Cheltenham Girls
High School

Student number .....
Teacher .....

2010

Higher School Certificate
Trial examination

Physics

TASK WEIGHTING: 35%

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data-sheet, formulae sheets and Periodic Table are provided at the back of this paper

Total marks – 100

Section I Pages 1 – `16

75 marks

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1 – 20
- Allow about 35 minutes for this part

Part B – 55 marks

- Attempt questions 21 – 32
- Allow about 1 hour and 40 minutes for this part

Section II Pages 17 – 20

25 marks

- Attempt Questions 33 - 37
- Allow about 45 minutes for this section

Section I - 75 marks

Part A - Multiple Choice questions - 20 marks

Attempt all questions 1 to 20

Allow about 35 minutes to complete this Part.

Select the alternative A, B, C or D, that best answers the question and indicate your choice by clearly marking your answer in the appropriate place on the Multiple Choice Answer Sheet provided.

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1. The mass of Mars is approximately 0.1 times the mass of Earth and Mars' diameter is approximately 0.5 times that of Earth.
   What is the approximate acceleration due to gravity on the surface of Mars?

   (A) $2\ ms^{-2}$
   (B) $4\ ms^{-2}$
   (C) $25\ ms^{-2}$
   (D) $50\ ms^{-2}$

2. The gravitational potential at a point P above the surface of a planet is defined as the work done per unit mass in moving a small test mass between P and another point.
   Which of the following defines this displacement?

   (A) From infinity to point P
   (B) From point P to infinity and beyond
   (C) From point P to the surface of the planet
   (D) From the surface of the planet to point P

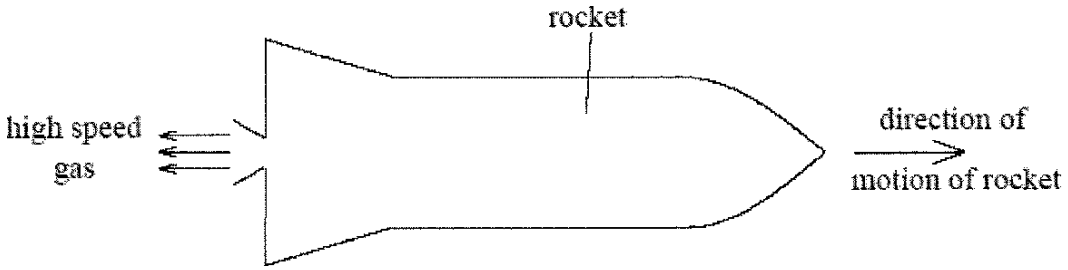
3. A satellite is placed in a circular orbit about the Earth.
   If the orbital radius of the satellite increases, what effect will this have on its kinetic energy and gravitational potential energy?

	Kinetic Energy	**Gravitational Potential Energy**
(A)	Increase	Decrease
(B)	Increase	Increase
(C)	Decrease	Decrease
(D)	Decrease	Increase

4. Planets A and B orbit the same star. The orbital radius of planet B is four times that of planet A.
Which of the following is the magnitude of the orbital period for planet B, compared to the orbital period for planet A?

(A) 4
(B) 8
(C) 16
(D) 64

5. The engine of a rocket ejects gas at high speed, as shown below.



Which statement explains why the rocket accelerates forward?

(A) The momentum of the gas is equal to the momentum of the rocket.
(B) The gas pushes on the air at the back of the rocket.
(C) The change in momentum of the gas gives rise to a force on the rocket.
(D) The ejected gas creates a region of high pressure behind the rocket.

6. Which of the following statements defines *torque?*

(A) Momentum of a rotating coil about its axis of rotation
(B) Force times parallel distance of the line of action of force from axis of rotation
(C) Force times the distance over which the force acts, measured as centrifugal momentum
(D) Force times perpendicular distance of the line of action of force from axis of rotation

7. A flat metal pendulum disc is set swinging between the poles of a horseshoe magnet, so that the plane of the disc is perpendicular to the magnetic field.
Which statement explains why the disc slows down?

(A) A back emf is set up in the disc.
(B) The magnetic field experiences a force in the opposite direction.
(C) Electromagnetic braking is occurring.
(D) Relative motion of the conductor in the magnetic field accelerates the disc.

8. Which of the following describes two advantages of generating AC current, compared to DC current?

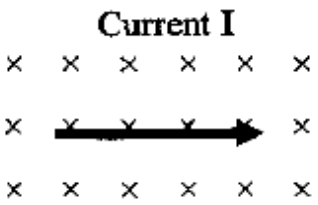
(A) AC is readily stored in batteries and runs AC motors; which are cheaper, simpler and more reliable.

(B) When transmitted, AC can use transformers to lower the voltage and uses the entire cross-section of its conducting cable; decreasing energy losses.

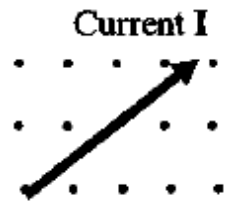
(C) AC generators are more reliable and transformers can be used to change voltage.

(D) AC runs motors which are cheaper, simpler, more reliable and uses the entire cross-section of its conducting cable; decreasing energy losses.

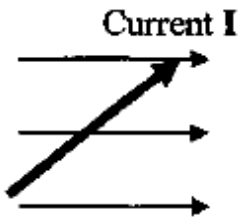
9. Three conductors are of equal length, carrying equal currents and are situated in magnetic fields of the same strength. The conductors are in different positions as shown in the following diagrams.



Magnetic field **(B)** into the page
Force on conductor= $\mathbf{F_1}$



Magnetic field **(B)** out of the page
Force on conductor= $\mathbf{F_2}$



Magnetic field **(B)** across the page
Force on conductor= $\mathbf{F_3}$

Which of the following correctly compares the magnitude of the forces FI, F2 and F3?

(A)	$\mathbf{F_1}$is greater than $\mathbf{F_3}$	$\mathbf{F_2}$ is zero
(B)	$\mathbf{F_1}$ equals $\mathbf{F_2}$	$\mathbf{F_2}$ is greater than $\mathbf{F_3}$
(C)	$\mathbf{F_1}$ is greater than $\mathbf{F_2}$	$\mathbf{F_2}$ equals $\mathbf{F_3}$
(D)	$\mathbf{F_1}$ is zero	$\mathbf{F_2}$ equals $\mathbf{F_3}$

10. What is the reason for laminating transformer cores?

(A) To increase the magnetic field passing through the core

(B) To increase eddy currents

(C) To prevent heat conduction

(D) To reduce heating effects

11. Which of the following explains why the resistance in metals increases as they are heated?

(A) Expansion of the metal

(B) Increased lattice vibration

(C) Pairing of electrons

(D) The effect of impurities

12 Which of the following is not an advantage of solid state devices, compared to thermionic state devices?

(A) Solid state devices are cheaper to manufacture.
(B) Solid state devices can be miniaturised easily.
(C) Solid state devices operate with greater reliability.
(D) Solid state devices need to heat up before operating normally.

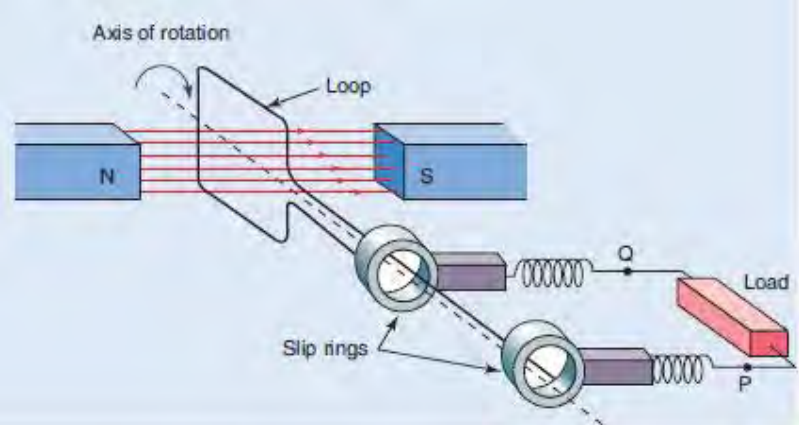
13 What is the wavelength of a quantum of radiation carrying 3×10^{-31} kJ of energy?

(A) 6.6×10^{-1} m
(B) 6.6×10^{2}m
(C) 4.5×10^{5}m
(D) 4.5×10^{8}m

14. Which of the following is not true of a satellite in a low-Earth orbit?

(A) The further from the Earth the satellite orbits, the longer its period.
(B) The satellite will start to lose altitude after some time.
(C) The satellite will slowly lose its ability to maintain a circular orbit.
(D) The satellite will have a period of about 24 hours.

15. Ellie connects a rectangular coil AC motor (with slip rings instead of a commutator) to an AC source and then to a DC source.

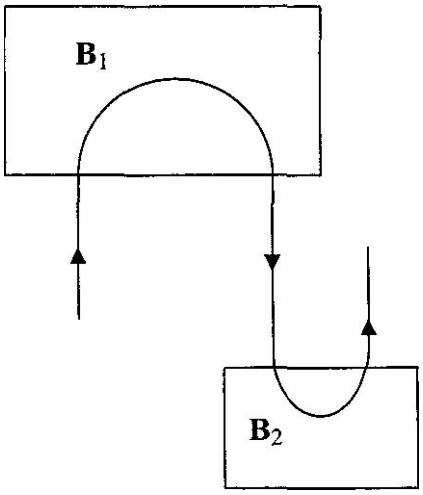


How does the response of the motor vary when comparing the AC source with the DC source?

(A) The motor will not move at all with a DC source, but will rotate continuously with an AC source;
(B) The motor will move only a little with a DC source, neither will it be able to rotate continuously with an AC source.
(C) The motor will rotate continuously with a DC source, but will only move a little with an AC source.
(D) The motor will move only a little with a DC source, but will rotate continuously with an AC source.

Use the following information to answer questions **16** and **17.**

An electron moving at speed v encounters two magnetic fields, B1 and B2. The fields are restricted to the rectangular areas shown and the electron moves in a semi-circular path through each field as indicated in the following diagram.



16. What are the directions of the magnetic fields $\mathbf{B_1}$ and $\mathbf{B_2}$?

	Magnetic field B_1	**Magnetic field B_2**
(A)	Out of the page	Into the page
(B)	Out of the page	Out of the page
(C)	Into the page	Out of the page
(D)	Into the page	Into the page

17. How does the strength of the magnetic fields $\mathbf{B_1}$ and $\mathbf{B_2}$ compare?

(A) $\mathbf{B_2}$ is stronger than $\mathbf{B_1}$.
(B) $\mathbf{B_1}$ is stronger than $\mathbf{B_2}$.
(C) $\mathbf{B_1}$ and $\mathbf{B_2}$ are equal in strength.
(D) $\mathbf{B_1}$ and $\mathbf{B_2}$ cannot be compared.

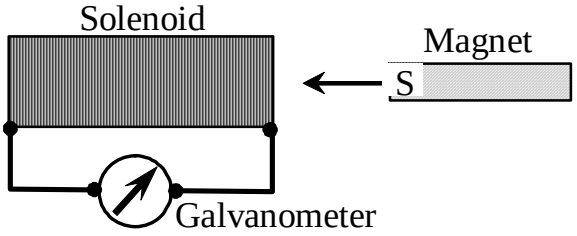
18. Two long straight current carrying conductors are set up, each carrying the same amount of current. What happens to the force on conductor X if the current in conductor Y is doubled and the distance between X and Y is halved?

(A) The force on conductor X is the same as the original amount.
(B) The force on conductor X becomes 2× the original amount.
(C) The force on conductor X becomes 4× the original amount.
(D) The force on conductor X becomes 8× the original amount.

19. A length of copper pipe is dropped from a height and falls vertically past the poles of a nearby large electromagnet, cutting magnetic flux lines. The coil current of the electromagnet is steadily increased. Which statement correctly describes how the coil current affects the moving pipe?

(A) As the coil current increases, the pipe cuts a greater amount of flux, and its rate of acceleration becomes significantly less than 9.8 ms^{-2}.
(B) As the coil current increases, the pipe cuts a greater amount of flux, and its rate of acceleration is constant at about 9.8 ms^{-2}.
(C) As the coil current increases, the pipe cuts a constant amount of flux, and its rate of acceleration is constant at about 9.8 ms^{-2}.
(D) As the coil current increases, the pipe cuts a greater amount of flux, and its rate of acceleration becomes significantly greater than 9.8 ms^{-2}.

20. Rhonda sets up the arrangement shown above, to test Faraday's experiment.



Initially she moves the south pole of a bar magnet towards the solenoid as shown, causing the needle of the galvanometer to deflect as shown. She then tests what happens as the magnet moves towards and away from the solenoid. Which one of the following tests produces a result which is opposite to that of the other three alternatives?

(A) Moving the south pole of the magnet towards the left-hand end of the solenoid.
(B) Moving the north pole of the magnet away from the right-hand end of the solenoid.
(C) Moving the north pole of the magnet away from the left-hand end of the solenoid.
(D) Moving the north pole of the magnet towards the right-hand

End of Part A

Section I -continued

Part B

Total marks (55)

Attempt questions 21 -32

Allow about 1 hour 40 minutes for this part

Answer the questions in the spaces provided. Show all relevant working in questions involving calculations.

Marks

Question 21 (4 marks)

(a) Define comprehensively Newton's *universal law of gravitation.* **2**

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(b) The average distance of Earth from the Sun is 1.5×10^{11} m. The acceleration due to the Sun's gravitational field at the Earth is 6.0×10^{3} ms^{-2} **2**
Calculate the approximate mass of the Sun.

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Question 22 (3 marks)

(a) Assume that you are inside a closed container with no windows. **2**

Identify whether it is possible to determine if the container is moving at a constant velocity or if it is stationary. State the relevant principle in Physics that justifies your answer.

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(b) Identify the name that is given to the frame of reference referred to in part (a). **1**

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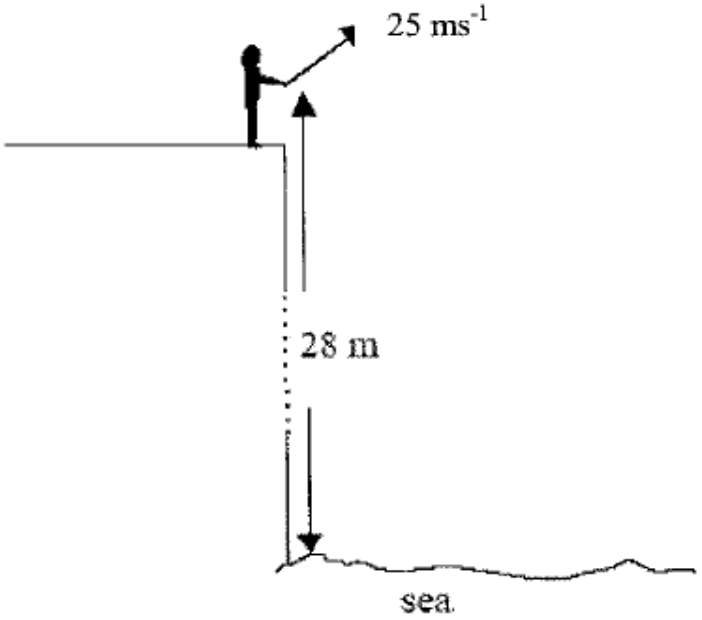
Question 23 (5 marks)

A stone is thrown from the top of a cliff at a height of 28 m above the sea. The stone is thrown at a speed of 25 ms^{-1} at an angle of 30° above the horizontal. (Air resistance is negligible.)

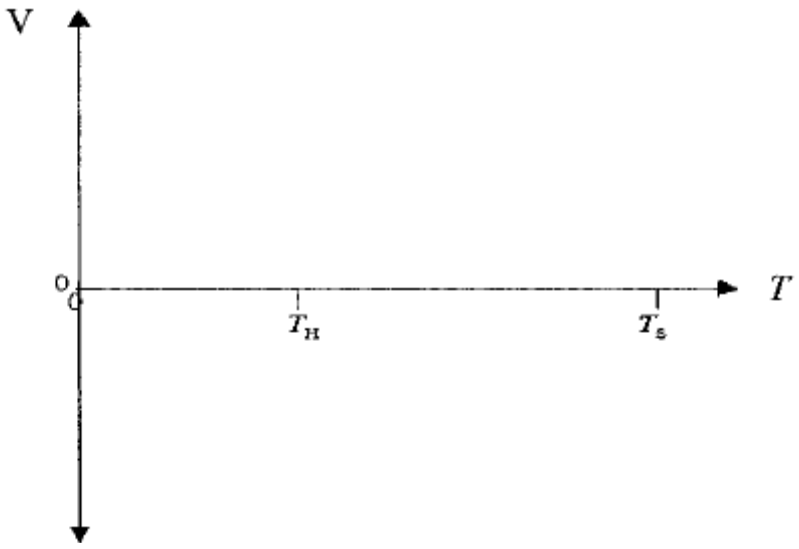
The maximum height reached by the stone from the point at which it is thrown is 8.0 m.

The stone leaves the cliff at time T = 0. It reaches its maximum height at T = T_H and strikes the sea at T = *Ts*.



Marks

(a) On the axis below, sketch a graph to show the variation in the magnitude of the vertical component of the velocity of the stone, from *T*= 0 to *T* = *Ts*. **3**



Question 23 continues on next page

(Question 23 continued) **Marks**

(b) Calculate the time *(T-total)* it will take for the stone to hit the water. **2**

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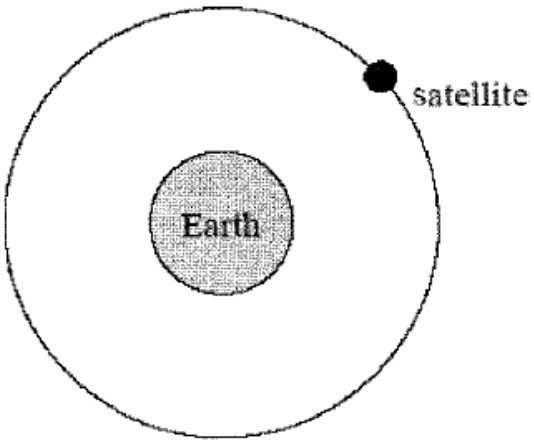
Question 24 (3 marks)

The diagram below shows a satellite in orbit about the Earth.
The diameter of the Earth is 12 560 km.

[not to scale]



(a) State the name of the force causing the satellite's acceleration and show the direction in which it acts, by drawing a vector to represent it on the above diagram. **1**

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(b) If the satellite is 20 000 km above the surface of the Earth, calculate acceleration of the satellite. **2**

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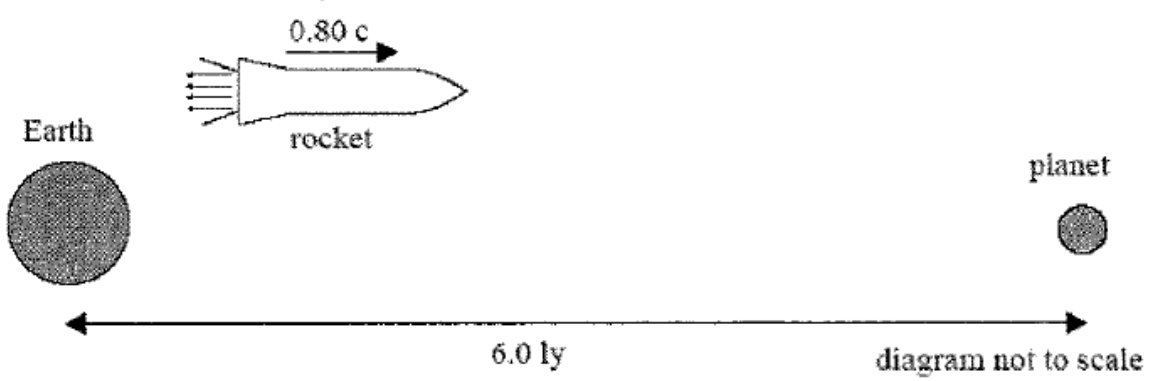
Question 25 (5 marks)

A rocket moving at 0.80 c, relative to Earth, passes the Earth on its way to a distant planet. The distance between Earth and the planet is 6.0 light years (ly) as measured by an observer on Earth.



Marks

(a) i. Calculate the duration of the journey from Earth to the planet, according to an observer on Earth. **1**

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ii. Calculate the duration of the journey from Earth to the planet, according to an observer in the space ship. **2**

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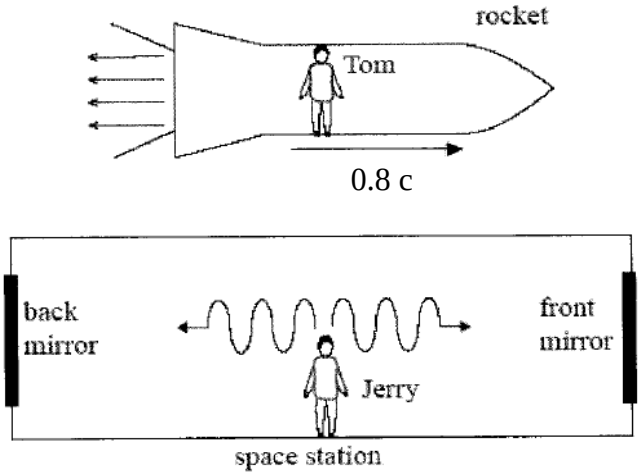
(b) Tom is an observer in a rocket that moves past a space station. Jerry is an observer in the middle of the space station. Jerry sends two light signals towards mirrors at the front and the back of the space station. The signals are emitted simultaneously according to both Tom and Jerry. The signals are reflected off the mirrors and reflected back to Jerry.

Question 25 (b) continues on next page

(Question 25 (b) continued) **Marks**



From Tom's frame of reference, determine whether the front or the back of the space station receives the signal first, or whether the signals arrive simultaneously. Justify your answer. **2**

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Question 26 (4 marks)

(a) A transformer connected to a 240V mains supply has a primary coil with 100 turns and a secondary coil with 750 turns.
Calculate the output voltage. **1**

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(b) Discuss the impact of the development of transformers on society. **3**

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Question 27 (6 marks) **Marks**

(a) Outline the basic principle of induction motors. **2**

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(b) Galvanometers and loudspeakers are both applications of the motor effect, and a moveable coil is a central part of each device.
Analyse how the motor effect is used to produce rotation of the coil in one device and vibration in the other. **4**

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Question 28 (5 marks)

(a) Justify the use of very high voltages for the transmission of electricity. **2**

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Question 28 continues on next page

(Question 28 continued) **Marks**

(b) Outline one possible reason for the limit on magnitude of the voltage used for transmission. **1**

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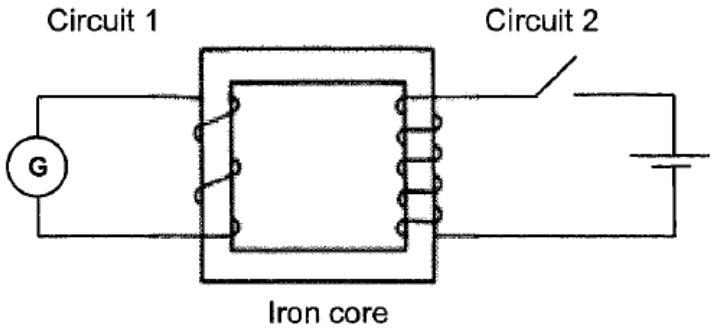
(c) In the space below, sketch TWO graphs showing the output of simple AC and DC generators. **2**

Question 29 (5 marks)

Two coils are wrapped around the opposite sides of an iron core, as shown. Circuit 1 has a galvanometer and circuit 2 has a switch and a battery.

When the switch is first closed, the galvanometer needle moves, then returns to zero.



(a) Explain the cause of the current flow in Circuit 1. **2**

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Question 29 continues on next page

(Question 29 continued) **Marks**

(b) Describe TWO changes to the apparatus that would increase the magnitude of the momentary current flow. **2**

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(c) Propose ONE change to the apparatus that would produce a continuous current in circuit 1 while the switch is held closed. **1**

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Question 30 (5 marks)

(a) Describe how p-type semiconductors are produced. **1**

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(b) Explain the change in electrical properties of p-type semiconductors, compared to electrical properties of pure semiconductors. **2**

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(c) Account for the difference in electrical resistance of conductors and insulators. **2**

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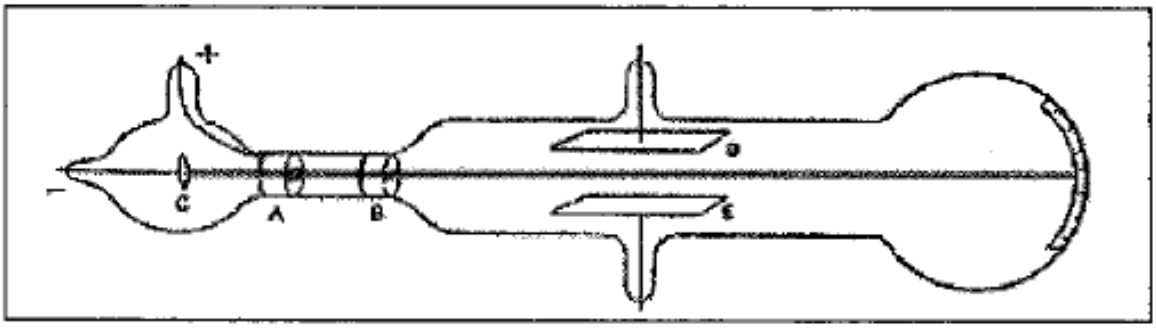
Question 31 (4 marks)

At the end of the nineteenth century, the inconsistent behaviour of cathode rays caused much debate among physicists.

The following diagram shows Thomson's original sketch of the apparatus he used to research cathode rays.



Explain how Thomson, using his apparatus, was able to settle the scientific debate about the nature of cathode rays. **4**

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Question 32 (6 marks)

Samuel Johnson (mid-eighteenth century), when asked "What is poetry?" replied: "Why, sir, it is much easier to say what it is not. We all know what light is; but it is not easy to tell what it is."

William Bragg (late-nineteenth century), when asked to explain what light is; replied that physicists use the wave theory on Monday, Wednesdays, and Fridays, and the particle theory on Tuesdays, Thursdays, and Saturdays.

Analyse the experimental AND theoretical contributions made by various scientists that resulted in the "particle model of light" referred to by William Bragg. **6**

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Section II

Total marks (25)

Attempt questions 33 -37

Allow about 45 minutes for this part

Answer the questions in the spaces provided. Show all relevant working in questions involving calculations.

Question 33 (5 marks) **Marks**

A team of NASA scientists puts a space probe on a journey to the outer planets by using the sling-shot effect around Venus.

(a) Describe how the speed of the craft relative to the planet changes as it moves towards the planet and away from the planet. **2**

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(b) A reporter at NASA writes that "The velocity of the craft relative to the planet may change but the craft cannot have more KE once it leaves the planet than it had when it was coming into the planet". Assess the validity of this claim. **3**

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Question 34 (4 marks) **Marks**

Select one of the pioneers of Space Travel, Esnault-Pelterie, Goddard, Oberth, O'Neill, Tsiolkovski, or Von Braun, and outline at least three of his contributions to space travel. **4**

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Question 35 (4 marks)

Discuss Einstein's and Planck's differing views about whether science research is removed from social and political forces. **4**

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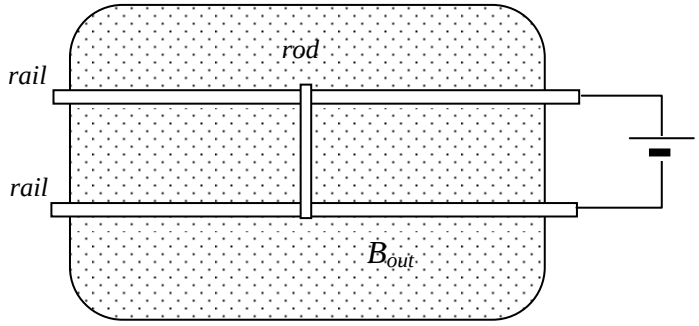
Question 36 (6 marks) **Marks**

The top view diagram below shows a 0.75 m conducting rod moving across a 0.25 T magnetic field (directed out) along two horizontal metal rails. A current flows into the rod from an external circuit powered by a 30 V battery. The electrical resistance of the system is 5.5 Ω.



(a) State the main physics principle which produces this effect. **1**

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(b) Given that V = I R, calculate the current in the rod and the force on the rod. **2**

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(c) Describe in detail the motion of the rod. **3**

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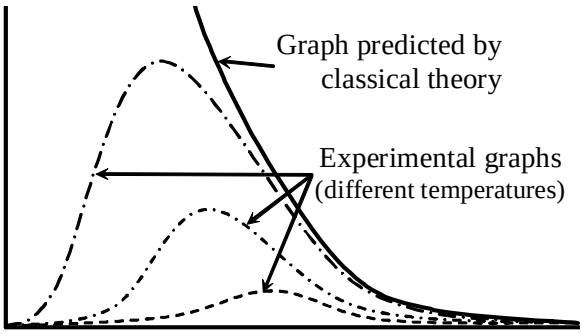
Question 37 (6 marks) **Marks**



These graphs illustrate a problem of the late 19th century, where physicists discovered there was a major variation between the theory and the experimental results.

(a) With what was this theory/experiment concerned? **1**

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(b) Identify both the axes associated with this graph. **1**

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(c) After some years without resolution, Max Planck proposed a radical explanation to the problem, which allowed the amended theory to fit experimental results. Outline Planck's proposals, and their significance. **4**

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(End of the Paper)

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 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
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}

FORMULAE SHEET

$v = f\lambda$

$I \propto \frac{1}{d^2}$

$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$

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

$R = \frac{V}{I}$

$P = VI$

Energy $= VIt$

$v_{av} = \frac{\Delta r}{\Delta t}$

$a_{av} = \frac{\Delta v}{\Delta t}$ therefore $a_{av} = \frac{v-u}{t}$

$\Sigma F = ma$

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

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

$W = Fs$

$p = mv$

Impulse $= Ft$

$E_p = -G\frac{m_1 m_2}{r}$

$F = mg$

$v_x^2 = u_x^2$

$v = u + at$

$v_y^2 = u_y^2 + 2a_y\Delta y$

$\Delta x = u_x t$

$\Delta y = u_y t + \frac{1}{2}a_y t^2$

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

$F = \frac{Gm_1 m_2}{d^2}$

$E = mc^2$

$l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$

$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

$m_v = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

$$d = \frac{1}{p}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

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

$$A_0 = \frac{V_{\text{out}}}{V_{\text{in}}}$$

$$\frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_{\text{f}}}{R_{\text{i}}}$$

Remove and hand this Multiple Choice Answer Sheet in separately.

PERIODIC TABLE OF THE ELEMENTS

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 65.41 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 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] 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 183.8 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 [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

KEY

Atomic Number
79
Au
Symbol of element
Atomic Weight
197.0
Gold
Name of element

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] 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 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.

Cheltenham Girls High School

Year 12 Higher School Certificate Physics

Trial examination

Student name ……

Student number ……

Class …… Teacher ……

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

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A ⊗ B ⊗ (correct ↙) C ○ D ○

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

Cheltenham Girls High School

2010 HSC Physics Trail Exam

Marking Guidelines

Section I - Part A

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

Section I - Part B

21(a)

Marking Criteria	Marks
Provides comprehensive definition of Newton's law of gravitation, referring to the masses of both objects and the inverse of the square of the distance.	2
Provides an answer which leaves out one of the dependencies from (a) OR writes the correct formula.	1

Sample answer:

The gravitational force between two objects is proportional to the product of the masses of the objects and inversely proportional to the square of the distance between them.

21(b)

Marking Criteria	Marks
Accurately calculates the approximate mass of the sun.	2
Provide correct equation and substitution of values, but makes an error in the calculation.	1

Sample answer:

$a = GM/r^2$

$M = ar^2/G$

$M = 6 \times 10^3 \times (1.5 \times 10^{11})^2 \div 6.67 \times 10^{-11} = 2.0 \times 10^{36}$ kg

22(a)

Marking Criteria	Marks
Identifies and correctly states the principle of relativity.	2
Provides answer which clearly states that no experiment can be done to determine the state of constant motion of the container without reference to outside the container OR correctly identifies the principle of relativity.	1

Sample answer:

According to the Principle of relativity, no experiment can be done to determine the state of constant motion of the container without reference to some point or object outside the container.

22(b)

Marking Criterion	Marks
Accurately identifies the name given to the frame of reference referred to in part	1

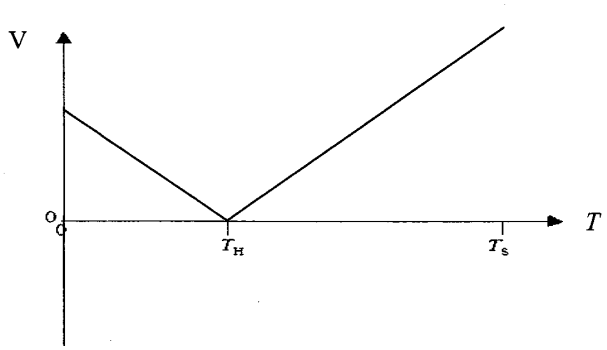
Sample answer:

Inertial frame of reference.

23(a)

Marking Criteria	Marks
Provides correct answer which shows the final speed is greater than initial speed, magnitude is zero at T H, and one gradient = -gradient of the other.	2-3
Provides an answer with two of the above requirements.	1

Sample answers:



23(b)

Marking Criteria	Marks
Accurately calculates the time it takes for the stone to hit the water.	2
Provides correct formula or other method but makes numerical or one substitution error in calculating answer.	1

Sample answer:

$T_{total} = T_S = T_H + T_{HS} = v \sin 30°/g + \sqrt{(2h/g)}$

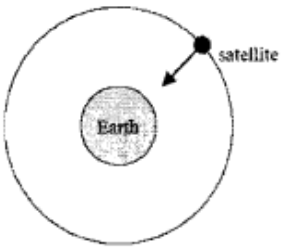
$T_{total} = 25 \times ½ \div 9.8 + \sqrt{\{2 \times (8 + 28) \div 9.8\}} = 4.0$ s

24(a)

Marking Criteria	Marks
Provides the correct force name AND correct vector addition to the diagram.	1

Sample answer:

Centripetal force or gravitational force



24(b)

Marking Criteria	Marks
Provides the correct answer	2
Provides correct formula or other method but makes numerical or one substitution error in calculating answer	1

Sample answer:

$a = GM_E/r^2 = 6.67 \times 10^{-11} \times 6 \times 10^{24} \div [(6280 + 20000) \times 10^3]^2 = 0.58\ ms^{-2}$

25(a) i

Marking Criteria	Marks
Correctly calculates the time for the journey from the Earth frame of reference	1

Sample answer: $t = d/v = 6\ ly \div 0.8\ c = 7.5$ years

25(a) ii

Marking Criteria	Marks
Accurately calculates the duration of the journey from the space ships frame of reference.	2
Provides correct formulae or attempts to calculate time dilation or length contraction with subsequent time calculation, but makes error in processing.	1

Sample answer:

$\ell = \ell o \sqrt{(1 - v^2/c^2)} = 6 \times \sqrt{[1 - (0.8c)^2/c^2]} = 3.6\ ly$

$t = d/v = 3.6\ ly \div 0.8\ c = 4.5$ years

25(b)

Marking Criteria	Marks
Provides correct answer and justification.	2
Provides correct answer but incorrect or no justification.	1

Sample answer:

From Tom's point of view both Signals travel at the same speed (and have been emitted simultaneously); so since the front of the station moves towards the signal (relative to Tom), Tom receives the reflected signal from the front mirror first.

26(a)

Marking Criteria	Marks
Accurately calculates the output voltage.	1

Sample answer:

$V_1/V_2 = n_1/n_2$

$240/V_2 = 100/750$

$V_2 = 1800v$

26(b)

Marking Criteria	Marks
Provides an accurate description of the impact of the development of transformers on society.	2-3
Provides some relevant information about the impact of the development of transformers on society.	1

Suggested answer:

Step-up transformers allow the transmission of electrical power while minimising energy losses and are needed in cathode ray type TVs. Step-down transformers are used to provide safe local power supply and various voltages in domestic and industrial devices. Combined with rectifying circuitry, transformers are increasingly used to charge the rechargeable batteries of many devices such as cordless drills, mobile phones and ipods.

Efficient transmission of power using transformers has allowed the development of large cities and factory locations away from power stations and the development of affordable electronic and household appliances without dependence on battery power.

27(a)

Marking Criteria	Marks
Provides an accurate outline of the basic principle of induction motors.	2
Provides some relevant information about induction motors.	1

Suggested answer:

In induction motors, a squirrel cage is surrounded by a rotating magnetic field that induces a current in the rods of the squirrel cage which then experiences a rotating force due to the magnetic field.

27(b)

Marking Criteria	Marks
Provides an accurate analysis of how the motor effect is used to produce rotation of the coil in one device and vibration in the other	3-4
Provides some relevant information about the motor effect	1-2

Suggested answer:

In galvanometers, the coil is flat, rectangular in shape and on an axis parallel to the plane of the coil. It is surrounded by a radial magnetic field of constant strength which acts perpendicular to the axis of the coil, exerting opposing forces on 2 opposite sides of the coil (the motor effect), causing a torque and rotation.

In speakers, the coil is circular and elongated. The surrounding magnetic field is radial, parallel to the plane of each turn in the coil. The motor effect results in forces perpendicular to the plane of the coil but in the same direction for each part of the circular turns of the coil. The coil then moves in the direction for the force and changes direction with changes in current direction.

28(a)

Marking Criteria	Marks
Provides an accurate justification of the use of very high voltages for the transmission of electricity.	2
Provides some relevant information about the use of high voltages for the transmission of electricity.	1

Suggested answer:

Electricity is transmitted at high voltages to reduce energy losses in transmission lines.

Power lost = I^2R where I is current flowing and R is resistance of transmission line which increases proportionally with length. This indicates that energy loss increases with distance and increases with the square of the current. Therefore it is best to transmit at low current by using the highest possible voltage. A high power transmission is still achieved as power transmitted = IV.

28(b)

Marking Criteria	Marks
Provides an outline of the reason for the limit on the magnitude of the voltage used for transmission.	1

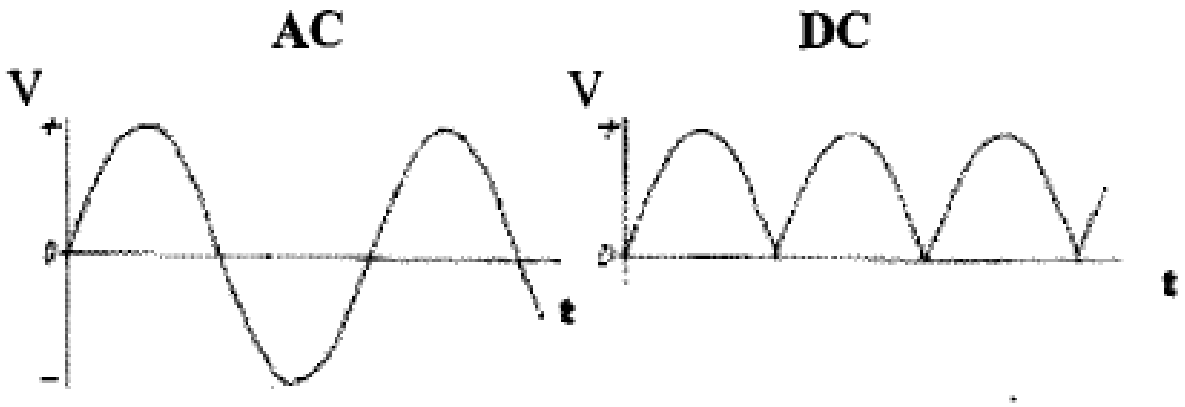
Suggested answer:

The voltage is limited as extreme voltages (above 500 kV) ionise the air and insulators are unable to prevent conduction to the ground at supports.

28(c)

Marking Criteria	Marks
Provides an accurate sketch showing the output of simple AC and DC generators.	2
Provides an accurate sketch showing the output of simple AC or DC generators	1

Suggested answer:



29(a)

Marking Criteria	Marks
Provides an accurate explanation of the cause of the current flow.	2
Provides some relevant information about the cause of current flow.	1

Suggested answer:

When the switch is closed, the current creates a magnetic field; the iron core is magnetised and coil 1 experiences a changing magnetic field which induces a current in coil 1. When the current in coil 2 reaches a steady value, the magnetic field is no longer changing and no current is induced in coil 1.

29(b)

Marking Criteria	Marks
Provides an accurate description of TWO changes to the apparatus to increase the magnitude of the momentary current flow.	2
Provides an accurate sketch description of ONE change to the apparatus to increase the magnitude of the momentary current flow.	1

Suggested answer:

Increase the voltage supplied in circuit 2, or increase the ratio of turns in coil 2 compared to coil 1.

29(c)

Marking Criteria	Marks
Proposes ONE change to the apparatus that would produce a continuous current in circuit 1 while the switch is held closed.	1

Suggested answer:

Use AC in circuit 2.

30(a)

Marking Criteria	Marks
Provides an accurate description of how p-type semiconductors are produced.	2

Suggested answer:

P-type semiconductors are produced by adding small amounts of group 3 atoms, that is, those with 3 electrons in their outermost shell (e.g. boron, gallium) to silicon.

30(b)

Marking Criteria	Marks
Provides an explanation of the change in the electrical properties of p-type semiconductors compared to the electrical properties of pure semiconductors.	2
Provides some relevant information about the electrical properties of p-type and pure semiconductors.	1

Suggested answer:

Doping a semi-conductor to make it p-type increases its conductivity. There are holes created where bonding electrons are missing. The holes are able to move through the lattice under an applied electrical field which is conduction of charge. The undoped semiconductor does not have holes and so movement of charge does not occur.

30(c)

Marking Criteria	Marks
Provides the reasons for the difference in electrical resistance of conductors and insulators.	2
Provides some relevant information about the electrical resistance of conductors and insulators.	1

Suggested answer:

In insulators, the valence band is full and there is a large gap between the valence and conduction bands preventing electrons from moving easily. In conductors, the conduction and valence bands blend into one band with many unfilled levels for electrons to move into making them mobile.

31

Marking Criteria	Marks
Provides an explanation of how Thomson was able to settle the debate about the nature of cathode rays using his apparatus.	3-4
Provides some relevant information about the nature of cathode rays.	1-2

Suggested answer:

The debate concerned whether cathode rays were negatively charged particles or electromagnetic radiation with a very short wavelength. Thomson reasoned that if the rays were charged particles, they could be deflected by both electric and magnetic fields. His experiment used both fields with the forces balanced allowing him to find a constant value of e/m for all cathode materials and firmly establishing that the rays were particles.

32

Marking Criteria	Marks
Provides an analysis of the experimental and theoretical contributions made by various scientists that resulted in the model of light referred to by Bragg.	5-6
Provides description of the experimental and theoretical contributions made by various scientists that resulted in the model of light referred to by Bragg.	3-4
Provides some relevant information about the model of light referred to by Bragg.	1-2

Suggested answer:

Explanations of the photoelectric effect were impossible with wave theory and theoretical explanations of black body radiation failed. Max Planck's concept of quanta produced a successful black body radiation theory, and Einstein used his concept to explain the photoelectric effect. Since a quantum of energy is equivalent to a particle, e-m radiation is now considered to be both particle and wave as referred to by Bragg.

Section II

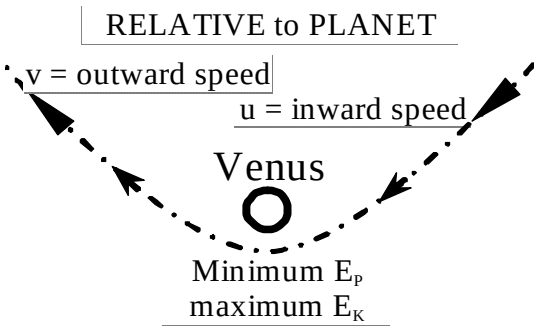
Question 33 (5 marks)

34 (a) (2 marks)

Criteria	Marks
• Correctly identifying that speed increases during approach ***and*** • Correctly identifying that speed decreases as it recedes	2
• Stating any one of the above	1

Sample answer

As the craft approaches Venus it loses more and more gravitational potential energy, which is converted into kinetic energy according to the law of Conservation of Energy – hence it goes faster until it reaches the point of closest approach. From that point the reverse occurs – the craft gains gravitational potential energy as it recedes, so it loses the same quantity of kinetic energy, thus slowing down.



33 (b) (3 marks)

Criteria	Marks
• Correctly outlines one physical principle supporting the reporter's claim • Correctly outlines one physical principle in contrary to the reporter's claim • Gives an appropriate assessment of the validity of the claim	3
• Omits only one of the above ***or*** • Merely states points supporting and opposing the claim, plus an assessment	2
• Provides one of the above	1

Sample answer

From the frame of reference of the planet the reporter's claim is correct. As shown above, the craft's path is hyperbolic, and since it starts 'at infinity' and returns there, the total energy it possesses remains unchanged. Further, the velocity of the craft changes even if its kinetic energy does not, because its direction is not the same as before. However, the planet is moving around the Sun, and hence the craft has actually gained both momentum and kinetic energy from Venus in the fly-by as viewed from any frame of reference apart from the planet. Hence, the claim by the reporter is invalid from our frame of reference, which is why craft do use the technique of gravitation-assist to change their total energy and speed.

Question 34 (4 marks)

Criteria	Marks
Outlines three or more facts on the contribution of the pioneer and relates these to space travel	4
Outlines two or more facts on the contribution of the pioneer and relates one to space travel	3
Outlines two or more facts on the contribution of the pioneer	2
A true statement about rocket history	1

Sample answer

Goddard built and launched many early experimental rockets and learned to wrap the tube carrying the liquid oxygen around the rocket motor; this not only kept the engine cool, it also meant that the oxygen arrived into the motor as a gas, ready to combust the fuel.

Goddard used liquid propellant to power his rockets. This allowed the development of modern liquid fuel rockets use in space travel.

Goddard developed stabilising gyroscopes for early experimental rockets; this allowed the development of modern gyroscope stabilised rockets used in space travel.

Question 35 (4 marks)

35 (a) (4 marks)

Criteria	Marks
• Fully discuss Einstein and Planck's differing views (at least 2 view points from each of them) about whether science research is removed from social and political forces.	4
• Partially discuss Einstein and Planck's differing views (less than 2 view points from each of them) about whether science research is removed from social and political forces.	3
• State one or two view points of Einstein and/or Planck about whether science research is removed from social and political forces.	2
• State one view point of Einstein and/or Planck about whether science research is removed from social and political forces.	1

Sample answer

Planck was a nationalist. He believed in his country and worked for his country. He was loyal to whatever the government was. When war broke out, Planck was one of the first of ninety three German intellectuals to sign a document supporting the role of Germany in the war. He devoted his work and research to whatever the war effort required of him.

Einstein was different. He had no particular politics and supported no government. He refused to sign the document supporting Germany's war effort, instead signing a different document which called for a peaceful world. He was a peacekeeper, and did not accept that his work should contribute to the killing of others.

Question 36 (6 marks)

36 (a) (1 mark)

Criteria	Mark
• Identifying the motor effect	1

Sample answer

This main physics principle involved here is the motor effect.

36 (b) (2 marks)

Criteria	Marks
• The correct formulae are given, *and values are correctly substituted*	2
• One correct formula is given, and substituted into to get an answer	1

Sample answer

$V = I \times R \quad \therefore 30 = I \times 5.5 \quad \therefore I = 5.45$ amperes

$F = B I \ell \sin\theta \quad \therefore F = 0.25 \times 5.45 \times 0.75 \times \sin 90° = 1.02$ newtons

36 (c) (3 marks)

Criteria	Marks
• The direction of the current through the rod is stated or implied • The direction of movement is stated with a correct reason • Continued acceleration is stated with correct reasoning	3
• Two of the above outcomes are achieved	2
• Any one of the above answers is correctly stated	1

Sample answer

The battery in the diagram has its positive terminal connected to the upper rail in the diagram, so current flows through the rod towards the lower rail. According to the right-hand 'slap' rule (etc), the rod experiences a force to the left ←

Also, since the force continues to be applied as long as the battery is connected to the system, the rod should continue to accelerate in that direction.

Question 37 (6 marks)

37 (a) (1 mark)

Criteria	Mark
• Identifies black-body radiation	1

Sample answer

The graph is from experiments on black-body radiation.

37 (b) (1 mark)

Criteria	Mark
• Correctly identifies both axes	1

Sample answer

One axis is wave-length, the other is intensity (or brightness, radiance, or energy released).

37 (c) (4 marks)

Criteria	Marks
• Description involving change from continuous energy amounts, energy in packets or quanta, and two significant developments	4
• Description involving change from continuous energy amounts, energy in packets or quanta, and one significant development	3
• Description involving change from continuous energy amounts, energy in packets or quanta, OR energy in packets and one significant developments	2
• One true statement about quantum theory	1

Sample answer

Planck proposed that energy is not absorbed and emitted continuously across all energies, but only in discrete amounts or packets of energy. These packets we called quanta. The significance of this is that it explained the black-body radiation curves correctly, bringing a more accurate understanding of thermodynamics. It also led to Einstein's work in identifying light quanta, and explaining the photoelectric effect.

(End of the Paper)