

QCE Physics Units 3&4

Paper 1

Student's Name: _____

Teacher's Name: _____

Time allowed

- Perusal time – 10 minutes
- Working time – 90 minutes

General instructions

- Answer all questions in this question and response booklet.
- QCAA-approved calculator permitted.
- Formula and data booklet provided.
- Planning paper will not be marked.

Section 1 (20 marks)

- 20 multiple choice questions

Section 2 (30 marks)

- 8 short response questions

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2023 QCE Physics Units 3&4 Written Examination.

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SECTION 1

Instructions

- Choose the best answer for Questions 1–20.
- This section has 20 questions and is worth 20 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	A	B	C	D
1.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION 2

Instructions

- Write using black or blue pen.
 - If you need more space for a response, use the additional pages at the back of this booklet.
 - On the additional pages, write the question number you are responding to.
 - Cancel any incorrect response by ruling a single diagonal line through your work.
 - Write the page number of your alternative/additional response, i.e. See page ...
 - If you do not do this, your original response will be marked.
 - This section has eight questions and is worth 30 marks.
-

DO NOT WRITE ON THIS PAGE

THIS PAGE WILL NOT BE MARKED

QUESTION 21 (3 marks)

Describe how an object can move with uniform circular motion. Refer to acceleration in your response.

QUESTION 22 (2 marks)

State the two postulates of special relativity.

Postulate 1 _____

Postulate 2 _____

QUESTION 23 (3 marks)

The Large Hadron Collider is the world's most powerful particle accelerator and has a circumference of 26.659 km. It accelerates protons to within half of a billionth of a trillionth of a percent of the speed of light, c .

Assume that the Large Hadron Collider accelerates a proton to a speed of $0.99999c$.

- a) Calculate the time it takes for a proton to travel the entire length of the Large Hadron Collider's circumference in the frame of reference of the Large Hadron Collider. *[1 mark]*

Time = _____ ns (to the nearest whole number)

- b) Calculate the time it takes for a proton to travel the entire length of the Large Hadron Collider's circumference in the frame of reference of the proton. *[2 marks]*

Time = _____ ns (to the nearest whole number)

QUESTION 25 (2 marks)

As part of a carefully controlled science experiment, a bullet is fired from a rifle at an angle of 30° above the ground and a speed of 350 m s^{-1} .

Assuming that air resistance is negligible and ignoring the curvature of Earth, determine the time it will take for the bullet to land on the ground.

Time = _____ s (to one decimal place)

QUESTION 26 (3 marks)

Explain how Lenz's law is consistent with the principle of conservation of energy in relation to a permanent magnet approaching one end of a solenoid.

QUESTION 27 (4 marks)

Identify the force that each of the four gauge bosons mediates.



Trial Examination 2023

Formula and Data Booklet

QCE Physics Units 3&4

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QCE Phys34_FB_2023

FORMULAS

Processing of data	
Percentage uncertainty (%) = $\frac{\text{absolute uncertainty}}{\text{measurement}} \times 100$	
Percentage error (%) = $\left \frac{\text{measured value} - \text{true value}}{\text{true value}} \right \times 100$	

Heating processes	
$T_K = T_C + 273$	$Q = mL$
$Q = mc\Delta T$	$\Delta U = Q + W$
$\eta = \frac{\text{energy output}}{\text{energy input}} \times \frac{100}{1} \%$	

Ionising radiation and nuclear reactions	
$N = N_0 \left(\frac{1}{2} \right)^n$	$\Delta E = \Delta mc^2$

Electrical circuits	
$I = \frac{q}{t}$	$P = I^2 R$
$V = \frac{W}{q}$	$V_t = V_1 + V_2 + \dots V_n$
$P = \frac{W}{t}$	$R_t = R_1 + R_2 + \dots R_n$
$R = \frac{V}{I}$	$I_t = I_1 + I_2 + \dots I_n$
$P = VI$	$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}$

Linear motion and force	
$v = u + at$	$W = \Delta E$
$s = ut + \frac{1}{2}at^2$	$W = Fs$
$v^2 = u^2 + 2as$	$E_k = \frac{1}{2}mv^2$
$a = \frac{F_{\text{net}}}{m}$	$\Delta E_p = mg\Delta h$
$p = mv$	$\sum \frac{1}{2}mv^2_{\text{before}} = \sum \frac{1}{2}mv^2_{\text{after}}$
$\sum mv_{\text{before}} = \sum mv_{\text{after}}$	

Waves	
$v = f\lambda$	$L = (2n - 1)\frac{\lambda}{4}$
$f = \frac{1}{T}$	$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$
$L = n\frac{\lambda}{2}$	$I \propto \frac{1}{r^2}$

Gravity and motion	
$v_y = gt + u_y$	$v = \frac{2\pi r}{T}$
$s_y = \frac{1}{2}gt^2 + u_y t$	$a_c = \frac{v^2}{r}$
$v_y^2 = 2gs_y + u_y^2$	$F_{\text{net}} = \frac{mv^2}{r}$
$v_x = u_x$	$F = \frac{GMm}{r^2}$
$s_x = u_x t$	$g = \frac{F}{m} = \frac{GM}{r^2}$
$F_g = mg$	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

Electromagnetism	
$F = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r^2}$	$F = qvB \sin\theta$
$E = \frac{F}{q} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$	$\phi = BA \cos\theta$
$V = \frac{\Delta U}{q}$	$\text{emf} = -\frac{n\Delta(BA_{\perp})}{\Delta t}$
$B = \frac{\mu_0 I}{2\pi r}$	$\text{emf} = -n \frac{\Delta\phi}{\Delta t}$
$B = \mu_0 nI$	$I_p V_p = I_s V_s$
$F = BIL \sin\theta$	$\frac{V_p}{V_s} = \frac{n_p}{n_s}$

Special relativity	
$t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$	$p_v = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$
$L = L_0 \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$	$\Delta E = \Delta mc^2$

Quantum theory	
$\lambda_{\text{max}} = \frac{b}{T}$	$\lambda = \frac{h}{p}$
$E = hf$	$n\lambda = 2\pi r$
$E_k = hf - W$	$mvr = \frac{nh}{2\pi}$
$\frac{1}{\lambda} = R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$	

PHYSICAL CONSTANTS AND UNIT CONVERSIONS

Heating processes	
Latent heat of fusion for water	$L_f = 3.34 \times 10^5 \text{ J kg}^{-1}$
Latent heat of vaporisation for water	$L_v = 2.26 \times 10^6 \text{ J kg}^{-1}$
Specific heat capacity of ice	$c_i = 2.05 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
Specific heat capacity of steam	$c_s = 2.00 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
Specific heat capacity of water	$c_w = 4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$

Ionising radiation and nuclear reactions	
Atomic mass unit	$1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$
Electron volt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Mass of an alpha particle	$m_\alpha = 6.6446572 \times 10^{-27} \text{ kg}$
Mass of an electron	$m_e = 9.1093835 \times 10^{-31} \text{ kg}$
Mass of a neutron	$m_n = 1.6749275 \times 10^{-27} \text{ kg}$
Mass of a proton	$m_p = 1.6726219 \times 10^{-27} \text{ kg}$
Speed of light in a vacuum	$c = 3 \times 10^8 \text{ m s}^{-1}$

Electrical circuits	
Charge on an electron	$e = -1.60 \times 10^{-19} \text{ C}$

Linear motion and force	
Mean acceleration due to gravity on Earth	$g = 9.8 \text{ m s}^{-2}$

Waves	
Speed of sound in air at 25°C	$v_s = 346 \text{ m s}^{-1}$

Gravity and motion	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Mass of Earth	$m_E = 5.97 \times 10^{24} \text{ kg}$

Electromagnetism	
Coulomb's constant	$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Magnetic constant	$\mu_0 = 4\pi \times 10^{-7} \text{ T A}^{-1} \text{ m}$

Quantum theory	
Wien's displacement constant	$b = 2.898 \times 10^{-3} \text{ m K}$
Planck's constant	$h = 6.626 \times 10^{-34} \text{ J s}$
Rydberg's constant	$R = 1.097 \times 10^7 \text{ m}^{-1}$

SCIENTIFIC NOTATION

Ratio to basic unit	Prefix	Abbreviation
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10	deca	da
10^2	hecto	h
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T

LIST OF ELEMENTS

Name	Atomic no.	Symbol
Hydrogen	1	H
Helium	2	He
Lithium	3	Li
Beryllium	4	Be
Boron	5	B
Carbon	6	C
Nitrogen	7	N
Oxygen	8	O
Fluorine	9	F
Neon	10	Ne
Sodium	11	Na
Magnesium	12	Mg
Aluminium	13	Al
Silicon	14	Si
Phosphorus	15	P
Sulfur	16	S
Chlorine	17	Cl
Argon	18	Ar
Potassium	19	K
Calcium	20	Ca
Scandium	21	Sc
Titanium	22	Ti
Vanadium	23	V
Chromium	24	Cr
Manganese	25	Mn
Iron	26	Fe
Cobalt	27	Co
Nickel	28	Ni
Copper	29	Cu
Zinc	30	Zn
Gallium	31	Ga
Germanium	32	Ge
Arsenic	33	As
Selenium	34	Se
Bromine	35	Br

Name	Atomic no.	Symbol
Krypton	36	Kr
Rubidium	37	Rb
Strontium	38	Sr
Yttrium	39	Y
Zirconium	40	Zr
Niobium	41	Nb
Molybdenum	42	Mo
Technetium	43	Tc
Ruthenium	44	Ru
Rhodium	45	Rh
Palladium	46	Pd
Silver	47	Ag
Cadmium	48	Cd
Indium	49	In
Tin	50	Sn
Antimony	51	Sb
Tellurium	52	Te
Iodine	53	I
Xenon	54	Xe
Cesium	55	Cs
Barium	56	Ba
Lanthanum	57	La
Cerium	58	Ce
Praseodymium	59	Pr
Neodymium	60	Nd
Promethium	61	Pm
Samarium	62	Sm
Europium	63	Eu
Gadolinium	64	Gd
Terbium	65	Tb
Dysprosium	66	Dy
Holmium	67	Ho
Erbium	68	Er
Thulium	69	Tm
Ytterbium	70	Yb

LIST OF ELEMENTS (CONTINUED)

Name	Atomic no.	Symbol
Lutetium	71	Lu
Hafnium	72	Hf
Tantalum	73	Ta
Tungsten	74	W
Rhenium	75	Re
Osmium	76	Os
Iridium	77	Ir
Platinum	78	Pt
Gold	79	Au
Mercury	80	Hg
Thallium	81	Tl
Lead	82	Pb
Bismuth	83	Bi
Polonium	84	Po
Astatine	85	At
Radon	86	Rn
Francium	87	Fr
Radium	88	Ra
Actinium	89	Ac
Thorium	90	Th
Protactinium	91	Pa
Uranium	92	U
Neptunium	93	Np
Plutonium	94	Pu

Name	Atomic no.	Symbol
Americium	95	Am
Curium	96	Cm
Berkelium	97	Bk
Californium	98	Cf
Einsteinium	99	Es
Fermium	100	Fm
Mendelevium	101	Md
Nobelium	102	No
Lawrencium	103	Lr
Rutherfordium	104	Rf
Dubnium	105	Db
Seaborgium	106	Sg
Bohrium	107	Bh
Hassium	108	Hs
Meitnerium	109	Mt
Darmstadtium	110	Ds
Roentgenium	111	Rg
Copernicium	112	Cn
Nihonium	113	Nh
Flerovium	114	Fl
Moscovium	115	Mc
Livermorium	116	Lv
Tennessine	117	Ts
Oganesson	118	Og

