S5 PHYSICS EXAMINATION MARKING GUIDE (THEORY)

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SECTION A (55 marks)

(1)

a) iii 1
b) iv 1
c) i 1

3

(2)

$\lambda = 656.3nm = 656.3 \times 10^{-9}m$
$c = 3 \times 10^{8} m/s$
$h = 6.63 \times 10^{-34} J.s$

$E = \frac{hc}{\lambda}$ ✓ 1

$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{656.3 \times 10^{-9}}$ ✓ 1

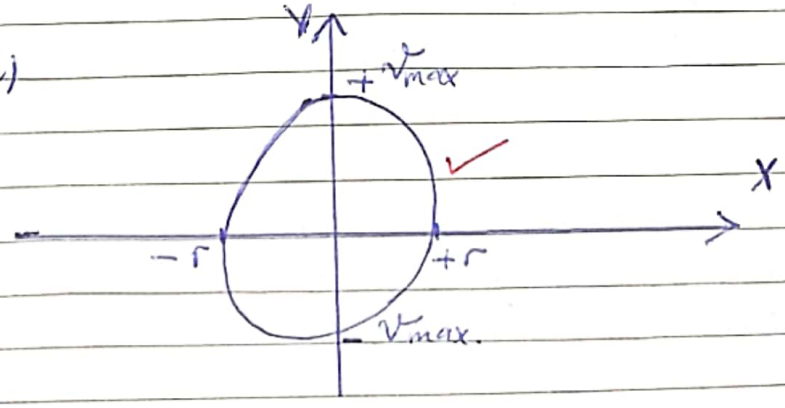
$E = 3.03 \times 10^{-19} J$ ✓ 1

3

(3)

a) Simple harmonic motion (SHM) is a type of motion where the restoring force is directly proportional to the displacement and acts in the direction opposite to that of displacement 1

b) i)



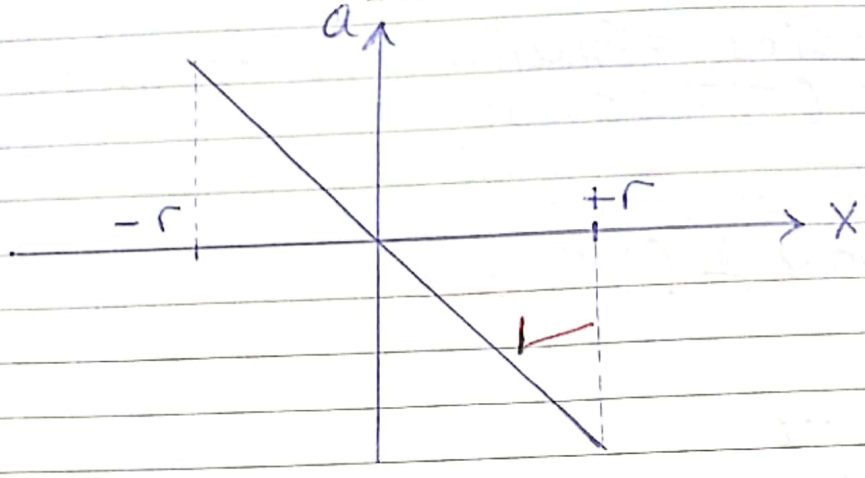
✓ 1

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ii)



1

3

(4)

a) - Length of the string. ✓
- Acceleration due to gravity

1

b) $T = 2\pi\sqrt{\frac{l}{g}}$ ✓

1

$g = \frac{4\pi^2 l}{T^2}$

$g = 4\pi^2 l f^2$

$g = 4 \times (3.14)^2 \times 37 \times 10^{-2} \times (0.819)^2$

$g = 9.78\ m/s^2$ ✓

1

3

(5)

a) Damped oscillations refers to a type of oscillatory motion where the amplitude of the oscillations gradually decreases over time ✓ due to the presence of external damping force.

1

In contrast, undamped oscillations are characterised by a constant amplitude ✓ of oscillation over time.

1

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b) * Absorption of vibrations: When a car encounters bumps or uneven road surfaces, the wheels and the vehicle body experience vertical oscilations. Damping helps absorb these vibrations by dissipating the kinetic energy into heat, thereby reducing the amplitude. 1

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4

(6)

a) ii) 1
b) iii) 1
c) ii) 1
d) ii) 1
e) iv) 1

5

(7) a) f_c, f_a, f_b 1

b) f_b, f_a, f_c 1

2

(8)

a) $20\ m^{-1}$ 1
b) $0.31\ m$ 1
c) $3.2\ m$ 1
d) $10\ m/s$ 1
e) Negative x-direction (right to left) 1

5

(9) a) Kirchhoff's junction rule states that the sum of currents entering the junction is equal to the sum of currents leaving the junction. 1

b) $18 - 0.5I_2 - 6I_1 - 2.5I_2 = 0$

$6I_1 + 3I_2 = 18$ 1

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$45I_3 - 0.5I_3 - 1.5I_3 - 6I_1 = 0$

$2I_3 + 6I_1 = 45$ ✓

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1

3

(10) $\ell = 800\,mm$

$V_1 = 1.18\,V$

$\ell_1 = 600\,mm$

$V_2 = ?$

$\ell_2 = 660\,mm$

a) $\frac{V_1}{\ell_1} = \frac{V_2}{L_2}$ ✓ $\Rightarrow K = \frac{1.18\,V}{0.60\,m}$ ✓ 1+1

b) $K = \frac{E_2(V_2)}{L_2} \Rightarrow E_2 = KL_2 = \left(\frac{1.18}{0.60} \times 0.66\right) V$

$E_2 = 1.298\,V$ ✓ 1

3

(11) a) Nuclear energy ✓ 1

b) * controlled nuclear fission refers to the process in which the splitting of atomic nuclei is carefully managed and regulated to produce a controlled release of energy. ✓ 1

* Uncontrolled nuclear fission refers to the rapid and uncontroled chain reaction of fission reactions, leading to a release of energy in an uncontrolled manner. ✓ 1

3

(12) a) Equipotential surfaces is one on which all the points are at the same potential. ✓ 1

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b) i) $F = EQ$ ✓ $= 12000 \times 1.6 \times 10^{-19}$ — 1

$F = 1.92 \times 10^{-14} N$ ✓ — 1

ii) $a = \frac{F}{m}$ ✓ $= \frac{1.92 \times 10^{-14}}{9.1 \times 10^{-31}}$ — 1

$a = 2.12 \times 10^{16} m/s^2$ ✓ — 1

iii) $d = \frac{1}{2} a t^2$ ✓ $\Rightarrow t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2 \times 0.02}{2.12 \times 10^{16}}}$ — 1

$t = 1.37 \times 10^{-9} s$ ✓ — 1

7

(13) a) Principle of Superposition of electric field states that the resultant electric field at a point due to charges in space is the vector sum of electric fields due to individual electric charges. ✓ — 1

b) i) $\Phi_E = EA$, $A = 4\pi r^2$

$E = \frac{KQ}{r^2}$ ✓ so, $E = \frac{9 \times 10^9 \times 10^{-6}}{1^2} = 9 \times 10^3 N/C$ — X

$\Phi_E = EA = 9000 \times 4 \times 3.14 \times 1$

$\Phi_E = 1.13 \times 10^5 Wb$ ✓ — 1

ii) $E = \frac{KQ}{r^2}$ ✓, $E = 8.6 \times 10^4 N/C$ ✓ — 0.5 + 0.5

iii) $\Phi_E = EA = E \times 4\pi r^2 = 3.6 \times 10^4 \times 4 \times \pi \times (0.5)^2$

$\Phi_E = 1.13 \times 10^5 Wb$ ✓ — 1

4

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(14) 1st law: The planets move in elliptical orbit with the sun as one focus. ✓ 1

2nd law: Line joining the sun and planet sweeps out equal areas in equal periods of time. ✓ 1

3rd law: The square of the period of revolution of the planets are proportional to the cubes of their mean distances from the sun. ✓ 1

$T^2 \propto R^3$

3

(15) a) Escape velocity is a speed at which a body must travel so as to break itself free from planets' gravitational pull. ✓ 1

b) $m_j = 318\ m_e$, $R_j = 11.2\ R_e$, $V_e = 11\ Km/s$

We Know that $V_j = \sqrt{\frac{2GM_J}{R_J}}$ ✓ and 0.5

$V_e = \sqrt{\frac{2Gm_e}{R_e}}$ ✓ 0.5

$\frac{V_J}{V_e} = \sqrt{\frac{m_j}{m_e} \times \frac{R_e}{R_j}}$

$V_J = V_e \sqrt{\frac{m_j}{m_e} \times \frac{R_e}{R_j}}$ ✓ 1

$V_j = 59.7\ Km/s$ ✓ 1

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SECTION B. (45 marks)

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(16) a) $n = 120$ (number of cells in series)

$E = 2V$

$r = 0.001\ \Omega$

$R = 4.8\ \Omega$

i) $I = \frac{nE}{R+nr}$ ✓ 1

$I = \frac{120 \times 2}{4.8 + (120 \times 0.001)}$ 1

$I = 48.7\ A$ ✓

ii) $E = V + Ir$ ✓ 1

$E_{tot} = V + I r_{tot}$

$V = E_{tot} - I r_{tot}$ ✓ 1

$V = 240 - (48.7 \times 0.001 \times 120)$ ✓ 1

$V = 234.156\ V$ ✓ 1

iii) $E = I^2 R t$ ✓ 1

$E = VI \cdot t$

$E = 234.156V \times 48.7A \times 3600\ s$ ✓ 1

$E = 41,052.2kJ$ ✓ 1

b) i) $I_1 + I_3 = I_2$ (1) ✓ 1

$20 = 8I_1 + 4I_2$ (2) ✓ 1

$20 = 8I_1 + 4$ (3)

$20 = 8I_1 + 12$

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$-12+20 = 8I_1$

$I_1 = \frac{8}{8}A \Rightarrow I_1 = 1A$ ✓ 1

$I_3 = I_2 - I_1 \Rightarrow I_3 = (3-1)A = 2A$ ✓ 1

$E_2 = 5I_3 + 4I_2$ ✓ 1

$E_2 = 5(I_2 - I_1) + 4I_2$

$E_2 = 5(3-1) + (4 \times 3)$ ✓ 1

$E_2 = 10 - 12|$ 1

$E = 2V$ ✓

15

(17) $m = 200g = 0.2kg$

$K = 5N/m$

$A = 5 \times 10^{-2} m$

a) $T = 2\pi\sqrt{\frac{m}{K}}$ ✓ 1

$T = 2 \times 3.14 \cdot \sqrt{\frac{0.2}{5}}$

$T = 1.256$ Sec ✓ 1

b) $V_{max} = \frac{2\pi A}{T}$ ✓ 1

$V_{max} = \frac{2 \times 3.14 \times 5 \times 10^{-2}}{1.256}$

$V_{max} = 0.25 m/s$ ✓ 1

c) $a_{max} = \omega^2 A$

$a_{max} = \frac{4\pi^2 A}{T^2}$ ✓ 1

$a_{max} = \frac{4 \times (3.14)^2 A}{1.256^2}$

$a_{max} = 1.25 m/s^2$ ✓ 1

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d) $ME = \frac{1}{2}kA^2$ ✓ 1

$ME = \frac{1}{2} \times 5 \times (5 \times 10^{-2})^2$

$ME = 6.25 \times 10^{-3} J$ ✓ 1

e) i) $x = A\sin(\omega t + \phi)$ ✓ 1

$x = 0.05 \sin(5t + \frac{\pi}{2})$ or $x = 0.05\cos 5t$ ✓ 1

ii) $v = \frac{d}{dt}(0.05\cos 5t)$ ✓ $= -0.25\sin 5t$ ✓ 1+1

iii) $a = \frac{d}{dt}(-0.25\sin 5t)$ ✓ $= -1.25\cos 5t$ ✓ 1+1

(15)

(12) a)

i) $a = \frac{F}{m}$ ✓, $F = Q \times E$ 1

$a = \frac{1.6 \times 10^{-19} C \times 200 N/C}{9.11 \times 10^{-31} kg}$ ✓ 1

$a = 35.12 \times 10^{12} m/s^2$ ✓ 1

ii) $l = d = v.t \Rightarrow t = \frac{l}{v}$ ✓ 1

$t = \frac{0.1 m}{3 \times 10^6 m/s}$ ✓ $= 3.3 \times 10^{-8} s$ ✓ 1+1

b) i) potential at A due x

$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r}$ ✓ 1

$V_{A_x} = 1 V$ ✓ 1

potential at A due to $y = -0.9 \times 10^{-2} V$ ✓ 1

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Potential V_A at A due to x and y

$V_A = 90\ V$ ✓ 1

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Since B is equidistant from equal and opposite charges, the potential V_B at B due to x and y

$V_B = 0$

ii) * $\vec{E}_{Ax} = \frac{9\times10^{9}\times2\times10^{-8}}{1^2} = 1.8\times10^{2}\ N/C$ ✓ 1

* $E_{Ay} = 0.45\times10^{2}\ N/C$ ✓ 1

$E_A = (1.8 - 0.45)\times10^{2}\ N/C$

$E_A = 1.35\times10^{2}\ N/C$ towards the left ✓ 1

* $E_B = E_x \cos 60° + E_y \cos 60°$ ✓ 1

$E_B = 1.8\times10^{2}\ N/C$ ✓ 1

15

(19) a) i) The satellite is subjected to gravitational force

$\frac{GMm}{r^2}$ ✓ This equal to the centripetal force $\frac{mv^2}{r}$ ✓ 1

$F_G = F_C$ ✓ $\Leftrightarrow \frac{GMm}{r^2} = \frac{mv^2}{r}$ ✓ 1+1

$v = \sqrt{\frac{GM'}{r}}$ ✓ 1

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ii) The K.E $= \frac{1}{2}mv^2$ ✓

$= \frac{1}{2} m \cdot \frac{GM}{r} = \frac{GMm}{2r}$ ✓ 1

b) i) The angular speed $\omega = 2\pi f = \frac{2\pi}{T}$ ✓ 1

$\omega = \frac{2\pi}{27.3 \times 24 \times 3600}$ rad/s ✓ 1

$\omega = 2.66 \times 10^{-6}$ rad/s ✓ 1

2) The mass of the Earth is given by

$\frac{GMm}{r^2} = \frac{mv^2}{r}$ ✓ 1

$M = \frac{rv^2}{G} = \frac{r^3\omega^2 \times 1}{G}$ ✓ 1

$M = 6.\times 10^{24}$ Kg ✓ 1

ii) $F_G = \frac{GMm}{r^2} = \frac{6.63\times10^{-11} \times 6\times10^{24} \times 7.4\times10^{22}}{(3.84\times10^{8})^2}$ ✓ 1+1

$F_G = 2\times10^{20}$ N ✓ 1

15

20 a) * Each electron moves in a circular orbit centered at the nucleus. ✓ 1

* When electron moves in its allowed orbit, it doesn't radiate energy. ✓ 1

* When an electron jumps from one allowed orbit to another, it radiates energy ✓ 1

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* The Angular momentum p of electrons are whole number multiples of $\frac{h}{2\pi}$ where h is the planck's constant.

i.e : $p = \frac{nh}{2\pi} = mvr$

b) It jumps to a higher energy level. ✓ 1

c) Photoelectric effect is the emission of electrons from metal surface when a light strikes it ✓ whereas Thermionic emmision is the the emission of electrons ~~then~~ from a heated cathode (filament) when it is electrically heated. ✓ 0.5 0.5

d) * They travel on straight line. ✓ 1
* They travel with the speed which is approximately equal to the speed of light. ✓ 1
* They can be deflected when they pass through an electric and magnetic field. ✓ 1
* They produce fluorescence when they hit the glass surfaces.

e) $E_4 = \frac{-1.36\ eV}{4^2} = -\frac{13.6}{16} \times 1.6 \times 10^{-19}\ J$

$E_4 = -1.36 \times 10^{-19}\ J$

$E_2 = -\frac{13.6}{4} \times 1.6 \times 10^{-19}\ J$

$E_2 = -5.44 \times 10^{-19}\ J$

$E_4 - E_2 = hf$ ✓ $\Rightarrow f = \frac{E_4 - E_2}{h}$ 1

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$$f = \frac{-1.36 \times 10^{-19} - (-5.44 \times 10^{-19})}{6.63 \times 10^{-34}}$$

$f = 6.15 \times 10^{14}$ Hz ✓ 1

f) $n = 6$ ✓ 1

h) $V_s = 2V$

$f = 1.61 \times 10^{15}$ Hz

i) $E = hf$ ✓ 1

$E = 6.63 \times 10^{-34}$ J·s $\times 1.61 \times 10^{14}$ Hz

$E = 1.067 \times 10^{-19}$ J ✓ 1

ii) $e.V_s = \frac{1}{2} m v^2$ ✓ 1

$v = \sqrt{\frac{2 \cdot eV_s}{m}}$

$v = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 2}{9.11 \times 10^{-31}}}$

$v = 8.38 \times 10^{5}$ m/s ✓ 1

15

— END —

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