



## GCE A LEVEL

1420U50-1F



S24-1420U50-1F

(Day 1) WEDNESDAY, 24 APRIL 2024

(Day 2) THURSDAY, 25 APRIL 2024

## PHYSICS – A2 unit 5

### Experimental Task

### Data Booklet

A clean copy of this booklet should be issued to candidates for their use during each A2 unit 5 Physics examination.

Centres are asked to issue this booklet to candidates at the start of the course to enable them to become familiar with its contents and layout.

#### Values and Conversions

Avogadro constant

$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$$

Fundamental electronic charge

$$e = 1.60 \times 10^{-19} \text{ C}$$

Mass of an electron

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

Molar gas constant

$$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$$

Acceleration due to gravity at sea level

$$g = 9.81 \text{ ms}^{-2}$$

Gravitational field strength at sea level

$$g = 9.81 \text{ N kg}^{-1}$$

Universal constant of gravitation

$$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

Planck constant

$$h = 6.63 \times 10^{-34} \text{ Js}$$

Boltzmann constant

$$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

Speed of light in vacuo

$$c = 3.00 \times 10^8 \text{ ms}^{-1}$$

Permittivity of free space

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$$

Permeability of free space

$$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$$

Stefan constant

$$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$$

Wien constant

$$W = 2.90 \times 10^{-3} \text{ m K}$$

Hubble constant

$$H_0 = 2.20 \times 10^{-18} \text{ s}^{-1}$$

$$T/\text{K} = \theta/^{\circ}\text{C} + 273.15$$

$$1 \text{ parsec} = 3.09 \times 10^{16} \text{ m}$$

$$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$$

$$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$$

$$\frac{1}{4\pi\epsilon_0} \approx 9.0 \times 10^9 \text{ F}^{-1} \text{ m}$$

**AS**

$\rho = \frac{m}{V}$	$I = \frac{\Delta Q}{\Delta t}$																			
$v = u + at$	$I = nAve$																			
$x = \frac{1}{2}(u + v)t$	$R = \frac{V}{I}$																			
$x = ut + \frac{1}{2}at^2$	$P = IV = I^2R = \frac{V^2}{R}$																			
$v^2 = u^2 + 2ax$	$R = \frac{\rho l}{A}$																			
$\Sigma F = ma$	$V = E - Ir$																			
$p = mv$	$\frac{V}{V_{\text{total}}}\left[\text{or } \frac{V_{\text{OUT}}}{V_{\text{IN}}}\right] = \frac{R}{R_{\text{total}}}$																			
$W = Fx\cos\theta$	$T = \frac{1}{f}$																			
$\Delta E = mg\Delta h$	$c = f\lambda$																			
$E = \frac{1}{2}kx^2$	$\lambda = \frac{a\Delta y}{D}$																			
$E = \frac{1}{2}mv^2$	$d\sin\theta = n\lambda$																			
$Fx = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$	$n = \frac{c}{v}$																			
$P = \frac{W}{t} = \frac{\Delta E}{t}$	$n_1v_1 = n_2v_2$																			
$\text{efficiency} = \frac{\text{useful energy transfer}}{\text{total energy input}} \times 100\%$	$n_1\sin\theta_1 = n_2\sin\theta_2$																			
$F = kx$	$n_1\sin\theta_{\text{C}} = n_2$																			
$\sigma = \frac{F}{A}$	$E_{\text{kmax}} = hf - \phi$																			
$\varepsilon = \frac{\Delta l}{l}$	$p = \frac{h}{\lambda}$																			
$E = \frac{\sigma}{\varepsilon}$																				
$W = \frac{1}{2}Fx$																				
$\lambda_{\text{max}} = \frac{W}{T}$																				
$P = A\sigma T^4$																				
<table><tr><td></td><td colspan="2">leptons</td><td colspan="2">quarks</td></tr><tr><td>particle (symbol)</td><td>electron (e<sup>-</sup>)</td><td>electron neutrino (ν<sub>e</sub>)</td><td>up (u)</td><td>down (d)</td></tr><tr><td>charge (e)</td><td>- 1</td><td>0</td><td>+ <math>\frac{2}{3}</math></td><td>- <math>\frac{1}{3}</math></td></tr><tr><td>lepton number</td><td>1</td><td>1</td><td>0</td><td>0</td></tr></table>			leptons		quarks		particle (symbol)	electron (e <sup>-</sup> )	electron neutrino (ν <sub>e</sub> )	up (u)	down (d)	charge (e)	- 1	0	+ $\frac{2}{3}$	- $\frac{1}{3}$	lepton number	1	1	0
	leptons		quarks																	
particle (symbol)	electron (e <sup>-</sup> )	electron neutrino (ν <sub>e</sub> )	up (u)	down (d)																
charge (e)	- 1	0	+ $\frac{2}{3}$	- $\frac{1}{3}$																
lepton number	1	1	0	0																

## A2

$\omega = \frac{\theta}{t}$	$C = \frac{\epsilon_0 A}{d}$
$v = \omega r$	$E = \frac{V}{d}$
$a = \omega^2 r$	$U = \frac{1}{2} QV$
$a = \frac{v^2}{r}$	$Q = Q_0 \left( 1 - e^{-\frac{t}{RC}} \right)$
$F = \frac{mv^2}{r}$	$Q = Q_0 e^{-\frac{t}{RC}}$
$F = m\omega^2 r$	$F = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{r^2}$
$a = -\omega^2 x$	$F = G \frac{M_1 M_2}{r^2}$
$x = A \cos(\omega t + \epsilon)$	$E = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2}$
$T = \frac{2\pi}{\omega}$	$g = \frac{GM}{r^2}$
$v = -A\omega \sin(\omega t + \epsilon)$	$V_E = \frac{1}{4\pi\epsilon_0} \frac{Q}{r}$
$T = 2\pi \sqrt{\frac{m}{k}}$	$\text{PE} = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{r}$
$T = 2\pi \sqrt{\frac{I}{g}}$	$V_g = -\frac{GM}{r}$
$pV = nRT$ and $pV = NkT$	$\text{PE} = -\frac{GM_1 M_2}{r}$
$p = \frac{1}{3} \rho c^2 = \frac{1}{3} \frac{N}{V} mc^2$	$W = q\Delta V_E$
$M / \text{kg} = \frac{M_r}{1000}$	$W = m\Delta V_g$
$n = \frac{\text{total mass}}{\text{molar mass}}$	$\frac{\Delta \lambda}{\lambda} = \frac{v}{c}$
$k = \frac{R}{N_A}$	$v = H_0 D$
$U = \frac{3}{2} nRT = \frac{3}{2} NkT$	$\rho_c = \frac{3H_0^2}{8\pi G}$
$W = p\Delta V$	$r_1 = \frac{M_2}{M_1 + M_2} d$
$\Delta U = Q - W$	$T = 2\pi \sqrt{\frac{d^3}{G(M_1 + M_2)}}$
$Q = mc\Delta\theta$	$A = \lambda N$
$C = \frac{Q}{V}$	$N = N_0 e^{-\lambda t}$

$A = A_0 e^{-\lambda t}$	$F = Bqv \sin \theta$
$N = \frac{N_0}{2^x}$	$B = \frac{\mu_0 I}{2\pi a}$
$A = \frac{A_0}{2^x}$	$B = \mu_0 nI$
$\lambda = \frac{\ln 2}{T_{\frac{1}{2}}}$	$\Phi = AB \cos \theta$
$E = mc^2$	flux linkage = $N\Phi$
$F = BIl \sin \theta$	

## Mathematical Information

### SI multipliers

Multiple	Prefix	Symbol
$10^{-18}$	atto	a
$10^{-15}$	femto	f
$10^{-12}$	pico	p
$10^{-9}$	nano	n
$10^{-6}$	micro	$\mu$
$10^{-3}$	milli	m
$10^{-2}$	centi	c

Multiple	Prefix	Symbol
$10^3$	kilo	k
$10^6$	mega	M
$10^9$	giga	G
$10^{12}$	tera	T
$10^{15}$	peta	P
$10^{18}$	exa	E
$10^{21}$	zetta	Z

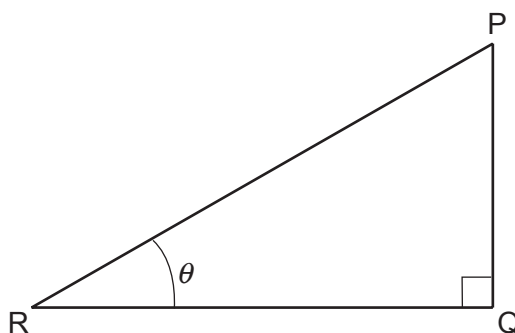
### Areas and Volumes

$$\text{Area of a circle} = \pi r^2 = \frac{\pi d^2}{4}$$

$$\text{Area of a triangle} = \frac{1}{2} \text{ base} \times \text{height}$$

Solid	Surface area	Volume
rectangular block	$2(lh + hb + lb)$	$lbh$
cylinder	$2\pi r(r + h)$	$\pi r^2 h$
sphere	$4\pi r^2$	$\frac{4}{3} \pi r^3$

### Trigonometry



$$\sin \theta = \frac{PQ}{PR}, \quad \cos \theta = \frac{QR}{PR}, \quad \tan \theta = \frac{PQ}{QR}, \quad \frac{\sin \theta}{\cos \theta} = \tan \theta$$

$$PR^2 = PQ^2 + QR^2$$

### Logarithms

[Unless otherwise specified 'log' can be  $\log_e$  (i.e.  $\ln$ ) or  $\log_{10}$ .]

$$\log(ab) = \log a + \log b$$

$$\log\left(\frac{a}{b}\right) = \log a - \log b$$

$$\log x^n = n \log x$$

$$\log_e e^{kx} = \ln e^{kx} = kx$$

$$\log_e 2 = \ln 2 = 0.693$$

**BLANK PAGE**

**BLANK PAGE**