
Student Number

SCEGGS Darlinghurst

2010

HIGHER SCHOOL CERTIFICATE
THEORY TASK

Physics

This PAPER does not necessarily reflect the content or format of the Higher School Certificate Examination for this subject.

General Instructions

- Working time – 70 minutes
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- Write your Student Number at the top of this page and page 3 and the Answer Booklet.

Total marks – 40

Section I Pages 1–5

20 marks
This section has two parts, Part A and Part B

Part A – 5 marks
- Attempt Questions 1–5
- Allow about 8 minutes for this part

Part B – 15 marks
- Attempt Questions 6-8
- Allow about 27 minutes for this part

Section II Page 6

20 marks
- Attempt Question 9
- Allow about 35 minutes for this section

Section		Marks Allocated	Marks Awarded
I	Part A	5	
	Part B	15	
II		20	
TOTAL		40	

Section I
20 marks

Part A – 5 marks
Attempt Questions 1–5
Allow about 8 minutes for this part

Write your answer in the space provided beneath each question.

1 If the radius of the Earth is 6380 km, what is the gravitational potential energy of a 2.00 kg rock on the surface of the Earth?

(A) -1.2×10^{8} J

(B) -1.2×10^{11} J

(C) -1.3×10^{8} J

(D) -1.3×10^{11} J

ANSWER: ……..

2 Which of the following statements about escape velocity is FALSE?

(A) The more massive a planet, the greater the escape velocity required.

(B) If a planet's radius were to increase, its escape velocity would decrease.

(C) Escape velocity is related to the Universal Gravitational constant G.

(D) A massive object trying to leave a planet needs a greater escape velocity than a less massive object.

ANSWER: ……..

3 The slingshot effect is used to increase the speed of a spacecraft as it approaches, swings around and leaves a planet. Which statement is correct?

(A) The energy of the planet stays constant.

(B) There is no energy loss or gain for the planet/spacecraft system.

(C) The momentum of the planet is constant.

(D) The potential energy of the spacecraft stays constant.

ANSWER: ……..

4 This question refers to the following information.

Planetary body	Surface Gravitational Field Strength (N/kg)
Sun	273.70
Earth	9.81
Moon	1.62
Mars	3.73

If the weight of an astronaut on Earth is 736 N, what is their weight on Mars?

(A) 122 N

(B) 280 N

(C) 736 N

(D) 2750 N

ANSWER: ……..

5 The Hubble Space Telescope (HST) of mass 11 000 kg is in circular orbit 600 km above the Earth (r_E = 6380 km). The centripetal force acting on the HST is:

(A) 1.1×10^{11} N

(B) 6.3×10^{11} N

(C) 9.0×10^{4} N

(D) 9.0×10^{10} N

ANSWER: ……..

Student Number

Section I (continued)

Part B – 15 marks
Attempt Questions 6-10
Allow about 27 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

Question 6 (3 marks)

A space rocket carries its fuel with it as well as oxygen. If hydrogen is the fuel, it reacts explosively with oxygen and produces steam which is forced out of the rocket at high speeds. **3**

Explain how conservation of momentum applies to the changing velocity of a space rocket.

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Marks

Question 7 (5 marks)

A cannon ball is fired horizontally with a velocity of 50.0 ms^{-1} from the edge of the top of a cliff 150 m above sea level. The canon was then rotated up so that it was at an angle of 55° to the horizontal. A cannon ball was then fired with the same speed. **5**

Contrast, quantitatively, the range of the two canon balls.

Marks

Question 8 (7 marks)

(a) The moon Phobos circles Mars in 7 hours and 39 minutes at a distance of 9.5×10^6 m as measured from their centres. Calculate its orbital speed in ms^{-1}. **2**

(b) Explain the issues associated with satellites in low Earth orbits. **3**

(c) Calculate the orbital radius of a satellite in a geostationary orbit, as measured from the centre of the Earth. **2**

Physics

Section II

20 marks
Attempt Question 9
Allow about 35 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.
Show all relevant working in questions involving calculations.

Marks

Question 9 Medical Physics (20 marks)

(a) The acoustic impedance of the human kidney is 1.62×10^6 kg m^{-2} s^{-1}. If the density of the human kidney is 1.04×10^3 kg m^{-3}, calculate the velocity that ultrasound travels with through the kidney. **2**

(b) Compare 'hard' and 'soft' X-rays. **3**

(c) Contrast the use of X-rays (DEXA) with ultrasound when investigating bone density in humans. **3**

(d) Assess the use of PET scans and CAT scans for the detection of cancer. **7**

(e) (i) Describe how the net spin of a nucleus is calculated. **2**

(ii) Explain with reference to precession and the Larmor frequency, how the net spin of protons is used in magnetic resonance imaging (MRI). **3**

End of paper

DATA SHEET

Charge on the electron, q_e	$-1 \cdot 602 \times 10^{-19}$ C
Mass of electron, m_e	$9 \cdot 109 \times 10^{-31}$ kg
Mass of neutron, m_n	$1 \cdot 675 \times 10^{-27}$ kg
Mass of proton, m_p	$1 \cdot 673 \times 10^{-27}$ kg
Speed of sound in air	340 ms^{-1}
Earth's gravitational acceleration, g	9.8 ms^{-2}
Speed of light, c	$3 \cdot 00 \times 10^{8}$ ms^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	$6 \cdot 67 \times 10^{-11}$ N m^2 kg^{-2}
Mass of Earth	$6 \cdot 0 \times 10^{24}$ 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}

2010 HIGHER SCHOOL CERTIFICATE THEORY TASK

Physics

FORMULAE SHEET

$v = f\lambda$

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

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

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

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

$P = VI$

Energy = VIt

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

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

$\Sigma F = ma$

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

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

$W = Fs$

$p = mv$

Impulse $= Ft$

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

$F = mg$

$v_x^2 = u_x^2$

$v = u + at$

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

$\Delta x = u_x t$

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

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

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

$E = mc^2$

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

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

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

2010 HIGHER SCHOOL CERTIFICATE THEORY TASK

Physics

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

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

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

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

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$

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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Answer Booklet

Instructions

- Write your Student Number in the space provided
- Write using blue or black pen
- Write your answers to question 12 in this booklet

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