Physics

HSC Course

2009

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 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 – 60 marks
Attempt questions 16 to 32
Allow about 1 hour and 40 minutes for this part

Section II – Medical Physics Module
25 marks
Attempt question 33
Allow about 45 minutes for this part

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

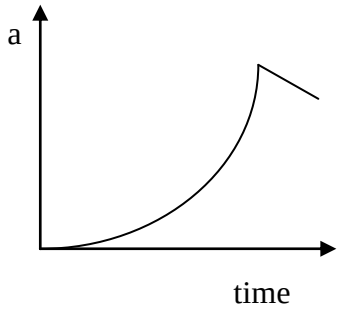
1. Why do all objects at any particular point on the Earth's surface accelerate at the same rate in free fall?

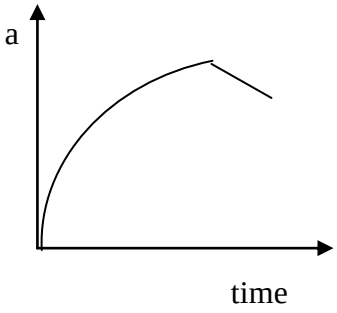
   (A) The gravitational force acting on each object is the same.
   (B) The gravitational force on each object is proportional to its mass
   (C) The acceleration is directly proportional to the gravitational force on each mass.
   (D) The acceleration is directly proportional to the mass of each object.

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.

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

i.





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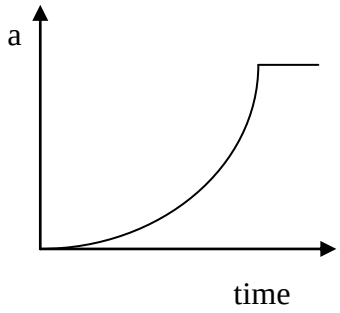
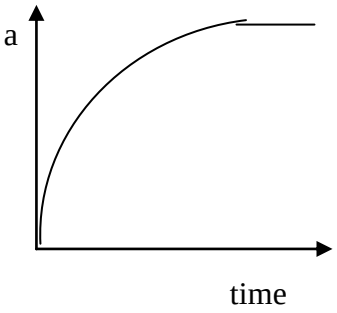


(D)



3. A spaceship is travelling at 0.9c away from the Earth. Microwave pulses sent by the spaceship are received once per second on Earth.

   What is the time interval between each pulse, as measured on the spaceship?

   (A) 0 s

   (B) 0.4 s

   (C) 1.0 s

   (D) 2.3 s

4. Compared with a geostationary satellite, a low-earth orbit satellite has

   (A) a longer period and a lower orbital velocity

(B) a longer period and a higher orbital velocity

(C) a shorter period and a lower orbital velocity

(D) a shorter period and a higher orbital velocity

5. Which of the following methods can be used to reduce eddy currents in transformers?

(A) Winding both the primary and secondary coil around the same magnetic core

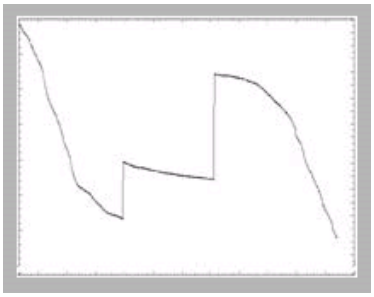
(B) Using a core that is conductive but not magnetic

(C) Placing laminations in the core

(D) Cooling the core below its critical temperature

6. Consider the following information from

http://www.spacetelescope.org/about/history/sm3b_a_little_boost.html



This graph changes in the altitude of the Hubble telescope's orbit around the Earth. The satellite was twice boosted into a higher orbit, once during the first and once during the second service missions. To carry out the service missions, the ISS, "space shuttle", took astronauts to carry out repairs and modifications. The top of the graph corresponds to an altitude of 615 km and the bottom to 580 km. The first boost in 1993 was 8 km and the second boost in 1997 was 15 km.

Choose the correct statement from the following about effect of these orbital boosts.

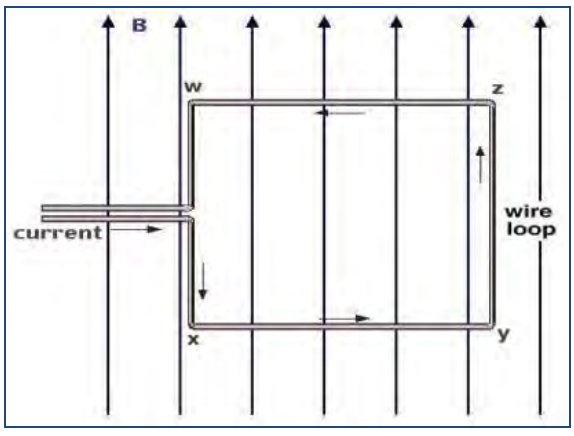
(A) They caused the period of the Hubble telescope to decrease.

(B) They decreased the potential energy of the Hubble telescope.

(C) They caused the Hubble telescope's orbital velocity to increase.

(D) They caused the centripetal force on the Hubble telescope to decrease.

7. The loop below is placed in a magnetic field as shown.

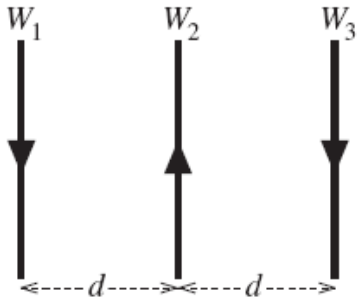


Which of the following best describes what will happen to the loop?

	Direction of force on WZ	Direction of force on XY	Rotation of loop before stopping
(A)	Into the page	Out of the page	90^0
(B)	Out of the page	Into the page	90^0
(C)	Into the page	Out of the page	180^0
(D)	Out of the page	Into the page	180^0

8. Three identical conductors shown below have been measured to have the following currents .

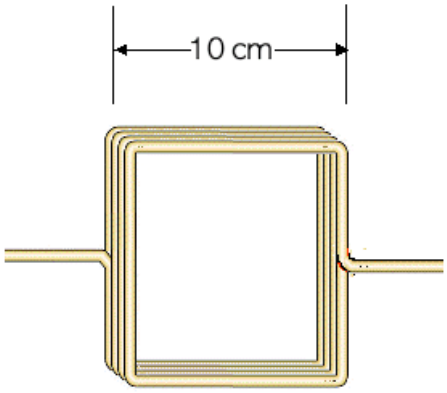
Conductor	Current (A)
W_1	1
W_2	2
W_3	4



Conductor W_2 is an equal distance from W_1 and W_3. What is the initial net force acting on W_1

(A) Zero.
(B) Non-zero and to the right.
(C) Non-zero and to the left.
(D) Non-zero and out of the page.

9. A student constructs a small electric motor by winding 20 coils in a square shape as shown below.



The resistance of the motor is 60 Ω and energy is supplied by a 12 V battery. Two magnets in the motor produce a magnetic field of 0.5 T.

What is the maximum torque supplied to the motor?

(A) 2×10^{-2} N.m

(B) 200 N.m

(C) 6 N.m

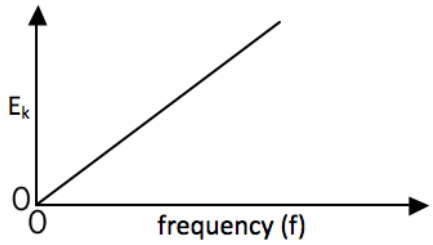
(D) 1 N.m

10. In a step-down transformer, the secondary coil has

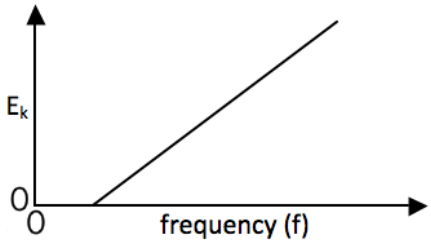
(A) fewer windings than the primary and the wires are thicker.
(B) fewer windings than the primary and the wires less thick.
(C) more windings than the primary and the wires are thicker.
(D) more windings than the primary and the wires less thick.

11. Which of the following graphs shows the relationship between the kinetic energy of photoelectrons (E_k) and the frequency (f) of incident light?

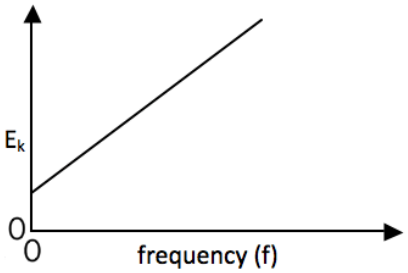
(A)



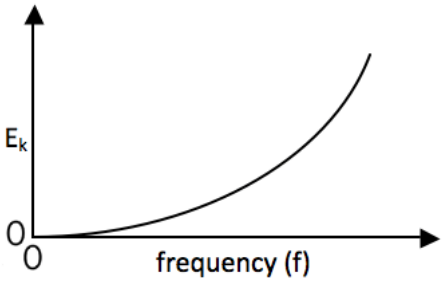
(B)



(C)



(D)



12. A minimum of 3.685×10^{-19} joules of energy is required to cause an electron to be ejected from sodium metal. Light of wavelength 4.28×10^{-7} m was shone onto sodium metal.
What is the maximum energy of photoelectrons that this light could produce?

(A) 7×10^{14} J

(B) 4.64×10^{-19} J

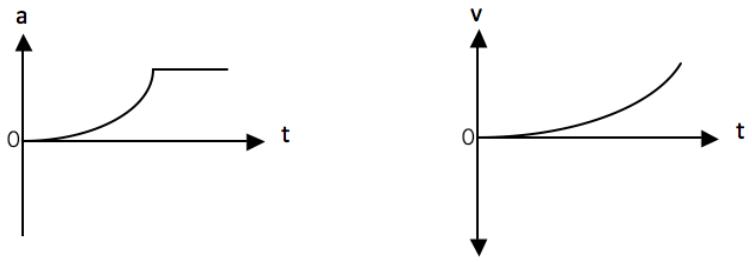
(C) 9.56×10^{-20} J

(D) 3.685×10^{-19} J

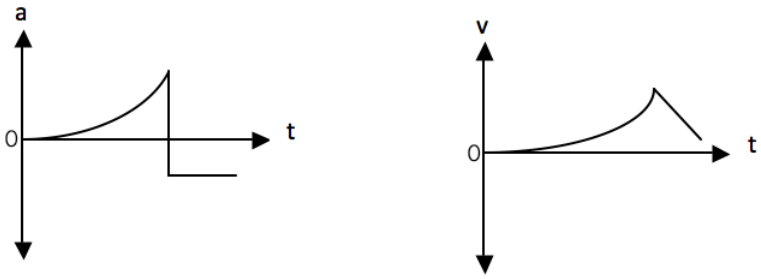
13. A rocket was launched vertically upwards as shown in the photograph. The fuel in the rocket lasts for 30 seconds.

Which pair of graphs best describes the acceleration (a) and the velocity (v) of the rocket over a period (t) of 40 seconds.

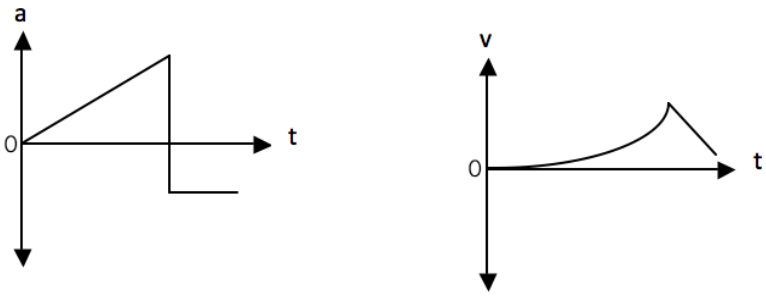
(A)



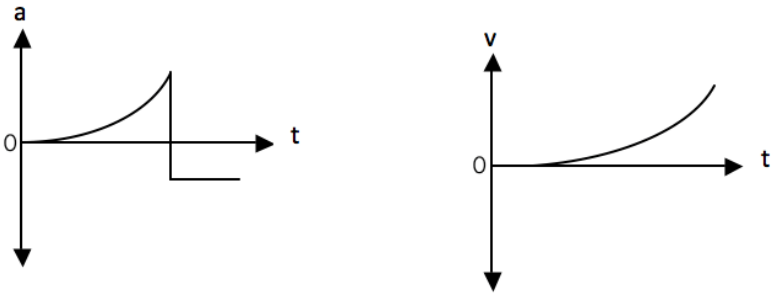
(B)



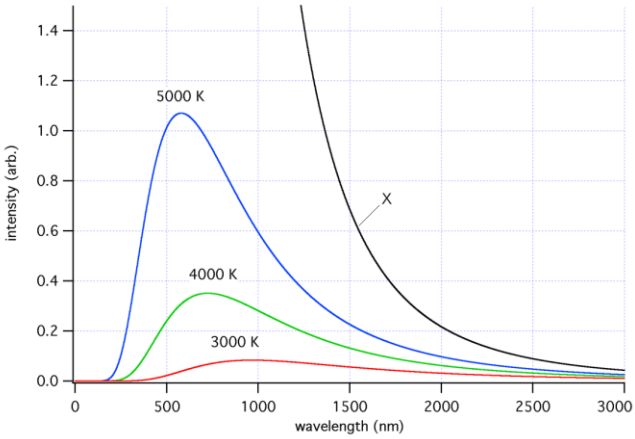
(C)



(D)



14. This graph shows the radiation curves for black bodies at three different temperatures.



What does the curve labelled "X" represent?

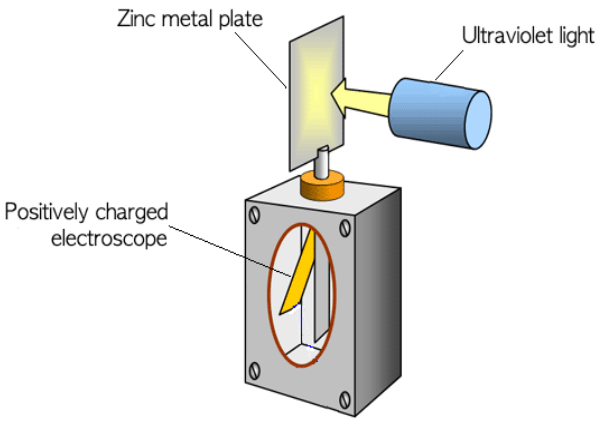
(A) A black body with a temperature greater than 5000 K

(B) A black body with a temperature less than 3000 K

(C) The results of a model for black body radiation first proposed by Planck

(D) The radiation curve for black bodies predicted by the wave model for light

15. The following equipment was used to investigate the photoelectric effect.



The electroscope was given a negative charge before the ultraviolet light was turned on and observations were recorded. The investigation was repeated and the electroscope the same initial charge but an ultraviolet light with a greater intensity was used.

Which of the following is an observation that would be made as a result of the increase in intensity of the ultraviolet light?

(A) The deflection of the moveable pointer will increase by a greater amount.

(B) The deflection of the moveable pointer will decrease more rapidly.

(C) Photoelectrons will be emitted having a greater kinetic energy.

(D) More photoelectrons will be emitted from the zinc.

16. Which pair of devices best represents technologies that are applications of the motor effect?

(A) Electrical transmission line, radio transmitter

(B) Generator, guitar pickup

(C) Transformer, induction coil

(D) Loudspeaker, galvanometer

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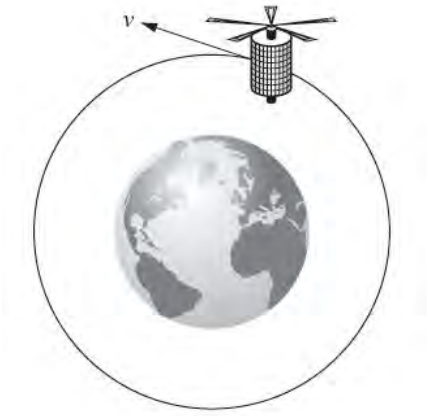
-Section I – Part B

Question 16

The diagram shows the Hubble space telescope in orbit around the Earth at an altitude of 600 km.



(a) **On the diagram**, draw an arrow to show the direction of the centripetal force acting on the satellite. 1M

(b) The space shuttle (mass: 2 029 203 kg) is travelling with a speed of 7860 m s^{-1} in orbit 340 km above the Earth's surface. The Earth has a radius of 6378 km.
Ignoring any change in kinetic energy calculate the work done to move the shuttle into an orbit at the same altitude as the Hubble telescope. 3M

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Question 17

A star called 55 Cancri is 41 light years from the Earth. A light year is the distance light travels in one year.
In 1997, a Jupiter-sized planet was discovered orbiting in a nearly circular path of radius 0.1 AU around the star with an orbital period of 14.7 Earth days (1 AU is the 150 million kilometre distance from Earth to the Sun). The planet was called 55 Cancri b.

(a) Calculate the orbital velocity of 55 Cancri b. 2M

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(b) In 2002, another planet, 55 Cancri d, was discovered in a circular orbit around the same star at a distance of 5.8 AU.
What is the ratio of the period of the new planet to the period of 55 Cancri b? 2M

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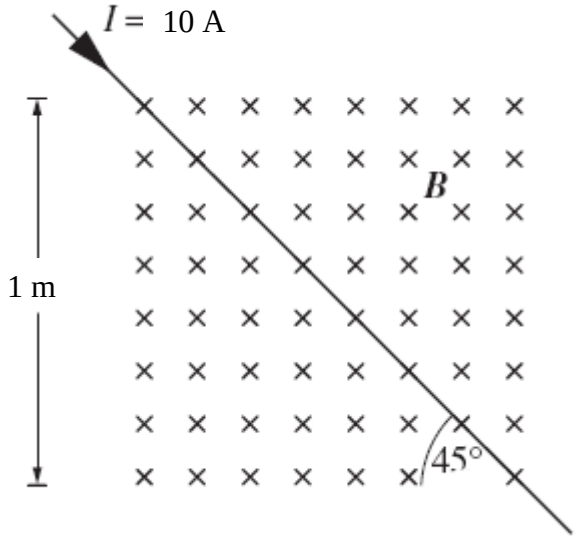
Question 18

Calculate the force acting on the conductor shown below. The magnetic field is confined to an area 1 m x 1 m and it has a strength of 0.01 T. 2M



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Question 19

The next question refers to a process applied to validate and develop scientific theories.

1. Make observations regarding a phenomenon being studied.
2. Use established theory to make predictions about the phenomenon.
3. Conduct controlled experiments to test the predictions.
4. If the predictions are confirmed, then the theory is validated.
5. If the predictions are not confirmed then the experiments are re-evaluated.
6. If the experiments are valid and the theory's predictions cannot be confirmed, then the theory must be modified.

At the end of the nineteenth century, Michelson and Morley performed a series of experiments using an interferometer. The results of Michelson and Morley's experiments did not support their hypothesis.

(a) Identify the theory most affected by the results of Michelson and Morley's experiments and outline the effect of these experiments on this theory. 3M

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(b) Albert Einstein proposed an alternative theory in 1905, which successfully explained the Michelson and Morley results. However, it was not widely accepted for many years. With reference to the validation process that is a part of science, explain why. 4M

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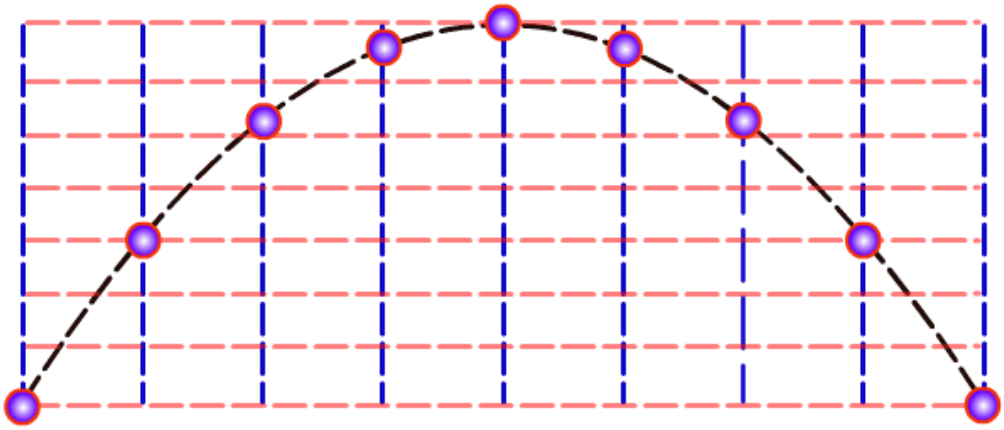
Question 20

The diagram below shows the trajectory of a projectile launched from the surface of the Earth. The projectile reaches its maximum height 4 seconds after launch and has an initial horizontal velocity of 25 m s^{-1}.



(a) Determine the maximum height reached by the projectile 2M

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(b) Calculate the initial velocity of the projectile. 3M

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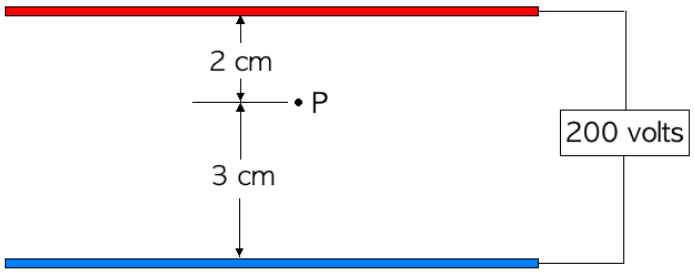
Question 21

Two oppositely charged metal plates are separated by 5 cm and the voltage between them is 200 V. Calculate the force that would act on an electron placed at the position, P, between the plates. 3M



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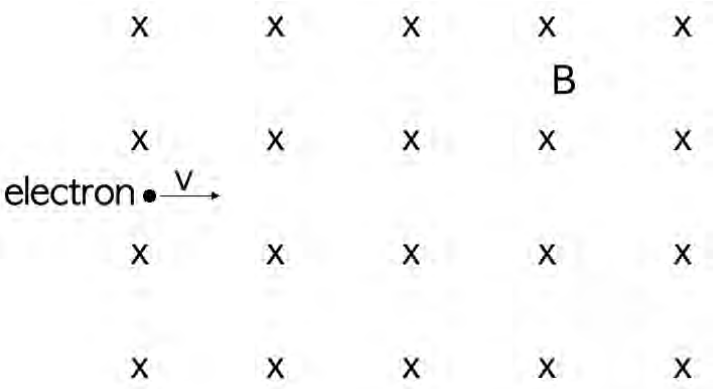
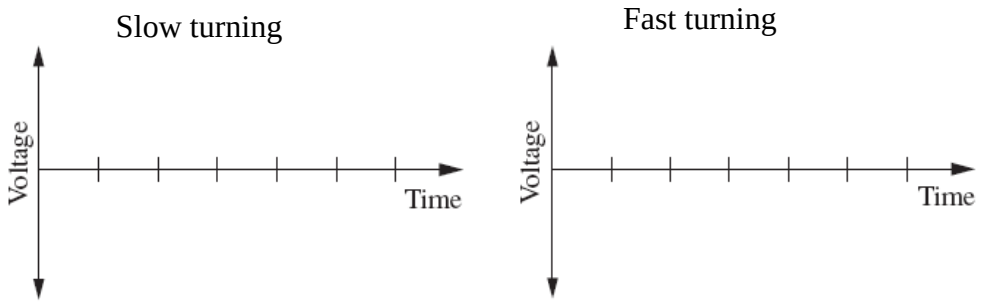
Question 22

Draw an electric field that would cause the electron entering the magnetic field with a velocity v below to follow a straight path through the combined fields. 2M



Question 23

A student conducts an investigation by turning a DC hand generator for period of 6 s and measuring the induced voltage using a data logger. The student repeats the experiment, but doubles the rate at which he turns the generator. Use the axes below to show the difference in the voltage signals observed over the six-second period. 3M



Question 24

(a) Identify the useful energy transformation that takes place on the screen of a TV set that uses a cathode ray tube. 1M

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(b) Outline how you would minimise two significant risks present conducting an investigation to observe striation patterns in discharge tubes at different gas pressures. 2M

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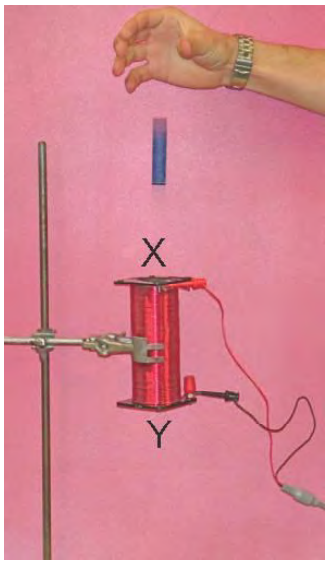
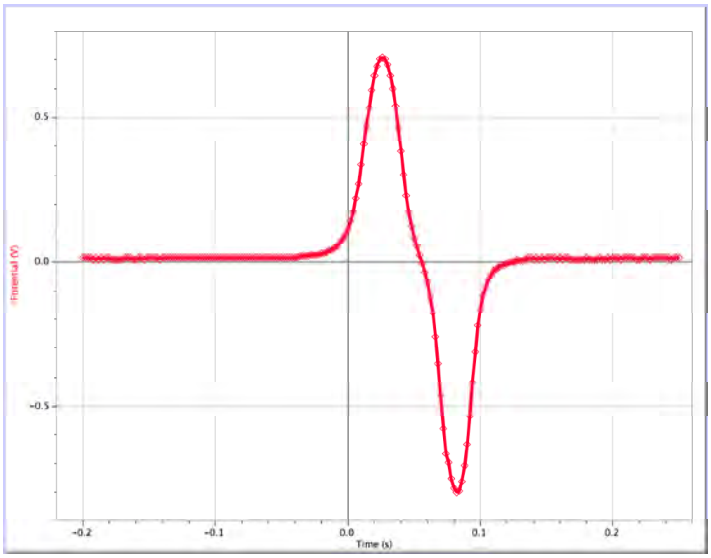
Question 25

A student performed an investigation to observe the voltage produced across the ends of a solenoid when a bar magnet was dropped through it as shown in the following photograph. The graph of potential difference (vertical axis) vs. time (horizontal axis), was recorded using a data logger is shown.





Relate the main features of the graph to the position and velocity of the magnet. 4M

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Question 26

The Maltese cross tube demonstrates that cathode rays have energy because they cause the glass to fluoresce. Outline two other properties of cathode rays that can be deduced using this tube. 2M

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Question 27

In the 19th Century, it was argued that cathode rays were particles. Describe two pieces of evidence supporting this idea, which could not be explained by the opposing view that cathode rays were electromagnetic radiation. 2M

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Question 28

Compare the structure and function of a galvanometer with that of an electric motor. 4M

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Question 29

Analyse the relationships between technology and advances in physics. 4M

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Question 30

Assess the environmental impacts of AC generators. 4M

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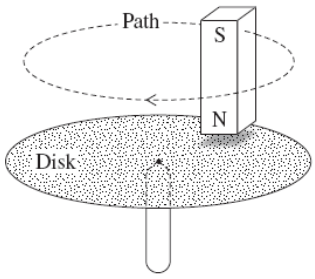
Question 31

A student conducted an investigation using the following apparatus. He moved the north pole of the magnet in a circular path just above an aluminium disk that was free to rotate.



(a) Which type of motor works in a similar way to the model? 1M

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(b) Propose what observations that the student would have made. 2M

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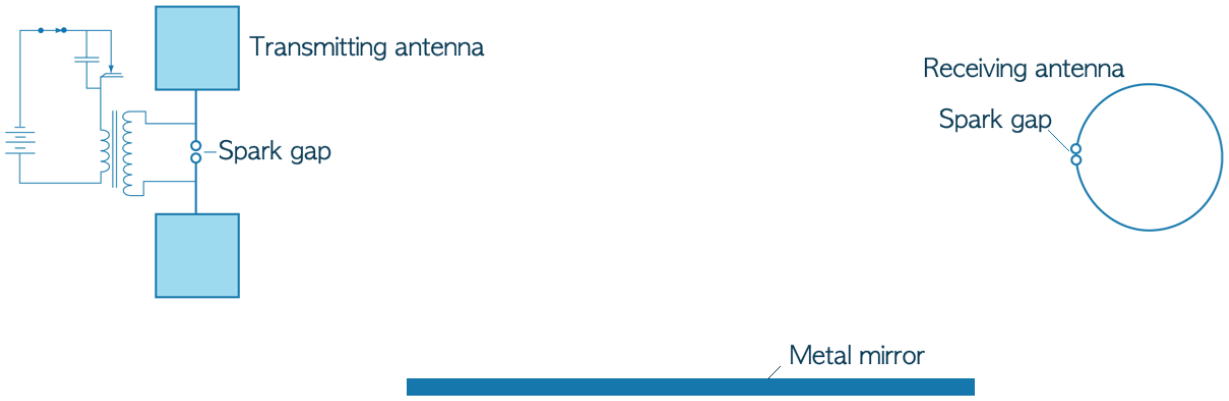
Question 32

Heinrich Hertz used apparatus represented by the diagram below to investigate electromagnetic waves.



(a) Explain the significance of the results of Hertz investigation with reference to the purpose of the investigation. 2M

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(b) When Hertz was making observations using only the transmitting and receiving antennas (without the metal mirror), he made a significant observation about the spark produced in the receiving antenna when glass was placed in between the transmitter and receiver.
Explain the observation that he made. 2M

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End of Part B

Section II
Option – Medical Physics – 25 marks

Question 33

(a) Outline the difference between sounds in the normal human hearing range and ultrasound used for medical imaging. (2M)

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(b) Describe how ultrasound is detected for use in medical imaging. (3M)

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(c) Explain how the distance to a tissue boundary is determined when ultrasound is used for medical imaging. (2M)

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(d) Contrast the physical processes that happen in the body, which are the bases for the production of an X-ray image compared to an ultrasound image. (3M)

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(e) Describe two mechanisms by which X-rays are produced in an X-ray tube. (2M)

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(f) The table below shows the speed of sound in, and density of, several different tissues.

Tissue	*Speed of sound in tissue* (m s^{-1})	*Density* (kg m^{-3})
Fat	1450	952
Blood	1570	1025
Kidney	1560	1038
Liver	1550	1065
Muscle	1580	1076

(i) Calculate the acoustic impedance of muscle. (1M)

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(ii) Identify the type of tissue that will result in the smallest proportion of the incident ultrasound being reflected at the boundary between the muscle and the other tissue. Justify your choice. (2M)

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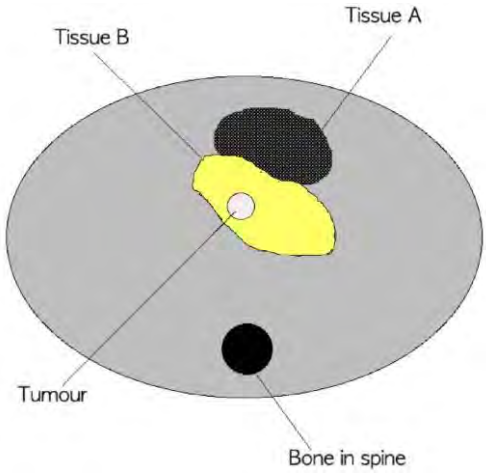
(g) The following diagram shows two different tissues, A and B, in a human body that have the same acoustic impedance as each other.



(i) The speed of sound in tissue A is greater than the speed of sound in tissue B. Explain how it is possible for tissues A and B to have the same acoustic impedance. (2M)

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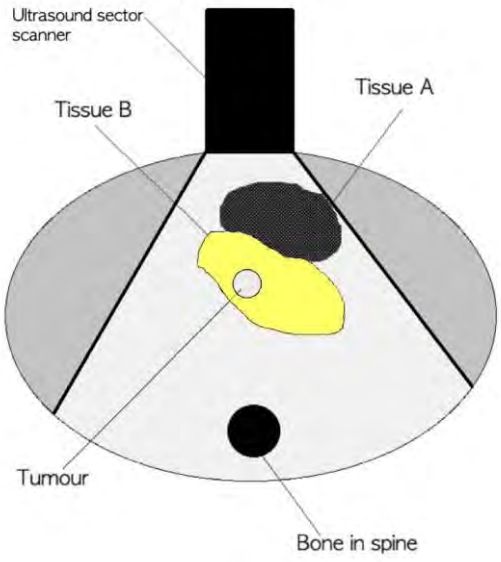
(ii) There is a tumour in tissue B, having a different acoustic impedance to the surrounding tissue. An ultrasound sector scan was done to produce an image of the region shown in the following diagram. Draw a diagram to show how this cross-section of the body would appear in an ultrasound image. (2M)



(h) With the aid of a diagram, outline the effect of the field produced by the superconducting electromagnets in an MRI machine. (2M)

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(i) Describe the effect of the radio frequency oscillator in an MRI machine and the significance of the frequency of the waves that it produces. (4M)

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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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

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

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

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

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

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

$$Z = \rho v$$

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

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

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

PERIODIC TABLE OF THE ELEMENTS

KEY

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

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.

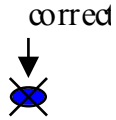
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(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:



(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) ⬭

Marking Criteria

M/C: 1 D 2 B 3 D 4C 5D 6A 7A 8A 9A 10B 11C 12B 13D 14B 15D

16a. Criteria	Mark/s
Arrow used to indicate the force acting from the satellite is towards the centre of the earth	1

16b. Criteria	Mark/s
Correctly calculates the initial E_p and final E_p using the appropriate radii including units (-1.209 x 10^{14} J and -1.164 x 10^{14}J respectively AND the difference between the final and initial values (4.5 x 10^{12}J)	3
Calculates the initial E_p and final E_p and the difference between them but uses incorrect radii (including incorrect unit conversions) OR Correctly calculates the initial E_p and final E_p using the appropriate radii including units but not the difference between them	2
Correctly calculates the initial E_p or final E_p	1

17a. Criteria	Mark/s
Correctly calculates the radius of orbit of 55 cancri b (1.5 x 10^{10}m) and the orbital velocity (7.42 x 10^4 m s^{-1})	2
Correctly calculates the radius of orbit of 55 cancri b	1

17b. Criteria	Mark/s
Correct calculation of the ratio using Kepler's law of periods (441.71:1)	2
Determines the period of 55 Cancri d (6493.21 days)	1

18. Criteria	Mark/s
Correctly calculates the length of conductor in the field (1.41 m) and calculates the magnitude of the force using F = BIlSinθ where θ = 90^o (0.14N). Note; direction not in marking criteria	2
Correctly calculates the length of conductor but does not use θ = 90^o in force calculation OR calculates the magnitude of the force using F = BIlSinθ where θ = 90^o using incorrect length	1

19a. Criteria	Mark/s
Identifies the theory as classical wave theory OR the aether model AND clearly outlines a significant effect on the theory (e.g. results brought into question the existence of the aether which was essential to explain how light could move through space AND therefore brought into question the validity of the theory which now required re-evaluating, modifying.	3
Identifies the theory as classical wave theory OR the aether model but does not clearly outline a significant effect on the theory OR the response contains contradictory or incorrect information	2
Identifies the theory as classical wave theory OR the aether model	1

19b. Criteria	Mark/s
Response identifies the theory as special relativity AND clearly describes at least one predictions (time dilation, length contraction etc) AND states that these predictions could not be tested at the time because the required technology had not been invented (atomic clocks etc) AND therefore the theory could not be validated at the time	4
Missing one of the above	3
Missing two of the above	2
Response identifies the theory as Special relativity	1

20a. Criteria	Mark/s
Subsitutes correctly into the formula to give a correct final answer (78.4m)	2
Uses the correct formula	1

20b. Criteria	Mark/s
Correctly calculates the initial vertical velocity (39.2 m s^{-1}) and uses a vector diagram and/or appropriate calculations to determine the final answer including the angle (46.49 m s^{-1} at 57.47^0 to ground)	3
Correctly calculates the initial vertical velocity (39.2 m s^{-1}) and uses a vector diagram and/or appropriate calculations to determine the magnitude OR direction of the final velocity	2
Correctly calculates the initial vertical velocity	1

21. Criteria	Mark/s
Correctly calculates the electric field strength (4000 N C^{-1}) and substitutes appropriately into F = qE to determine the final answer (-6.40 x 10^{-16} N)	3
Substitutes appropriately into F = qE to determine the final answer but does not correctly calculate F	2
Correctly calculates the electric field strength (4000 N C^{-1})	1

22. Criteria	Mark/s
Field represented using arrows that are in the correct plane AND field lines are in the correct direction (vertically down the page).	2
Correct field lines without direction indicated	1

23. Criteria	Mark/s
Graphs indicate a changing DC voltage that is higher in frequency and amplitude for the fast turning generator.	3
Two of the three characteristics outlined above	2
One of the three characteristics outlined above	1

24a. Criteria	Mark/s
Kinetic to light	1

24b. Criteria	Mark/s
Two significant precautions related to the high voltage source, production of X-rays or the possible implosion of the tube. E.g. eye protection to be worn to protect from glass if a tube breaks)	2
One significant precaution OR identifies two risks	1

25. Criteria	Mark/s
A clear answer which relates the position and size of the peaks on the graph to the position of the magnet and its increasing velocity as it passes through the solenoid.	4
Answer relates the peaks on the graph to the position of the magnet only	1-2

26. Criteria	Mark/s
Two relevant properties outlined	2
One relevant property outlined.	1

27. Criteria	Mark/s
Two of the following pieces of evidence outlined : • Deflection by magnetic or electric fields • Momentum as demonstrated by the paddle wheel experiment • Measured velocity less than that of light.	2
One property outlined.	1

28. Criteria	Mark/s
One similarity and one difference in the structure and	4

function using the correct text type.	
One similarity and one difference in the structure and function using the incorrect text type OR three similarities/differences.	3
Two similarities/differences	2
One similarity or difference	1

29. Criteria	Mark/s
Three/four examples of the relationship between technology and advances in physics. Each link clearly explained and at least one example of technology leading to advances in physics and vice versa.	4
Three/four examples of the relationship between technology and advances in physics. Each link clearly explained.	2-3
One/two examples of the relationship between technology and advances in physics.	2
A correct statement about the relationship between technology and advances in physics.	1

30. Criteria	Mark/s
A positive/negative judgement of the impact/s AND Three significant impacts clearly related to the environment.	4
A judgement and two impacts OR Three impacts	3
Two impacts	2
One impact.	1

31a. Criteria	Mark/s
Induction motor	1

31b. Criteria	Mark/s
Any two relevant observations that are likely to be made in carrying out the experiment.	2
One relevant observation	1

32a. Criteria	Mark/s
Answer identifies the result (calculation of the speed of the waves) and relates this to the significance of the speed being the same as that of light.	2
Answer identifies the result.	1

32b. Criteria	Mark/s
Answer outlines the result (spark less intense) and explains this in terms of the photoelectric effect.	2
Result outlined.	1

33a. Criteria	Mark/s
States that human hearing range is typically 20 Hz to 20 kHz and ultrasound used for medical imaging typically is in the range 2 MHz to 10 MHz (not just above 20 kHz, this is not "medical")	2
States that higher frequency sound waves are used for medical imaging that can be heard by humans.	1

33b. Criteria	Mark/s
States that piezoelectric crystal distortions (or pressure) results in voltages being produced across opposite faces of the crystal.	3
States that ultrasound waves distort or apply varying pressure to the piezoelectric crystals OR that the crystals produce a voltage.	2
States that ultrasound is detected using a piezoelectric crystal	1

33c. Criteria	Mark/s
States that because the speed of ultrasound in human tissues is known and the time for the reflected pulse to return is measured, then the distance to the tissue boundary is s=(t/2) x speed	2
States that the distance can be calculated because both the speed and time are known quantities.	1

33d. Criteria	Mark/s
States that X-rays must be transmitted through the body whereas ultrasound is reflected back to the detector AND that X-ray image production relies upon different absorption of rays by different tissues (especially bone).	3
Contrasts either transmission/reflection or differential absorption/reflection due to impedance difference	2
Identifies a relevant interaction between body tissues and either ultrasound or X-rays	1

33e. Criteria	Mark/s
Describes braking (or acceleration/direction change) of electrons at anode (Bremsstahlung radiation) AND K-shell electron excitation by electrons in cathode ray	2
Describes one mechanism for X-ray production	1

33f(i). Criteria	Mark/s
Calculates the correct acoustic impedance and states the correct unit (1.7×10^6 rayls)	1

33fii). Criteria	Mark/s
Identifies the liver-muscle boundary because the acoustic impedance difference is least between these two tissues	2
Identifies the liver-muscle boundary without a reason or gives the correct reason but the incorrect boundary (due to a calculation error)	1

33g(i). Criteria	Mark/s
States that because acoustic impedance is the product of density and speed of sound, if the speed of sound in A is greater than in B then the density of tissue B must be greater than the density of tissue A	2
States only that the density of tissue B is greater than the density of tissue A	1

33g(ii). Criteria	Mark/s
Shows tissues A and B merged as one with the tumour visible, LABELLED, bone in spine visible front only (rear curved part not visible)	2
Shows tissues A and B merged as one with no distinction between them OR has the sector section correct showing tumour and bone in spine	1

33h. Criteria	Mark/s
Uses a diagram and description indicating that proton spins are randomly oriented before the application of the strong B field and that they align approximately parallel and antiparallel to the applied B field (but are not perfectly aligned)	2
Describes alignment fully without a diagram or uses a diagram that is not fully correct (e.g. spins aligned exactly to field) and has a deficient verbal outline.	1

33i. Criteria	Mark/s
Includes in the description: (1) The applied RF frequency is the same as the Lamor frequency which is explicitly related to precession (2) States that energy is absorbed from the RF signal by the proton (or states that the proton goes to a higher energy state) (3) States that the RF causes spin-flip and/or putting precession of protons into phase (not enough to just say "higher energy") (4) That energy is re-emitted by the proton after the RF pulse and that this is detected (best answers stated that the intensity of the emitted signal is related to the H-atom density in the tissue)	4
Three of the above	3
Two of the above	2
One correct statement about the MRI process that is related to the RF pulse.	1