Student Number _____

Caringbah High School
Year 12 Physics
Trial Exam 2023

Write all your answers in this answer booklet.

Use pen for written responses and pencil for diagrams and graphs.

Total Marks: 100

Task Length: 3 hours + 5 minutes reading time

PART A: Multiple Choice Questions (20 marks)

PART B: Longer Response Questions (80 marks)

Task Prepared by: J. Warner

OUTCOME	*MARK*
Knowledge and Understanding	*/ 75*
Working Scientifically *1, 3, 4, 5, 13, 15, 16, 17, 24b, 24c, 25b, 27 & 33*	*/ 25*
Total	*/ 100*

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the task.

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

PART A: Circle the letter of the BEST answer on the grid (20 marks)

1. *Which one of the following best describes a hypothesis?*

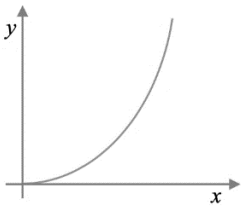
A. A testable scientific explanation.
B. A well-tested scientific explanation.
C. A scientific explanation by a famous scientist.
D. A widely believed and highly plausible explanation.

2. *Which statement describes how an electromagnetic wave is propagated?*

A. An oscillating electric field causes an oscillating magnetic field perpendicular to the electric field.
B. An oscillating magnetic field causes a constant electric field perpendicular to the magnetic field.
C. An oscillating magnetic field causes an oscillating electric field parallel to the magnetic field.
D. An oscillating electric field causes a constant magnetic field parallel to the electric field.

3. *Light, sound, gravitation, electrostatics, and many other physical principles all follow an inverse-square law.*

Which of the following graphs depicts this relationship?

A.


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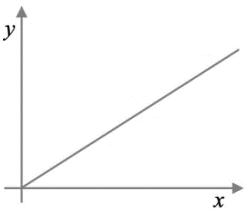
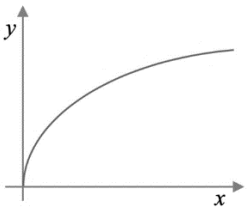
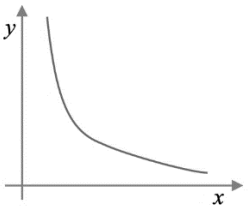


C.


D.


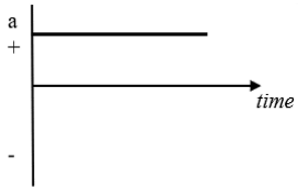
4. *An investigation is designed to determine the size of a generated current when the strength of a magnet is varied. Which is the independent variable for this investigation?*

A. Speed of the magnet.
B. Strength of the magnet.
C. Size of the generated current.
D. Distance between the coil and the magnet.

5. *A projectile is launched at 30° to the horizontal.*

Which alternative below represents the projectile's acceleration while it remains in flight, assuming the upwards direction is positive?

A.



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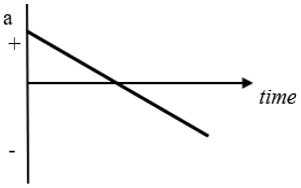

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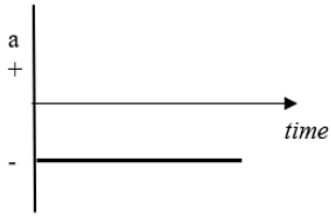
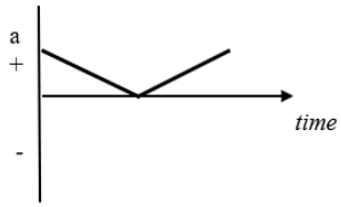


D.



6. *The rest length of a train is 120 m, and the rest length of the platform is 96 m. The train moves past the station so fast that it is measured by an observer on the platform to be the same length as the platform.*

How fast must the train be travelling?

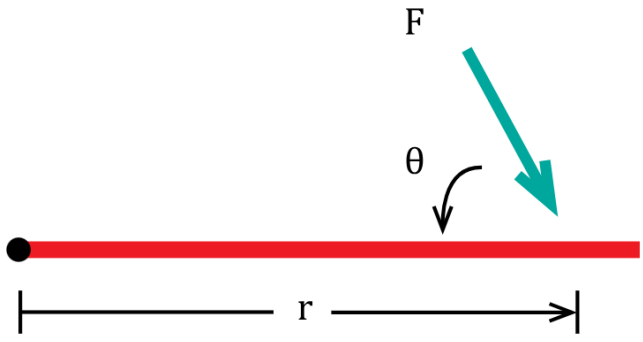
A. *0.60c*

B. *0.75c*

C. *0.80c*

D. *1.25c*

7. *A force is applied at 45° (θ) to a door. The force is applied at a distance (r) 28 cm from the pivot point. Calculate the magnitude of the force (F) required to achieve a torque of 51 Nm?*



A. *2.6×10^2 N*

B. *2.6 N*

C. *1.0×10^3 N*

D. *6.4×10^4 N*

8. *Laser thermometers are used at airports to detect the surface skin temperature of passengers prior to boarding planes. Laser thermometers detect the infrared radiation emitted by the surface of the skin, and give an alert when a wavelength is reached that corresponds to 35.6°C.*

Which of the following wavelengths corresponds with a temperature of 35.6°C?

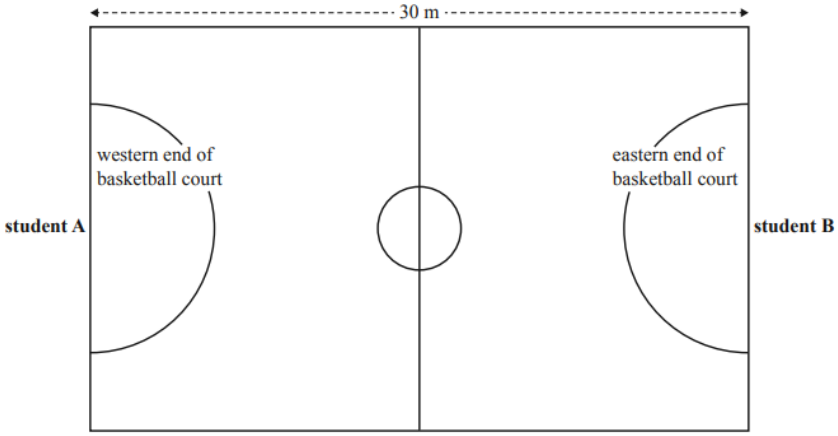
A. 940×10^3 nm

B. 9.40×10^3 nm

C. 940 nm

D. 940 µm

9. *Students use sound to test the ideas of the Michelson–Morley experiment. They conduct an experiment on an outdoor basketball court on a windy day. Student A stood at the western end and created a loud pulse of sound. Student B stood 30.0 m away at the eastern end with a sound detector, as shown below.*



They found that the sound travelling towards the eastern end took 0.0857 s to reach student B. Student B, at the eastern end, then created a loud pulse of sound. This time the sound travelling towards the western end took 0.0909 s to reach student A.

Which one of the following best explains their observations?

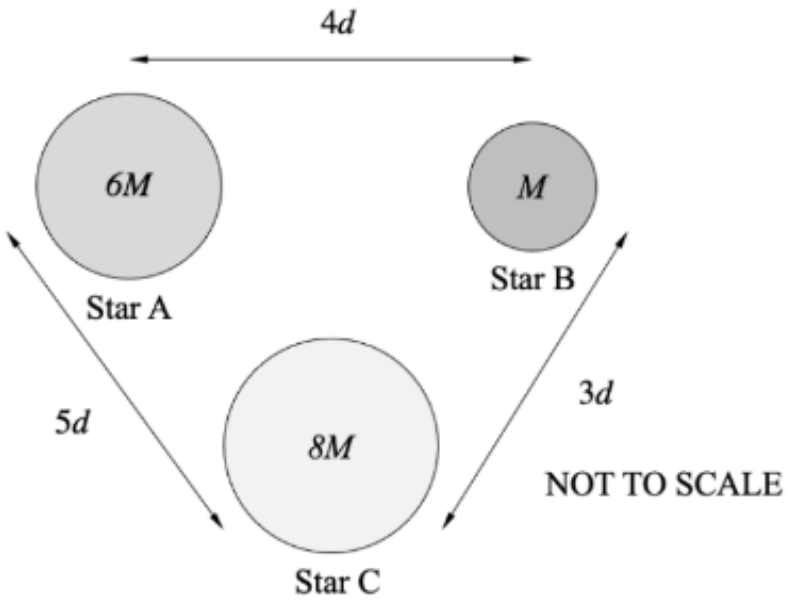
A. The wind was blowing to the east at 10 $m.s^{-1}$.

B. The wind was blowing to the east at 20 $m.s^{-1}$.

C. The wind was blowing to the west at 20 $m.s^{-1}$.

D. The speed of sound is the same in all inertial reference frames.

10. *In a distant galaxy, three stars (A, B and C) form a three-star system. The relative mass of each star and distance between their centres is shown.*



How many times greater is the gravitational force between Star B and Star C compared to that between Star A and Star B?

A. 1.78

B. 5.12

C. 2.16

D. 2.37

11. *What did Plank propose to explain the relationship between emitted wavelength and intensity for a black body cavity radiator?*

A. The black-body radiation curve for different temperatures will peak at different wavelengths that are inversely proportional to the temperature.

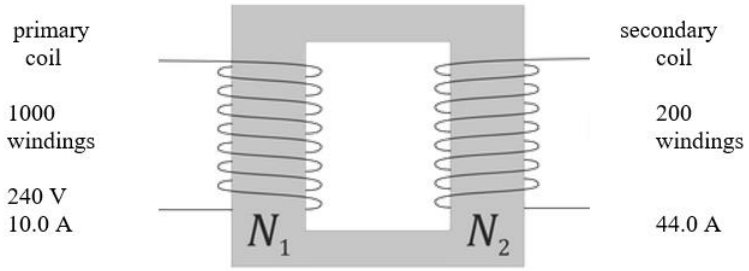
B. The total energy radiated per second per unit area is proportional to the fourth power of the absolute temperature.

C. The radiation emitted and absorbed by the walls of the black body cavity is quantised.

D. The emitted light is not only a wave but can also be described as a collection of particles known as photons.

12.	*A monochromatic light source is emitting green light with a wavelength of 550 nm. The light source emits 2.8×10^{16} photons every second.* *Which one of the following is closest to the power of the light source?* *A. 1.0×10^{-2} W* *B. 3.3×10^{-11} W* *C. 2.1×10^{9} W* *D. 6.3×10^{16} W*	
13.	*An electron moving between charged plates experiences a force. The distance between the plates is 10 cm and the voltage across is 150 V.* *How much work was done to shift the electron 3 mm perpendicular between the plates?* *A. 7.2×10^{-18} J* *B. 2.7×10^{-19} J* *C. 2.4×10^{-16} J* *D. 7.2×10^{-19} J*	
14.	*Calculate the work function for copper, which has a threshold frequency of 1×10^{9} MHz.* *A. 3.9 eV* *B. 3.9 MeV* *C. 4.1 eV* *D. 4.1 MeV*	

15. *A transformer has 1000 windings on the primary coil and 200 windings on the secondary coil.*

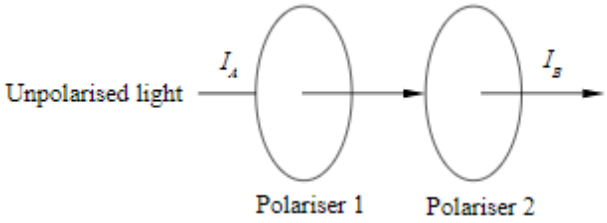


The primary voltage is 240 V, with a primary current of 10.0 A. The secondary current is 44.0 A.

What is the efficiency and type of this transformer?

	Efficiency	***Type***
A.	*23%*	*Step-up*
B.	*44%*	*Step-up*
C.	*20%*	*Step-down*
D.	*88%*	*Step-down*

16. *Unpolarised light passes through two consecutive polarisers as shown. I_A is the intensity of the unpolarised light, and I_B is the intensity of light after polariser 2.*



The value of I_B: I_A is 0.375.

What is the angle between the transmission axis of polariser 1 and polariser 2?

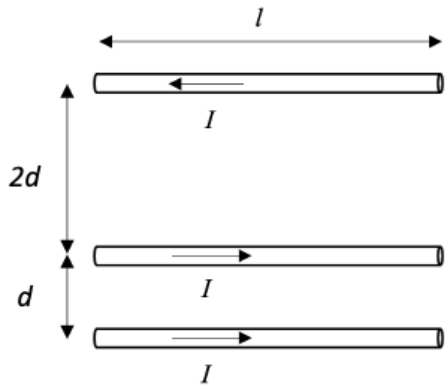
A. *30°*

B. *41°*

C. *52°*

D. *64°*

17. *Three equal length (l) straight conductors, each carrying equal current I, are placed parallel as shown. The middle straight conductor is placed 2d and d units from the top and bottom conductors respectively.*



The expression for the magnitude of the net force acting on the middle conductor is:

A. $\frac{lkI^2}{2d}$

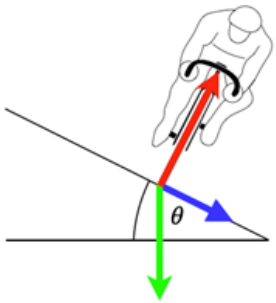
B. $\frac{2lkI^2}{d}$

C. $\frac{3lkI^2}{2d}$

D. $\frac{lkI^2}{d}$

18. *A cyclist is riding around a corner on a banked track. He is travelling faster than the design speed of the bank. Which of the following vector diagrams illustrates the forces acting on the cyclist?*

A.



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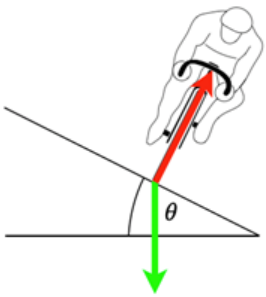

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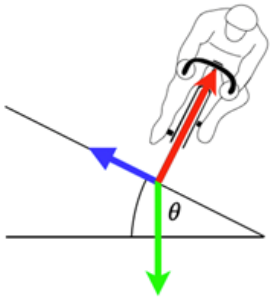
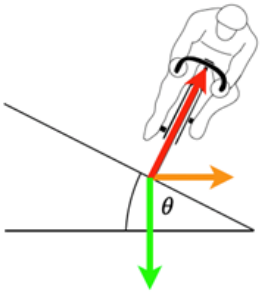
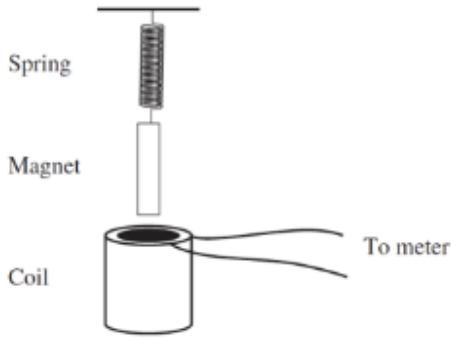


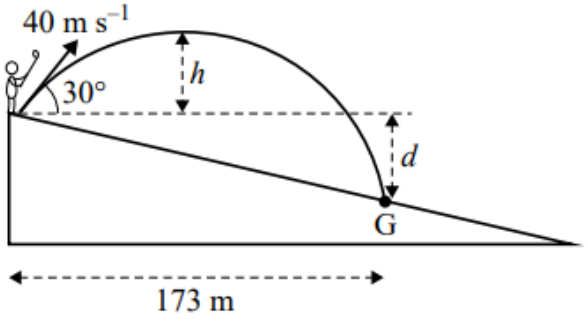
D.



19.	*A large warehouse ceiling fan has blades 1.5 m in length that rotate so the tip of the blade travels a distance of 2.5 m in 0.5 s. At what angular velocity does the turbine rotate?* *A.* $72^\circ s^{-1}$ *B.* $92^\circ s^{-1}$ *C.* $120^\circ s^{-1}$ *D.* $191^\circ s^{-1}$	
20.	*A student is investigating electromagnetic induction using a bar magnet hanging from a spring that is fixed to the ceiling as shown.*  *The bar magnet is pulled down so that it is inside the solenoid, and then released. The student noted that when the solenoid is connected to an ammeter, the bar magnet comes to rest more quickly than when it is connected to a voltmeter.* *Which statement best explains this observation?* *A. The induced emf from the voltmeter keeps the magnet moving.* *B. The induced emf from the ammeter opposes the magnet's movement.* *C. The voltmeter has a greater electrical resistance than the ammeter.* *D. The magnitude of induced emf is greater when the coil is connected to an ammeter.*	

PART B: Longer Answers (80 marks)

21. *A golfer hits a ball on a part of a golf course that is sloping downwards away from him, as shown below.*



The golfer hits the ball at a speed of 40 m.s^{-1} and at an angle of 30° to the horizontal.

a. Calculate the maximum height, h, that the ball rises above its initial position. **2**

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The ball lands at a point at a horizontal distance of 173 m from the hitting-off point, as shown above.

b. Calculate the vertical drop, d, from the hitting-off point to the landing point, G. **3**

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22. *Students have a model that can be used as a motor or generator, depending on the connections used. The magnets provide a uniform magnetic field of 2.0×10^{-3} T. EFGH is a square coil of each side length 4.0 cm with 10 turns. A 6.0 V battery and an ammeter are connected to the shaft through a commutator.*

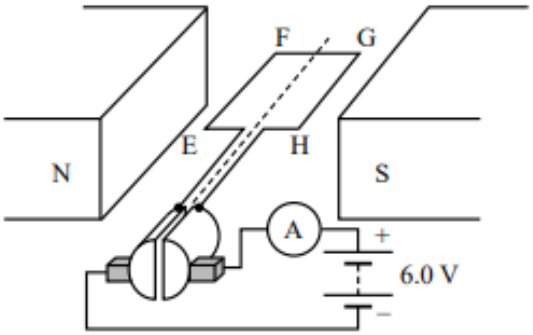

Diagram 1

a. The ammeter shows a current of 4.0 A. With the coil horizontal as shown in Diagram 1, what is the force on the side EF? Give the magnitude and direction (up, down, left, right) of the force. **2**

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The model is now set up as a DC generator, with the output connected to a voltmeter and oscilloscope via a commutator, as shown in Diagram 2, with the same coil of side length 4.0 cm and 10 turns, and a uniform magnetic field of 2.0×10^{-3} T. The shaft is rotated by hand.

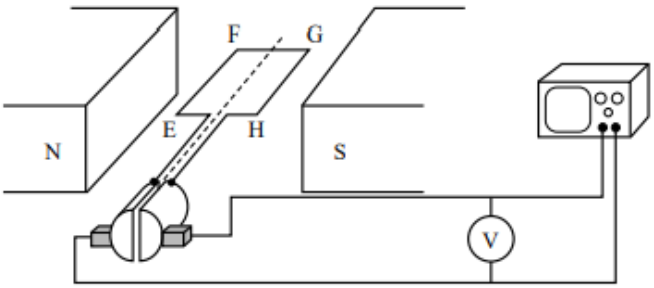

Diagram 2

b. The shaft and coil make two complete revolutions per second. Calculate the magnitude of the average voltage as shown on the voltmeter during one-quarter revolution. **2**

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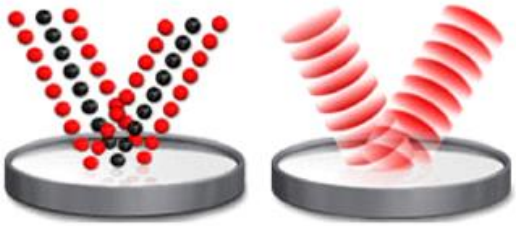
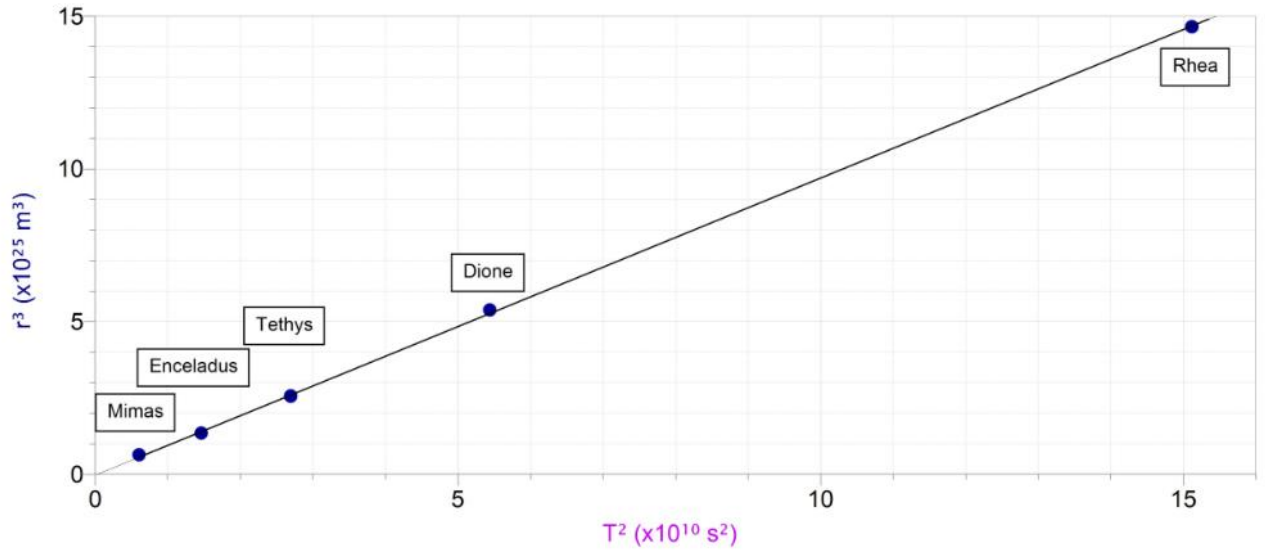
Question 22 continues on the next page.

	c. The students wish to convert this DC generator into an AC generator. Identify the change or changes the student would have to make to achieve this. Justify your answer. …… …… …… ……	**2**
23.	*The diagram shows two different models of light that were around in the late 1600s.*  **Model 1** **Model 2** *a. Which of these models was proposed by Newton?* …… …… *b. With reference to general characteristics of scientific models, why was Newton's model rejected in favour of the model proposed by Huygens?* …… …… …… …… …… ……	**1** **2**

24. *The figure below shows a graph of the orbital radius cubed of the inner moons of Saturn plotted against their orbital period squared.*



a. Identify which of Kepler's laws of planetary motion is supported by the data shown in the graph. **1**

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b. Use the line of best fit provided in the graph to show that the mass of Saturn is 5.7 x 10^{26} kg. **3**

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c. Calculate the escape velocity of a 50 000 kg rocket on the surface of Saturn if the radius of Saturn is 5.8 x 10^{7} m. **2**

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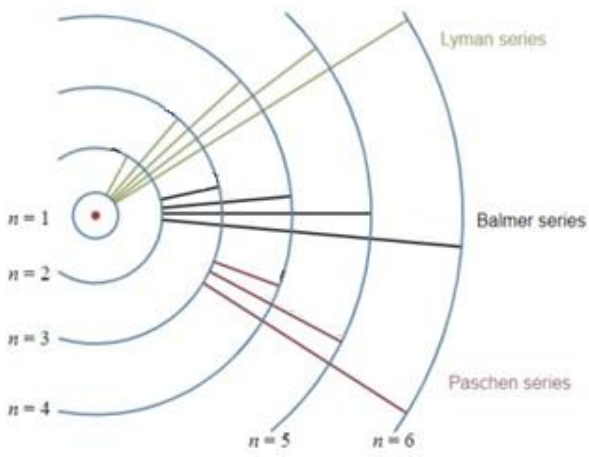
25. *Below is a diagram of Bohr's model of the atom showing the different series of electron transitions within a hydrogen atom.*



a. Identify which series is responsible for producing electromagnetic radiation with wavelengths greater than visible light. **1**

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b. Calculate the frequency of photons emitted when electrons move from $n_i = 3$ to $n_f = 2$ orbit. **2**

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c. Describe a limitation of this model of the atom. **2**

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26. *A muon is an elementary particle produced from cosmic radiation and found in Earth's atmosphere. The average altitude at which muons are created is 15 km above surface of Earth.*

Additional information about muons can be found in the table below.

Particle Class	Lepton
Mass (kg)	1.88×10^{-28}
Charge (C)	-1.602×10^{-19}
Mean Life Time (μs)	2.2

a. Calculate the average gravitational potential energy of a muon at 15 km above surface of Earth. **2**

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b. Determine the work done by gravity on a muon that descends from 15 km to an altitude of 10 km above surface of Earth. **2**

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Classical physics assumes that regardless of their velocity, muons cannot cover long distances due to their short lifetime.

c. Explain from the muon's perspective why they are detected on the surface of Earth. **2**

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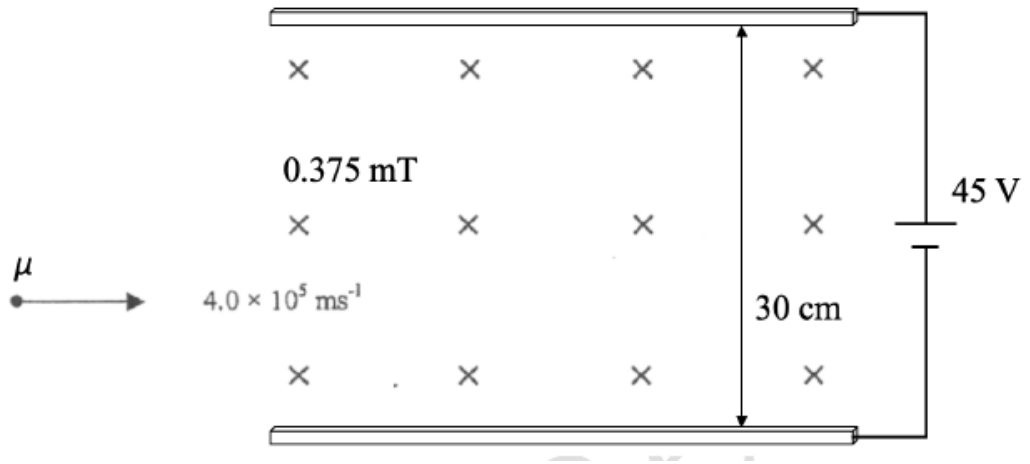
Question 26 continues on the next page.

Suppose that a muon is subject to a magnetic and electric field as shown. The magnetic field strength is 0.375 mT. The electric field is created by a pair of parallel metal plates 30 cm apart and connected to a potential difference of 45 V.



The muon (μ) enters the magnetic and electric field at 4.0 x 10^5 ms^{-1}. Assume gravity is negligible.

d. Analyse the path of the muon as it travels through these two fields. Include calculations in your response. **4**

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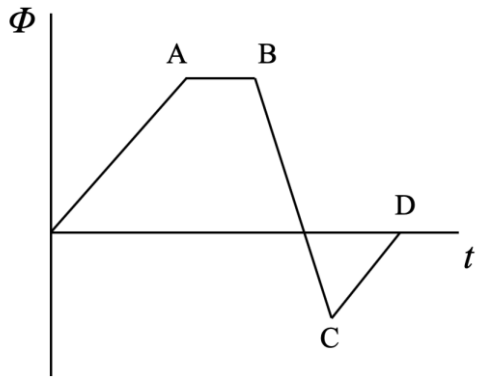
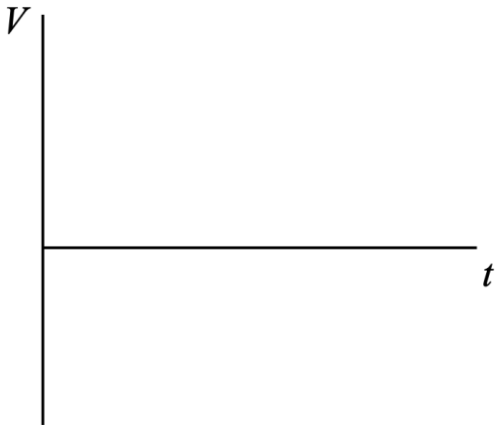
27.	*Outline an investigation that could be conducted to calculate the wavelength of monochromatic light emitted by a laser. Ensure that the investigation is valid by accounting for sources of error in your experimental design. Support your response with a diagram.* …… …… …… …… …… …… …… …… …… …… …… …… …… ……	**4**

28. *The change in magnetic flux with time generated by the primary coil of a faulty transformer is shown below. A, B, C and D represent specific time points during this change.*



a. On the graph below, show how the secondary voltage of the same transformer changes with time. On your graph, clearly indicate time points A, B, C and D. **2**



b. Describe ONE way energy is lost in a transformer and how these losses are commonly reduced. **2**

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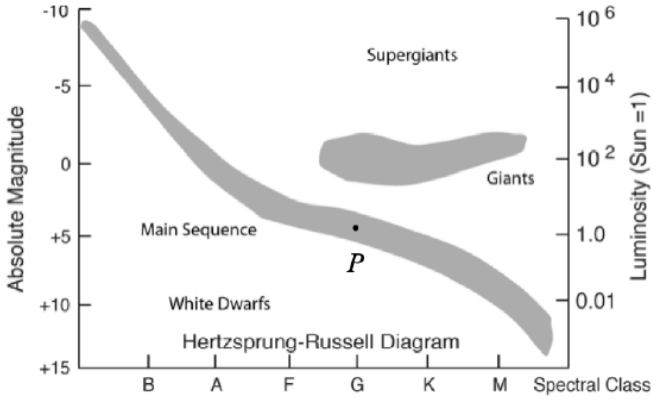
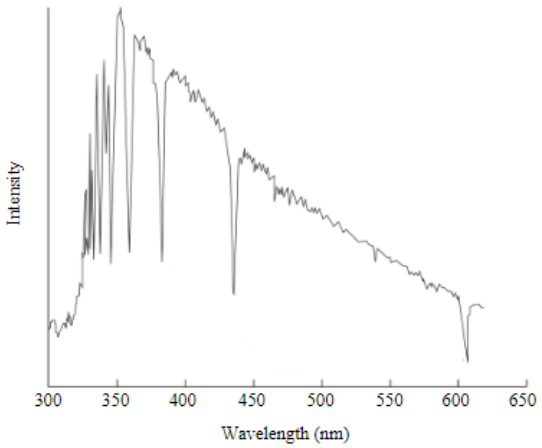
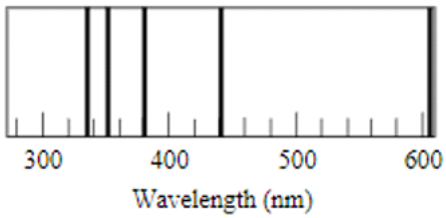
29. *A Hertzsprung–Russell diagram is shown below (left). Point P indicates a particular star in the Milky Way galaxy. The second diagram below (right) shows the spectrum of radiation emitted from star P.*



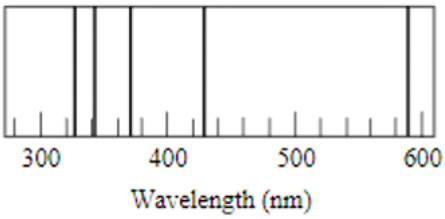


Below are two absorption spectra, one from star P and one from a laboratory.

Absorption Spectrum of Star P



Absoprtion Spectrum of an Element from a Laboratory



a. Describe what the absorption spectra reveal about the motion of star P. **2**

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b. Describe what changes will occur to the absorption spectrum of P as it continues onto the next evolutionary stage as a star. **2**

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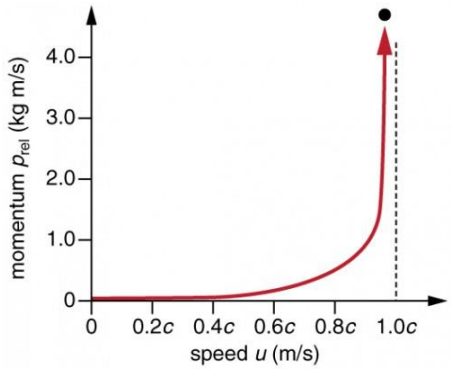
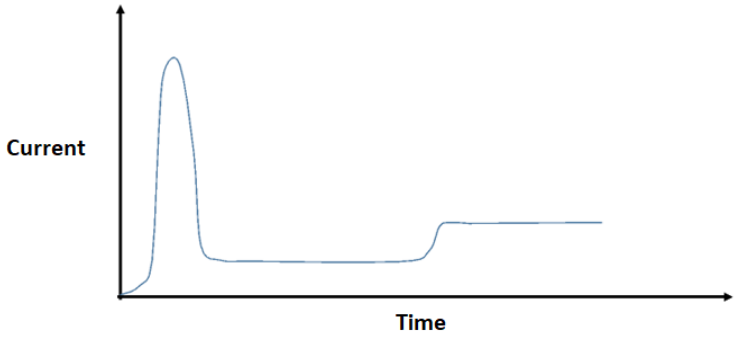
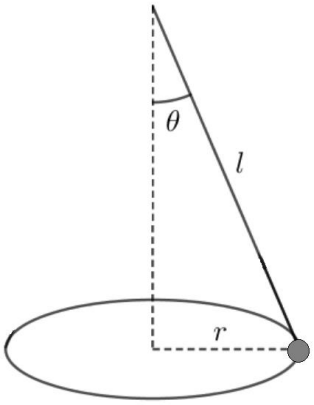
Question 29 continues on the following page.

	c. Explain why there are relatively fewer Main Sequence stars in spectral classes B and A. …… …… …… …… …… …… …… .	**3**
30.	*As a spacecraft approaches the speed of light, the extra momentum provided by the thrust from its propulsion system results in very little increase in speed. The relationship between the spacecrafts momentum and speed is depicted in the diagram below.*  *With reference to appropriate mathematical relationships, explain this apparent discrepancy in Newtonian physics theory.* …… …… …… …… …… …… …… …… …… …… .	**3**

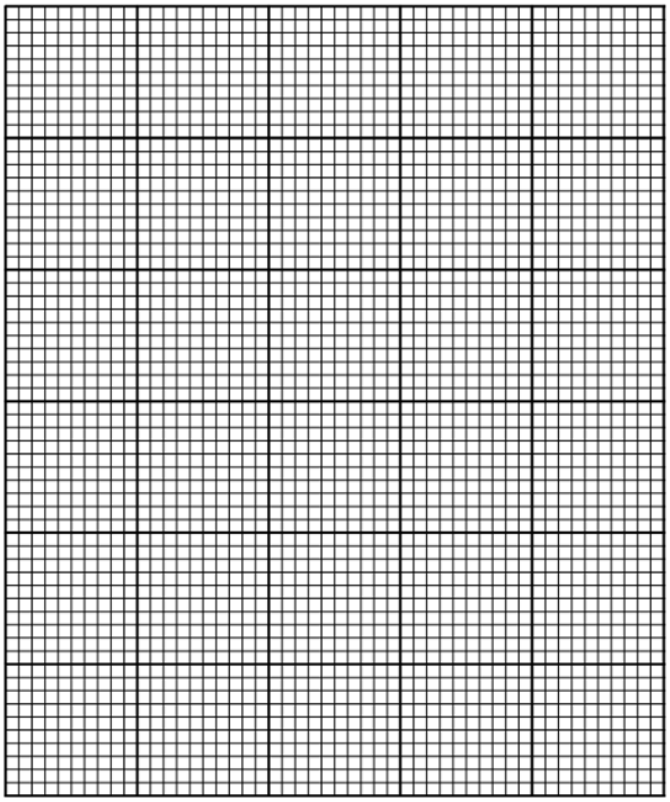
31.	*A student investigated how the current passing through an electric drill varied when it was turned on and then used to drill a hole. The student used a battery-operated electric drill and connected it to an ammeter to measure the current in the rotor.* *When the drill was switched on, the current rapidly increased to 5.5 A and then reduced quickly to a steady value of 0.9 A. The drill was then used to drill a hole, placing a load on the motor. The current went up to 2.1 A while it was drilling.* *The student then created a current vs time graph using the data they collected.*  *Explain the variations in current.* …… …… …… …… …… …… …… …… …… ……	**3**
32.	*Compare the spectra produced by discharge tubes and incandescent light bulbs.* …… …… …… …… ……	**2**

33. *A ball moves in a circular path at the end of a string, forming a conical pendulum, as shown in the diagram below (left). A student found that if the speed of the ball varies, the angle (θ) changes. Some experimental values are recorded in the table below (right).*



Velocity^2 (m.s^{-1})^2	**r tan (θ)**
15.75	1.59
22.56	2.28
31.33	3.20
43.68	4.45
61.75	6.25
90.73	9.23

a. Draw a graph showing the relationship between Velocity^2 and r tan (θ). **3**



b. Determine the acceleration due to gravity (g) using the gradient of the graph and then use it to assess the accuracy of this investigation. **3**

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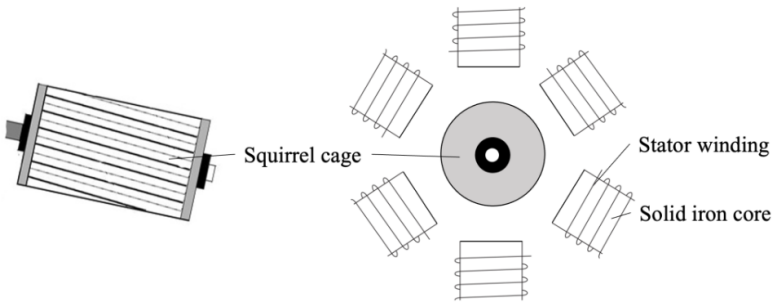
34. *The diagram shows an AC induction motor.* **3**



Explain the operation of this device.

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35. *A uranium-234 atom, initially at rest, undergoes alpha decay. The masses of the atoms involved are shown in atomic mass units (u).* **3**

$$\underset{234.0409\ u}{^{234}\mathrm{U}} \rightarrow \underset{230.0331\ u}{^{230}\mathrm{Th}} + \underset{4.0026\ u}{^{4}\mathrm{He}}$$

The kinetic energy of Thorium-230 is 7.02×10^{-15} J.

Calculate the kinetic energy of the alpha particle.

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36. *Heavy vehicles such as trains or rollercoasters at amusement parks often use a braking system known as "Magnetic" (or "Electromagnetic") braking. Below is a diagram of a simplified magnetic brake.*

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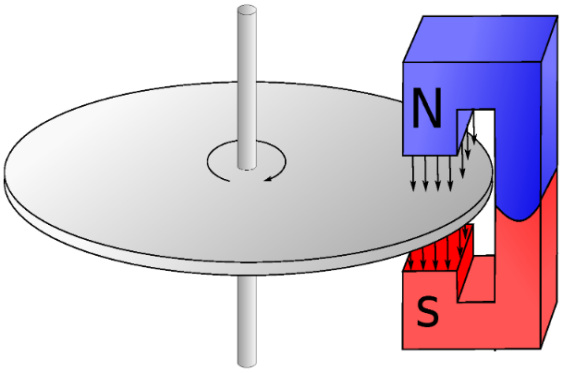

Explain the physics principles underlying magnetic braking, including how conservation of energy applies to these systems.

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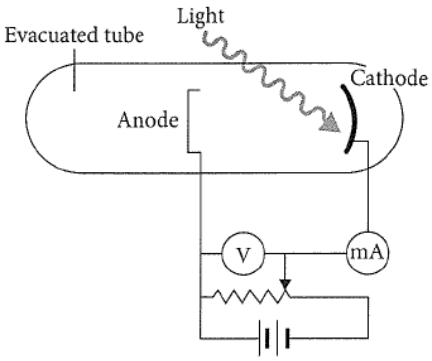
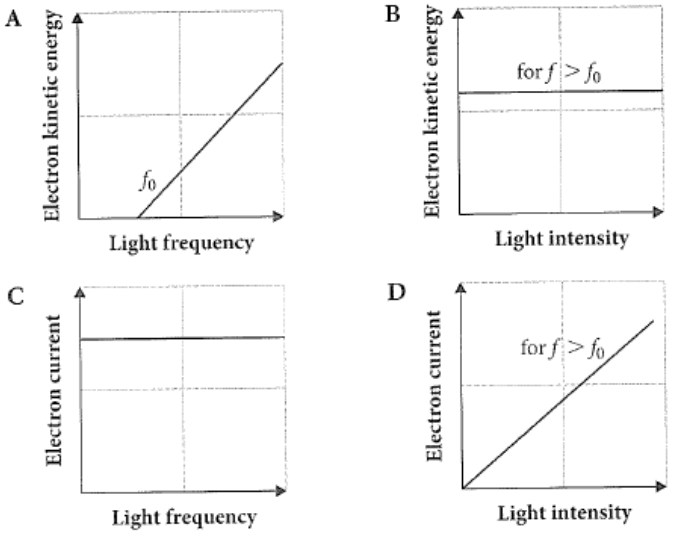
37. *Light is shone on a phototube, as shown in the diagram below (left). The frequency is increased, and the voltage and current are monitored.* **5**

The experiment is repeated, but this time the frequency is set to the lowest frequency at which current is detected. The light intensity is then increased, and the voltage and current are monitored.

The results are shown in the graphs below (right).





Analyse the results and explain how they support the idea of the quantum nature of light.

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PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

1 H 1.008 Hydrogen																	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	57–71 Lanthanoids	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	89–103 Actinoids	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 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

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 is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).

Task Evaluation ***Name: _____***

Total Mark: *_____ out of _____*

Mark sub-totals

Multiple choice mark: _____ out of _____

Knowledge and understanding mark: _____ out of _____

Working Scientifically mark: _____ out of _____

Circle the number that best matches. Key: 1– never 2-occasionally 3-sometimes 4-mostly 5-always

Aspect	*never*	*occasionally*	*sometimes*	*mostly*	*always*
I pay attention in class	*1*	*2*	*3*	*4*	*5*
I complete all my classwork	*1*	*2*	*3*	*4*	*5*
I ask the teacher when I need help	*1*	*2*	*3*	*4*	*5*
I make summary notes to study	*1*	*2*	*3*	*4*	*5*
I get distracted in class	*1*	*2*	*3*	*4*	*5*
I keep my OneNote book up to date	*1*	*2*	*3*	*4*	*5*
I provide sufficient detail in my OneNote responses/notes	*1*	*2*	*3*	*4*	*5*
I completed past papers to prepare for the test	*1*	*2*	*3*	*4*	*5*
I can communicate my understanding in tests	*1*	*2*	*3*	*4*	*5*

Questions:

1. *Do you feel that your performance in this task represents your understanding of Science?*

   _____

2. *What does your teacher do that helps you understand in Science?*

   _____

3. *What can your teacher do to improve your understanding in Science?*

   _____

4. *What do you do to maximise your results in Science?*

   _____

5. *What could you do better/differently to improve your results in Science?*

   _____

6. *Is there anything else you want your teacher to know?*

   _____

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

$96 = 120\sqrt{\left(1-\frac{v^2}{c^2}\right)}$

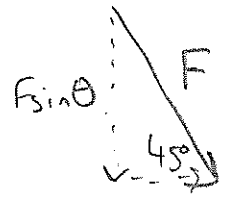
$\left(\frac{96}{120}\right)^2 = 1-\frac{v^2}{c^2}$

$v^2 = (1-0.64)c^2$

$v = \sqrt{(1-0.64)c^2}$

$v = 0.6c$ ∴ A

7) $T = F\sin\theta r$



$F = \frac{T}{r\sin\theta} = \frac{51}{(0.28)(\sin 45)}$

$= 257.6N$

$2.6\times10^2 N$ ∴ A

8) $\lambda_{peak} = \frac{b}{T}$ $0°C = 273°K$

$\lambda = \frac{2.898\times10^{-3}}{273+35.6}$

$\lambda = 9.4\times10^{-6} m$

$= 9.4\times10^3 nM$ ∴ B

9) $V_E = \frac{30}{0.0857} = 350 m/s$

$V_W = \frac{30}{0.0909} = 330 m/s$

$V_E = V_S + V_{wind}$

$V_W = V_S - V_{wind}$

∴ $V_{wind} = 10 m/s$ East

∴ A

10) $F_G = G\frac{M_1M_2}{r^2}$

$F_{G:B\&C} = \frac{8}{3^2} = 0.889$

$F_{G:A\&B} = \frac{6}{4^2} = 0.375$

$\frac{0.889}{0.375} = 2.37$ ∴ D

12) $E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(3\times10^{8})}{550\times10^{-9}}$

$= 3.61\times10^{-19} J$

$P = \frac{\Delta E}{\Delta t} = \frac{(3.61\times10^{-19})(2.8\times10^{16})}{1}$

$= 0.01 W$

$= 1\times10^{-2} W$ ∴ A

13) $\mathcal{E} = \frac{V}{d} = \frac{150}{0.1} = 1500$

$W = qEd = (1.602\times10^{-19}) \times (1500) \times (0.003)$

$= 7.209\times10^{-19}$ ∴ D

14) $E = hf$

$= (6.626\times10^{-34})(1\times10^{15})$

$= 6.626\times10^{-19}$

$1ev = 1.602\times10^{-19}\ J$

$\therefore \frac{6.626\times10^{-19}}{1.602\times10^{-19}} = 4.1ev$

∴ C

15) $\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $V_S = \frac{N_S V_P}{N_P}$

$V_S = \frac{(200)\times(240)}{1000} = 48v$

$\%\ Efficiency = \frac{V_S I_S}{V_P I_P} = \frac{(44)(48)}{(10)(240)}$

$= 0.88 \times 100\% = 88\%$

$240v \rightarrow 48v$ ∴ stepdown

∴ D

16) I_A → $\frac{I_A}{2}$ → I_x → $I_B = I_x \cos^2\theta$

$I_B = I_x \cos^2\theta$

$I_B = \frac{I_A}{2}\cos^2\theta$

$\frac{2I_B}{I_A} = \cos^2\theta$

$\cos\theta = \sqrt{\frac{2I_B}{I_A}}$

$\theta = \cos^{-1}\sqrt{2\times0.375}$

$\theta = 30°$

∴ A

17) 1st to middle:

$F_1 = \frac{1kI^2}{2d}$

3rd to middle:

$F_3 = \frac{1kI^2}{d}$

∴ net force $= F_1 + F_3$

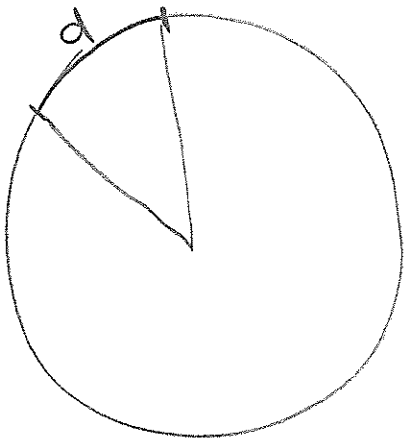
$F_2 = \frac{1kI^2}{2d} + \frac{1kI^2}{d}$

$= \frac{1}{2}\left(\frac{1kI^2}{d}\right) + 1\left(\frac{1kI^2}{d}\right)$

$= \frac{3}{2}\frac{1kI^2}{d} = \frac{3}{2}\frac{kI^2}{d}$

∴ C

19) $C = 2\pi r$



$$d = \frac{\theta}{360^\circ} \times 2\pi r$$

$$\theta = \frac{360^\circ \times d}{2\pi r}$$

$$\theta = \frac{360 \times 2.5}{2 \times \pi \times 1.5} \qquad \theta = 95.49^\circ$$

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{95.49^\circ}{0.5} = 191^\circ s^{-1}$$

$\therefore$ D

9Student Number _____

Caringbah High School
Year 12 Physics
Trial Exam 2023

Write all your answers in this answer booklet.

Use pen for written responses and pencil for diagrams and graphs.

Total Marks: 100

Task Length: 3 hours + 5 minutes reading time

PART A: Multiple Choice Questions (20 marks)

PART B: Longer Response Questions (80 marks)

Task Prepared by: J. Warner

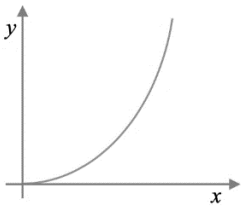
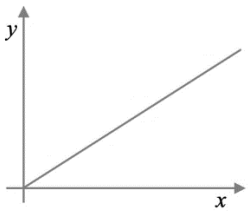
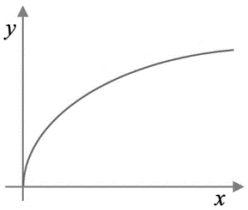
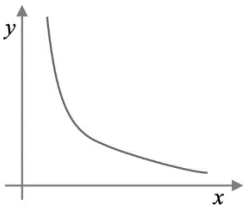
OUTCOME	*MARK*
Knowledge and Understanding	/
Working Scientifically	/
Total	/ 100

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the task.

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

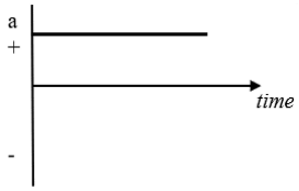
PART A: Circle the letter of the BEST answer on the grid (20 marks)

1.	*Which one of the following best describes a hypothesis?* *A. A testable scientific explanation.* *B. A well-tested scientific explanation.* *C. A scientific explanation by a famous scientist.* *D. A widely believed and highly plausible explanation.*	
2.	*Which statement describes how an electromagnetic wave is propagated?* *A. An oscillating electric field causes an oscillating magnetic field perpendicular to the electric field.* *B. An oscillating magnetic field causes a constant electric field perpendicular to the magnetic field.* *C. An oscillating magnetic field causes an oscillating electric field parallel to the magnetic field.* *D. An oscillating electric field causes a constant magnetic field parallel to the electric field.*	
3.	*Light, sound, gravitation, electrostatics, and many other physical principles all follow an inverse-square law.* *Which of the following graphs depicts this relationship?* *A.*  *B.*  *C.*  *D.* 	
4.	*An investigation is designed to determine the size of a generated current when the strength of a magnet is varied. Which is the independent variable for this investigation?* *A. Speed of the magnet.* *B. Strength of the magnet.* *C. Size of the generated current.* *D. Distance between the coil and the magnet.*	

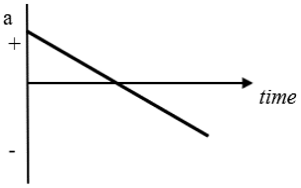
5. *A projectile is launched at 30° to the horizontal.*

Which alternative below represents the projectile's acceleration while it remains in flight, assuming the upwards direction is positive?

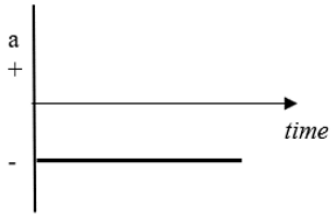
A.



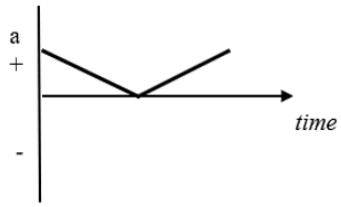
B.



C.



D.



6. *The rest length of a train is 120 m, and the rest length of the platform is 96 m. The train moves past the station so fast that is measured by an observer on the platform to be the same length as the platform.*

How fast must the train be travelling?

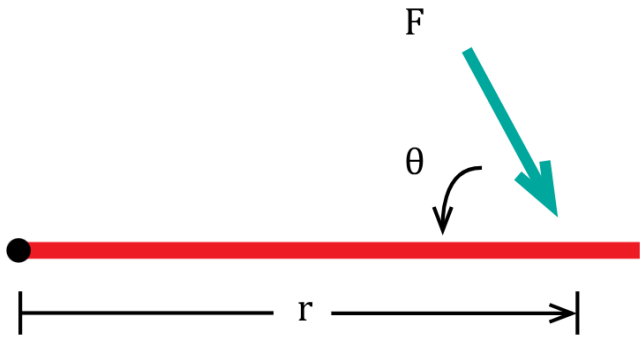
A. *0.60c*

B. *0.75c*

C. *0.80c*

D. *1.25c*

7. *A force is applied at 45° (θ) to a 28 cm long spanner (r). Calculate the magnitude of the force (F) required to achieve a torque of 51 Nm?*



A. *2.6×10^2 N*

B. *2.6 N*

C. *1.0×10^3 N*

D. *6.4×10^4 N*

8. *Laser thermometers are used at airports to detect the surface skin temperature of passengers prior to boarding planes. Laser thermometers detect the infrared radiation emitted by the surface of the skin, and give an alert when a wavelength is reached that corresponds to 35.6°C.*

Which of the following wavelengths corresponds with a temperature of 35.6°C?

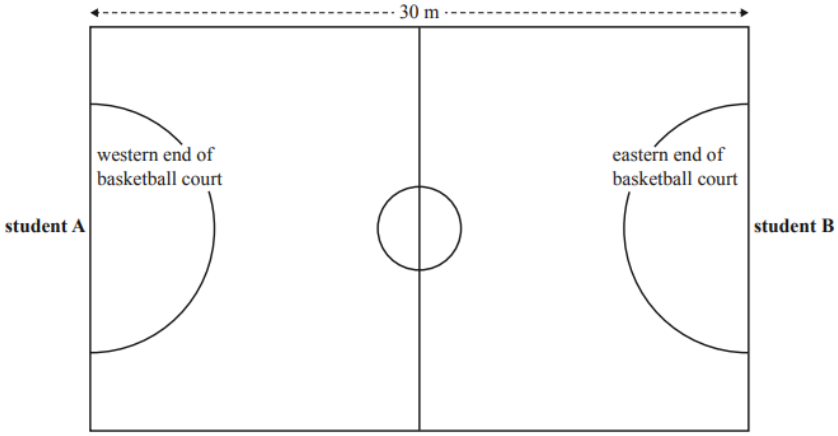
A. 940×10^3 nm

B. 9.40×10^3 nm

C. 940 nm

D. 940 µm

9. *Students use sound to test the ideas of the Michelson–Morley experiment. They conduct an experiment on an outdoor basketball court on a windy day. Student A stood at the western end and created a loud pulse of sound. Student B stood 30.0 m away at the eastern end with a sound detector, as shown below.*



They found that the sound travelling towards the eastern end took 0.0857 s to reach student B. Student B, at the eastern end, then created a loud pulse of sound. This time the sound travelling towards the western end took 0.0909 s to reach student A.

Which one of the following best explains their observations?

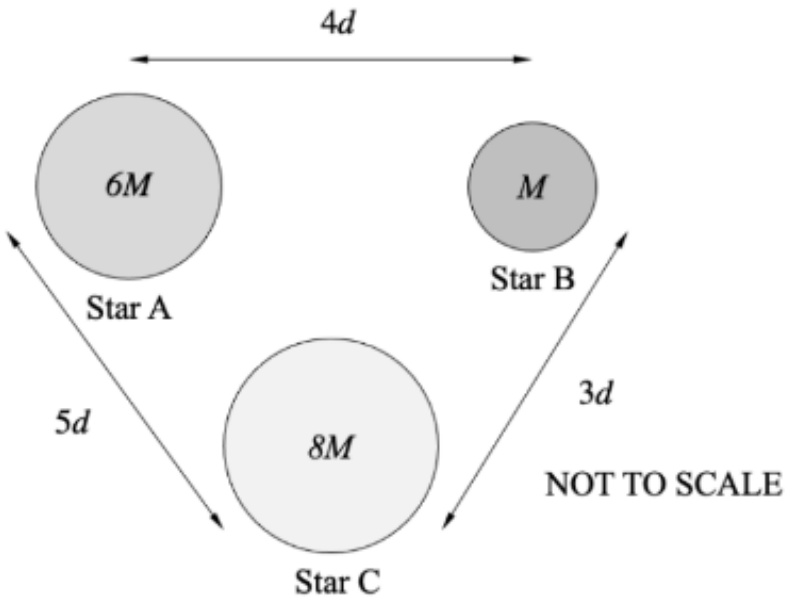
A. The wind was blowing to the east at 10 $m.s^{-1}$.

B. The wind was blowing to the east at 20 $m.s^{-1}$.

C. The wind was blowing to the west at 20 $m.s^{-1}$.

D. The speed of sound is the same in all inertial reference frames.

10. *In a distant galaxy, three stars (A, B and C) form a three-star system. The relative mass of each star and distance between their centres is shown.*



How many times greater is the gravitational force between Star B and Star C compared to that between Star A and Star B?

A. 1.78

B. 5.12

C. 2.16

D. 2.37

11. *What did Plank propose to explain the relationship between emitted wavelength and intensity for a black body cavity radiator?*

A. The black-body radiation curve for different temperatures will peak at different wavelengths that are inversely proportional to the temperature.

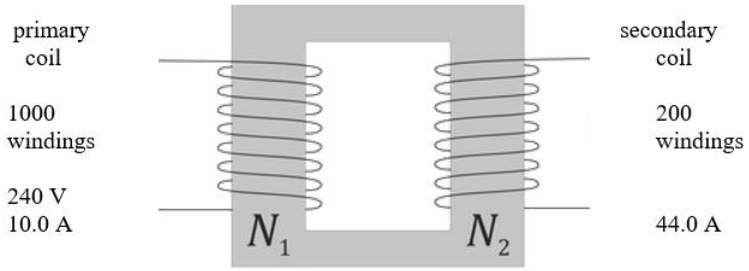
B. The total energy radiated per second per unit area is proportional to the fourth power of the absolute temperature.

C. The radiation emitted and absorbed by the walls of the black body cavity is quantised.

D. The emitted light is not only a wave but can also be described as a collection of particles known as photons.

12.	*A monochromatic light source is emitting green light with a wavelength of 550 nm. The light source emits 2.8×10^{16} photons every second.* *Which one of the following is closest to the power of the light source?* *A. 1.0×10^{-2} W* *B. 3.3×10^{-11} W* *C. 2.1×10^{9} W* *D. 6.3×10^{16} W*	
13.	*An electron moving between charged plates experiences a force. The distance between the plates is 10 cm and the voltage across is 150 V.* *How much work was done to shift the electron 3 mm perpendicular between the plates?* *A. 7.2×10^{-18} J* *B. 2.7×10^{-19} J* *C. 2.4×10^{-16} J* *D. 7.2×10^{-19} J*	
14.	*Calculate the work function for copper, which has a threshold frequency of 1×10^{9} MHz.* *A. 4.1 eV* *B. 4.1 MeV* *C. 3.9 eV* *D. 3.9 MeV*	

15. *A transformer has 1000 windings on the primary coil and 200 windings on the secondary coil.*

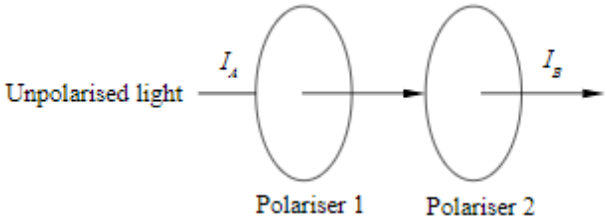


The primary voltage is 240 V, with a primary current of 10.0 A. The secondary current is 44.0 A.

What is the efficiency and type of this transformer?

	Efficiency	***Type***
A.	*23%*	*Step-up*
B.	*44%*	*Step-up*
C.	*20%*	*Step-down*
D.	*88%*	*Step-down*

16. *Unpolarised light passes through two consecutive polarisers as shown. I_A is the intensity of the unpolarised light, and I_B is the intensity of light after polariser 2.*



The value of I_B: I_A is 0.375.

What is the angle between the transmission axis of polariser 1 and polariser 2?

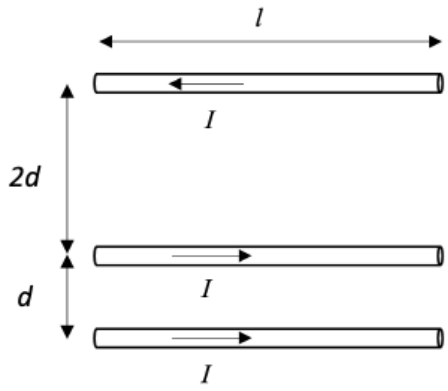
A. *30°*

B. *41°*

C. *52°*

D. *64°*

17. *Three equal length (l) straight conductors, each carrying equal current I, are placed parallel as shown. The middle straight conductor is placed 2d and d units from the top and bottom conductors respectively.*



The expression for the magnitude of the net force acting on the middle conductor is:

A. $\frac{lkI^2}{2d}$

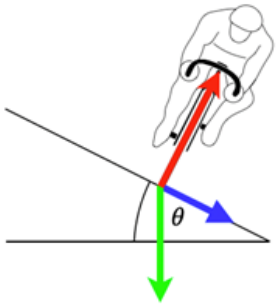
B. $\frac{2lkI^2}{d}$

C. $\frac{3lkI^2}{2d}$

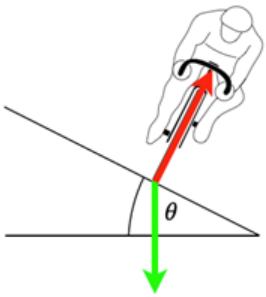
D. $\frac{lkI^2}{d}$

18. *A cyclist is riding around a corner on a banked track. He is travelling faster than the design speed of the bank. Which of the following vector diagrams illustrates the forces acting on the cyclist?*

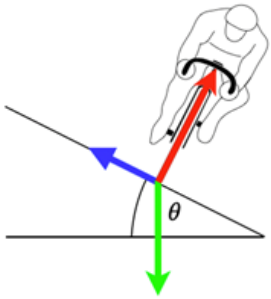
A.



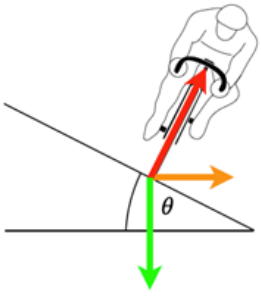
B.



C.



D.



19. *A large warehouse ceiling fan has blades 1.5 m in length that rotate so the tip of the blade travels a distance of 2.5 m in 0.5 s. At what angular velocity does the turbine rotate?*

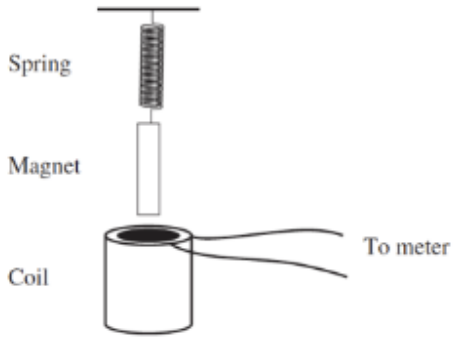
A. $72^\circ s^{-1}$

B. $92^\circ s^{-1}$

C. $120^\circ s^{-1}$

D. $191^\circ s^{-1}$

20. *A student is investigating electromagnetic induction using a bar magnet hanging from a spring that is fixed to the ceiling as shown.*



The bar magnet is pulled down so that it is inside the solenoid, and then released. The student noted that when the solenoid is connected to an ammeter, the bar magnet comes to rest more quickly than when it is connected to a voltmeter.

Which statement best explains this observation?

A. *The induced emf from the voltmeter keeps the magnet moving.*

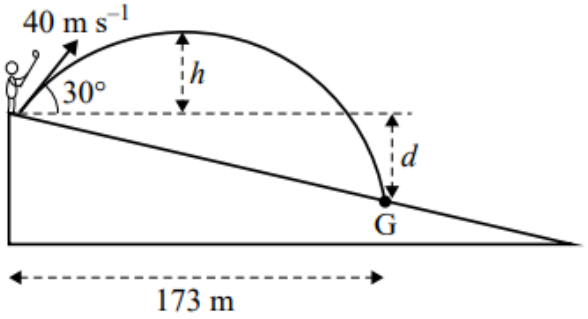
B. *The induced emf from the ammeter opposes the magnet's movement.*

C. *The voltmeter has a greater electrical resistance than the ammeter.*

D. *The magnitude of induced emf is greater when the coil is connected to an ammeter.*

PART B: Longer Answers (80 marks)

21. *A golfer hits a ball on a part of a golf course that is sloping downwards away from him, as shown below.*



The golfer hits the ball at a speed of 40 m.s^{-1} and at an angle of 30° to the horizontal.

a. Calculate the maximum height, h, that the ball rises above its initial position. **2**

2 mark answer

1 mark relevant formula

This was mostly done ok

$u_v = 40\sin 30 = 20 \text{ m s}^{-1}$

$v^2 = u^2 + 2ax$

$0 = 20^2 + 2 \times (-10) \times x$

$x = 20 \text{ m}$

The ball lands at a point at a horizontal distance of 173 m from the hitting-off point, as shown above.

b. Calculate the vertical drop, d, from the hitting-off point to the landing point, G. **3**

3 mark answer

-1 mark for error

Many students did not realise to use the total time of flight to find the vertical displacement of d. Marks were given where there were steps towards a correct solution

$t = \frac{x}{v} = \frac{173}{40\cos 30} = 5.0 \text{ sec}$

Step two was to use this time to calculate the final displacement:

$x_v = u_v t + \frac{1}{2}at^2$

$x = (20 \times 5) + (0.5 \times -10 \times 25)$

$x = -25 \text{ m}$

22. *Students have a model that can be used as a motor or generator, depending on the connections used. The magnets provide a uniform magnetic field of 2.0×10^{-3} T. EFGH is a square coil of each side length 4.0 cm with 10 turns. A 6.0 V battery and an ammeter are connected to the shaft through a commutator.*

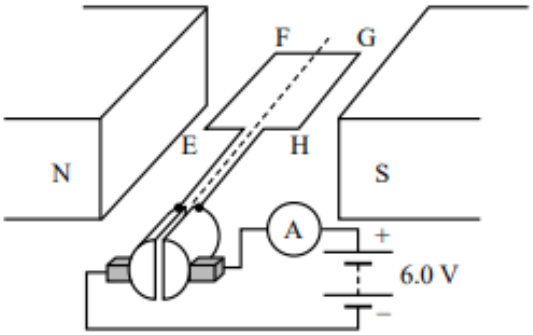


Diagram 1

a. The ammeter shows a current of 4.0 A. With the coil horizontal as shown in Diagram 1, what is the force on the side EF? Give the magnitude and direction (up, down, left, right) of the force. **2**

.....The force was found using:

.....$F = nBIl$

.....$F = 10 \times (2 \times 10^{-3}) \times 4.0 \times 0.04$

.....$F = 3.2 \times 10^{-3}$ N

The direction was given by the right-hand slap rule (or equivalent), which was **up**.

2 mark magnitude and direction

-1 mark for an error

This was done well apart from forgetting there are 10 turns

The model is now set up as a DC generator, with the output connected to a voltmeter and oscilloscope via a commutator, as shown in Diagram 2, with the same coil of side length 4.0 cm and 10 turns, and a uniform magnetic field of 2.0×10^{-3} T. The shaft is rotated by hand.

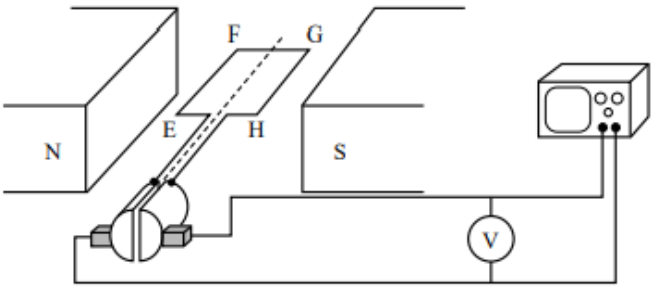


Diagram 2

b. The shaft and coil make two complete revolutions per second. Calculate the magnitude of the average voltage as shown on the voltmeter during one-quarter revolution. **2**

Calculation of EMF is done using Faraday's law:

... $EMF = \dfrac{n \times B \times A}{t}$

... $EMF = \dfrac{10 \times (2 \times 10^{-3}) \times (0.04)^2}{0.125}$

... $EMF = 0.26$ mV

2 marks answer

-1 mark for an error

Many students did not use the correct formula to calculate EMF.

Marks were given for using correct formula and working towards a correct solution. Many students also did not account for 10 turns

Question 22 continu

c. The students wish to convert this DC generator into an AC generator. Identify the change or changes the student would have to make to achieve this. Justify your answer. **2**

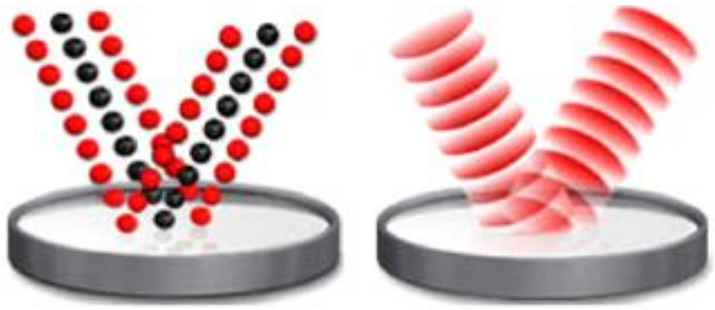
2 marks: identifies slip ring and justifies

1 mark: missing one of the above

The student would need to replace the split-ring commutator with slip rings. The slip rings would maintain a constant connection throughout the rotation of the armature and the rotating armature would generate an ac current as it rotates within the magnetic field.

This was mostly done ok. However, some students spoke about motors not generators. An answer must explain that a constant connection is maintained through replacing split ring with slip rings.

23. *The diagram shows two different models of light that were around in the late 1600s.*



a. Which of these models was proposed by Newton? **1**

1 mark: Model 1

b. With reference to general characteristics of scientific models, why was Newton's model rejected in favour of the model proposed by Huygens? **2**

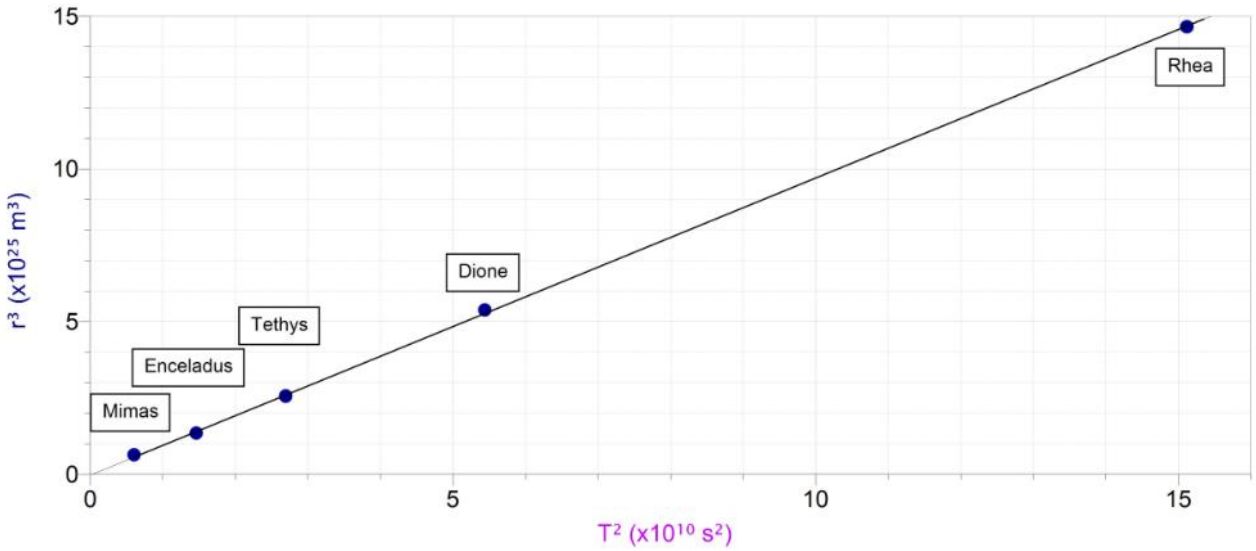
2 marks: identifies scientific models can predict/explain observations and then links this to double slit experiment

1 mark: missing one of the above.

Models must be able to predict/explain scientific observations. Newtons model could not explain diffraction of light and the results of Young's Double slit experiment. However, Huygens model could.

This was done ok, There must be a mention of young's double slit experiment and how newtons model could not explain this.

24. *The figure below shows a graph of the orbital radius cubed of the inner moons of Saturn plotted against their orbital period squared.*



a. Identify which of Kepler's laws of planetary motion is supported by the data shown in the graph. **1**

1 mark: Keplers 3rd Law

b. Use the line of best fit provided in the graph to show that the mass of Saturn is 5.7 x 10^{26} kg. **3**

Criteria	Marks
Answer: Correctly calculates the gradient of the line of best fit and uses this to calculate the correct mass of Saturn	3
Uses a correct approach to calculate the gradient and a correct approach to calculate the mass of Saturn but makes a calculation error or misses the exponents in the calculation of the gradient	2
Demonstrates an understanding of the correct approach but makes more than one error	1

Sample answer:
The gradient of the graph is:

$$gradient = \frac{(13.5-1)\times 10^{25}}{(14-1)\times 10^{10}} = 9.6\times 10^{14} m^3 s^{-2}$$

The mass of Saturn is given by rearranging Kepler's 3rd law to make M the subject:

$$M = \frac{r^3}{T^2}\frac{4\pi^2}{G} = 9.6\times 10^{14}\times\frac{4\times\pi}{6.67\times 10^{-11}} = 5.7\times 10^{26}\text{kg}$$

Marks were lost if the gradient was not calculated correctly. This includes not having two data points each for rise and run.

The equations needs to be correctly arranged for r^3/T^2 and gradient substituted in.

c. Calculate the escape velocity of a 50 000 kg rocket on the surface of Saturn if the radius of Saturn is 5.8 x 10^7 m. **2**

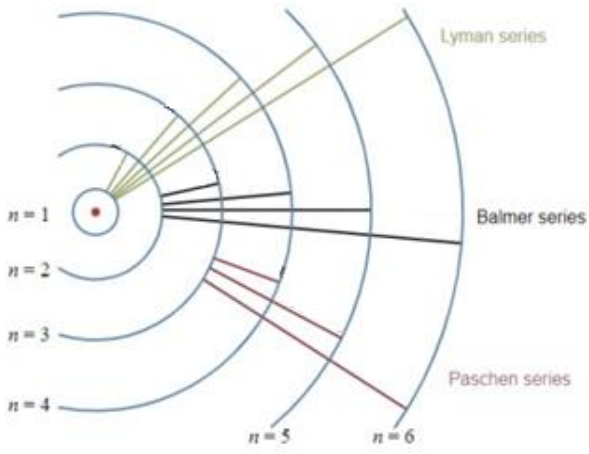
2 marks: answer

1 mark: escape velocity formula

3.6 x 10^4m/s

Sometimes incorrect formula was used.

25. *Below is a diagram of Bohr's model of the atom showing the different series of electron transitions within a hydrogen.*



a. Identify which series is responsible for producing electromagnetic radiation with wavelengths greater than visible light. **1**

1 mark: Paschen Series

Many students interpreted a wavelength greater than visible light as having more energy. Remember Greater wavelength, lower frequency.

b. Calculate the frequency of photons emitted when electrons move from $n_i = 3$ to $n_f = 2$ orbit. **2**

2 marks correct answer

1 mark: relevant formula

4.57×10^{14} Hz

Remember to calculate frequency correctly. Errors were made in substitution and not calculating frequency correctly

c. Describe a limitation of this model of the atom. **2**

2 marks: Identifies and then describes limitation

1 mark: description is lacking details

Bohr's model combines principles from both classical and quantum physics. Circular motion of electrons is from classical physics while the quantisation of its momentum and energy of orbits is from quantum physics.

Bohr does not provide an explanation to 'stationary states' of electrons. The model does not explain why electrons can remain in their orbits without spiralling into the nucleus due to electrostatic attraction.

Predictions made by Bohr's model is only accurate for the hydrogen atom. The accuracy decreases as the effective nuclear charge of an atom or ion increases

Mostly done fine.

26. *A muon is an elementary particle produced from cosmic radiation and found in Earth's atmosphere. The average altitude at which muons are created is 15 km above surface of Earth.*

Additional information about muons can be found in the table below.

Particle Class	Lepton
Mass (kg)	1.88×10^{-28}
Charge (C)	-1.602×10^{-19}
Mean Life Time (μs)	2.2

a. Calculate the average gravitational potential energy of a muon at 15 km above surface of Earth. **2**

$$U = -\frac{(6.67 \times 10^{-11})(6.0 \times 10^{24})(1.88 \times 10^{-28})}{(6371000 + 15000)}$$

2 marks: Answer with units

1 mark: Answer without units

-1.18 x 10^{-20} J

For full marks answer must have units

b. Determine the work done by gravity on a muon that descends from 15 km to an altitude of 10 km above surface of Earth. **2**

2 marks: correct answer

1 mark: relevant formula

-9.23 x 10^{-24} J

Results were mixed, make sure to correctly calculate the difference in energy

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

$$W = -\frac{(6.67 \times 10^{-11})(6.0 \times 10^{24})(1.88 \times 10^{-28})}{(6371000 + 10000)} - U_{initial}$$

Classical physics assumes that regardless of their velocity, muons cannot cover long distances due to their short lifetime.

c. Explain from the muon's perspective why they are detected on the surface of Earth. **2**

2 marks: explanation includes length contraction, relativistic speeds, and reference to muons lifetime

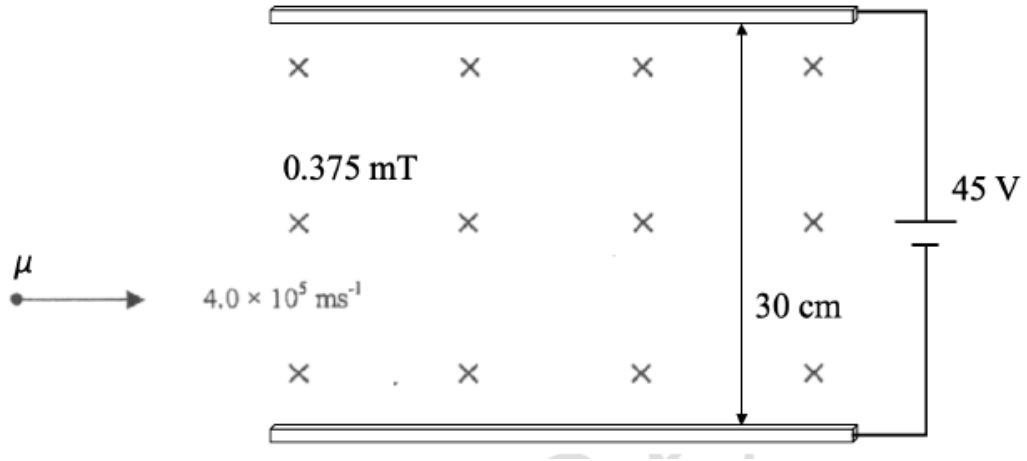
1 mark: Explanation lacks one of the above

As muons move at relativistic speeds, length contraction occurs in space in the direction of their velocity. This means that the distance they must travel to the surface of the earth has contacted and becomes smaller allowing them to reach the earth's surface despite their short lifetimes.

This was done ok.

Question 26 continues on the next page.

Suppose that a muon is subject to a magnetic and electric field as shown. The magnetic field strength is 0.375 mT. The electric field is created by a pair of parallel metal plates 30 cm apart and connected to a potential difference of 45 V.



The muon (μ) enters the magnetic and electric field at 4.0 x 10^5 ms^{-1}. Assume gravity is negligible.

d. Analyse the path of the muon as it travels through these two fields. Include calculations in your response. **4**

4 marks: Calculations for the force due to electric field, magnetic field, showing they are equal and stating the particle will travel in a straight line.

-1 mark for each of the above which are not addressed.

A muon is negatively charged which means its experiences an electric force in the **upward direction** towards the positively charged metal plate.

$$F = qE$$

$$F = (-1.602 \times 10^{-19})\left(\frac{45}{0.3}\right)$$

$$F = -2.403 \times 10^{-17}\ N$$

$$F_e = 2.403 \times 10^{-17}\ N\ upwards$$

Additionally, the muon is subject to magnetic force which acts **downwards** upon its entry.

$$F = qvB\sin\theta$$

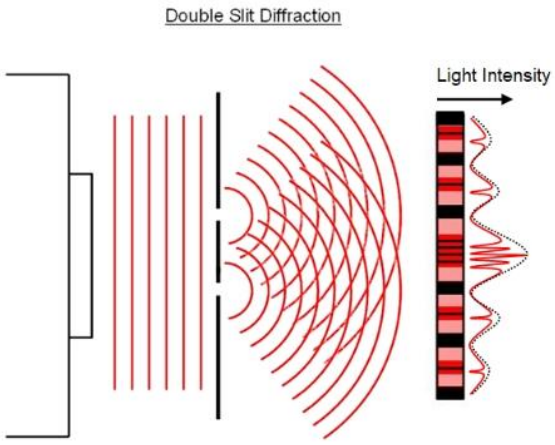
$$F = (-1.602 \times 10^{-19})(4.0 \times 10^{5})(0.375 \times 10^{-3})\sin 90°$$

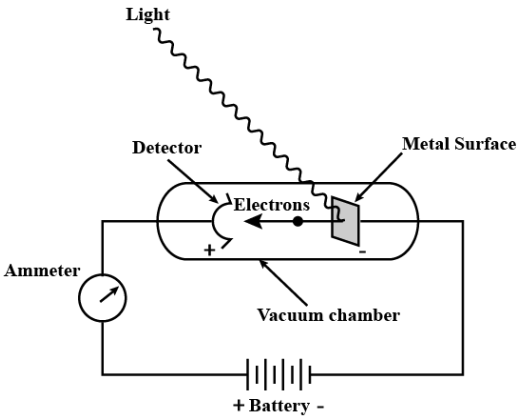
$$F = -2.403 \times 10^{-17}\ N$$

$$F_m = 2.403 \times 10^{-17}\ N\ upwards$$

Thus, the muon experiences two forces of equal magnitude in two opposite direction. The net force is zero which means it passes through two fields in a straight line undeflected.

27. *Outline an investigation that could be conducted to calculate the wavelength of monochromatic light emitted by a laser. Ensure that the investigation is valid by accounting for sources of error in your experimental design. Support your response with a diagram.* **4**





	Mark
Student outlines experiment including the following: • *Outlines how experiment is conducted* • *Outlines how results are gathered and wavelength calculated* • *2 sources of error accounted for* • *Diagram is relevant and supports experimental procedure*	*4*
Missing 1 of the above	*3*
Missing 2 of the above	*2*
Provides relevant information	*1*

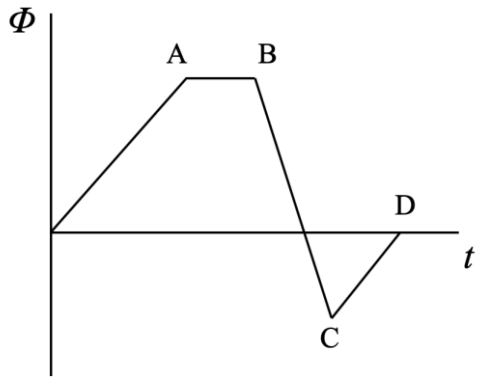
Students could use double slit or photoelectric effect.

A laser was set up so that it's emitted light was directed through a double slit apparatus. This was cause diffraction to occur between the wavelengths of light passing through the slits. The resulting interference pattern would be established on a screen some distance (L) from the slits. Bright bands would form from constructive interference and dark bands would form from destructive interference. Students would then measure the distance from the central maxima to the first order maxima. They could then use the formula mλ = dx/L to find the wavelength of the laser. The students would need to measure the distance between the slits (d), the distance between bright spots (x) and the distance from the slits to the interference pattern (L).

Some sources of error for the investigation include:

- *Ensuring that L is large enough to create a clear interference pattern and minimise measurement error.*
- *Using a precise measuring instrument to measure from the centre of each maxima (for x)*
- *Ensure that d is small enough to cause diffraction or using a diffraction grating to produce a clear interference pattern.*

28. *The change in magnetic flux with time generated by the primary coil of a faulty transformer is shown below. A, B, C and D represent specific time points during this change.*



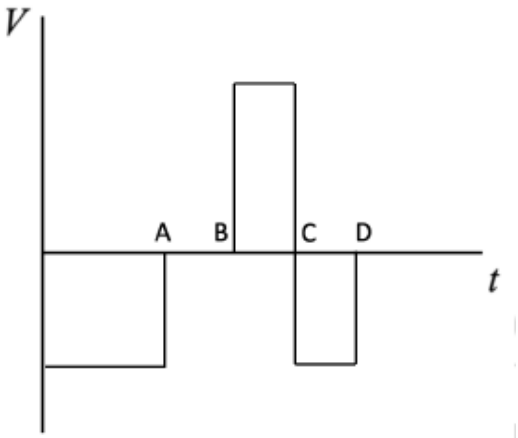
a. On the graph below, show how the secondary voltage of the same transformer changes with time. On your graph, clearly indicate time points A, B, C and D. **2**

2 marks: correct answer

-1 per error

Common errors: change of flux direction would mean a change direction for induced emf.

Gradient reflects emf magnitude.



b. Describe ONE way energy is lost in a transformer and how these losses are commonly reduced. **2**

2 marks: Describes how energy is lost AND how it is reduced

1 mark: Describes how energy is lost OR how it is reduced.

The changing magnetic field, created by AC in the primary coil, induces eddy currents in the iron core because of Faradays law. These eddy currents transform electrical energy into heat and results in power lose ($P_{loss} = I^2 R$). This is often reduced through lamination of the iron core which involved separating the core into thin layers and inserting insulation in between. This reduces the size of eddy currents induced and the amount of electrical energy converted into heat.

Some students created more than 1 energy loss. If the question states "One" then only the first response is considered.

Some students lacked the correct terminology – eddy currents, insulation, reduced surface area, heat.

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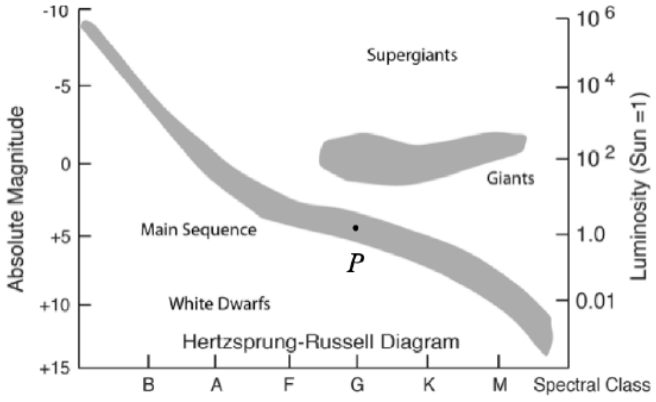
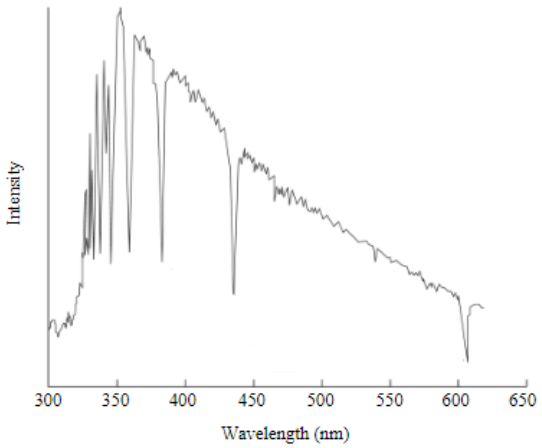
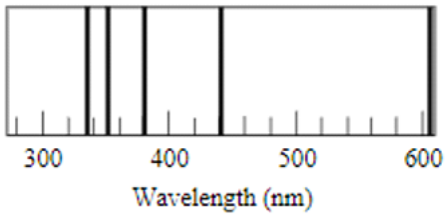
29. *A Hertzsprung–Russell diagram is shown below (left). Point P indicates a particular star in the Milky Way galaxy. The second diagram below (right) shows the spectrum of radiation emitted from star P.*



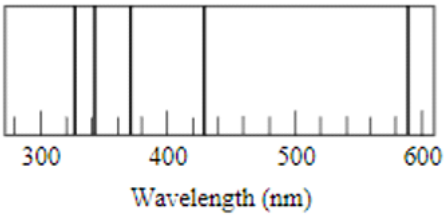


Below are two absorption spectra, one from star P and one from a laboratory.

Absorption Spectrum of Star P



Absoprtion Spectrum of an Element from a Laboratory



a. Describe what the absorption spectra reveal about the motion of star P. **2**

1 mark identify translational and rotational

2 marks Description.

The absorption spectrum of star P are thickened which means that Star P must have rotational velocity. The absorption spectrum is also red shifted meaning the Star has translational velocity away from the Earth.

1 mark explains 1 change to the absorption spectra

2 marks : explains at least 2 changes to the absorption spectra

b. De... e next **2**

P is currently a Main sequence star, which will evolve into a Red Giant. As the star expands into a red giant, its surface temperature and atmospheric density decrease due to a drastic increase in radius. A reduction in surface temperature will increase the dominant wavelength present in the absorption spectra (λmax = b/T). A reduction in density will cause the absorption lines to become thinner than before.

Other changes include: Red giants are more luminous which means the overall intensity of P's spectrum will increase. During the transition into a red giant, P may change spectral class which means some absorption lines disappear or decrease in intensity and new ones may appear. Red giants fuse heavier elements and so the elements present in the absorption spectra will change.

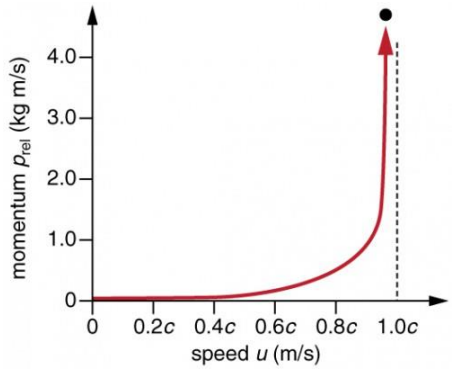
Many students did not make the link between a red giant and the absorption spectra changes that would occur.

c. *Explain why there are relatively fewer Main Sequence stars in spectral classes B and A.* **3**

Spectral Class B and A have higher core temperatures compared to the rest of the group. This means the CNO cycle is the predominant process for energy production which consumes hydrogen at a much greater rate than the proton-proton chain. As a result, Main Sequence stars in classes A and B transition into Red Giants more rapidly.

Did not accept "less likely to form" as this was not covered in the syllabus. Answers were awarded for recognising the fusion processes in high mass stars.

30. *As a spacecraft approaches the speed of light, the extra momentum provided by the thrust from its propulsion system results in very little increase in speed. The relationship between the spacecrafts momentum and speed is depicted in the diagram below.* **3**



With reference to appropriate mathematical relationships, explain this apparent discrepancy in Newtonian physics theory.

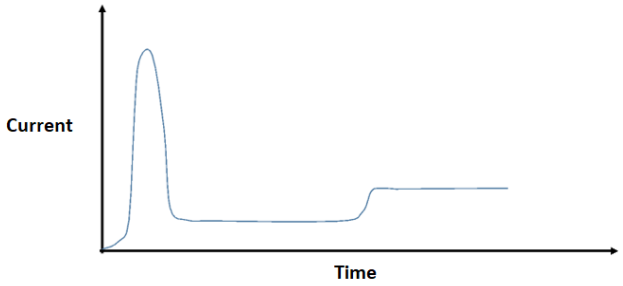
Criteria	***Mark***
Student explains discrepancy including the following: • *Clearing links extra momentum to mass increase* • *Reference to classical and relativistic momentum formulas* • *Objects would require infinite energy to travel at the speed of light* • *Described Newtonian physics*	*3*
Missing 1 of the above	*2*
Provides 1 of the above	*1*

When a propulsion system imparts extra momentum to an object, its mass increases due to mass dilation resulting from relativistic speeds. While classical physics follows a straightforward linear relationship between momentum and velocity (p = mv), special relativity introduces a more complex formula for relativistic momentum $p_v = \frac{m_0 v}{\sqrt{\left(1-\frac{v^2}{c^2}\right)}}$. This formula reveals that as an object approaches the speed of light, its mass increases significantly. Consequently, the amount of energy required to further accelerate the object also increases, approaching infinity as the speed of light is approached. This fundamental change in behaviour prevents any massive object from achieving or surpassing the speed of light, in stark contrast to the predictions of classical

31. *A student investigated how the current passing through an electric drill varied when it was turned on and then used to drill a hole. The student used a battery-operated electric drill and connected it to an ammeter to measure the current in the rotor.*

When the drill was switched on, the current rapidly increased to 5.5 A and then reduced quickly to a steady value of 0.9 A. The drill was then used to drill a hole, placing a load on the motor. The current went up to 2.1 A while it was drilling.

The student then created a current vs time graph using the data they collected.



Explain the variations in current.

Criteria	***Mark***
Student explains variations including the following: • *Initial increase before back emf* • *Constant current when voltage and back emf are balanced* • *Increase in current following reduction in motor speed and back emf*	*3*
Missing 1 of the above	*2*
Provides 1 of the above	*1*

The current initially increases to a maximum as the motor is turned on and before the rotor begins to spin. As the rotor begins to spin it will cause a change in flux in the armature resulting in back emf and a decrease in current. When the back emf and supply voltage are balanced the current remains constant. When the drill is used and the rotor velocity decreases, so too does the back emf and this results in an increase in current.

This question is an application of motors and is about back emf. All 3 changes are due to changes in motor speed, changes in flux and the resulting back emf reducing current flow.

3

32. *Compare the spectra produced by discharge tubes and incandescent light bulbs.*

1 mark states a spectra feature of one

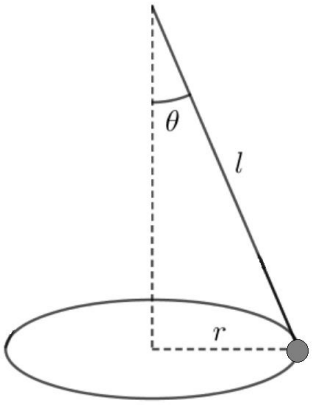
2 marks a spectra feature of each.

Discharge tubes produce discontinuous spectra whilst incandescent light bulbs produce continuous spectra.

Students are advised to use the terms continuous and discontinuous when commenting on spectra.

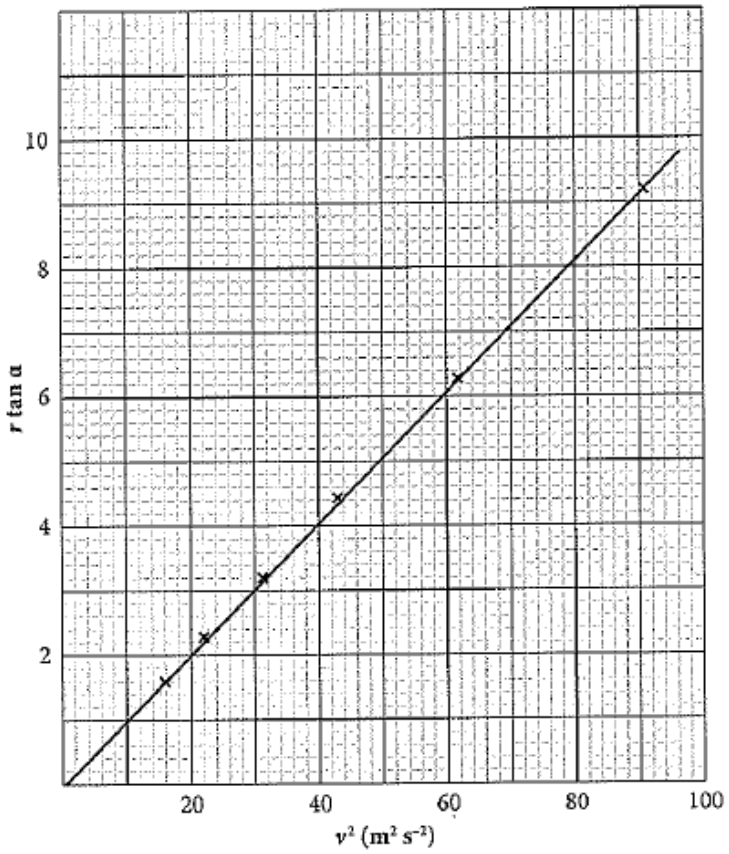
2

33. *A ball moves in a circular path at the end of a string, forming a conical pendulum, as shown in the diagram below (left). A student found that if the speed of the ball varies, the angle (θ) changes. Some experimental values are recorded in the table below (right).*



Velocity^2 (m.s^{-1})^2	r tan (θ)
15.75	1.59
22.56	2.28
31.33	3.20
43.68	4.45
61.75	6.25
90.73	9.23

a. Draw a graph showing the relationship between Velocity^2 and r tan (θ).



3

3

b
c

Criteria	Mark
• Uses two points on the line to find a gradient • Uses the gradient for find acceleration due to gravity • Assesses the accracy by comparing their experimental value to the true value of 9.8	3
Missing 1 of the above	2
Provides 1 of the above	1

Because $\tan(\alpha) = \frac{\left(\frac{mv^2}{r}\right)}{mg}$; therefore, $\frac{v^2}{r\tan(\alpha)} = g$

Slope $= \frac{1}{g} = \frac{(9.0 - 1.0)}{(88 - 10)} = 0.103$; therefore, $g = 9.75\ \text{m s}^{-2}$

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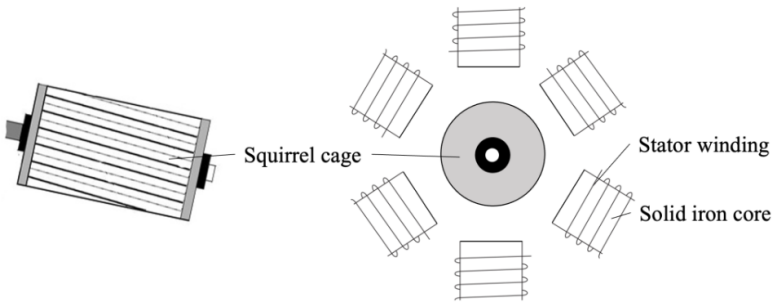
8/9/23

34. *The diagram shows an AC induction motor.*



Explain the operation of this device.

3

Criteria	***Mark***
Thoroughly explains operation of AC induction motors	*3*
Briefly explains or describes operation of AC induction motors	*2*
Correctly identifies components of its operation.	*1*

When AC is supplied to the stator winding around the iron core, a magnetic field is produced. The AC is supplied to three pairs of electromagnets in three phases such that a rotating magnetic field is created. The squirrel cage contains rotor bars that experience changes in magnetic flux due to this rotating magnetic field. By Faradays law, emf and current are induced in the rotor bares. When current flows through a rotor bar in the form of eddy currents, an electromagnetic force acts on it, The force produces torque and causes the squirrel cage to rotate in the same direction as the rotating magnetic field. OTHER INFO: The rotational speed of the squirrel cage will always be slower than the rotating magnetic field so that the squirrel cage continuously experiences a change in magnetic flux.

This was poorly answered by most of the grade and will require revision for the HSC

35. *A uranium-234 atom, initially at rest, undergoes alpha decay. The masses of the atoms involved are shown in atomic mass units (u).* **3**

$$^{234}U \rightarrow {}^{230}Th + {}^{4}He$$
$$234.0409\ u \qquad 230.0331\ u \qquad 4.0026\ u$$

The kinetic energy of Thorium-230 is

Calculate the kinetic energy of the a

Criteria	Marks
• Provides correct calculations the kinetic energy	3
• Provides the correct calculations of the mass defect in joules	2
• Provides some relevant steps	1

Sample answer:

Consider mass defect of alpha decay:

$E = mc^2$

$E = (234.0409 - 230.0331 - 4.0026)(931.5\ \text{MeV}/c^2)c^2$

$E = 4.8438$ MeV

$E = 4.8438 \times 10^6 \times 1.602 \times 10^{-19} = 7.76 \times 10^{-13}$ J

Energy is transformed into kinetic energies of ^{230}Th and alpha particle.

Kinetic energy of alpha particle = $7.76 \times 10^{-13} - 7.02 \times 10^{-15} = 7.69 \times 10^{-13}$ J.

Two methods for calculating the energy released when mass is converted to energy:

Method 1:

Convert mass to kg and use $E = mc^2$.

1 amu = $1.661 \times 10^{-27}\ kg$

Then you will have energy in Joules.

You can convert to eV by dividing by 1.602×10^{-19}.

Method 2:

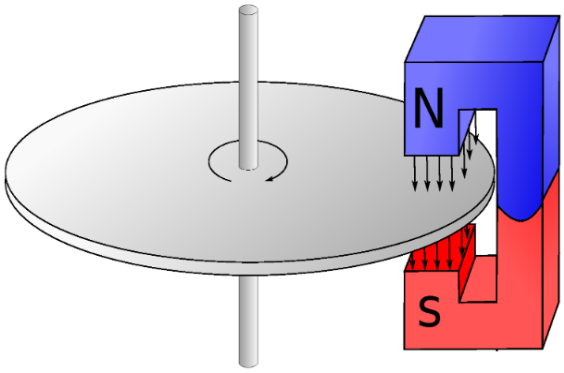
Multiply the mass in amu by $931.5\ \frac{MeV}{c^2}$.

Then you have energy in MeV.

You can convert MeV to Joules by multiplying MeV by 1×10^6 to get eV then multiplying by 1.602×10^{-19} J.

Students commonly made a mistake of using the wrong mass in $E = mc^2$. Refer to this table for how to convert masses to energy.

36. *Heavy vehicles such as trains or rollercoasters at amusement parks often use a braking system known as "Magnetic" (or "Electromagnetic") braking. Below is a diagram of a simplified magnetic brake.* **5**



Explain the physics principles underlying magnetic braking, including how conservation of energy applies to these systems.

.....

Criteria	***Mark***
Answer demonstrates thorough knowledge and understanding of the physics of electromagnetic braking and communicates this logically and effectively using correct scientific terms. Including the following: • *Links relative motion between conductor and magnetic field to production of change in flux* • *Describes Faradays Law* • *Describes Lenz's Law* • *Links the production of eddy currents to the force that slows the vehicle.* • *Describes how conservation of energy relates to this situation* • *Response is succinct.*	*5*
Four of the above (excluding succinct)	*4*
Three of the above (excluding succinct)	*3*
Two of the above (excluding succinct)	*2*
Provides relevant and correct information	*1*

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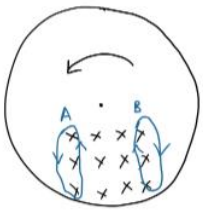


- In electromagnetic braking there is relative motion between a solid conductor (e.g. a rotating wheel) and a strong magnetic field.
- This relative motion produces a change in magnetic flux through regions of the conductor. In the case of the wheel shown below, there are two regions (A and B) in which the flux is changing.
- By Faraday's law ($\varepsilon = -\frac{\Delta\Phi}{\Delta t}$), this changing magnetic flux induces an emf, which drives an eddy current (induced current).
- The magnetic field produced by these eddy currents opposes the change in magnetic flux (Lenz's law), producing an anticlockwise current at A and a clockwise current at B.
- The part of these currents that are in the magnetic field experience a force due to the motor effect which, by the right hand rule, is in the opposite direction to the rotation of the wheel, slowing it.
- This effect can also be understood using conservation of energy (that energy is never created or destroyed, only transformed) by noting that the eddy currents dissipate electrical energy as heat in the wheel, and that this energy *must* come from the rotational energy of the wheel, causing it to slow down.

Students did not need to include eddy current direction.

Students will need to revise this concept and plan their responses before starting to write. Dot points could help students break down the steps involved:

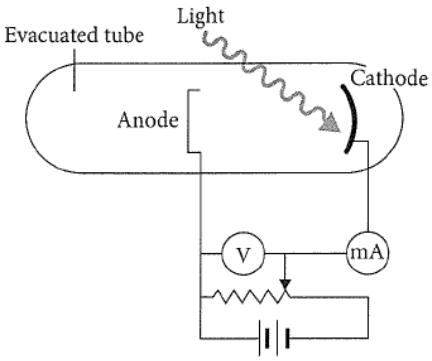
- *Relative motion and change in flux*
- *Change in flux and faradays*
- *Lenz law and force reducing change in flux*
- *Force slows wheel*
- *Kinetic energy is converted into electrical and heat energy.*

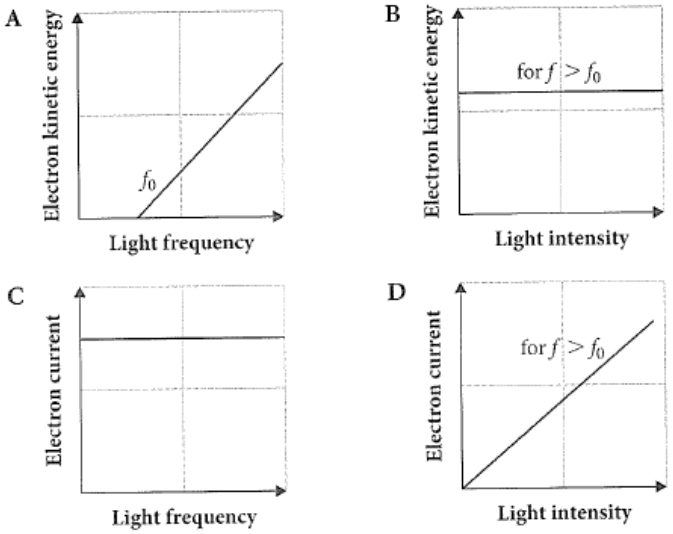
NOTE: these dot points would need to be expanded in a full response

37. *Light is shone on a phototube, as shown in the diagram below (left). The frequency is increased, and the voltage and current are monitored.* **5**

The experiment is repeated, but this time the frequency is set to the lowest frequency at which current is detected. The light intensity is then increase, and the voltage and current are monitored.

The results are shown in the graphs below (right).





Analyse the results and explain how they support the idea of the quantum nature of light.

Criteria	***Mark***
Thorough analysis of results from both experiments (IV = frequency and IV = Light intensity) and thorough explanation of a quantum model of light with reference to experimental results.	*5*
Response is lacking minimal details in analysis of results OR in explanation	*4*
Response is lacking details in analysis of results AND in explanation	*3*
Brief analysis of the experiments and description of quantum nature of light	*2*
Provides correct relevant information	*1*

See next page for sample response.

Most students answered this well but were missing an analysis of each graph and then linking the analysis to relevant equations and Einstein's photoelectric effect. Many students did not explain graph D well enough for full marks.

In Graph A, electron energy versus frequency, the frequency of light needs to be above a certain value before electrons can be ejected. Any additional frequency above this value results in an increase in electron kinetic energy. This suggests that light energy is delivered in quanta (photons). If the frequency is below the threshold frequency, it will not have enough energy to cause photoelectrons to be emitted even over time. This supports the formula k = hf – work function.

In graph B, the kinetic energy does not change as the intensity changes This is because the energy of the photoelectrons is determined by the frequency of the incident light photons according to E = hf.

Graph C shows that changing the frequency of the incident light does not change the number of photoelectrons emitted and Graph D shows that as intensity is increased, the current increases. This indicates that more electrons will be ejected with higher intensity light. This agrees with Einstein's explanation of the photoelectric effect as one photon can give its energy to one electron. As intensity of light increases, the number of photons increases which can interact with electrons, which then increases current.

The quantum nature of light is demonstrated by the fact that a minimum amount of energy is needed for photoelectrons to be emitted and only a change in frequency will affect the energy of the photons and kinetic energy of the photoelectrons. Also, the one-to-one interaction of photons and electrons reveal the particle nature of photons and is supported in graph D.

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

1 H 1.008 Hydrogen																	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	57–71 Lanthanoids	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	89–103 Actinoids	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 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

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 is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).

Task Evaluation ***Name: _____***

Total Mark: *_____ out of _____*

Mark sub-totals

Multiple choice mark: _____ out of _____

Knowledge and understanding mark: _____ out of _____

Working Scientifically mark: _____ out of _____

Circle the number that best matches. Key: 1– never 2-occasionally 3-sometimes 4-mostly 5-always

Aspect	*never*	*occasionally*	*sometimes*	*mostly*	*always*
I pay attention in class	*1*	*2*	*3*	*4*	*5*
I complete all my classwork	*1*	*2*	*3*	*4*	*5*
I ask the teacher when I need help	*1*	*2*	*3*	*4*	*5*
I make summary notes to study	*1*	*2*	*3*	*4*	*5*
I get distracted in class	*1*	*2*	*3*	*4*	*5*
I keep my OneNote book up to date	*1*	*2*	*3*	*4*	*5*
I provide sufficient detail in my OneNote responses/notes	*1*	*2*	*3*	*4*	*5*
I completed past papers to prepare for the test	*1*	*2*	*3*	*4*	*5*
I can communicate my understanding in tests	*1*	*2*	*3*	*4*	*5*

Questions:

1. *Do you feel that your performance in this task represents your understanding of Science?*

   _____

2. *What does your teacher do that helps you understand in Science?*

   _____

3. *What can your teacher do to improve your understanding in Science?*

   _____

4. *What do you do to maximise your results in Science?*

   _____

5. *What could you do better/differently to improve your results in Science?*

   _____

6. *Is there anything else you want your teacher to know?*

   _____