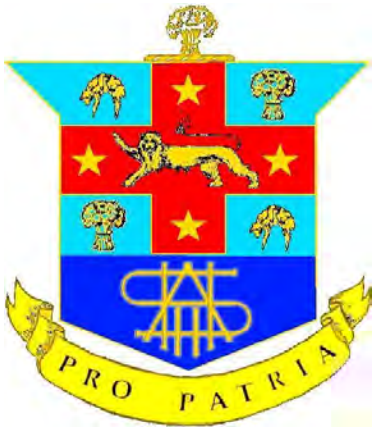


Physics

HSC Course

2010

Year 12 Trial HSC Examination

Total marks 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours

- Attempt all questions
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your I.D. number on each answer sheet
- Liquid paper must NOT be used on this paper

- For your convenience, the multiple choice answer sheet and the data sheets at the back may be removed from the rest of the paper

Total marks – 100
Section I
75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
Attempt questions 1-20 (multiple choice)
Allow about 35 minutes for this part.

Part B – 55 marks
Attempt questions 20-33
Allow about 1 hour and 40 minutes for this part

Section II – Medical Physics Module
25 marks
Attempt question 34
Allow about 45 minutes for this part.
Answer this section in a separate booklet.

Teachers: Mr Coombes, Mr Robson

Task Weighting: 40 %

Multiple-choice Answer Sheet
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 this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Section I – Part A

1. Why do all objects at any particular point on the Earth's surface accelerate at the same rate in free fall?

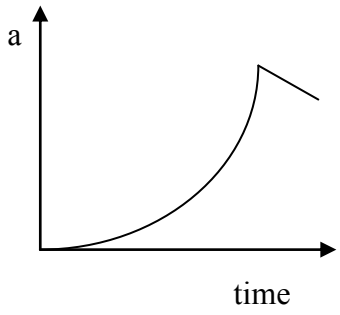
   (A) The gravitational force acting on each object is the same.
   (B) The gravitational force on each object is proportional to its mass
   (C) The acceleration is directly proportional to the gravitational force on each mass.
   (D) The acceleration is directly proportional to the mass of each object.

2. Travelling at near light speeds presents the possibility that humans may one day be able to travel to galaxies far away. Which choice correctly explains the reason for this?

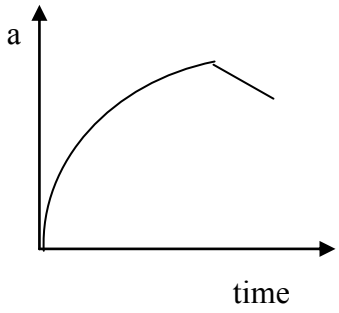
   (A) Near light speeds allow humans to travel much further in the same amount of time.
   (B) Time dilation allows for a person on board a space craft to age more slowly.
   (C) Length contraction allows for the distance to far away galaxies to contract.
   (D) Both space and time change for a person on board the space craft.

3. Which of the following acceleration versus time graphs best describes the acceleration of a rocket for the first few minutes after launch?

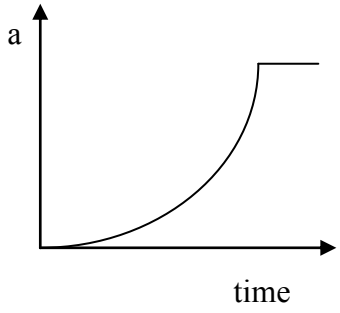
(A)



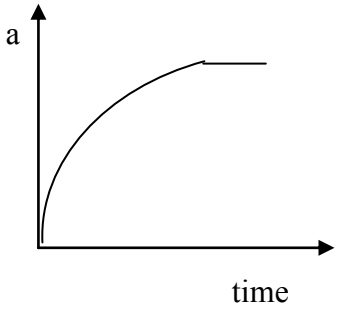
(B)



(C)



(D)



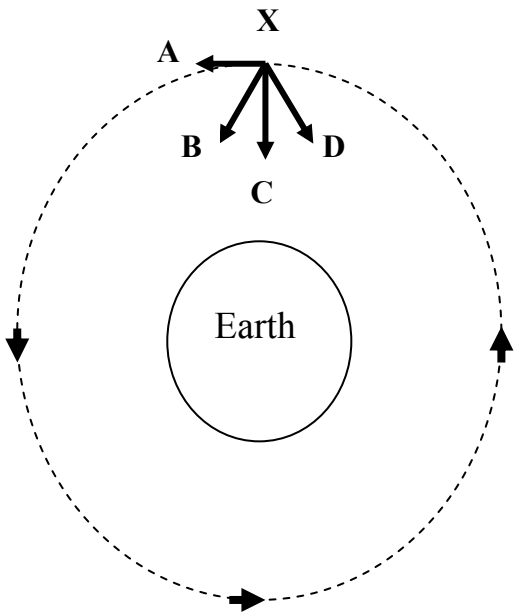
4. A new planet called Pitt was discovered in a distant galaxy. It has a radius that is 10 times that of the Earth and a radius that is 5 times that of the Earth. Which value is closest to the acceleration due to gravity on planet Pitt.

(A) 3.92 ms^{-2}
(B) 4.90 ms^{-2}
(C) 19.6 ms^{-2}
(D) 24.5 ms^{-2}

5. Which choice correctly identifies the reason why the term g-force is used to compare the effects of launch on different astronauts.

(A) Astronauts have different tolerances for g-force but not other forces.
(B) G-forces are much stronger than gravitational forces.
(C) Astronauts typically have different masses.
(D) Astronauts will become unconscious if the g-force exceeds 3.

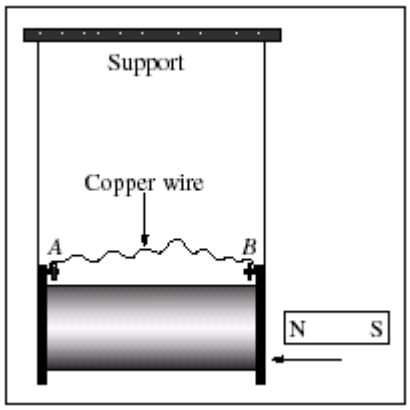
6. A low-earth orbiting satellite moves anti-clockwise around the Earth as shown below. Considering all forces acting on the satellite, which option correctly shows the direction of the net force acting on this low-earth orbiting satellite at point X.



7. Two space ships approach each other both travelling at 0.5c relative to an outside observer. The captain of P sends a microwave message to the captain of Q. Which choice regarding the relative speeds of the spaceships and the messages they receive is correct.

	Speed of ships relative to each other	Speed of message tain of Q.
A	c	More than c.
B	c	c
C	Less than c	More than c
D	Less than c	c

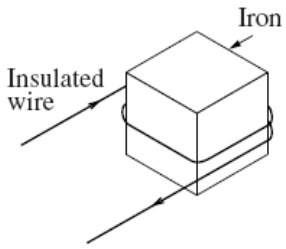
8. A student conducted an investigation by pushing a magnet into a solenoid. The solenoid was suspended so that it was free to move.

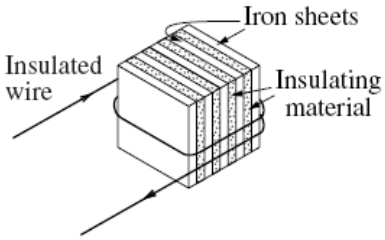


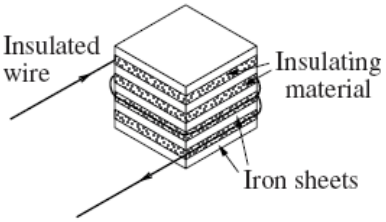
Which statement is the best explanation of what would happen in this investigation?

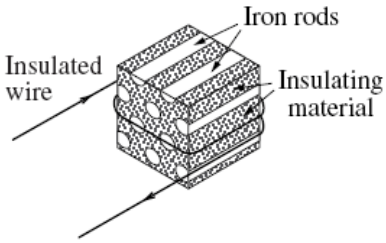
(A) The solenoid will move towards the magnet due to the induced current in the solenoid.
(B) The solenoid will move away from the magnet due to the induced current in the solenoid.
(C) The solenoid will not move because there is no change in flux through the solenoid.
(D) The solenoid will not move because solenoid has no power supply.

9. Which of the following designs would produce the most efficient transformer?

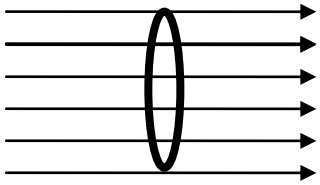
(A)


(B)


(C)


(D)


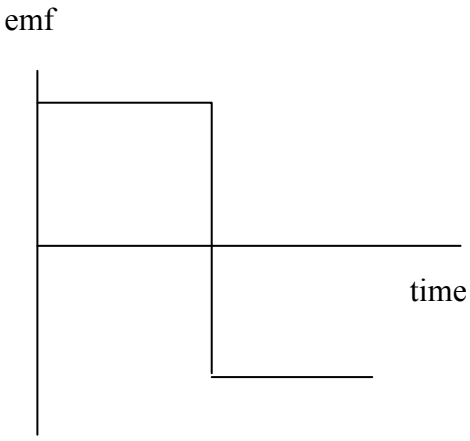
10. A metal ring has its plane perpendicular to a magnetic field as shown.



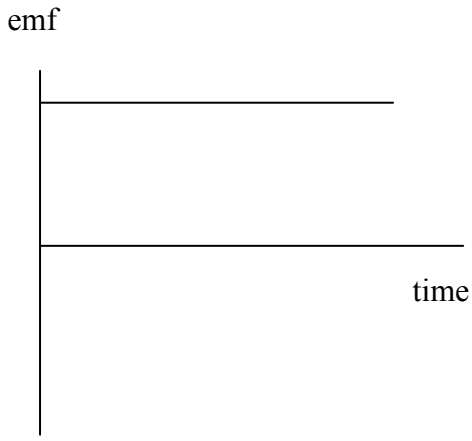
Magnetic field

Over a period of time, the strength of the magnetic field is reduced at a uniform rate from 0.5T to zero. Then its direction is reversed and the strength is increased, at eh same uniform rate back up to 0.5T.
Which graph shows a possible emf induced in the ring during this time?

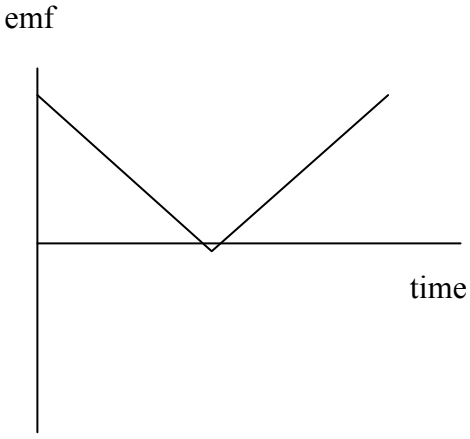
(A)



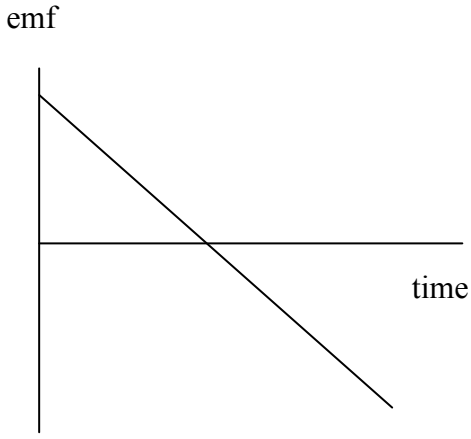
(B)



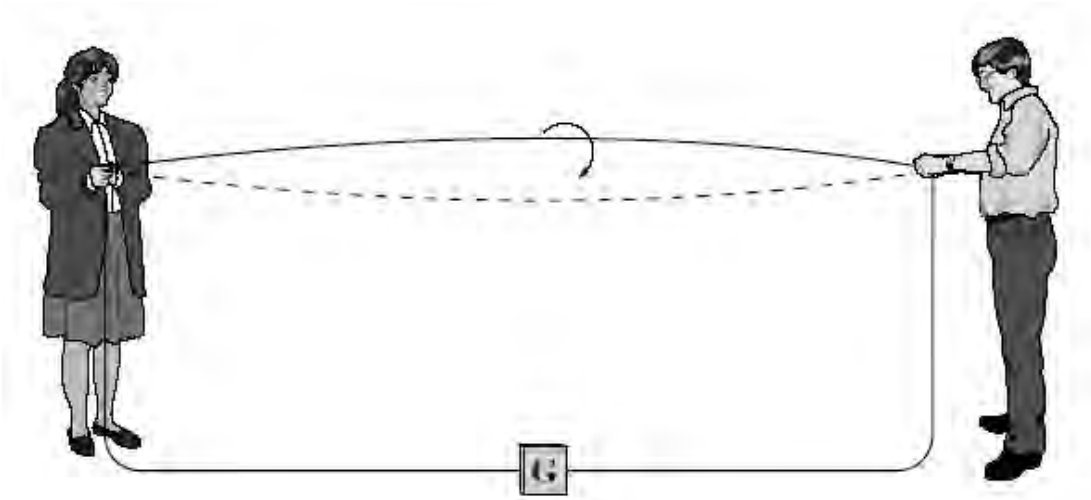
(C)



(D)



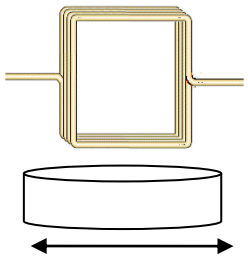
11. Two students carried out an investigation to measure the induced current by moving a wire in the Earth's magnetic field.



Which choice shows how the investigation should be carried out to maximise the current induced in the wire. Assume that an equal force is applied to the wire regardless of the type of motion used.

	Orientation of wire	Motion of wire
A	East-West	Up and down
B	East-West	Circular motion
C	North-South	Up and down
D	North-South	Circular motion

12. A student designs an electric motor by placing a square loop of wire above a 3cm diameter neodymium magnet as shown below.



3cm

If the student makes the loop out of a 1.2m long piece of wire, how many square loops should the student wind in order to produce the maximum amount of torque?

(A) 5

(B) 10

(C) 15

(D) 20

13. Magnetic flux density is :

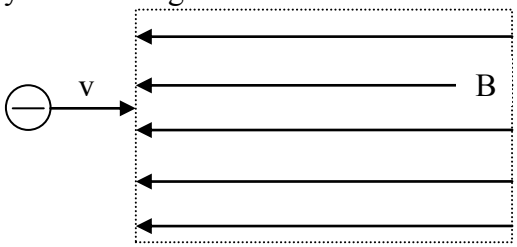
(A) the same as magnetic field strength

(B) the magnetic field strength divided by the area through which it passes.

(C) proportional to the amount of flux lines through a loop of any size.

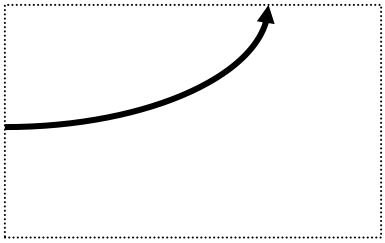
(D) equivalent to the force acting on an electron within the field.

14. A negatively charged particle enters a region with a uniform magnetic field. The direction of the particle's velocity and the magnetic field are shown in the diagram

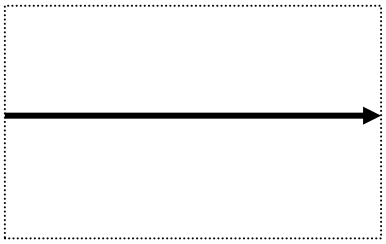


Which diagram best represents the subsequent path of the particle in the magnetic field?

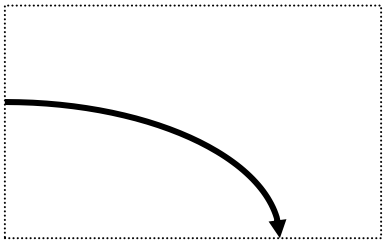
(A)



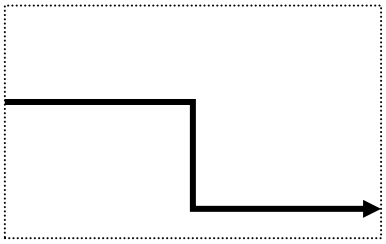
(B)



(C)



(D)



15. A light ray of wavelength λ is incident on a metallic surface in a vacuum. No electrons are emitted from the surface.
Which of the following is most likely to cause electrons to be emitted from the surface of the metal?

(A) Decrease the frequency of the incident light.

(B) Decrease the wavelength of the incident light.

(C) Increase the intensity of the incident light.

(D) Use a metal with a greater work function.

16. A photon of light has an energy of 3.75×10^{-19} joules. What is its wavelength?

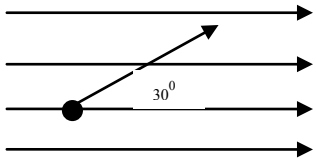
(A) 450 nm

(B) 490 nm

(C) 530 nm

(D) 560 nm

17. A proton enters a magnetic field at an angle of 30^0 as shown in the diagram below. The proton has a velocity of 3.0×10^6 m s^{-1} and experiences a force of 1.2×10^{-13} N into the page.



The magnitude of the magnetic flux density is

(A) 0.25 T

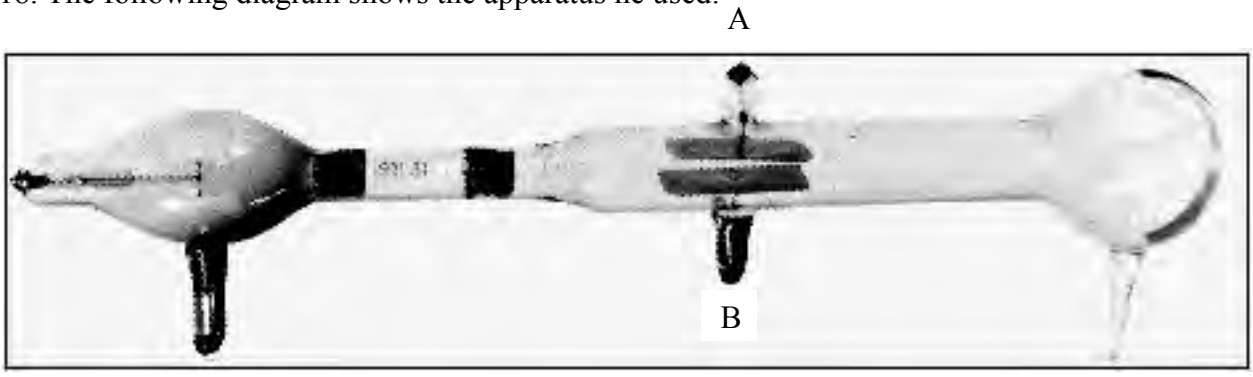
(B) 0.5 T

(C) 1.25 T

(D) 5.0 T

J.J. Thomson carried out an experiment to determine the charge to mass ratio of electrons.

18. The following diagram shows the apparatus he used.



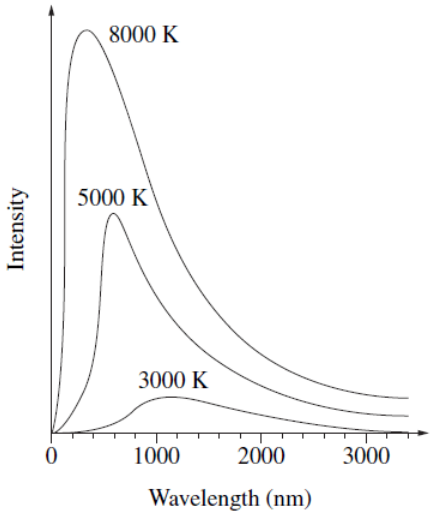
An electric field is produced by applying a voltage across plates A-B, with B being positive. Which of the following choices best represents the direction of a magnetic field which, when applied to the region of the charged plates, would cause the cathode ray to pass through the tube undeflected?

(A) vertically down the page
(B) vertically up the page
(C) into the page
(D) out of the page

19. Between 1886 and 1889, Heinrich Hertz performed a series of experiments which determined the speed of the newly discovered radio waves. This involved measuring their wavelength. What method was used to do this?

(A) The radio waves were passed through a glass sheet and the effect on the spark detector observed.
(B) The radio wave beam was split into two using a half-silvered mirror and recombined.
(C) The effect of the radio waves on cathode rays in a cathode ray tube was observed.
(D) The interference pattern produced when radio waves combined was observed.

20. The graph shows the intensity-wavelength curves for blackbodies at different temperatures. Similar results obtained by experimental physicists at the end of the 1800s were a major problem because they could not be explained using classical wave physics.



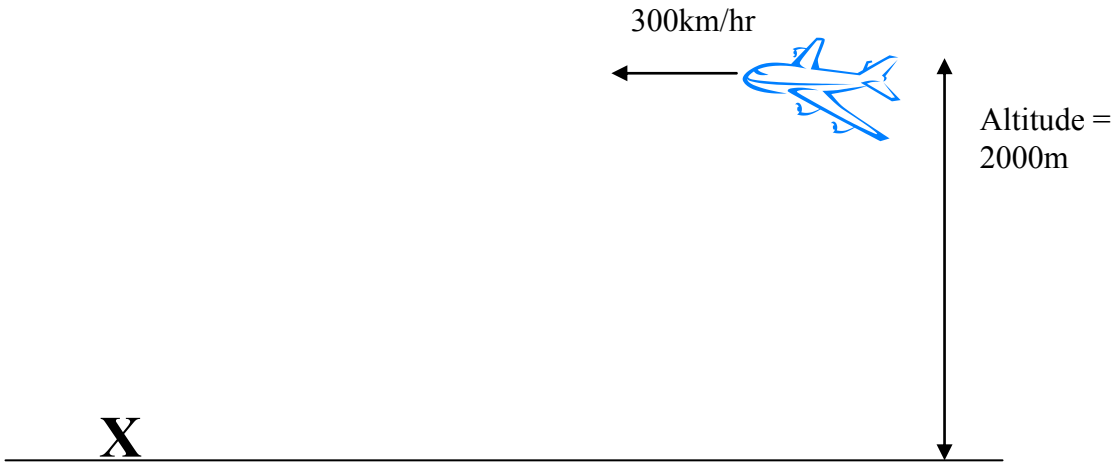
In 1900, Max Planck proposed a mathematical model which produced theoretical results which matched the experimental ones.

What assumption was his model based on?

(A) Light is quantised and its frequency is directly proportional to its intensity.
(B) Light is a wave with a frequency that is directly proportional to its energy.
(C) Light is quantised and its frequency is directly proportional to the energy of the quanta.
(D) Light is a wave with a frequency that is inversely proportional to its wavelength

Section I – Part B

21. A bomber travels at 300 km/hr above its desired target as shown below. At what distance before the target does the bomb have to be released in order to hit the target. Ignore air resistance in your calculations. **(3 marks)**



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22. Saturn has a moon called Tethys which has an orbital period of 1.9 days and an orbital radius of 295,000km. Calculate the mass of Saturn**. (3 marks)**

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23. Recount the method used in the Michelson-Morley experiment and describe the result that they anticipated. **(4 marks)**

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24. An observer on Earth is watching a spaceship of rest length 50m moving away from Earth at 0.6c.
(a) Calculate the length of the ship from the observer's point of reference. **(2 marks)**

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(b) The observer falls asleep when the clock on board the spaceship and his watch both read exactly 10am. When he wakes up the times differ by 10 minutes.
What time is it on the observer's watch? **(3 marks)**

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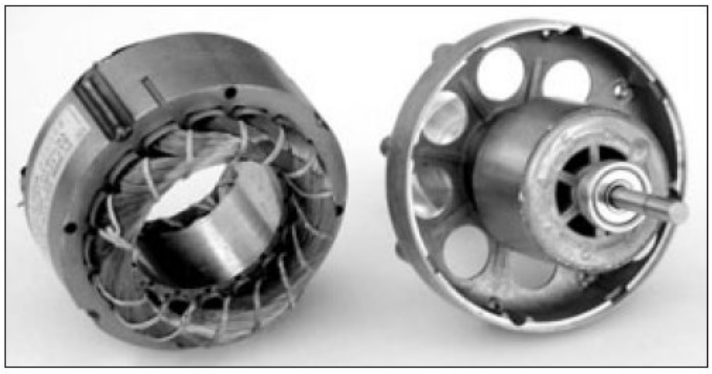
25. The following picture shows a commonly used electric motor.



Compare the construction of this motor with a simple DC electric motor. **(3 marks)**

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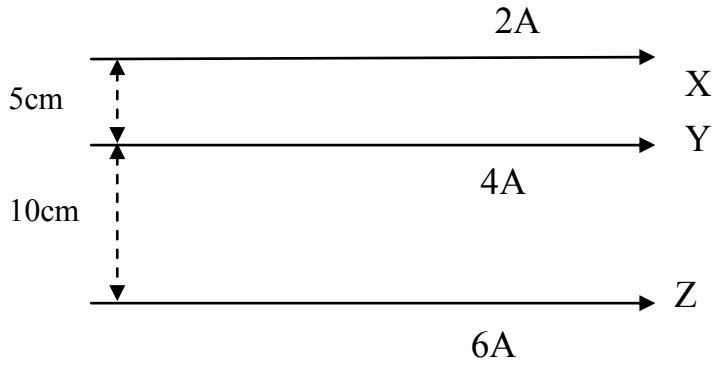
26. Assess the importance of transformers in providing a safe and efficient supply of electrical energy to homes. **(6marks)**

27. Three long, straight, parallel wires; X, Y and Z are 5cm and 10cm apart respectively and carry currents of 2A, 4A and 6A. The currents in wires X and Y are in the opposite direction to the current in wire Z.



Calculate the magnitude AND direction of the force per unit length on wire Y, due to the other two wires. **(3 marks)**

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28. The motion of the Earth and other planets is utilized when sending space probes to planets further from the sun in the solar system. Explain why this is the case. **(4 marks)**

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29. Explain why the wires of the secondary coil in a step up transformer are a different thickness to the wires in the primary coil**. (3 marks)**

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30. Recount the experiment that you performed in class to measure the effect on a generated electric current when the distance between the coil and magnet is varied. **(4 marks)**

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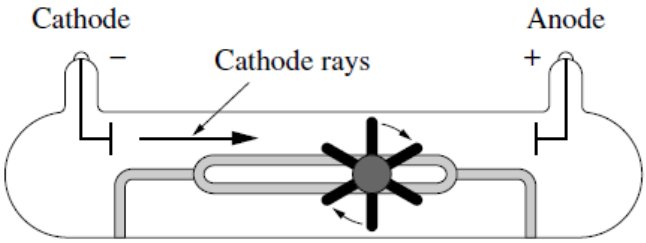
31. During the nineteenth century, scientists performed a variety of experiments using cathode ray tubes. One tube contained a glass wheel as shown below.



(a) Outline one observation about cathode rays that was made using this type of tube**.(1 mark)**

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(b) Assess the importance of this observation in determining whether cathode rays were waves or charged particles**.(3 marks)**

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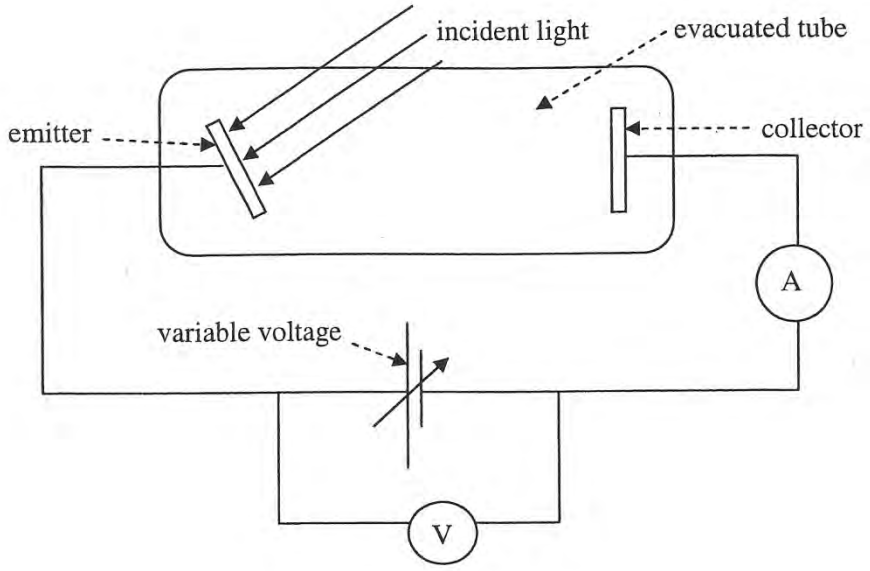
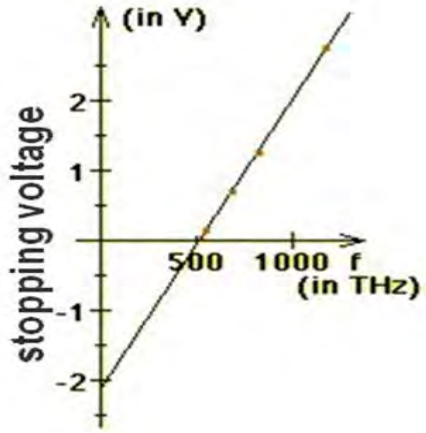
32. The diagram shows equipment set up to investigate the photoelectric effect. Light of different frequencies is shone onto the emitter and the voltage adjusted to just prevent electrons reaching the collector. In this situation, the work done by the applied electric field reduces the kinetic energy of the photoelectrons to zero.



The results of one experiment using a particular metal emitter are shown in the graph below.



(Note: a THz = 1 x 10^{12} Hz)

(a) Identify the threshold frequency for the metal emitter. **(1 mark)**

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(b) The work function of a metal can be calculated using the following formula

work function = energy in a photon – kinetic energy of photoelectron

Using the graph, calculate the work function of the metal emitter**.(2 marks)**

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(c) Evaluate the significance of experiments such as this in changing the direction of scientific thinking at the end of the nineteenth century. **(4 marks)**

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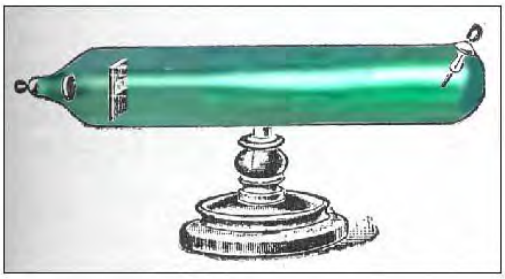
33. The diagrams below show two pieces of technology that could be used in a television.



Cathode Ray Tube

Solenoid

(a) Outline an advance in physics that resulted in the use of each device in a television. **(2 marks)**

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(b) Assess the impact of each advance identified in part (a) on the development of the television.
(4 marks)

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End of Part B

Section II
Option – Medical Physics – 25 marks

Question 34: Answer this question in a separate booklet

a) (i) Define the term acoustic impedance. **(1 mark)**

(ii) The table provides information about the acoustic properties of some body tissues

Body Tissue	Density (kg m^{-3})	Velocity (m s^{-1})
Blood	1060	1570
Brain	1025	1540
Fat	925	1450
Muscle	1075	1590

Calculate the acoustic impedance of brain tissue. **(2 marks)**

(iii) A stroke, or cerebrovascular accident, occurs when blood supply to part of the brain is disrupted, causing brain cells to die. **Using information in the table** and an appropriate calculation, determine whether an ultrasound image of the brain is likely to successfully identify the location of a damaged blood vessel. **(3 marks)**

(b) Below is an X-ray image and a CAT scan of the same part of the body of a patient suffering an unusual medical condition.

X-ray image

CAT scan

(i) Explain how the CAT scan was produced**.** **(3 marks)**

(ii) "CAT scans are always a better diagnostic tool than conventional X-ray images". Assess this statement with reference to this patient's medical condition**.** **(5 marks)**

(c) The next question refers to the table below

Isotope of Iodine	Half Life (days)	Decay Products
Iodine-123	0.55	gamma rays
Iodine-125	59	gamma rays
Iodine-131	8.00	beta particles, gamma rays

(i) Calculate the amount of iodine-131 remaining after 24 hours if the initial mass was 200 mg. **(1 mark)**

(ii) Identify which isotope listed above would be most suitable to image the thyroid gland. Justify your answer with reference to information in the table**.** **(3 marks)**

(iii) Describe how the radioactive isotope of iodine can be used to image the thyroid gland. **(3 marks)**

(d)Analyse the relationship between scientific advances and medical imaging techniques. **(5 marks)**

END OF EXAM

HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

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

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

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

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

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79	Symbol of element: Au
Atomic Weight	197.0	Name of element: 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 65.41 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							

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.

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Multiple-choice Answer Sheet

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 this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Part A

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

Marking Criteria

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

21. Criteria	Mark/s
Uses and appropriate method to calculate a distance of 1684m	3
Correctly calculates the time of fall OR Uses the correct method but with one incorrect substitution.	2
Uses the correct method but with two errors.	1

22. Criteria	Mark/s
Uses an appropriate method to calculate a mass of 5.6×10^{26}kg	3
Correctly method of calculation in kg but with one incorrect substitution OR Correct answer with incorrect units.	2
Correctly method of calculation but with two incorrect substitutions.	1

23. Criteria	Mark/s
Outlines the method including a diagram or detailed description of the apparatus and the rotation of the apparatus AND Describes the expected result which is a change in the interference pattern after rotation.	4
Method correct without a description of the expected result or one aspect of method omitted.	3
Two important aspects omitted.	2
Three important aspects omitted.	1

24a. Criteria	Mark/s
Correct calculation of answer of 40m.	2
Correct method with one error(not including calculation of longer length)	1

24b. Criteria	Mark/s
Correct calculation of time difference and identifies time on observers watch as 10:50am.	3
Correct calculation of time difference but incorrect time on observers watch..	2
Identifies that the observer's time is equal to the time on board plus 10 minutes.	1

25. Criteria	Mark/s
Three significant differences or two differences and one similarity using comparative sentences.	3
Two significant similarities or differences with no incorrect comparisons. Must use comparative sentences	2
One significant similarity or difference with no incorrect comparisons.	1

26. Criteria	Mark/s
Judgement of importance AND Significant reasoning related to safety and efficiency AND Demonstrates a logical progression and good use of scientific terminology	6
Judgement of importance AND Significant reasoning related to safety and efficiency	4-5
Limited discussion of issues related to safety and efficiency	2-3
One correct point related to efficiency or safety.	1

27. Criteria	Mark/s
Answer calculates the force per unit length due to wire X and Y and adds them using appropriate vector addition.	3
Answer calculates the force per unit length due to wire X and Y and adds them incorrectly. OR Correct method with one error or substitution..	2
Correct method with two errors	1

28. Criteria	Mark/s
Answer explains how the Earths orbital motion and the slingshot effect can be utilised to minimise the fuel needed by the probe.	4
Answer demonstrates some understanding of how orbital motion of the Earth and the slingshot effect are utilised.	2-3
Answer identifies that the slingshot effect or orbital motion of the Earth is utilised.	1

29. Criteria	Mark/s
Explanation of why increasing voltage decreases current and relates the change in current to the wires in the secondary being thinner.	3
Explanation of why increasing voltage decreases current.	2
Identifies that increasing voltage decreases current.	1

30. Criteria	Mark/s
Correct description of method including ▪ A suitable method of controlling speed. ▪ The use of a galvanometer or micro ammeter ▪ Measurements across a specific range of distances. ▪ Repetition of each measurement at least three times.	4
Correct description of method with one of the above omitted.	3
Correct description of method with two of the above omitted.	2
Correct description of method with three of the above omitted.	1

31a. Criteria	Mark/s
Clearly outlines one OBSERVATION (eg the paddle wheel rotates when the beam is turned on) – no marks if an inference is included!	1

31b. Criteria	Mark/s
States that the observation is VERY/QUITE important and Clearly and correctly links the observation to a particle property (eg rotating wheel implies cathode rays have momentum and therefore mass) and States that this is a property of particles not waves	3
Links the observation to a particle property but does not assess the importance OR Clearly assesses the importance but does not establish a link between the observation and the particle property	2
Response contains a link between the observation and a relevant particle property	1

32a. Criteria	Mark/s
F = 500 THz or 5.00×10^{14} Hz (must have correct units)	1

32b. Criteria	Mark/s
Calculation clearly shows that the work function equals the photon energy when the stopping voltage (and hence E_k) is zero (x-intercept on graph gives threshold frequency). Work function = 3.313×10^{-19} J	2
Calculates E = hf as 3.313×10^{-19} J	1

32c. Criteria	Mark/s
A well-structured response which states that the experiments were VERY significant (evaluate statement) and • outlines the failure of classical wave physics to explain the results of experiments on the photoelectric effect and blackbody radiation and that therefore • there was a requirement for a new model of light – the particle model which was • the start of a new way of scientific thinking – quantum physics	3-4
Response outlines some relevant experiments and their	1-2

results but does not clearly link this to failure of classical theory and hence the requirement of a new model of light.	

33a. Criteria	Mark/s
Outlines a scientific advance related to each device (eg the discovery that an electric current produces a magnetic field leads to solenoids being used to produce magnetic fields in a TV; the discovery that cathode rays were a stream of negatively charged particles leads to CR tubes being used in a TV)	2
Outlines one advance that relates to one device	1

33b. Criteria	Mark/s
Response contains a clear assessment of the impact (eg the impact was great, very significant etc) and Clearly links each advance outlined in part (a) to the use of each device in a TV	3-4
Response clearly links each advance outlined in part (a) to the use of each device in a TV	3
Response establishes a clear link between one advance and the use of a technology in the TV	2
Response outlines the role of each device in the TV	

34 a (i). Criteria	Mark/s
Defines acoustic impedance as the product of a material's density and the acoustic velocity (Z = pv)	1

34 a (ii). Criteria	Mark/s
Correctly calculates the acoustic impedance as 1578500 $kgm^{-2}s^{-1}$ or rayls (must have correct units)	2
Calculates correct value without units	1

34 a (iii) Criteria	Mark/s
Response states that an ultrasound image would NOT successfully locate the blood vessel AND Justifies this by correctly calculating the percentage of US reflected from a brain/blood boundary (0.07 %) andthat therefore the reflected signal would have too low an intensity to be detected	3
States no and performs the relevant calculation but does not link this clearly to the detection of the boundary.	2
Performs the relevant calculation correctly	1

34 b (i) . Criteria	Mark/s
A thorough description which includes • a fan-shaped beam of X-rays is passed through the body • The X-ray tube is rotated 180^0 around the body • a ring of detectors on the opposite side of the body detects variations in the intensity of transmitted X-rays • data analysed by computer (A diagram was useful to illustrate these features)	3
Response contains the above points but lacks detail and/or clarity (eg no diagram)	2
Response missing one essential point	1

34 b (ii). Criteria	Mark/s
Response includes a sentence stating that the statement is incorrect an indication that the nail can only be seen in the X-ray and not the CAT scan a comprehensive discussion of the advantages/disadvantages of CAT scans as opposed to X-rays (at least 3) that are relevant to the patient in the question	5
A comprehensive response but No clear assessment made OR No indication that the CAT scan does not show the nail	4
Response includes a comprehensive discussion of the advantages/disadvantages of CAT scans as opposed to X-rays (at least 3) but does not relate it to the patient	3
A general and superficial discussion of the uses of X-rays and CAT scans.	1-2

34 c (i) Criteria	Mark/s
Response is a calculation showing an understanding of an exponential decay process	1

34 c (ii) Criteria	Mark/s
Identifies I-123 and states that its shorter half life means that the patient will not be exposed to gamma radiation for too long (potential to ionise body chemicals or cause radiation poisoning) AND That the half life is still long enough for the iodine to accumulate and be metabolised in the thyroid AND That the only product is gamma rays – no highly ionising beta particles as produced by I-131	3
Response identifies I-123 but omits one of the above reasons	2
Response identifies I-123 OR Response contains the above information but includes significant errors (eg that a beta particle is involved in producing a PET scan)	1

34 c (iii). Criteria	Mark/s
A comprehensive response which includes Radioisotope is injected/ingested/inhaled and travels in blood to the thyroid Radioisotope accumulates and is metabolised in the thyroid Decay of isotope produces gamma rays which pass through the body and are detected by gamma ray cameras The data is then processed by a computer	3
Response missing one of the above or containing a significant error	2
Response missing two of the above or containing two significant errors	1

34 d Criteria	Mark/s
A well-structured response which identifies at least 2 significant scientific advances (eg induction, piezoelectric effect, radioactive decay) and clearly relates the implications of these advances to at least 3 different imaging techniques	4-5
Response identifies a single advance but also includes at two or more relevant advances in technology which are related to imaging techniques OR Response identifies relevant advances but does not clearly link them to the imaging techniques	2-3
Identifies one advance in science	1