CRANBROOK SCHOOL

YEAR 12 TRIAL HSC EXAMINATION

PHYSICS
2 UNIT HSC COURSE
2001

Answers

DIRECTIONS TO CANDIDATES:

- Write your Student Number at the top right hand corner of this page.

Section I
PART A Multiple Choice

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

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

Write your answers in the spaces provided for each question.

Question 16 (7 marks) — Marks

(a) (i) • The speed of light is constant and independent of the motion of the observer.
• All inertial frames of reference are equivalent or/ laws of physics are the same in all inertial frames — 2

(ii) the length of an object appears to decrease to an external observer when the object is moving at speeds close to the speed of light.
• the time in a moving frame (close to the speed of light) appears to go slower to a stationary observer. — 3

(b) $t_s = \frac{t_o}{\sqrt{1 - v^2/c^2}}$ t_s = time observed by stationary obs.

$t_s = \frac{2.2}{\sqrt{1 - \frac{0.99^2}{1}}} = \frac{2.2}{0.1410673} = 15.6 \mu s$

distance observed = $15.6 \times 10^{-6} \times 3 \times 10^8$ (speed of light)

= 4680m (4.7 km)

4630m

(92.2)

next page

Marks

Question 17 (6 marks)

(a) Using $r^3/T^2 = \frac{GM}{4\pi^2}$ where M = mass of mars

$T = 7h\ 39m = 2.754 \times 10^4 s$ $\therefore M = \frac{4\pi^2 r^3}{GT^2}$

$M = \frac{4\pi^2 \times (9.5 \times 10^6)^3}{6.67 \times 10^{-11} \times (2.754 \times 10^4)^2} = 6.7 \times 10^{23}$ kg ✓ 2

(b) • The satellites are hidden for part of their orbit around the Earth.

• Due to appreciable air-resistance, they lose their orbital velocity and spiral down to Earth (may burn up on re-entry) 2

(c) $r^3/T^2 = GM/4\pi^2 \Rightarrow r^3 = \frac{GMT^2}{4\pi^2}$

$T = 24$ hours $= 24 \times 60 \times 60$

$r = \sqrt[3]{\frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times (24 \times 60 \times 60)^2}{4\pi^2}} = 4.23 \times 10^7$ m 2

Question 18 (3 marks)

Three issues discussed from one of the following:

• Distance and time of travel (one issue)

Speed required (linked to above – one issue) 3

• Fuel to be carried for manoeuvring and return flight.

• Communications difficulties (weak signal)

• Hazards from radiation & perhaps asteroids.

Marks

Question 19 (4 marks)

(a) $v_{max\ height} = 0$ $v = u + at$ $a = -9.8 m/s^2$

$0 = 80 \sin 30 + (-9.8)t$

$\therefore t = \frac{80 \sin 30}{9.8} = 4.1 s$

(b) $v^2 = u^2 + 2as \Rightarrow 0 = (80 \sin 30)^2 + 2(-9.8)s$

$s_{max} = \frac{40^2}{19.6} = 81.6$ m (82 m)

$\therefore$ Total height above sea level = 182 m

(c) Speed at max height is horizontal component of initial velocity $= 80 \cos 30° = 69.3 = 69$ m/s

(d) time down: $s = -182$ m from max height, $u_{max\ height} = 0$ vertically

$s = ut + \frac{1}{2}at^2$

$-182 = 0 + \frac{1}{2}(-9.8)t^2 \Rightarrow t = \sqrt{\frac{182}{4.9}} = 6.1 s$

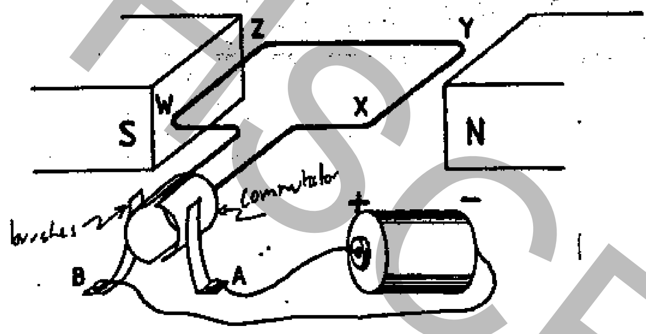
$\therefore$ Total time $= 6.1 + 4.1$ (time up) $= 10.2$ s

next page

4

Marks

Question 20 (7 marks)



(a) Commutator: allows the current in the coil to change direction every ½ revolution so coil travels in constant direction.

Brushes: allow current to conduct to coil without affecting the rotation of the coil

(b) $\tau_{max} = nIAB = 20 \times 9.0 \times 0.20 \times 0.40 \times 0.32$

$= 4.6$ Nm — 2

(c) (i) multiple coils ensure that active coil is always aligned to field lines for maximum torque. Allows smooth torque + maximum torque — 1

(ii) curved faces provide a radial field so that coil is always aligned with field lines ∴ smooth, strong torque — 1

(iii) laminations reduce eddy current build up in rotor ∴ reducing heating in rotor and energy loss — 1

5

Marks

Question 21 (2 marks)

Similarity: both contain coils in magnetic fields, respond to a current causing movement of the coil

Difference: The galvanometer has hair springs to prevent it moving full circle (provides counter torque) as well as no commutator (doesn't need to move full circle)

Question 22 (2 marks)

Motors act as generators producing currents in them as they turn in a magnetic field. The current opposes the change that caused it (Lenz's law) and leads to back emf. The nett current drops in the coil as it picks up speed ∴ resistance can be removed as it is not likely to burn out the coil.

6

Marks

Question 23 (6 marks)

(a) High voltages produced by transformers are accompanied by lower currents. This reduces current heating effects in wires and losses of efficiency (energy) in transmission. 1 1 (2)

(b) $N_s : N_p = 500000 : 25000$

$= 20 : 1$ 1

(c) $V_p I_p = V_s I_s \quad \therefore I_s = \frac{V_p I_p}{V_s} = \frac{25000 \cdot 1000}{500000}$

$= 50\,A$ 1

(d) The transformer consists of a laminated core about which wires are wound. This reduces eddy currents and so energy losses due to heating are reduced. 1 1 (2)

Question 24 (8 marks)

(a) $E_{max} = hf - \phi \qquad \phi = \text{work function}$

$1.3 \times 10^{-19} = 6.626 \times 10^{-34} \times 7 \times 10^{14} - \phi$

(4.6382×10^{-19})

$\therefore \phi = 4.6382 \times 10^{-19} - 1.3 \times 10^{-19} = 3.3 \times 10^{-19}\,J$ (3.34×10^{-19}) 1

$\phi = h f_0 \qquad f_0 = \text{threshold frequency}$

$f_0 = \frac{\phi}{h} = \frac{3.34 \times 10^{-19}}{6.626 \times 10^{-34}} = 5.04 \times 10^{14}$

$= 5.0 \times 10^{14}\,Hz$ 1

Question 24 continued next page

7

Marks

Question 24 continued

(b) Intensity: No effect on the maximum KE of electrons as max KE depends on the frequency 1

• increases the value of photoelectric current as more electrons are released. 1

Frequency: • Emission is frequency dependent, below the threshold frequency no emission occurred as the minimum energy depended on a min frequency 1

• No effect on the photoelectric current as frequency only determines the energy not the number. 1

(c) Classical theory predicted that emission is independent of frequency and that the KE of photoelectrons would increase with light intensity 1 1

Question 25 (4 marks)

(a) $F = Bqv = 0.1 \times 1.602 \times 10^{-19} \times 1 \times 10^{5}$

$1.6 \times 10^{-15}\,N$ 1

Direction: up the page (in the same plane of page) 1

(b) $F = ma \quad \therefore a = \frac{F}{m} = \frac{1.6 \times 10^{-15}}{9.109 \times 10^{-31}} = 1.8 \times 10^{15}\,m/s^2$ 1

(c) $F_{mag} = F_{Elec} = qE \quad \therefore E = \frac{F}{q} = \frac{1.6 \times 10^{-15}}{1.60 \times 10^{-19}} = 9987.5\,N/C$

$1 \times 10^{4}\,N/C$

NO

Question 26 (4 marks)

(a) Energy losses in wires due to resistance would be greatly reduced saving large amounts of energy which would be used as electrical energy and reducing costs and environmental problems. Also power plants can be built very far from population centres. — 1

(b) any 2
- Ceramic superconductors are too brittle and difficult to make into wires for transmission — 1
- They are chemically unstable in some environments — 1
- Costly and difficult to manufacture

Question 27 (4 marks)

(a) In a metal the increase in temperature increases the increased vibrations of lattice ions increases the probability of collisions with conduction electrons. — 1

In semiconductors the increase in temperature provides the energy to promote conduction electrons into the conduction band – jumping the forbidden gap thus lowering resistance — 1

(b) Thermionic emission: emission of electrons from surface when a material (such as a metal) is heated. — 1

- Solid state devices are compact resulting in miniaturisation
OR They waste less energy in heating effects than thermionic devices — 1
OR cheaper to manufacture.
or long start-up time while they heat up

Question 28 (3 marks)

(a) These are +ve charged and accelerate the electrons emitted by the cathode. — 1

(b) Deflect the electron beam and have two time bases for vertical and horizontal deflection. — 1

(c) The coating fluoresces (lights up) as electrons strike the screen to give an image of the signal (picture). — 1

10

Marks

Question 29 (7 marks)

(a) $F_{mag} = F_{elec}$ on charged particles — 1

$Bqv = qE$ — 1

$\therefore v = E/B$

(b) $F_{mag} = F_c$ — 1

$Bqv = \frac{mv^2}{r} \Rightarrow m = \frac{Bqr}{v}$ (or use momentum) — 1

$\therefore m \propto r \quad \therefore m_2 > m_1$

(c) line 1 From (b) above $q = \frac{mv}{Br}$ and $m = \frac{Bqr}{v}$ — (1)

$\therefore q \propto \frac{1}{r}$ and $m \propto r$ — (1)

$\therefore$ small mass, large charge bends most

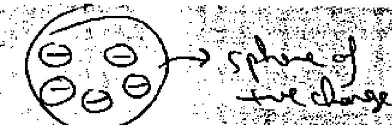
line 1: ${}^{6}_{3}Li^{2+}$

line 2 ${}^{6}_{3}Li^{+}$ — (1)

line 3 ${}^{7}_{3}Li^{+}$

next page

11



Marks

Question 30 (7 marks)

(a) A sphere of positive charge with electrons embedded in it. — 1

(b) Alpha particles were fired at gold foil and the deviation of the α-particles was detected by using a scintillating screen after passing through the gold foil — 1, 1

(c)(i) The deviation of the α-particles after passing through the gold foil would be very small. — 1

(ii) Most of the α-particles passed through with small deviations but a small number showed large deviations (scattering) — 1

(iii) The +ve charge in the atom must be concentrated in a very small volume and that the atom was largely empty space. — 1, 1

(the mass of the atom is concentrated in the nucleus as it was known that mass of +ve charges [protons] is larger than that of electrons).

Marks

(a)

d (cm)	Period, T (s)	d^2 (cm^2)	T^2 (s^2)
10	6.78	100	46.0
15	7.18	225	51.6
20	7.70	400	59.3
25	8.00	625	64.0
30	9.10	900	82.8
35	9.68	1225	93.7

(b) Graph paper

(c) A: "y" intercept

∴ A = 42 s²

B: Gradient = $\frac{96 - 44}{1300 - 50}$ = 0.042 s² cm⁻²

(d) A represents the (period)² when the two masses are both at the 50 cm mark of the ruler (minimum (period)²). Experimentally, it can be measured by placing the masses at the 50 cm mark.