Candidate Number or Name: _____

Ascham School

Trial Examination 2008

Physics

Time allowed: 2 $\frac{1}{4}$ hours (plus 5 minutes reading time)

SECTION I

PART A - 15 one mark multiple choice questions.

Write your answers in pencil on the Part A multiple choice answer sheet. (15 marks)
Write your Candidate number on the answer sheet.

PART B - Short and long response questions.

Write your answers in the space provided. (65 marks)
Write your Candidate number on each section.

SECTION II

Option: Medical physics (20 marks)

Write your answers to this section in the writing booklet.
Write your Candidate number on the booklet.

A periodic table, data sheet and a formula sheet are provided.

Section 1

Total marks (80)

Part A

Total marks (15)

Attempt questions 1 to 15

Use the multiple choice answer sheet.

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

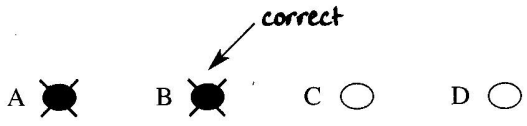
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

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

A ● B ⊗ C ○ D ○

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



Ascham HSC Trial Examination 2008

Name or No:

Section I Part A (15 marks)

1. The following table lists the various values of gravitational field strength at the planet's surface (g) and average radius (r) for planets of the Alderan system. All planets listed orbit a common star.

Planet	g (N / kg)	r (× 10^6 m)
Lis	9.6	1.2
Tat	12.1	0.3
Kat	6.7	1.2
Cha	8.2	25

From this data we could conclude that:

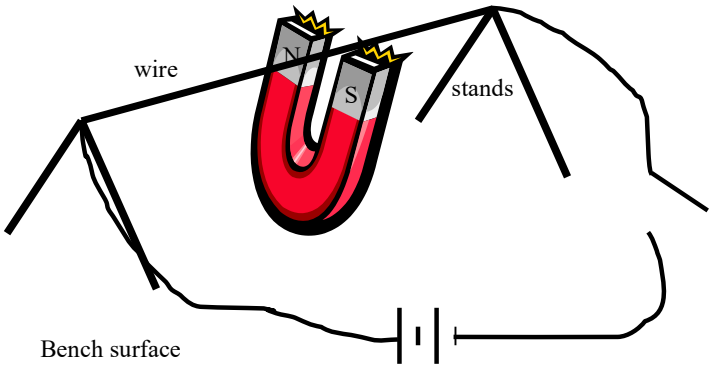
A) The planet Tat has a higher mass than the planet Lis.

B) The planet Kat is larger than the planet Cha.

C) The planet Lis has a higher mass than the planet Kat.

D) The planet Tat is the closest planet to their common star.

2. A rigid conducting wire connected to an external circuit is placed across a magnet with a very low mass as shown. The wire is secured onto a set of stands which in turn is secured to the bench. Predict what will happen when the switch is closed.



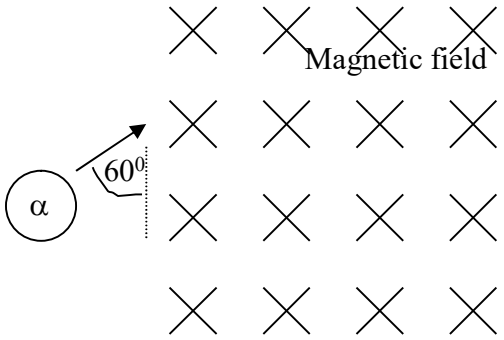
A) The wire will jump out of the magnet.

B) The wire will move down sharply.

C) Nothing will happen.

D) The magnet will jump upwards.

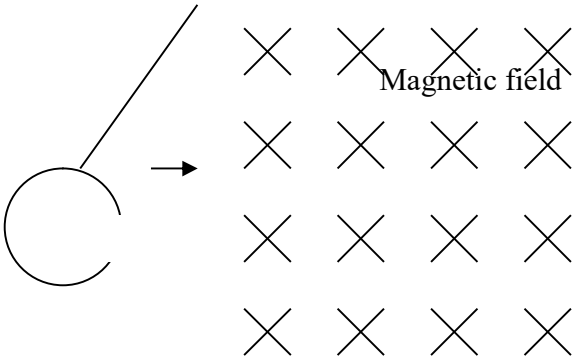
3. An alpha particle enters a magnetic field at the angle shown.



The velocity of the alpha particle is 2×10^3 ms^{-1}, the charge on the alpha particle is 3.2×10^{-19} C, and the strength of the magnetic field is 0.5T. The magnitude of the force on the alpha particle is then:

A) 3.2×10^{-16} N B) 2.77×10^{-16} N C) 0 N D) 2.45×10^7 N

4. An open metal ring is left to swing through a magnetic field as shown. Ignoring friction effects which of the following statements are true?



A) Eddy currents will be induced in the ring thereby slowing the ring down.

B) An emf will be induced in the ring but there will be no slowing down of the ring.

C) The ring will not move at all from its initial position.

D) The ring will experience a force downwards.

5. A traveler in a space ship flies at a speed of 0.8c from star A to Star B in 3 years according to the traveler. How long would an observer on the Earth measure the trip to take?

A) 5 years B) 6.2 years C) 1.8 years D) 2.4 years

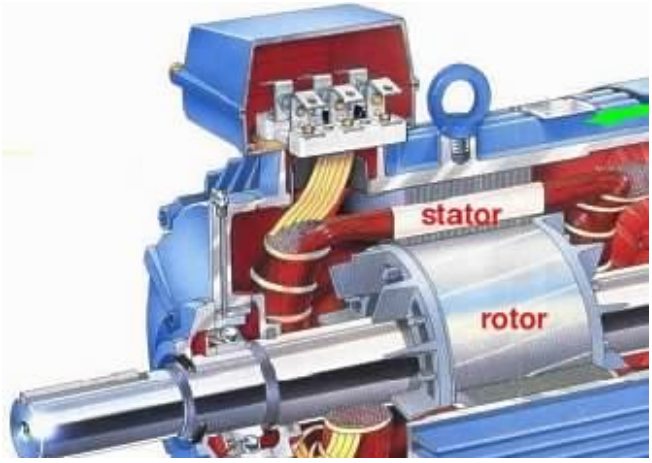
6. Three satellites A, B and C orbit a common planet. The following table summarises the properties of these planets.

Satellites	Mass (kg)	Orbital Radius (km)	Period (hours)
A	600	5000	23
B	1200	-	184
C	1800	7211	69

Using these values calculate the orbital radius of Satellite B.

A) 20000 km B) 10000 km C) 320000 km D) 1200 km

7. The following diagram is a representation of a particular type of motor. Identify this type of motor.



http://www.mech.uwa.edu.au/DANotes/motors/steady/steady.html

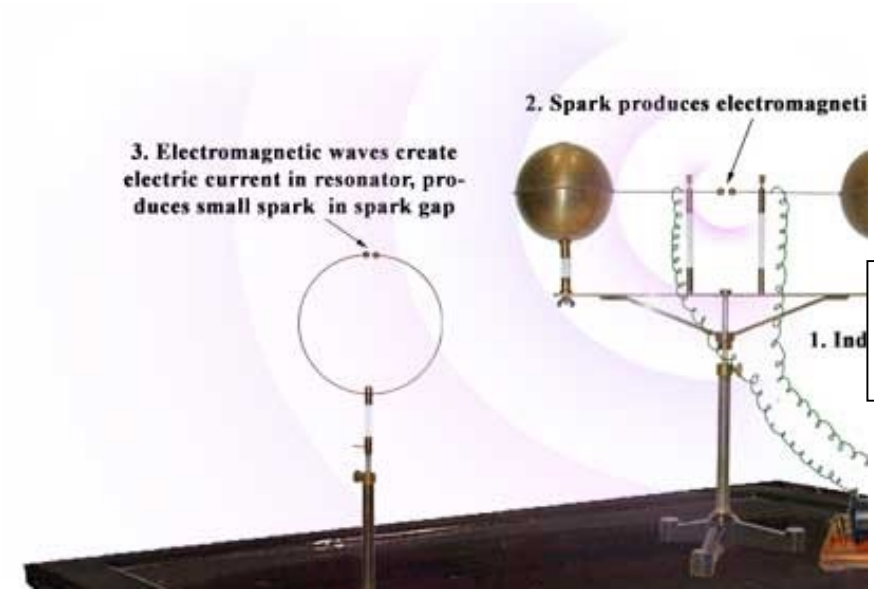
A) DC motor

B) AC Induction motor

C) Synchronous AC motor

D) Brushless DC motor

8. Study the diagram below. This setup was responsible for the development of which device in use today?



http://www.math.uni-hamburg.de/spag/ign/events/hertz07.htm

A) TV

B) Mobile Phone

C) Radio

D) Satellite

9. JJ Thomson showed that the charge to mass ratio for the 'particles' which made up cathode rays was always a constant. This meant that:

A) Cathode rays consist of the same kind of particles.

B) The charge of an electron could be determined.

C) The mass of the electron could be determined.

D) Cathode rays had a wavelike nature.

10. A transformer converts AC 240 V to AC 4.2 V assuming it has 100% efficiency, calculate the number of turns in the secondary coil if the primary coil has 1000 turns.

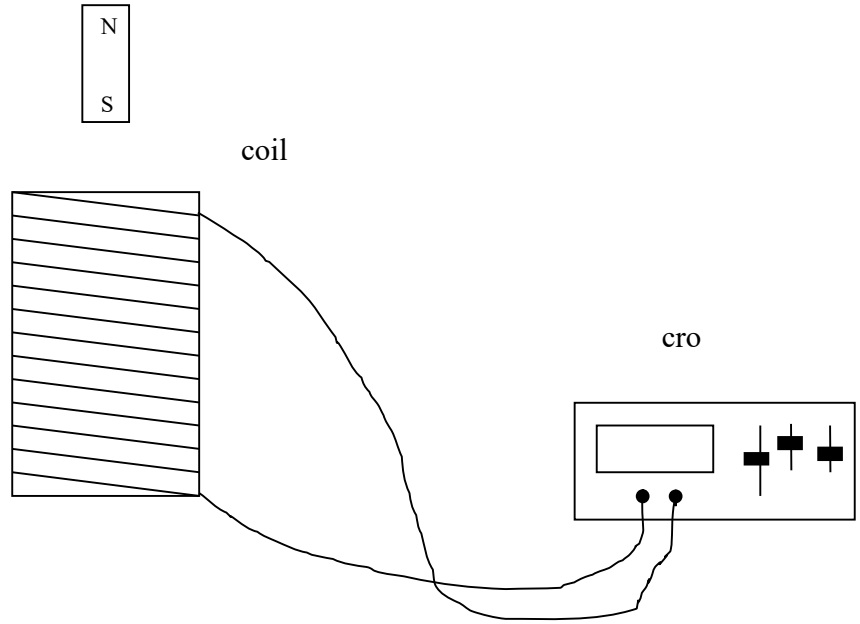
A) 18 turns

B) 16 turns

C) 57000 turns

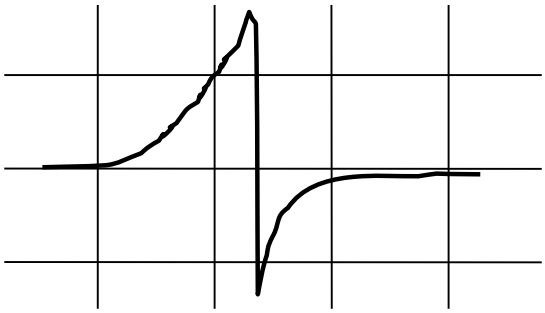
D) 2318 turns

11. A magnet is dropped into a coil of wire which is connected to a cathode ray oscilloscope as shown.

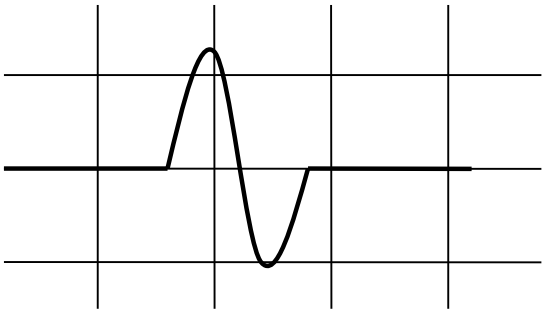


Which of the graphs below would show up on the oscilloscope as the magnet completely falls through?

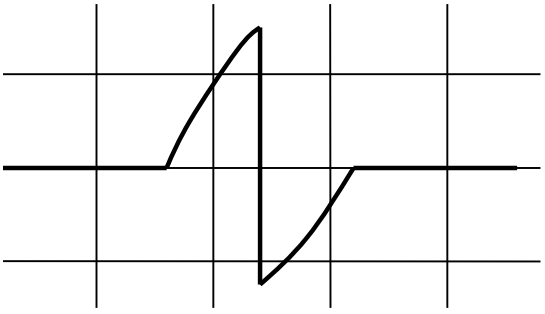
A)



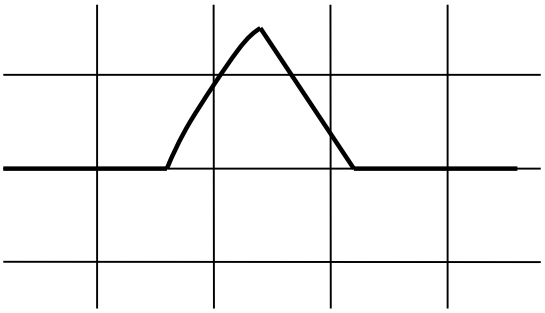
B)



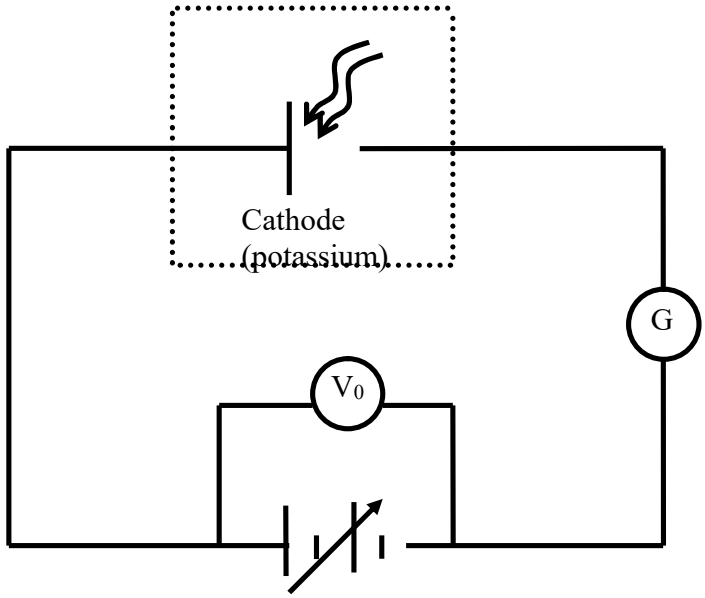
C)



D)



12. The following diagram is a setup used to demonstrate the photoelectric effect. Which of the following would most affect the amount of current in the circuit?



A) Decreasing the frequency of the light

B) Increasing the wavelength of the light.

C) Increasing the light intensity.

D) Changing the cathode material from potassium to sodium.

13. The length of a spaceship is measured to be 30.00 m at rest on Earth. The ship now takes off to the moon travelling at a constant speed of 13km/s. An observer remaining on Earth would measure the ship's length to be closest to:

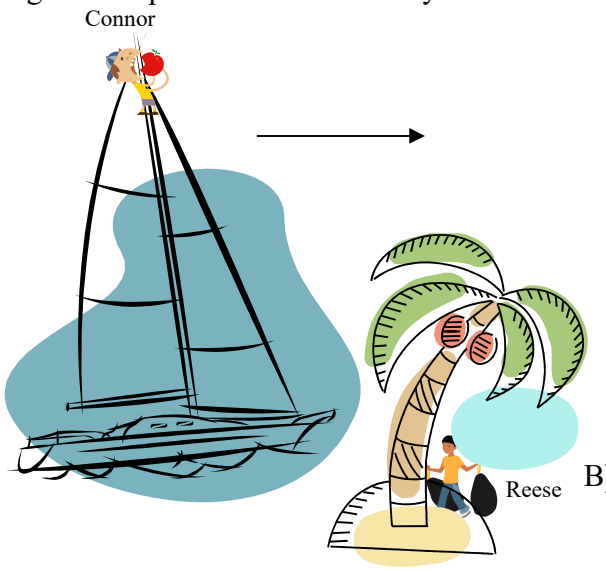
A) 29.00 m

B) 30.00 m

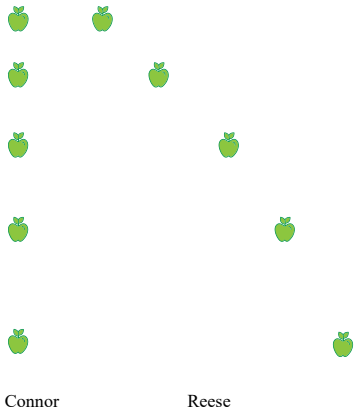
C) 31.00 m

D) 17.89 m

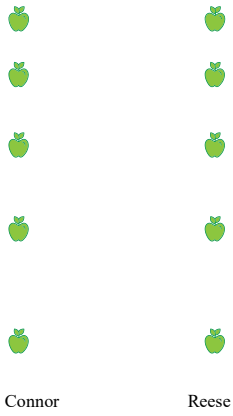
14. Connor is on a sailing boat. He decides to climb up the sail to get a better view whilst eating his apple. Unfortunately for him, he accidentally drops the apple. Reese is stranded on a nearby island and sees this happening. Which picture below correctly shows how each boy sees the falling apple?



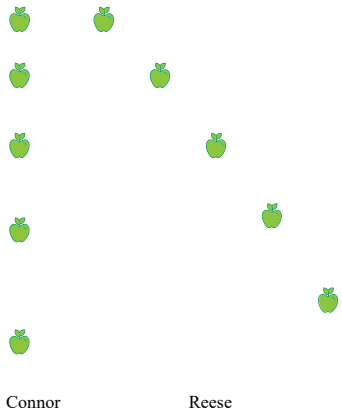
A)



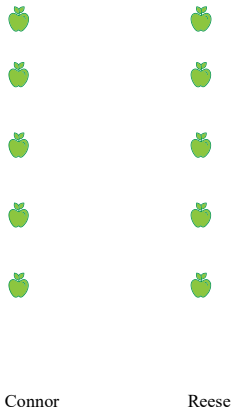
B)



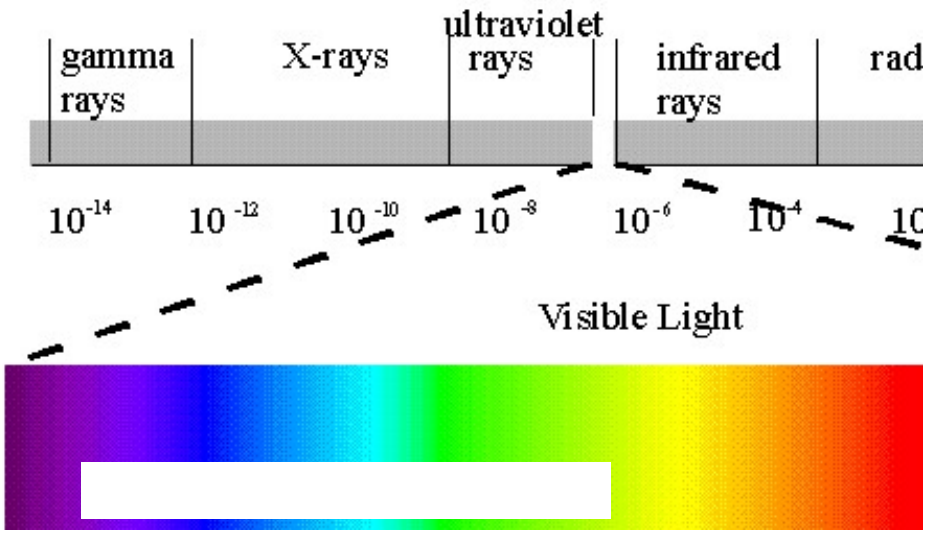
C)



D)



15. A photon of electromagnetic radiation has an energy of 1.24×10^{-6} eV. Using the graph below, this type of radiation would be most suitable for:



http://www.yorku.ca/eye/spectrum.gif

A) sterilization of medical equipment.

B) medical imaging

C) radio communication

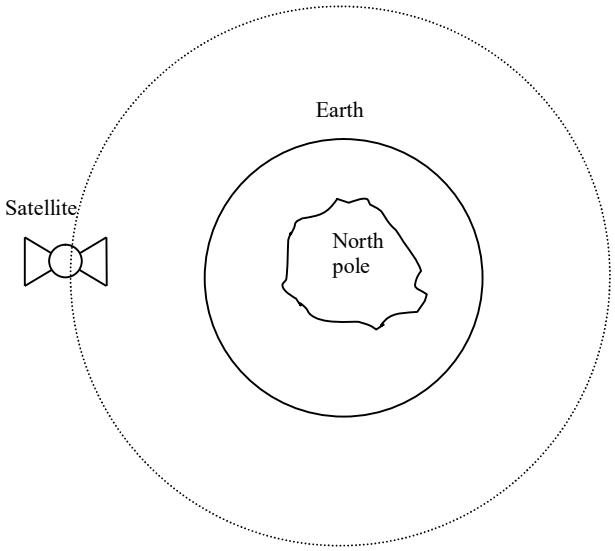
D) illumination

Ascham HSC Trial Examination 2008

Name or No:

Section I Part B (65 marks)

16.



A satellite orbits Earth in a near circular path as shown.

a) On the diagram, draw the velocity and acceleration vectors of the satellite.

/2

b) Given that the mass of the satellite is 600 kg and the altitude is 35800 km, calculate the required velocity v_c for the satellite to maintain its circular path.

_____

_____

_____

_____

_____

/2

c) Draw the resulting path of the satellite if the velocity v of the satellite is suddenly increased such that $v > v_c$.

/2

d) State one use for this particular type of satellite and justify its positioning (altitude).

Use: _____

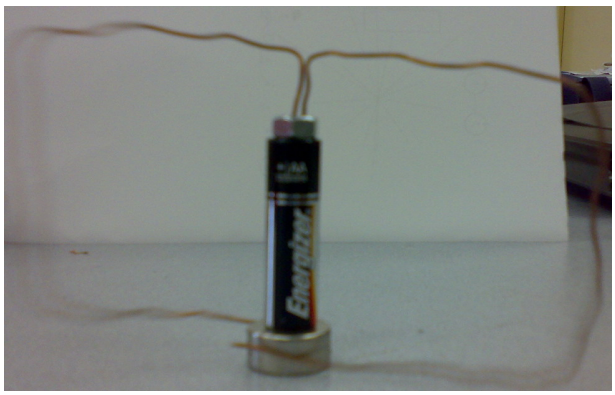
Justification:

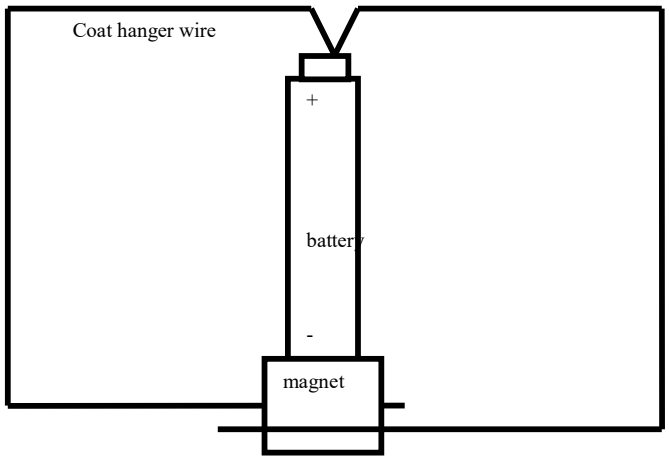
_____

_____

/2

17.





A simple motor can be constructed using a powerful magnet, battery and coat hanger wire fashioned into a rectangular shape as shown. Explain with reference to the motor effect how this is possible and include the direction of rotation in your answer. You may use diagrams to assist with your explanation.

_____

_____

_____

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/3

18. Explain why it is dangerous if an industrial grade motor is prevented from spinning when the power is switched on.

_____

_____

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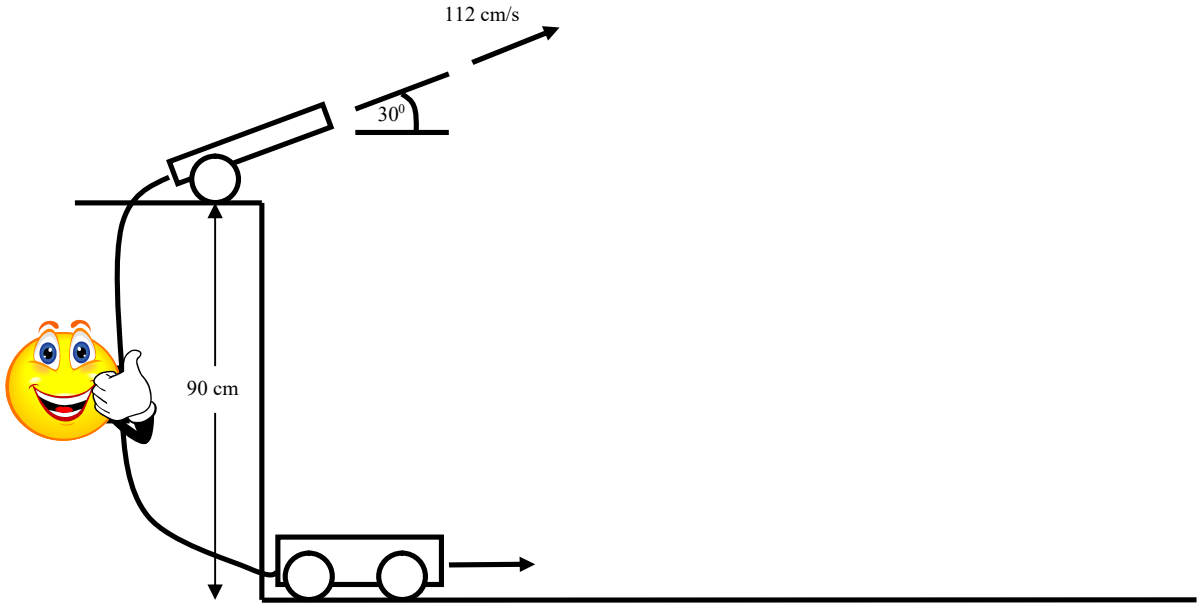
_____

/3

19. Captain 'Smilesalot' is playing with his toys. In his hand is a trigger which simultaneously fires a canon and starts a motorised toy cart which travels at a constant speed. The canon sits atop a desk 90 cm high whilst the cart is on a horizontal floor.



If the angle of the canon is at 30^0 to the horizontal determine:

a) the required speed of the cart if it is to meet with the projectile.

/2

b) the time of flight of the projectile.

/3

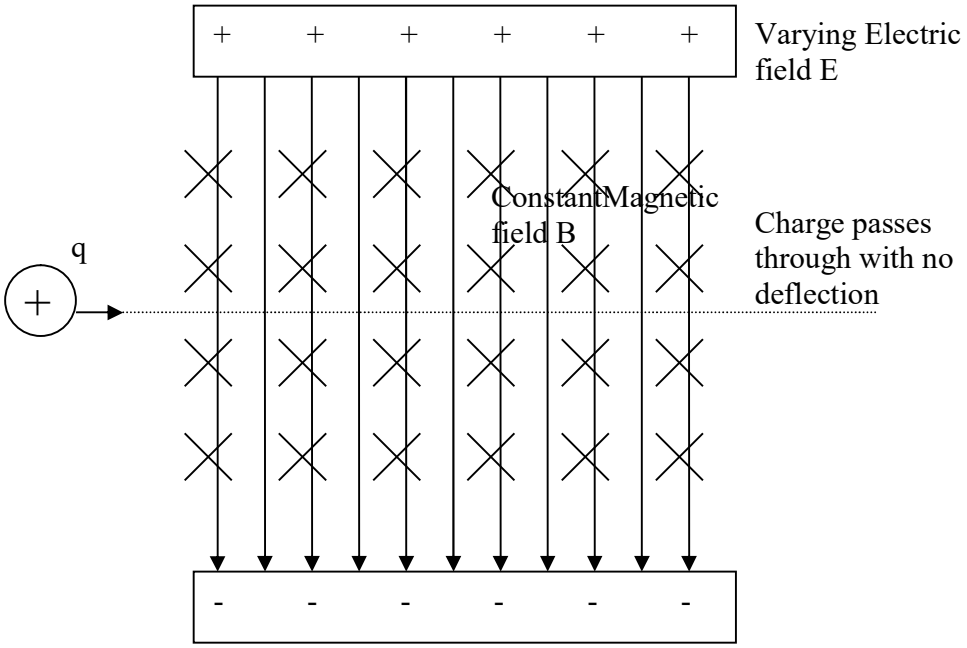
20. It is often said that Einstein's special relativity theory contradicts common sense. Discuss this statement with reference to predictions, experiments and findings.

/4

21. Outline Planck's contribution to our understanding of black body radiation.

/3

22. A student fires a positive charge q through a velocity selector. The selector consists of an electric field and a magnetic field superimposed as shown. She decides to keep the strength of the magnetic field constant and vary the electric field such that for a given velocity the charge will pass through undeflected.



a) Derive an equation showing the relationship between the velocity of the charge v, the electric field strength E and the magnetic field strength B (you may neglect the effects of gravity).

/3

(Q22 is continued over the page)

b) The results she obtains are as follows:

Velocity v ($\times 10^5$ m/s)	Electric Field Strength E ($\times 10^3$ V/m)
2.10	63
3.25	97
4.18	125
5.79	175
8.13	250

Plot these results on the axes below and draw a line of best fit.

/4

c) Use the line of best fit that you have drawn to get an approximate value for the magnetic field strength used (show all working).

_____

_____

_____

/2

23.

a) Describe a first hand investigation you did (or studied) to show the factors affecting the amount of electromagnetic braking on a metal sheet.

/6

b) State how this principle may be applied usefully in today's society.

/2

24.

a) Define an inertial frame of reference.

_____

_____

/1

b) Describe an experiment which allows you to identify whether you are in an inertial frame of reference.

_____

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/3

25.

a) Albert Einstein did not rely on serendipitous (chance) discoveries or observations in order to develop his theories. In fact, the technology at the time did not allow these theories to be tested for quite some time. State one prediction that arose from Einstein's relativity theory.

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_____

/1

b) Give an example of an experiment used to show the above prediction is in fact correct.

_____

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/2

26.

a) A satellite in a particular orbit has a mass of 1200 kg, its altitude is 850 km. Given that the radius of the earth is 6.4×10^6 m, calculate the satellite's gravitational potential energy.

_____

_____

_____

_____

/3

b) What is the minimum amount of energy required for the satellite to leave its orbit and escape Earth's gravitational field?

_____

/1

26. Describe using diagrams and words a thought experiment used to explain the relativity of simultaneity.

/5

28. A generator is a device that transforms kinetic energy into electrical energy. Assess the impact of the development of generators on today's society.

/6

Section II Option Medical Physics (20 marks)

1.

a) Using the values in the table below calculate the percentage reflection when ultrasound passes from air to skin.

Medium	Acoustic impedance Z (/kg/m^2/s)
Air	429
water	1.50×10^6
Muscle	1.70×10^6
bone	7.50×10^6
Soft tissue	1.63×10^6

_____

_____

_____

_____

/2

b) Hence justify the use of an acoustic gel when taking ultrasound images of the human body.

_____

_____

_____

/2

2. Describe an application in real life whereby an A scan can be used with maximum effectiveness.

_____

_____

_____

/2

3. Explain why the element Hydrogen is of most importance to doctors and scientists in the field of MRI.

_____

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/2

4. Outline the production of gamma rays and their use in the diagnostic procedure of PET.

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/3

5. The following image is a picture of a human larynx (voice box) taken by an endoscope. The subject here was suspected to have a condition known as laryngitis. Discuss the endoscope's suitability in diagnosis of a disease of this type.

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/3

6. An understanding of electromagnetic radiation and its effects on biological as well as artificial items has been crucial in the development of medical diagnosis. Justify this statement with reference to the production and display of images used for medical diagnosis.

/6

End of Paper ☺

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

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

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

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

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

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

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

$$Z = \rho v$$

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

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

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

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 Lanthanides	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 [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] 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

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.

Ascham HSC Trial Examination 2008

Multiple Choice Answer Sheet **Number or Name:** _____

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