m}^{-3}$
Magnetic permeability constant, μ_o	4Л $\times 10^{-7}$ N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth, M_E	6.0×10^{24} kg
Radius of the Earth, r_E	6.371×10^{6} m
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^{7} m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^{3} kg m^{-3}
Specific heat capacity of water	4.18×10^{3} J kg^{-1} K^{-1}
Wein's displacement constant	2.898×10^{-3} mK

FORMULAE SHEET

Motion, forces and gravity

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$\Delta U = mg\Delta h$$

$$P = \frac{\Delta E}{\Delta t}$$

$$\sum \frac{1}{2}mv_{\text{before}}^2 = \sum \frac{1}{2}mv_{\text{after}}^2$$

$$\Delta \vec{p} = \vec{F}_{\text{net}}\Delta t$$

$$\omega = \frac{\Delta\theta}{t}$$

$$\tau = r_{\perp}F = rF\sin\theta$$

$$v = \frac{2\pi r}{T}$$

$$U = -\frac{GMm}{r}$$

$$v = u + at$$

$$\vec{F}_{\text{net}} = m\vec{a}$$

$$W = F_{||}s = Fs\cos\theta$$

$$K = \frac{1}{2}mv^2$$

$$P = F_{||}v = Fv\cos\theta$$

$$\sum m\vec{v}_{\text{before}} = \sum m\vec{v}_{\text{after}}$$

$$a_{\text{c}} = \frac{v^2}{r}$$

$$F_{\text{c}} = \frac{mv^2}{r}$$

$$F = \frac{GMm}{r^2}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

Waves and thermodynamics

$$v = f\lambda$$

$$f = \frac{1}{T}$$

$$d\sin\theta = m\lambda$$

$$n_{\text{x}} = \frac{c}{v_{\text{x}}}$$

$$I = I_{\max}\cos^2\theta$$

$$Q = mc\Delta T$$

$$f_{\text{beat}} = |f_2 - f_1|$$

$$f' = f\frac{(v_{\text{wave}} + v_{\text{observer}})}{(v_{\text{wave}} - v_{\text{source}})}$$

$$n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\sin\theta_{\text{c}} = \frac{n_2}{n_1}$$

$$I_1r_1^2 = I_2r_2^2$$

$$\frac{Q}{t} = \frac{kA\Delta T}{d}$$

FORMULAE SHEET

Electricity and magnetism

$$E = \frac{V}{d}$$

$$V = \frac{\Delta U}{q}$$

$$W = qV$$

$$W = qEd$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{\mu_0 N I}{L}$$

$$\Phi = B_{\parallel} A = BA\cos\theta$$

$$\varepsilon = -N\frac{\Delta \Phi}{\Delta t}$$

$$\frac{V_\mathrm{p}}{V_\mathrm{s}} = \frac{N_\mathrm{p}}{N_\mathrm{s}}$$

$$\vec{F} = q\vec{E}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$I = \frac{q}{t}$$

$$V = IR$$

$$P = VI$$

$$F = qv_{\perp}B = qvB\sin\theta$$

$$F = lI_{\perp}B = lIB\sin\theta$$

$$\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$$

$$\tau = nIA_{\perp}B = nIAB\sin\theta$$

$$V_\mathrm{p} I_\mathrm{p} = V_\mathrm{s} I_\mathrm{s}$$

Quantum, special relativity and nuclear

$$\lambda = \frac{h}{mv}$$

$$K_{\max} = hf - \phi$$

$$\lambda_{\max} = \frac{b}{T}$$

$$E = mc^2$$

$$E = hf$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_\mathrm{f}^2} - \frac{1}{n_\mathrm{i}^2}\right)$$

$$t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$l = l_0\sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

$$p_\mathrm{v} = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$N_\mathrm{t} = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

PERIODIC TABLE OF THE ELEMENTS

1 **H** 1.008 Hydrogen	**KEY** Atomic number Chemical symbol Standard atomic weight Name of element																2 **He** 4.003 Helium
3 **Li** 6.941 Lithium	4 **Be** 9.012 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 22.99 Sodium	12 **Mg** 24.31 Magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.97 Phosphorus	16 **S** 32.07 Sulfur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.87 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 72.64 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.61 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.96 Molybdenum	43 **Tc** Technetium	44 **Ru** 101.1 Ruthenium	45 **Rh** 102.9 Rhodium	46 **Pd** 106.4 Palladium	47 **Ag** 107.9 Silver	48 **Cd** 112.4 Cadmium	49 **In** 114.8 Indium	50 **Sn** 118.7 Tin	51 **Sb** 121.8 Antimony	52 **Te** 127.6 Tellurium	53 **I** 126.9 Iodine	54 **Xe** 131.3 Xenon
55 **Cs** 132.9 Caesium	56 **Ba** 137.3 Barium	Lanthanoids 57-71 * -	72 **Hf** 178.5 Hafnium	73 **Ta** 180.9 Tantalum	74 **W** 183.9 Tungsten	75 **Re** 186.2 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.2 Iridium	78 **Pt** 195.1 Platinum	79 **Au** 197.0 Gold	80 **Hg** 200.6 Mercury	81 **Tl** 204.4 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 209.0 Bismuth	84 **Po** Polonium	85 **At** Astatine	86 **Rn** Radon
87 **Fr** Francium	88 **Ra** Radium	Actinoids 89-103 ** -	104 **Rf** Rutherfordium	105 **Db** Dubnium	106 **Sg** Seaborgium	107 **Bh** Bohrium	108 **Hs** Hassium	109 **Mt** Meitnerium	110 **Ds** Darmstadtium	111 **Rg** Roentgenium	112 **Cn** Copernicium	113 **Uut** Unutrium	114 **Fl** Flerovium	115 **Uup** Ununpentium	116 **Lv** Livermorium	117 **Uus** Ununseptium	118 **Uuo** Ununoctium

***Lanthanoids**

57 **La** 138.9 Lanthanum	58 **Ce** 140.1 Cerium	59 **Pr** 140.9 Praseodymium	60 **Nd** 144.2 Neodymium	61 **Pm** Promethium	62 **Sm** 150.4 Samarium	63 **Eu** 152.0 Europium	64 **Gd** 157.3 Gadolinium	65 **Tb** 158.9 Terbium	66 **Dy** 162.5 Dysprosium	67 **Ho** 164.9 Holmium	68 **Er** 167.3 Erbium	69 **Tm** 168.9 Thulium	70 **Yb** 173.1 Ytterbium	71 **Lu** 175.0 Lutetium

****Actinoids**

89 **Ac** Actinium	90 **Th** 232.0 Thorium	91 **Pa** 231.0 Protactinium	92 **U** 238.0 Uranium	93 **Np** Neptunium	94 **Pu** Plutonium	95 **Am** Americium	96 **Cm** Curium	97 **Bk** Berkelium	98 **Cf** Californium	99 **Es** Einsteinium	100 **Fm** Fermium	101 **Md** Mendelevium	102 **No** Nobelium	103 **Lr** Lawrencium

Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
Information on elements with atomic numbers 113 and above has been updated to match HSC Physics and Chemistry amendments (2016).

STUDENT ID________________________

2022 Physics HSC Trial Examination
Section I – Answer Sheet

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

.

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

19	A ○	B ○	C ○	D ○
20	A ○	B ○	C ○	D ○

2022 HSC Trial
Physics Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21 (6 marks)

(a)

Criteria	Marks
• Provides TWO quantitative features	2
• Provides ONE quantitative feature	1

Sample answer:
The projectile's vertical velocity approaches zero.
The projectile is reaching its maximum height.

(b)

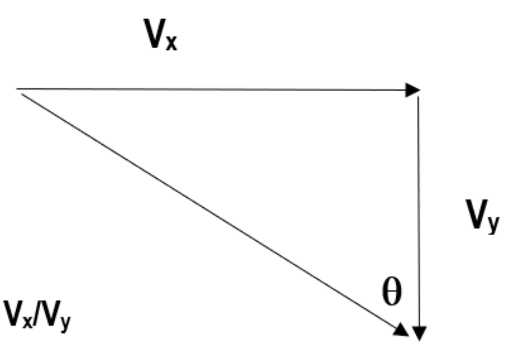
Criteria	Marks
• Correctly states TWO features *The range would be greater, the maximum height would be higher, the flight time would be greater and the acceleration due to gravity would be 1.6 ms^{-2} on the Moon*	2
• Correctly states that the Moon's acceleration due to gravity is less than Earth	1

Sample answer:
The projectile's flight on the Moon would occur under the influence of an acceleration due to gravity of $1.6 ms^{-2}$. This would mean that all aspects of the projectile flight would change. The projectile's range, maximum height and flight time would all increase because of this lower acceleration due to gravity value experienced on the Moon.

(c)

Criteria	Marks
• Shows the landing angle can be calculated using tan θ = Vx/Vy	2
• States that the landing angle can be calculated using a trigonometric method or SOHCAHTOA	1

Sample answer:



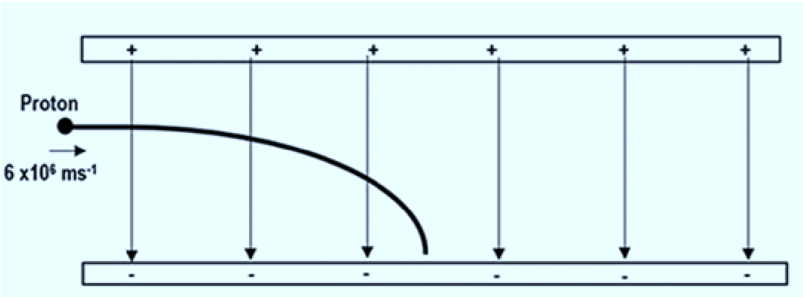
$\text{Tan } \theta = V_x/V_y$

Question 22 (5 marks)

(a)

Criteria	Marks
• Correctly draws plates and trajectory with relevant features	2
• Provides some relevant information	1

Sample answer:



(b)

Criteria	Marks
• Correctly calculates acceleration	2
• Provides some relevant information	1

Sample answer:

a = qE/m = qV/md

a= $(1.6 \times 10^{-19}\text{C})\ (200\ \text{V})/\ (1.67 \times 10^{-27}\ \text{kg})\ (40 \times 10^{-3}\ \text{m})$

a = $3.2 \times 10^{-17}/\ 6.68 \times 10^{-29}$

a = $4.79 \times 10^{11}\ \text{ms}^{-1}$

Question 23 (5 marks)

(a)

Criteria	Marks
• Correctly calculates the current in the coil changed	2
• Provides some relevant information	1

Sample answer:

$\tau = nBIA \sin\theta$

$I = \tau / BA$

$I = 0.25\text{Nm} / (0.6\text{T})\ (8 \times 5 \times 10^{-3}\ \text{m}^2)$

$I = (0.25) / (0.024)$

$I = 10.4$ A

Using the right-hand palm rule, the coil is turning in a clockwise direction.

(b)

Criteria	Marks
• Correctly equates $\tau/d = 19.6\ \text{m}^2\text{s}^{-2}$	3
• Correctly equates $\tau = 2\ (9.6)\ d$	2
• Provides some relevant information	1

Sample answer:

$\tau = mgd$

$\tau = 2\ (9.8)\ d$

$\tau/d = 19.6\ \text{m}^2\text{s}^{-2}$

Question 24 (5 marks)

(a)

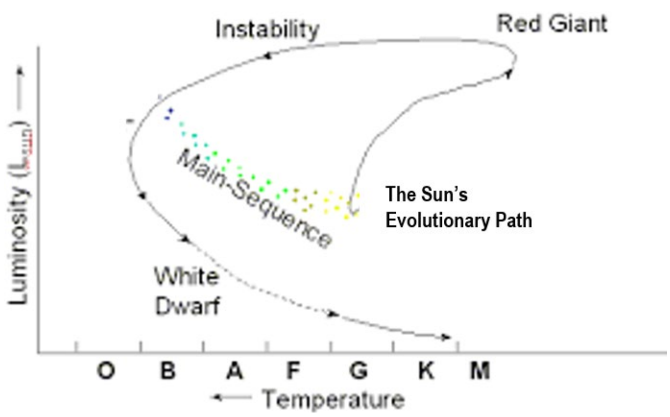
Criteria	Marks
• Identifies the position of the Sun on the H-R diagram • Describes two features of the Sun that relate to its position	3
• Identifies the position of the Sun on the H-R diagram • Describes one features of the Sun that relate to its position	2
• Provides some relevant information	1

Sample answer:
The Sun is a yellow G2 spectral class, main sequence star. It has a luminosity of 1 as the Sun is the reference point for all other stars on the H-R diagrams. This means the Sun has a surface temp of about 5800^{o}K, making it a medium level surface temperature when compared to other stars and it has an absolute magnitude of 4.8 (as read from H-R diagram).

(b)

Criteria	Marks
• Provides correct evolutionary path identifying main stages	2
• Provides at least partially correct evolutionary path	1

Sample answer:
(ie. It follows the indicated evolutionary path as it moves from the main sequence stage to the red giant stage then to the white dwarf stage.)



Question 25 (5 marks)

(a)

Criteria	Marks
● Describes clearly what the Balmer Series measures	2
● Provides some relevant information	1

Sample answer:
The Balmer Series measures the visible emission spectrum created in a hydrogen atom between the energy levels n = 2 and n = 6.

(b)

Criteria	Marks
● Calculates the wavelength using n=1 and n=3 in the correct formula	3
● Uses n=1 and n=3 in the correct formula	2
● Provides some relevant information	1

Sample answer:
$1/\lambda = R\ (1/2^2 - 1/3^2)$
$1/\lambda = 1.097 \times 10^7\ (1/2^2 - 1/3^2)$
$\lambda = 656$ nm

Question 26 (5 marks)

Criteria	Marks
● Describes Lenz's Law and Faraday's Law ● Describes how each reading on the ammeter relates to these laws *(.2; -.2 and 0s)*	5
● Outlines Lenz's Law and Faraday's Law ● Outlines how each reading on the ammeter relates to these laws	4
● Outlines Lenz's Law ● Outlines how TWO readings on the ammeter relates to this law	3
● Identifies the main ideas of Lenz's Law ● Relates TWO readings on the ammeter to this law	2
● Relates ONE reading on the ammeter in some way to Lenz's Law	1

Sample answer:
Faraday's law states that a moving magnetic field will induce a current in a coil. Lenz's Law states that the current created in the coil will be in a direction that creates a magnetic field that opposes the changes in magnetic flux that induced it. The 0.2 µA reading is produced by the changing flux of the magnet moving into the coil. Once the magnet stops moving, according to Faraday's Law so does the current. Following Lenz's Law as the magnet is moved out of the coil the changing flux is now reversed, this means the current direction must also reverse, hence -0.2 µA. Then again following Faraday's Law the current stops as the magnet stops.

Question 27 (5 marks)

(a)

Criteria	Marks
• Identifies the evidence produced by the Geiger-Marsden results • Describes the component of the Geiger-Marsden experiment the simulation models • Describes how the tennis ball rebounding off the golf ball models this component and the evidence produced.	4
• Identifies the evidence produced by the Geiger-Marsden results • Outlines the component of the Geiger-Marsden experiment the simulation models • Relates the tennis ball rebounding off the golf ball to this component and the evidence produced	3
• Identifies the evidence produced by the Geiger-Marsden results • Relates the tennis ball rebounding off the golf ball to the Geiger-Marsden results	2
• Provides some relevant information	1

Sample answer:
The tennis ball rebounding off the golf ball simulates the alpha particle, in the Geiger-Marsden experiment, returning from the atoms in the gold foil. It was not expected that the alpha particles would return in the way they did, as it was not then known that most of the atom's mass was centralised in the nucleus. The rebounding tennis ball models the evidence the rebounding alpha particles supplied. This evidence supported a change in the model of the atom to one that was mostly empty space with a small, centralised nucleus containing most of the mass.

(b)

Criteria	Marks
• Correctly outlines the feature modelled	1

Sample answer:
The distance of 2 m simulates that the atom is mainly free space.

Question 28 (7 marks)

(a)

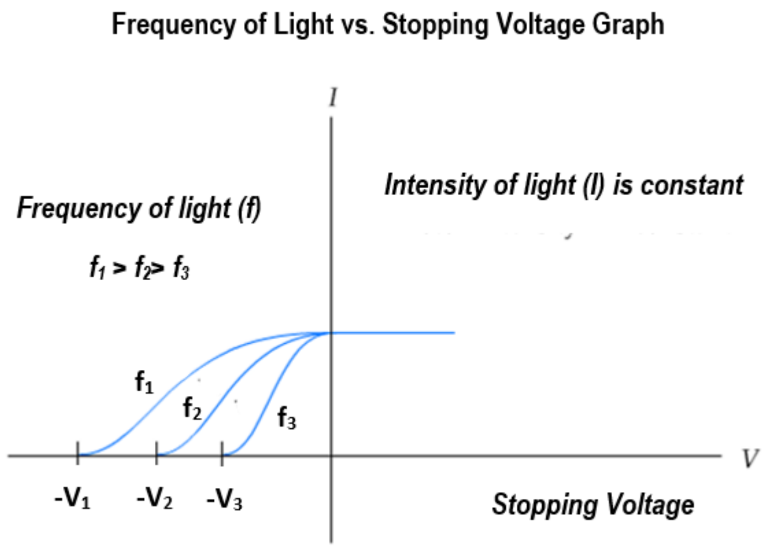
Criteria	Marks
• Describes the results produced by this experiment • Describes how these results do not support a classical wave model	4
• Identifies the main results achieved from this experiment • Describes how these results do not support a classical wave model	3
• Identifies the main results achieved from this experiment • Relates these in some way to not supporting a classical wave model	2
• Provides some relevant information	1

Sample answer:
The experiment showed that a minimum frequency of light was required for electrons to gain enough kinetic energy to start the current flowing, once this minimum was achieved, increasing the frequency increased kinetic energy. Measuring the stopping potential as intensity was increased showed that the kinetic energy was independent of the intensity. These results did not support the classical wave model. The wave model predicted that the kinetic energy of electrons should only be dependent on light intensity, not frequency as the experimental results showed. The results therefore discredited the classical wave model while supporting the quantum model of light.

(b)

Criteria	Marks
• Plots a graph which shows the stopping voltage increasing as the frequency of light increase as the intensity of light remains constant	3
• Plots a graph which shows the stopping voltage increasing as the frequency of light increases	2
• Provides some relevant information	1

Sample answer:



Question 29 (6 marks)

(a)

Criteria	Marks
• Correctly explains Kepler's third Law of periods • Correctly describes what the ratio r^3/T^3 means in relation to the solar system graph	3
• Correctly describes Kepler's third Law of periods	2
• Provides some relevant information	1

Sample answer:
The axes of the graph represent r^3 and T^2 which relates directly to Kepler's Third Law of Periods which states that the ratio r^3/T^2 is a constant k for all planets orbiting the same central mass, Kepler's Law states that the constant, $k = GM/4\pi^2$, which is the gradient of the line therefore is $GM/4\pi^2$.

(b)

Criteria	Marks
• Correctly substitutes data from the graph and explains why the other planets follow the same relationship	3
• Correctly substitutes yr^2/AU^3 using the data from the graph	2
• Provides some relevant information	1

Sample answer:
$1yr^2/1AU^3 = 4\pi^2/GM_{sun}$ data from the graph (Earth)
The ratio of the yr^2 / AU^3 = K = $4\pi^2/GM_{sun}$
This constant is the same for each planet and plots these planets on this graph proportionally depending on the semi-major axis measurement and orbital period.

Question 30 (6 marks)

(a)

Criteria	Marks
• Correctly calculates the binding energy per nucleon of He-4 and U-238 • Describes how their similar binding energies cannot be used to distinguish whether they are going to undergo fusion or fission reactions	6
• Correctly calculates the binding energy per nucleon of He-4 and U-238 • Relates results in some relevant way to student's predictions	5
• Calculates the binding energy per nucleon of He-4 OR U-238 with few mistakes • Relates results in some relevant way to student's predictions	4
• Calculates the binding energy per nucleon of He-4 OR U-238 showing some accurate steps • Identifies that smaller binding energies per nucleon like He-4 are typically involved with fusion reactions and larger binding energies per nucleon like U238 are typically involved in fission reactions	3
• Calculations show some relevance to binding energy per nucleon of He-4 OR U-238 • Identifies that smaller binding energies per nucleon like He-4 are typically involved in fusion reactions	2
• Provides some relevant information	1

Sample answer:

The binding energy per nucleon can be used to determine whether an atom is likely to undergo nuclear fusion or fission but, in this case, it cannot be used as both atoms will have a very similar binding energy/nucleon.

The binding energy per nucleon of helium-4 is
2 protons = (2) (1.00728u) = 2.01456u
2 neutrons (2) (1.00876u) = 2.0174u
2 electrons (2) (0.00055u) = 1.1x10^{-3}u
Mass defect = 4.03306u -= 4.0026u (actual total mass)
Binding energy = (0.03046) (931.5MeV) =28.37 MeV
Binding energy/ nucleon = 28.37/4 = <u>7.09 MeV</u>

The binding energy per nucleon of Uranium-238 is
92 protons = (92) (1.00728u) = 92.669u
146 neutrons (146) (1.00876u) = 147.279u
92 electrons (92) (0.00055u) = 0.0506u
Mass defect = 239.999u -= 238.05u (actual total mass)
Binding energy = (1,949) (931.5 MeV) =1815.4 MeV
Binding energy/ nucleon = 1815.4/238 = <u>7.62 MeV</u>

In this case the binding energy per nucleon cannot be used as a distinguishing factor for both He-4 and U-238. The size of the atom is what determines whether they will undergo fission and fusion reactions. Uranium-238 is larger it is likely to undergo fission reactions and Helium-4 is smaller it is likely to undergo fusion reactions.

Question 31 (7 marks)

(a)

Criteria	Marks
• Provides a detailed description of TWO sources of inefficiencies in a transformer and TWO ways to decrease these sources	4
• Provides a detailed description of TWO sources of inefficiency in a transformer and ONE way to decrease an efficiency	3
• Provides a detailed description of TWO sources of inefficiency in a transformer	2
• Provides some relevant information	1

Sample answer:

Eddy currents can be generated in the core of transformers which creates inefficiency especially with the flux density exchange in the core. To overcome the transformer eddy current loses which occur in the core, a transformer's core must be laminated using varnish or paper to increase the resistivity. This breaks up the eddy currents and decreases their effect, this increases the efficiency of the transformer. Magnetising and demagnetising in the core and AC power supplies can lead to molecular friction in the core, called hysteresis. This friction produces heat which will cause the resistance in coils to increase causing the transformer to be inefficient. To lower the hysteresis, silicon steel or high-grade steel is used in the manufacture of the core.

(b)

Criteria	Marks
• Calculates the best way to transmit this power using the largest possible current which will result in the lowest power loss.	2
• States that transformers need to step up voltage to overcome power loss as Power Loss = I^2R	1

Sample answer:

The power station must step up voltage to the safety limit of 3050 V to overcome power loss. To do this it must use a current of 5000000/3050=1639 A as this gives the best possible situation to avoid power loss as $P_{Loss} = I^2 R$.

ie: $P_{loss} = (1639^2 A)(4\Omega/km)$

$P_{loss} = 10745 W/km$

Question 32 (8 marks)

(a)

Criteria	Marks
• States that Source A and Source B are creating absorption spectra and names ONE possible source	2
• Provides some relevant information	1

Sample answer:
Source A and B are both absorption spectra sources as they both contain black lines on a full coloured spectrum. A possible source for both source A and B can be a continuous laboratory light passing through a cold solution.

(b)

Criteria	Marks
• Draws that the spectra lines from source A are red shifted or moved to the right in the direction of the galaxy moving away from the Earth	2
• Provides some relevant information	1

Sample answer:

(c)

Criteria	Marks
• Explains how THREE features of stars can be verified from spectra produced in a laboratory	4
• Explains how TWO features of stars can be verified from spectra produced in a laboratory	3
• Explains how ONE feature from stars can be verified from spectra created in the laboratory	2
• Provides some relevant information	1

Sample answer:
The chemical elements of a star can be verified by cross referencing their absorption spectra against standard spectra of known elements created in a lab. High density stars are identified by the broadening of their spectral lines. Spectra of a gases produced in a laboratory confirms the thin sharp lines of low-density gases and the broadening of lines at higher densities. A rotating star also has broader spectra lines as the spectra shifts from blue shifting to red shifting as the starlight is directed towards us and away from us. These features can be measured against stationary sources of spectra created in a laboratory.

Question 33 (6 marks)

(a)

Criteria	Marks
• Calculates potential energy correctly	3
• Makes some progress with calculation	2
• Provides correct formula	1

Sample answer:

U = -GMm/r

U = -6.67×10^{-11} (5.972×10^{24} kg) (2×10^{6} kg)/(380×10^{3} m) + (6371×10^{3} m)

U= -7.96×10^{20}/6751000

U = -1.17×10^{14} J

(b)

Criteria	Marks
• Correctly calculates the total work done to move the satellite into its new orbit	3
• Makes some progress to calculate the total work done to move the satellite	2
• Provides some relevant information	1

Sample answer:

W = U_{final} -$U_{initial}$

W = $(-GMm/r)_{final}$ – $(- GMmr)_{initial}$

W = (-6.67×10^{-11}) (5.97×10^{24} kg)(2×10^{6} kg)/(6371×10^{3} m) + (560×10^{3} m) –

(-6.67×10^{-11}) (5.97×10^{24} kg) (2×10^{6} kg)/(6371×10^{3} m) + (380×10^{3})

W = (-1.15×10^{14}) + (1.17×10^{14})

= 2×10^{12} J

Question 34 (6 marks)

(a)

Criteria	Marks
• Correctly calculate relativistic mass of the electron and compares it to the rest mass	3
• Correctly calculate relativistic mass of the electron	2
• Provides some relevant information	1

Sample answer:

Mass of electron

$m = m_o / \sqrt{1 - v^2/c^2}$

$m = 9.109 \times 10^{-31} / \sqrt{1 - (2.6 \times 10^8)^2/(3 \times 10^8)^2}$

$m = 9.109 \times 10^{-31} / 0.5$

$m = 1.82 \times 10^{-30}$ kg

m is about 50% larger that m_o

(b)

Criteria	Marks
• Correctly calculate velocity needed for the five times mass increase	3
• Makes good progress in the calculation	2
• Provides some relevant information	1

Sample answer:

For particles that are 5 times larger:

$1/5 = \sqrt{1 - v^2/c^2}$

$1 - v^2/c^2 = (1/5)^2$

$v^2/c^2 = 1 - (1/5)^2$

$v = c\sqrt{1 - (1/5)}$

$v = c\sqrt{1 - (0.2)}$

$v = c\sqrt{(0.8)}$

$v = 3 \times 10^8 \times 0.8944$

$v = 2.683 \times 10^8$ ms^{-1}

2022 HSC Trial
Physics
Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I			
1	1	5.1.1	PH12-12, PH12-4
2	1	5.2.3	PH12-12, PH12-5
3	1	6.2.3	PH12-13, PH12-4
4	1	8.5.2	PH12-15, PH12-4
5	1	7.1.1	PH12-14, PH14-3
6	1	6.1.3	PH12-13, PH12-6
7	1	6.1.4	PH12-13, PH12-1
8	1	5.2.5	PH12-14, PH12-7
9	1	8.4.3	PH12-15, PH12-6
10	1	7.2.4	PH12-14, PH12-4
11	1	6.2.1	PH12-13, PH12-3
12	1	5.2.2	PH12-12, PH12-2
13	1	8.3.2	PH12-15, PH12-4
14	1	7.2.3	PH12-14, PH12-2
15	1	6.2.3	PH12-13, PH12-6
16	1	8.3.4	PH12-15, PH12-2
17	1	5.3.4	PH12-12, PH12-3
18	1	7.3.3	PH12-14, PH12-6
19	1	5.3.1	PH12-12, PH12-4
20	1	5.3.2	PH12-12, PH12-6

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	2	5.1.1	PH12-12, PH12-4
21 (b)	2	5.1.4	PH12-12, PH12-6
21 (c)	2	5.1.2	PH12-12, PH12-7
22 (a)	2	6.1.2	PH12-13, PH12-7
22 (b)	2	6.1.1	P12-13, PH12-6
23 (a)	2	6.4.1	PH12-13, PH12-2
23 (b)	3	6.4.1	PH12-13, PH12-6
24 (a)	3	8.1.6	PH12-15, PH12-2
24 (b)	2	8.1.6	PH12-15, PH12-2
25 (a)	2	8.3.2	PH12-15, PH12-4
25 (b)	3	8.3.3	PH12-15, PH12-6
26	5	6.3.2	PH12-13, PH12-1
27 (a)	4	8.2.2	PH12-15, PH12-2
27 (b)	1	8.2.2	PH12-15, PH12-6
28 (a)	4	7.3.2	PH12-14, PH12-3
28 (b)	3	7.3.2	PH12-14, PH12-7
29 (a)	3	5.3.4	PH12-12, PH12-1
29 (b)	3	5.3.4	PH12-12, PH12-5
30	6	8.4.5	PH12-15, PH12-2
31 (a)	4	6.3.3	PH12-13, PH12-7
31 (b)	2	6.3.4	PH12-13, PH12-6
32 (a)	2	7.1.4	PH12-14, PH12-7
32 (b)	2	7.1.5	PH12-14, PH12-5
32 (c)	4	7.1.6	PH12-14, PH12-4
33 (a)	3	5.3.5	PH12-12, PH12-3
33 (b)	3	5.3.5	PH12-12, PH12-6
34 (a)	3	7.4.3	PH12-14, PH12-5
34 (b)	3	7.4.3	PH12-14, PH12-5