Physics

HSC Course

2011

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 20-34
Allow about 1 hour and 40 minutes for this part

Section II – Medical Physics Module
25 marks
Attempt all questions in this section.
Allow about 45 minutes for this part.

Teachers: Mr Coombes, Mr Pitt, Mr Trotter

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. Which of the following correctly describes a geostationary orbit?

	Orbital period (hours)	***Orbital decay***
(A)	Between 2 and 5	Significant
(B)	Between 2 and 5	Insignificant
(C)	24	Significant
(D)	24	Insignificant

2. The acceleration due to gravity on Earth's surface is 9.8 m s^{-2}. Suppose the radius of Earth was reduced to a quarter of its present value while its mass remained the same.

   What would be the new value of the acceleration due to gravity on the surface in m s^{-2}?

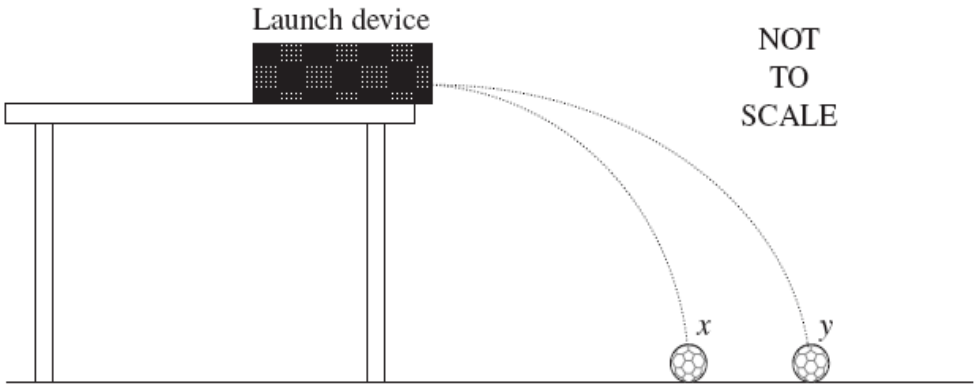
   (A) 9.8 / 16

   (B) 9.8 / 4

   (C) 4 x 9.8

   (D) 16 x 9.8

3. A device launches two identical balls (x and y) simultaneously in a horizontal direction from the same height. Ball y is lauched with double the velocity of ball x.



Which statement correctly describes what will happen?

(A) Ball y will have double the range of ball x.

(B) Ball y will have less than double the range of ball x.

(C) Ball y will have a shorter time of flight than ball x.

(D) Ball y will have a longer time of flight than ball x.

4. Satellites that are part of the global positioning system (GPS) have on-board atomic clocks. Which option describing the clocks is most correct?

(A) The clock on the Earth runs slower according to observers on Earth.

(B) The clock on the satellite runs slower according to observers on Earth.

(C) Both clocks run at the same rate according to observers on Earth.

(D) There is no way to tell which clock runs slower when they're in relative motion.

5. Planet T-Trot has a mass that is 5 times greater than the Earth and a radius that is 3 times greater. What is the acceleration due to gravity on planet T-Trot?

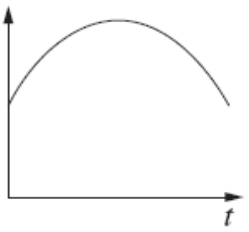
(A) 0.55 m s^{-2}

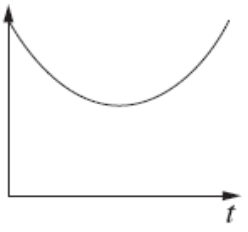
(B) 5.44 m s^{-2}

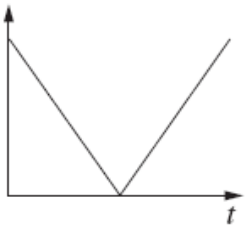
(C) 16.3 m s^{-2}

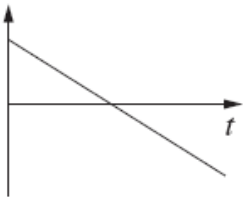
(D) 81.7 m s^{-2}

6. A ball was thrown upward at an angle of 45^0. It landed at the same height from which it was thrown. Which graph best represents the kinetic energy of the ball during the flight?

(A) 

(B) 

(C) 

(D) 

7. Muons created in the upper atmosphere are unstable and have a lifetime of 1.5 microseconds. They travel toward the Earth at 0.995c. They can therefore travel on average approximately 448 m according to Newtonian physics. In fact they travel ten times this distance from where they are formed in the upper atmosphere.
   Which option best accounts for this fact due to the effects described by special relativity?

   (A) In the Earth frame of reference, the distance the muon travels is really 448 m due to length contraction of their paths to the ground.

   (B) In the Earth frame of reference, the muon lifetime contracts, allowing it to travel a greater distance than predicted by Newtonian physics.

   (C) In the muon's frame of reference, the distance the muon travels is really 448 m due to length contraction of their paths to the ground.

   (D) In the muon's frame of reference, the muon lifetime is increased, allowing it to travel a greater distance than predicted by Newtonian physics.

8. These equations relate some of the variables affecting the operation of a transformer.

$$\frac{V_P}{V_S} = \frac{n_P}{n_S} \qquad Transformer\ efficiency = \frac{Power\ Output}{Power\ Input}$$

   Which of the following statements is true?

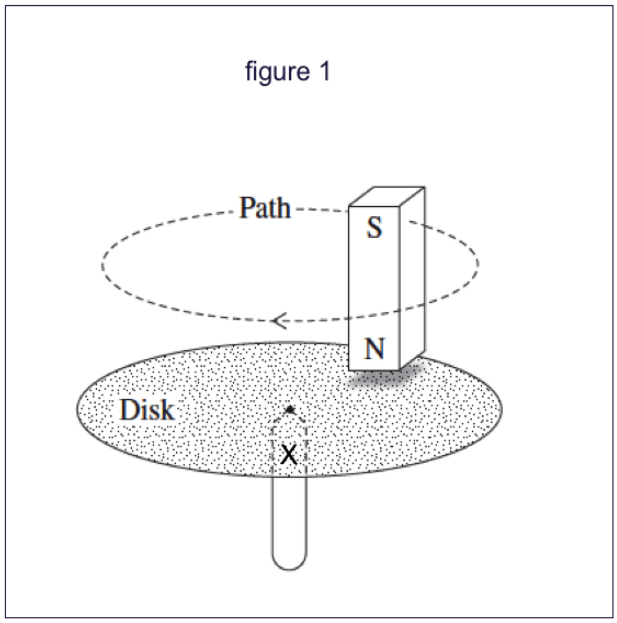
   (A) The voltage output of a transformer is less than that predicted by the transformer equation only if the equation is applied to a step-down transformer.

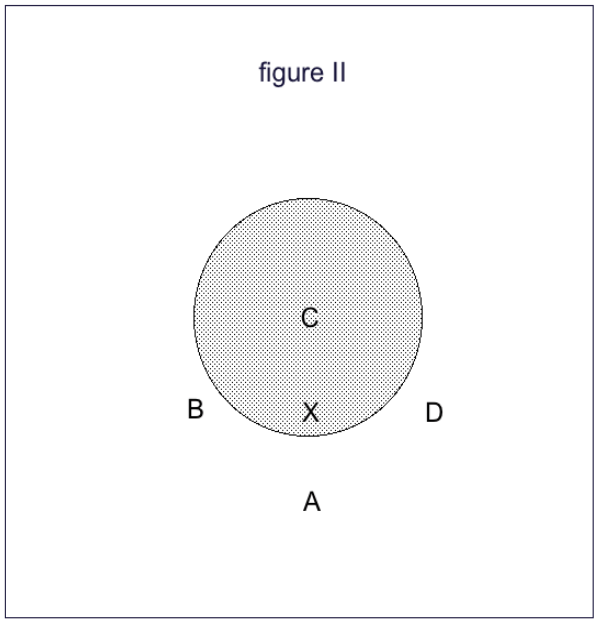
   (B) The power output of a transformer is less than the power input because not all the flux produced by the primary coil passes through the secondary coil.

(C) The power output of a transformer is less than the power input due to induced currents in the core.

(D) In a step-up transformer, the output current is greater than the input current.

9. The diagram in figure 1 shows apparatus used to investigate the principal of an induction motor. Figure II shows the disk viewed from above.





As the magnet moves to the left above the point X in diagram II, toward which direction is the force that is produced on the disk by the magnet at the point X?

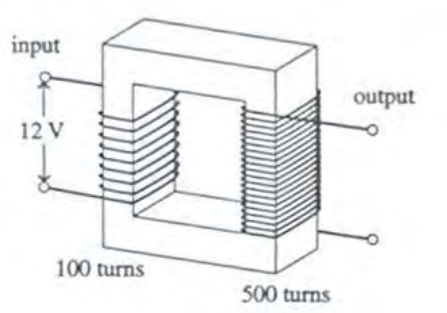
(A) A

(B) B

(C) C

(D) D

10. The following diagram shows a transformer which has a 12 V AC input.



What is the output voltage of the transformer?

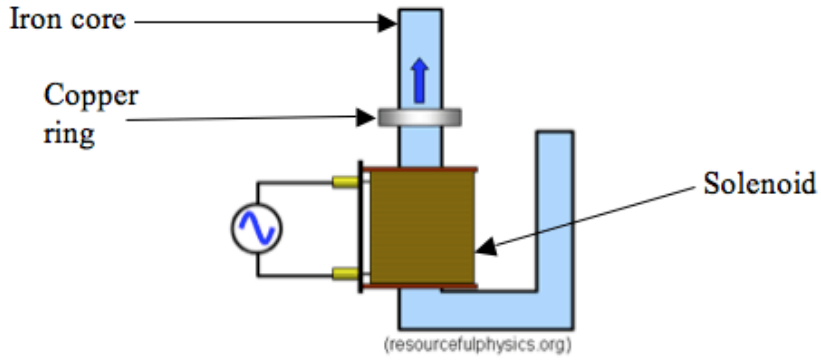
(A) 600 V

(B) 500 V

(C) 60 V

(D) 48 V

11. The following apparatus causes a copper ring to be initially propelled upwards.



Which answer best explains why the ring is propelled upwards.

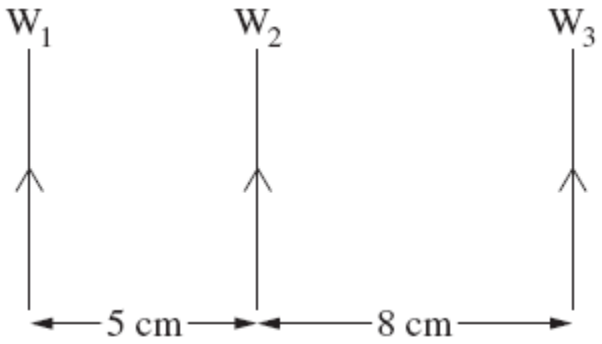
(A) The motor effect provides an upwards force on the ring.

(B) The ring acts like the squirrel cage rotor in an induction motor.

(C) The ring experiences a magnetic force from the solenoid.

(D) Eddy currents in the ring produce an opposing magnetic field.

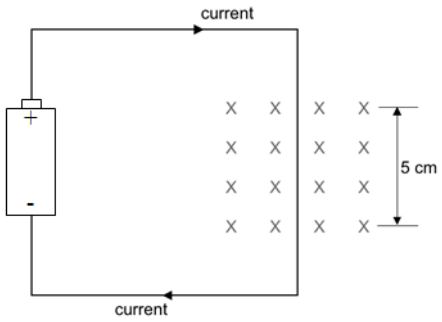
12. Three current carrying wires are placed near each other as shown below.



The current in W_3 is double the current in both W_1 and W_2.
Which response correctly identifies the initial movement of the wires?

	W_1	W_2	W_3
(A)	Right	Right	Left
(B)	Left	Left	Right
(C)	Right	Left	Left
(D)	Left	Right	Right

13. A current of 2 A flows through the wire, 5 cm of which passes through a magnetic field having a strength of 3×10^{-2} T.



What is the force produced on the wire?

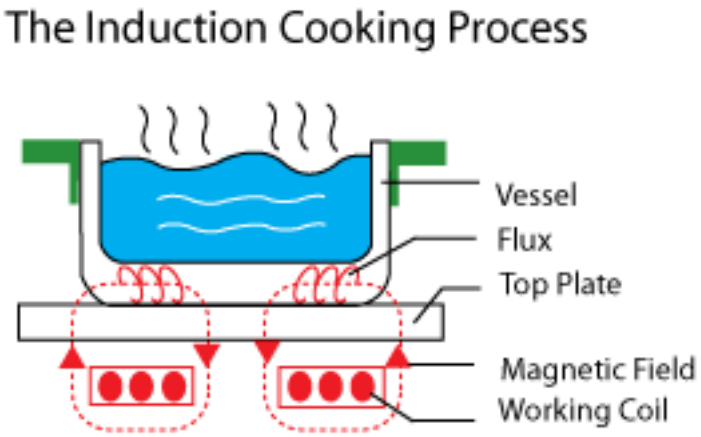
(A) 0.003 N to the left

(B) 0.003 N to the right

(C) 0.3 N to the left

(D) 0.3 N to the right

14. The following diagram shows some of the components involved in the induction cooking process.



Which option best describes the material of which the cooking vessel must be made?

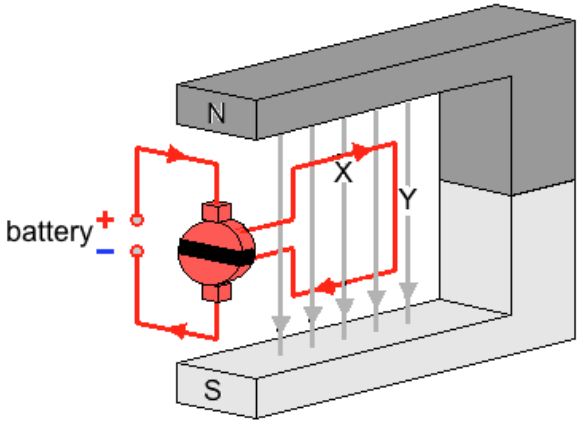
(A) magnetic

(B) non-magnetic

(C) electrical insulator

(D) electrical conductor

15. The diagram below represents an electric motor.



Which of the following actions would **NOT** increase the maximum torque on the coil by a factor of 4?

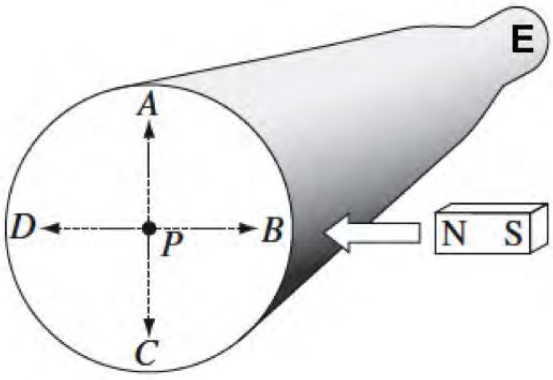
(A) Double the current and double the lengths X and Y of the sides of the coil.

(B) Double the current and double the magnetic field strength.

(C) Double the number of turns on the coil and double the area of the coil.

(D) Increase the current by a factor of four.

16. A cathode ray beam produced by the electron gun at E in the cathode ray tube, strikes the screen at point *P*, producing a bright spot.



The north end of a magnet is brought towards the beam as shown and the spot moves away from the position P. In what direction must an electric field be applied to cause the spot to move back to P while the magnet remains in the position shown?

(A) Toward the top of the page

(B) Toward the bottom of the page

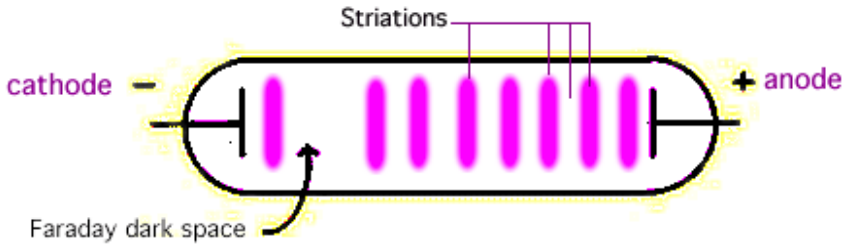
(C) Into the page

(D) Out of the page

17. Blue light causes photoelectrons to be emitted from the surface of sodium metal at a specific rate. What would happen to the number and kinetic energy of photoelectrons emitted per second if the intensity of the light shining on the sodium metal was increased?

	Kinetic Energy of photoelectrons	Number of photoelectrons
(A)	More	The same
(B)	More	More
(C)	The same	More
(D)	The same	The same

18. A student sketched a diagram of the pattern of striations in a discharge tube as follows.



How could the pattern of striations be changed?

(A) Change the type of gas in the tube

(B) Change the voltage between the anode and cathode

(C) Change the type of metal used for the electrodes

(D) Change the pressure of the gas in the tube

19. Which of the following was used by Heinrich Hertz to determine the wavelength of radio waves of known frequency?

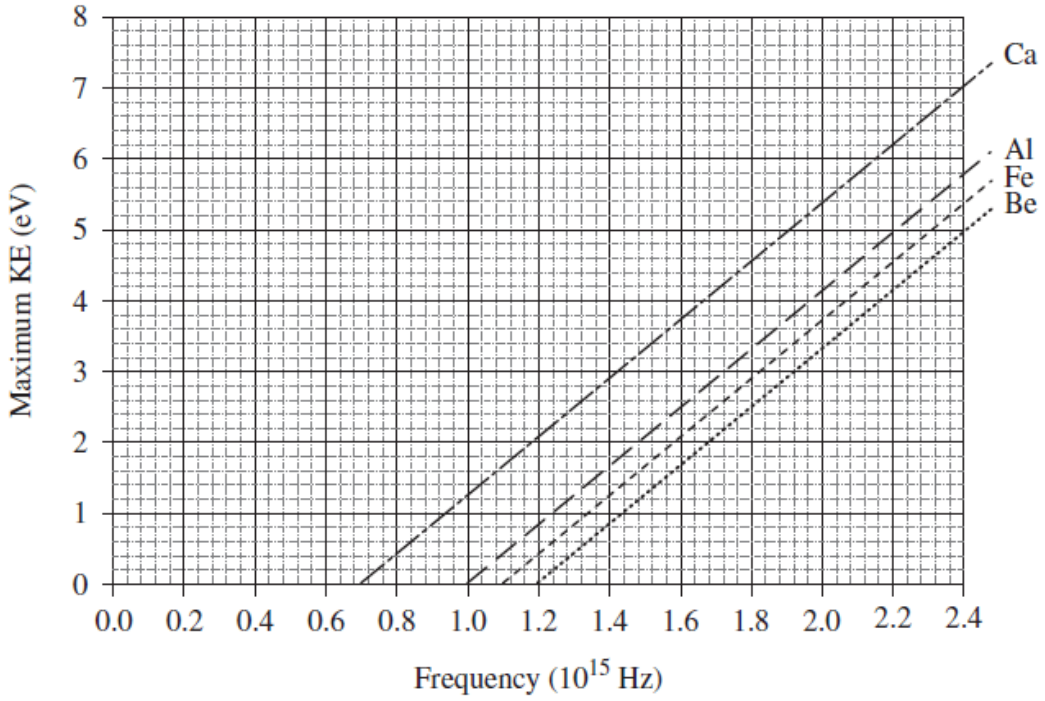
(A) Dividing the speed of light by the frequency of the radio waves

(B) Using the interference of reflected radio waves

(C) Using receiving antennas of different lengths

(D) Placing the receiver is a dark box

20. When electromagnetic radiation shines on metals, photoelectrons may be emitted. The maximum kinetic energy of emitted photoelectrons is plotted against radiation frequency for four metals as shown in the graph.



Radiation of wavelength 375 nm is shone onto all four metals.

Which of the following lists the metals that would release photoelectrons?

(A) Calcium only

(B) Calcium and aluminium

(C) Aluminium, iron (Fe) and beryllium

(D) All four metals

End of Part A

Section I – Part B

21. The image shows the final launch of the space shuttle on July 8th 2011 (Mission STS-135)

(a) Identify three significant forces acting on the vehicle as it ascends through the atmosphere and relate these to its motion during the launch from Earth into space. 3M

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(b) On its website, NASA makes the following statement about the space shuttle launch.

"The Solid Rocket Boosters (SRBs) operate in parallel with the main engines for the first two minutes of flight to provide additional thrust needed for the Orbiter to escape the gravitational pull of the Earth"

Analyse the claim made in this statement. 3M

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22. Consider the following thought experiment.

A train having a length of 50 m is moving along a straight track at 0.999c when the train enters a mountain tunnel of length 40 m, which has a door at each end of the tunnel that can be closed instantaneously using a radio signal. An observer watching from a mountain above the tunnel sees the train enter the tunnel and uses a radio signal to close the doors simultaneously at the two ends so that the train is trapped fully inside the mountain tunnel.

(a) Calculate the length of the train according to the observer. 2M

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(b) Analyse this thought experiment from the frame of reference of passengers on the train. 3M

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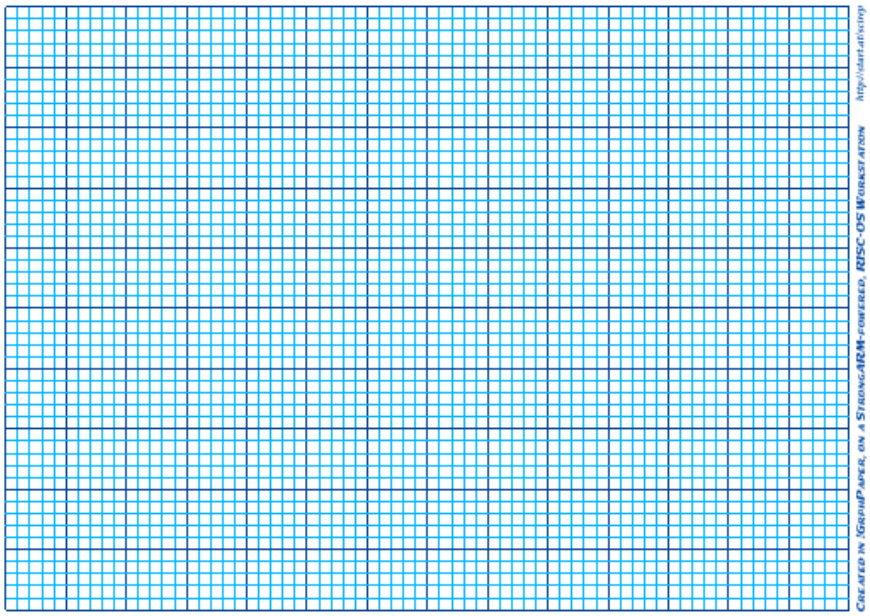
23. The table below shows the value of g at various locations from Earth's centre.

Location	Distance from Earth's centre (m)	Acceleration due to gravity (m s^{-2})	
At the Earth's surface	6.38×10^6	9.8	
2000 km above surface	8.38×10^6	5.68	
4000 km above surface	1.04×10^7	3.70	
10000 km above surface	1.64×10^7	1.49	

(a) Sketch a graph of Distance vs Acceleration due to gravity. Graph the acceleration due to gravity on the vertical axis. 2M



(b) A student concludes from the graph above that the acceleration due to gravity is inversely proportional to distance. Propose how a second graph could be used to confirm this relationship. 2M

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24. Einstein imagined a thought experiment in which an observer saw his reflection in a mirror that he held in front of his face. He then imagined that the observer travelled at the speed of light while holding the mirror in the same position. He asked the question "Would the observer still see his reflection?"

(a) What answer to Einstein's question was predicted by the Aether model? 1M

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(b) Explain the answer deduced by Einstein in this thought experiment. 2M

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25. Jupiter has an orbital radius around the sun that is 5.2 times that of the Earth. Calculate the length of one year on Jupiter. (i.e. the time that it takes Jupiter to orbit the sun) 3M

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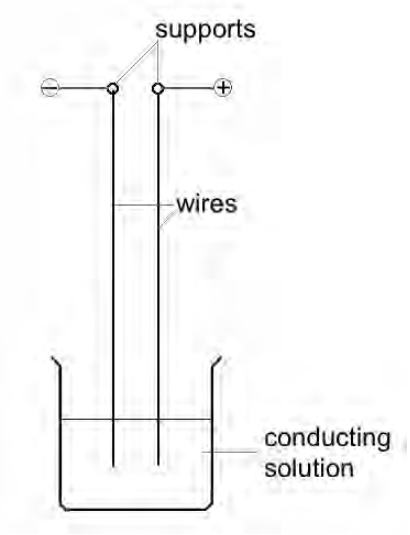
26. Two wires are suspended 4 cm apart, dipped into a conducting solution as shown below. The battery connected as shown causes a current of 3 amperes to flow through the wires.



Calculate the force per metre produced between the wires. 3M

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27. The following device is used to change voltages from one value to another.

Explain how this device works. 4M

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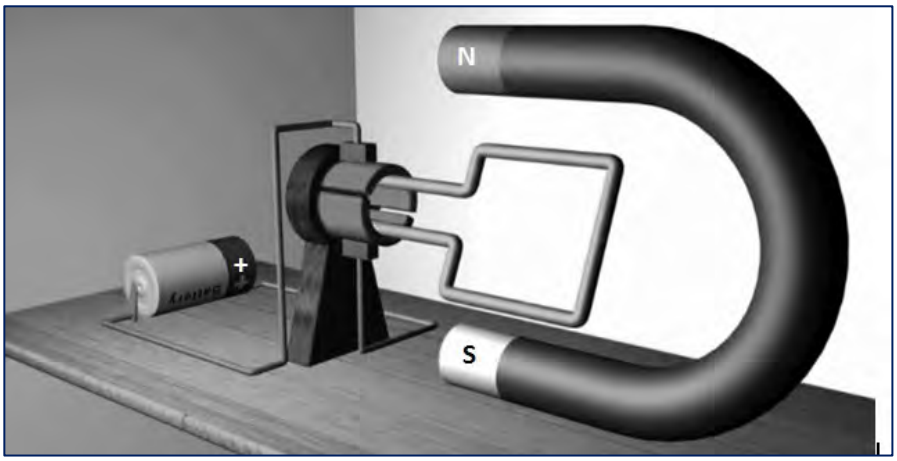
28. This is a diagram representing an electric motor



(a) Identify the type of motor **and** label the parts of the motor on the diagram. 2M

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(b) **S**how **on the diagram** the direction in which the coil is rotating 1M

29. When an electric motor is starting up, there can be a surge of current, which initially is much greater than the current that flows through the motor when it is turning at a constant speed.

Explain why this occurs. 3M

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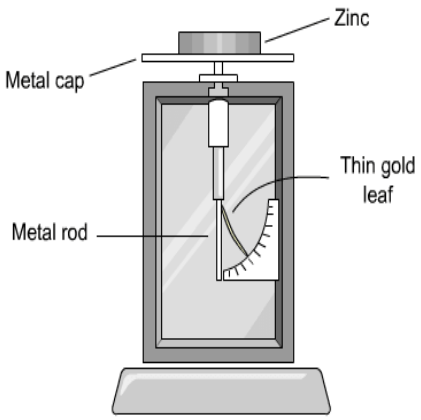
30. The diagram shows a charged electroscope. When the electroscope is uncharged, the thin gold leaf hangs vertically against the metal rod. The diagram shows the position of the gold leaf when the electroscope is charged. A gold leaf is a thin, rectangular sheet similar to metal foil.



Propose how could this apparatus be used to demonstrate the photoelectric effect. In your answer, identify any other apparatus that would be needed, outline the steps that would be carried out and the observations that would be made that are consistent with the photoelectric effect.

3M

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31. Explain why transmitting electrical energy at high voltages is more efficient than using low voltages. Use appropriate equation/s to support your answer. 3M

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32. Explain how Thomson measured the charge-to-mass ratio of cathode rays. 5M

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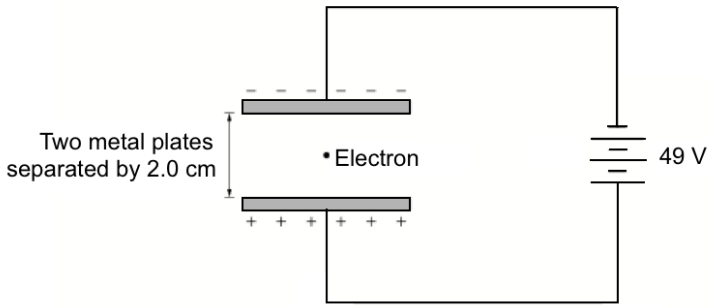
33. The diagram shows two parallel horizontal metal plates connected to a DC source of electricity. Suspended between the plates is an electron.



(a) Using conventional symbols, draw the electric field between the plates 1M

(b) Calculate the electric field strength. 2M

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(c) Calculate the acceleration of the electron. 2M

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34. Assess the impact of advances in the understanding of cathode rays on the development of technologies. Refer to at least two technologies in your answer. 5M

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Section II
Option – Medical Physics – 25 marks

(a) Describe how ultrasound is detected in the medical ultrasound imaging process. (3M)

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(b) An ultrasound pulse strikes heart muscle tissue moving towards the transducer. Compare the properties of the reflected pulse with the initial pulse. 3M

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(c) Compare the structure and function of coherent and incoherent bundles of optic fibres in an endoscope. 3M

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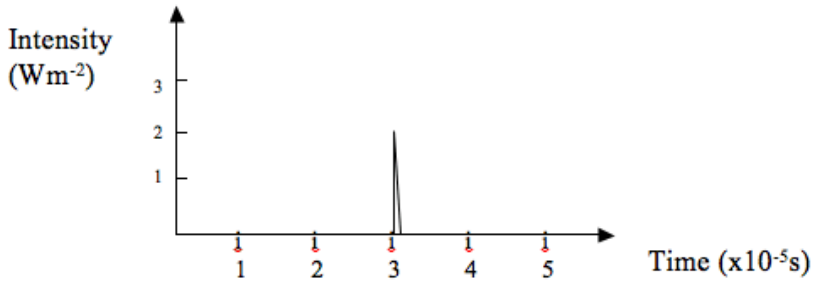
This section continues on the following page

(d) An A-scan ultrasound is used to assist in making a medical diagnosis. The ultrasound travels through fat tissue (velocity=1500 m s^{-1}, Z=1.4 Rayls) and strikes an organ. The A-scan record below shows the result of this process for ultrasound having an initial intensity 100 W m^{-2}. The initial pulse was applied at t = 0 s.



(i) Use the above graph to calculate the distance of the organ from the transducer. 2M

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(ii) Calculate the acoustic impedance of the tissue of which the organ is composed. 3M

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(iii) A-scans provide limited information about the area being examined. What advances in technology have made it possible to produce ultrasound images which show far greater detail? 2M

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(e) Explain how x-rays are used to produce CAT scan images. Use an appropriate diagram to clarify your explanation. 4M

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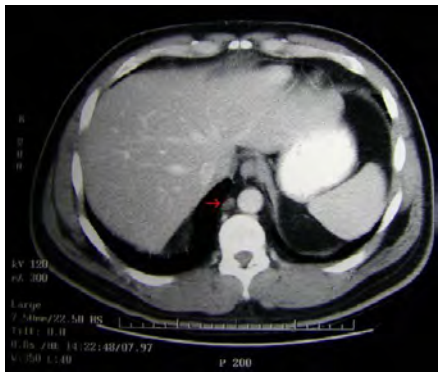
(f) Image I shows an unborn baby and Image II shows a CAT scan of an adult's chest.

Image I ***Image II***



Compare the benefits and risks of these two imaging technologies. 5M

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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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

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

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

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

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

PERIODIC TABLE OF THE ELEMENTS

KEY

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

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

21a. Criteria	Mark/s
Identifies three forces* and relates the upward acceleration of the rocket to the sum of these forces. [*Upward thrust of rocket engines, downward weight force due to gravity and air resistance, which is in the opposite direction to the velocity]	3
States that the upward thrust exceeds the other forces acting on the vehicle and so it accelerates upward OR identifies 3 forces and makes a relevant statement about one of them e.g. the direction in which the force acts.	2
Identifies two forces acting on the launch vehicle during its ascent into orbit OR makes a relevant statement that relates the vehicle's motion to the force/s acting on it.	1

21b. Criteria	Mark/s
Makes a correct judgment about the NASA statement [e.g. that it is not completely correct] **and** relates the motion of the Orbiter to this judgement [e.g. the Orbiter does not escape Earth's gravity, but rather its orbit around the Earth is maintained by gravity, which supplies the required centripetal force]	3
States that the shuttle never escapes the gravitational attraction of the Earth AND makes no incorrect statements in the answer (which reflect a poor understanding of the physics)	2
States that the SRBs are necessary initially because of the large mass of the launch vehicle or that the extra force is required due to the friction produced by the Earth's atmosphere as the rocket increases in speed.	1
The best response would state that the statement is false because the shuttle does not escape the Earth's gravity and that it is gravity that ultimately keeps the shuttle in orbit and that the function of the rocket engines is to increase speed of the rocket to the value that is required for orbit and also to increase the potential energy of the spacecraft as work is done against gravity. Students could also state that work is done against friction.	

22a. Criteria	Mark/s
Calculates the correct length [2.24 m]	2
Correct substitution but incorrect answer.	1

22b. Criteria	Mark/s
Provides a thorough analysis which demonstrates an understanding of the effects of viewing events from different inertial reference frames on length contraction (with reference to the contracted tunnel length from the train frame of reference) and the determination of whether events are simultaneous, depending on the frame of reference. The answer needs to state that two events cannot be simultaneous from two different inertial reference frames moving relative to each other.	3
Demonstrates reasoning by relating the effects of relativity to the inertial frame of reference. Answer states that two events cannot be simultaneous in two frames of reference moving relative to each other OR states that length contraction of the tunnel is observed by a person on the train due to the relative motion of the train and the tunnel.	2
Makes a correct and relevant statement about the effects predicted by special relativity theory.	1

23a. Criteria	Mark/s
Has axes correctly labelled, appropriate linear scales and plots the acceleration value for each data pair accurately AND draws a curved line of best fit.	2
Plots some points correctly and draws curved line of best fit.	1

23b. Criteria	Mark/s
States that a new graph must be plotted of acceleration vs. 1/distance (or 1/a vs. distance) and that if the graph is linear, then distance and acceleration are inversely proportional.	2
States that acceleration should be plotted against 1/distance OR states that if a graph of acceleration vs. 1/distance^2 is a straight line then acceleration is proportional to the inverse square of the distance.	1

24a. Criteria	Mark/s
States that the image would not be visible	1

24b. Criteria	Mark/s
Reasons that observations made within any inertial frame of reference must be the same as those made in any other inertial frame of reference and therefore the observer must be able to see his reflection [whether he is stationary or moving].	2
States that the speed of light is constant and that the reflection must be visible.	1

25. Criteria	Mark/s
Calculates the correct orbital period using either $\frac{R^3}{T^2} = contant$ or $\frac{R^3}{T^2} = \frac{GM}{4\pi^2}$ Answer is 11.85 years, 4328 days or 3.74 x 10^8 seconds	3
Correctly substitutes all variables into either formula	2
Makes a correct substitution into either formula	1

26. Criteria	Mark/s
Calculates the correct magnitude of the force [4.5 x 10^{-5} N] using the formula $\frac{F}{l} = k\frac{I_1 I_2}{d}$ and states that the force is repulsive	3
Substitutes correctly into the formula	2
Has one correct substitution into the formula	1

27. Criteria	Mark/s
States that a varying or **AC voltage** is applied to the primary coil AND The current flowing in the primary coil produces a **changing** magnetic flux which passes through the secondary coil AND That the changing flux through the secondary coil induces a voltage or e.m.f. across the secondary coil AND States that the purpose of the iron core is to increase the flux by becoming magnetised and to direct all the flux through the secondary coil (or to provide a primary-secondary flux linkage) Any incorrect statement or bad physics results in a one-mark loss, even if it is not one of the above points.	4
States that a varying or **AC voltage** is applied to the primary coil AND that a **changing** magnetic flux which passes through the secondary coil which induces a voltage or e.m.f. across the secondary coil.	3
States that the changing current in the primary coil induces a voltage across the secondary coil.	2
States a correct, relevant fact about the operation of a transformer.	1

28a. Criteria	Mark/s
Identifies the motor as a DC motor and labels at least 3 parts correctly including the split ring commutator	2
Identifies the motor as a DC motor and labels one part correctly	1

28b Criteria	Mark/s
Shows the correct direction of rotation e.g. top rotates out of page or anticlockwise viewed from the right-hand end of the coil	1

29 Criteria	Mark/s
States that the rotating coil of a motor generates an e.m.f due to the changing flux through it, which opposes the voltage applied to drive the motor and **reasons** that because at low speeds, when the motor is starting up, that this induced back e.m.f. is negligible, the current through the motor is initially relatively large, but as it gets faster and the back e.m.f. increases the effective voltage across the coils decreases and therefore the current through the coils decreases.	3
States that the rotating coil generates a back e.m.f. that opposes the supplied voltage and relates this to the current.	2
Makes a statement of Lenz's law or states that there is no back e.m.f. when the motor is initially stationary.	1

30 Criteria	Mark/s
Identifies additional apparatus as a source of UV light or light above the threshold frequency of zinc. AND Clearly outlines the steps used to carry out the experiment including beginning with a negatively charged electroscope AND Outlines the effect of the UV light on the charged electroscope (loses its negative charge quickly), demonstrating a high level of understanding of the photoelectric effect.	3
Identifies additional apparatus as a source of UV light or light above the threshold frequency of zinc. AND Demonstrates a sound understanding of the photoelectric effect and its effect on the electroscope.	2
Identifies additional apparatus as a source of UV light or light above the threshold frequency of zinc. OR Demonstrates a sound understanding of the photoelectric effect and its effect on the electroscope.	1

31 Criteria	Mark/s
Using a logical progression of ideas, clearly explains that when transmitting electrical energy, energy is lost due to heating of power lines AND Power loss is proportional to the square of the current using the equation $P=I^2R$ AND To minimise power loss electrical energy should be transmitted at low current and, as a result, high voltage.	3
Two of the above	2
One of the above	1

32 Criteria	Mark/s
Using a logical progression of ideas, clearly explains that Thomson applied both an electric and magnetic fields to balance the forces caused by each and cause cathode rays to pass through undeflected AND includes equation v=E/B AND Thomson applied only the magnetic field and measured the radius AND includes equation q/m=v/rB	4-5
Clearly explains two to three of the above	2-3
One of the above	1

33a Criteria	Mark/s
Field drawn approximates parallel lines from positive to negative.	1

33b Criteria	Mark/s
Gives correct answer with units 2450 $N.C^{-1}$ or $V.m^{-1}$	2
Gives either correct answer or units.	1

33c Criteria	Mark/s
Calculates the force on electron (3.9×10^{-19} C) OR equates Eq=ma AND calculates acceleration of electron (4.3×10^{14} $m.s^{-2}$)	2
One of the above	1

34 Criteria	Mark/s
Clearly gives and assessment of the statement AND gives two significant advances in understanding AND makes a substantial link from each advance to two different technologies.	4-5
Clearly gives and assessment of the statement AND gives two significant advances in understanding OR gives two significant technologies and shows a reasonable understanding of the role of cathode rays in each technologies.	2-3
Clearly gives and assessment of the statement OR gives one significant technology and shows a basic understanding of the role of cathode rays in the technology.	1

Medical Physics

(a) Criteria	Mark/s
Relates the returning ultrasound pulse to the deformation of a piezoelectric crystal and a potential difference produced across the crystal. Answer must use correct scientific terms.	3
Relates the returning ultrasound pulse to : - the deformation of a piezoelectric crystal OR a potential difference produced across the crystal.	2
Answer identifies that the piezoelectric effect is responsible for the detection of ultrasound.	1

(b) Criteria	Mark/s
Answer compares three properties of the incident pulse to the reflected pulse (e.g. same speed, lower frequency, higher intensity). Property must be relevant and correctly worded.	3
Answer compares two properties	2
Answer compares one properties.	1

(c) Criteria	Mark/s
Answer makes one significant structural comparison and two significant functional comparisons. Structural comparison must be specific and not ambiguous.	3
Answer makes one correct structural comparison and one significant functional comparison. OR Two significant functional comparisons	2
Two functional features identified.	1

(d) (i) Criteria	Mark/s
Correct answer calculated (2.25 cm)	2
Correct working with one error.	1

(d) (ii) Criteria	Mark/s
Correct answer of 1.86 or 1.05 Rayls.	3
Uses correct equation but with one incorrect substitution	2
Uses correct equation but with two incorrect substitutions	1

(d) (iii) Criteria	Mark/s
A significant advance in technology (eg development of high power computer processors) related to an improvement in the detail of ultrasound images.	2
A significant advance outlined OR An outline of a ultrasound scan that produces a higher quality image (eg sector scans.)	1

(e) Criteria	Mark/s
A description of the features of a CAT scan including x-rays past through the patient at varying angles, detection of the ultrasound and the processing of information by a computer. Features of the machine related to the production of a tomographic image. Answer must include a correct diagram with an x-ray source and ring of detectors labelled and be well structured and correctly use scientific terminology.	5
Demonstrates a significant understanding of the CAT process with the use of an appropriate diagram.	3-4
Identifies some of the features of a CAT scan.	1-2

(f) Criteria	Mark/s
Five comparative statements between CAT and ultrasound that includes both risks and benefits of each technology.	5
4-5 benefits or risks of each technology outlined but not using comparative statements.	3-4
Identifies some benefits and/or risks of each technology.	1-2