Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2023
Deferred Examinations

Marking Scheme

Physics

Higher Level

Note to teachers and students on the marking schemes for the deferred examinations

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. However, it should be noted that the marking schemes for the deferred examinations may not necessarily be as detailed as the corresponding marking schemes for the main sitting of an examination, which serve to ensure consistency across a large team of examiners.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination, and the need to maintain consistency in standards between the main sitting and the deferred sitting and from year to year. In the case of the deferred examinations, this means that the level of detail may vary by question, as the marking scheme will only have been finalised for the questions attempted by the candidates who sat these examinations.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with a senior examiner when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes (whether for the main examinations or the deferred examinations) should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination concerned. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination will not necessarily be the same for the deferred sitting as for the main sitting or from one year to the next.

1.

(*i*) ramp/air track, trolley, timer system, string & weights (9)

(*ii*) using your diagram or otherwise, explain

(*a*) initial & final velocity, displacement / time

(*b*) $v^2 = u^2 + 2as$ / $v = u + at$

(*iii*) using weights (12)

(*iv*) set the slope of the track so that friction was balanced by acceleration due to gravity
cleaned the track / oiled the wheels of the trolley

(*v*) changing mass would introduce a third variable

(*vi*) masses transferred from the trolley to the pan

(*vii*) m = 0.532 kg (19)

2.

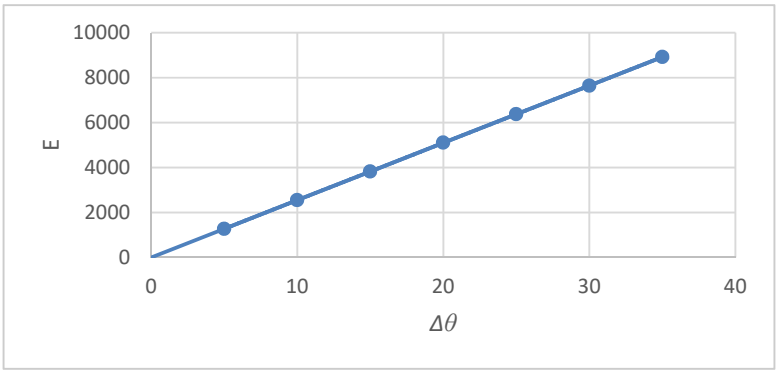
(*i*) current carrying coil / hot copper pellets

(*ii*) remove the heat source / Stir the water / wait until highest temperature is reached

(*iii*) lagging / lid

(*iv*) it can be ignored in the calculation (19)

(*v*)



(*vi*) m = 254.8 J K^{-1}

(*vii*) c = 4176.6 J Kg^{-1} K^{-1} (21)

3.

(*i*) image cannot be formed on a screen / only a virtual image is formed

(*ii*) shape / check if it formed a magnified/inverted/real image

(*iii*) focus image of a distant object on a screen
measure the distance from the lens to the screen (12)

(*iv*) object, lens, screen, correct arrangement

(*v*) u = object to lens

v = lens to the screen (10)

(*vi*) avoid error of parallax / measure to/from centre of the lens (6)

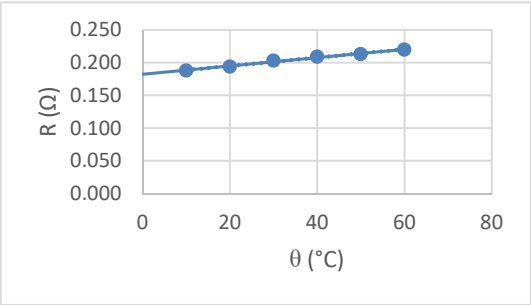
(*vii*) (f =) 79.5, 80.6, 80.6, 79.4 mm

$f_{average}$ = 80.0 mm (12)

4.

(*i*) heat source, wire, thermometer

(*ii*)



(18)

(*iii*) reference to 273.15

θ = 26.85 °C

(*iv*) R = 0.199 mΩ

(*v*) micrometer / digital / vernier callipers

(*vi*) resistivity formula

area formula

$\rho = 1.49 \times 10^{-7}\ \Omega\ m$

(*vii*) steel (22)

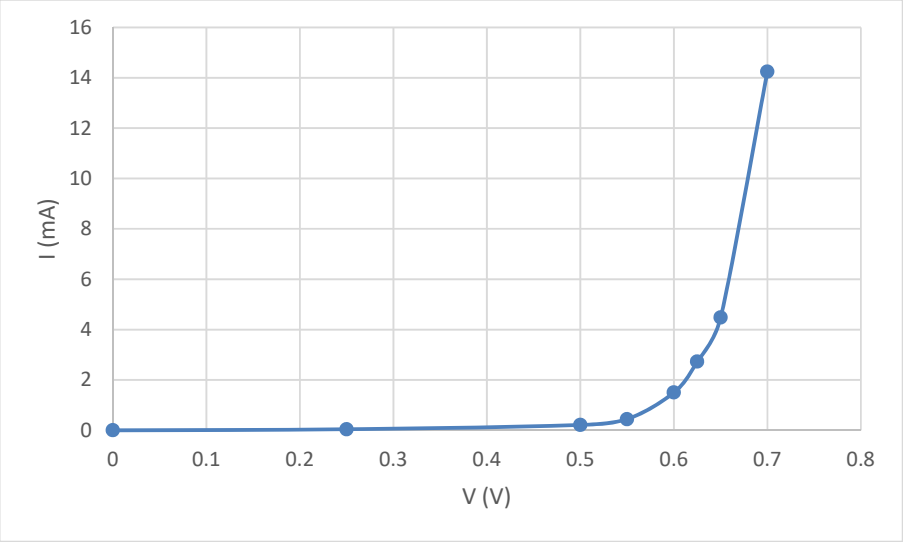
5.

(*i*) diode in forward bias, voltage source, ammeter in series, voltmeter in parallel

(*ii*) rheostat was adjusted

(*iii*) protective resistor put in series with it (22)

(*iv*) draw a suitable graph on graph paper to show the variation of I with V for the semiconductor diode.



(*v*) V ≈ 0.55

(*vi*) reverse the diode/battery connections / use a microammeter / put the voltmeter across only the diode (18)

6. (*a*) $F_{Horizontal} = 44\cos 60$

$F_{Net} = 22 - 20.5 = 1.5$ N in the direction of the table

(*b*) $F = ma$ / $F = -ks$ / $a = -\omega^2 s$

$ma = ks$

$\omega = \sqrt{\frac{k}{m}}$

(*c*) Heat loss for 90 minutes = 1.62×10^6 (J)

$E = ml$

mass per minute = 0.0074 kg

(*d*) $f \propto \sqrt{T}$

$f_{new} = \sqrt{2} \times 205 = 290\ Hz$

(e) concave side always gives an inverted image as long as the object is outside the focal length

convex side always gives an upright image

(*f*) $n = \frac{1}{\sin C}$

$C = 24.4^{\circ}$

(g) polarisation / vibrations of a transverse wave restricted to vibrate in one plane only

reflection polarises light which can be blocked by correctly oriented polaroids in the sunglasses

(*h*) balloon becomes charged by friction

like charges in the wall are repelled

balloon sticks to unlike charges left closest to the surface of the wall

(*i*) live – brown
neutral – blue
earth – yellow & green
arrangement with fuse

(*j*) axes labelled

shape

(*k*) $F = BIl$ / $T = Fd$

$F = 1.43 \times 10^{-3}$ (N)

$T = 7.15 \times 10^{-5}$ Nm

(*l*) *a*. to conserve energy / to conserve momentum
in beta decay

or

b. an electrical switch operated by an electromagnet
example: car ignition system (8 × 7)

7.

(*i*) upthrust on an object is equal to
the weight of the fluid displaced

(*ii*) Diagram: Object in a fluid, overflow can, electronic/newton balance,

Method: Find weight of object in air & weight in water

Find weight of fluid displaced

Result: (Weight of object in air – Weight of object in water) = Weight of fluid displaced

(*iii*) the weight of the fluid displaced by the steel is less than the upthrust / weight of the steel

(*iv*) because of its shape the average density of the ship includes the air it contains making it less dense than water / the weight of the fluid displaced by the boat equals the weight of the boat (24)

(*v*) $\rho = \frac{m}{v}$

ρ = 1.29 kg m^{-3}

(*vi*) Calculate the total pressure acting on the balloon when it is at a depth of 37 m.

p = ρgh

$p_{Total} = P_{atm} + \rho gh = 101300 + 372752.8 = 474052.8$ Pa

(*vii*) pressure is inversely proportional to volume

for a fixed mass of gas at constant temperature

(*viii*) Calculate the density of the air in the balloon at a depth of 37 m.

$p_1v_1 = p_2v_2$

v (at 37 m depth) = 1282 cm^3

$\rho = \left(\frac{m}{v}\right) = \frac{7.75}{1282} = 0.006\ g\ cm^{-3}$ = 6 kg m^{-3}

(*ix*) Upthrust Arrow > [weight arrow + friction arrow] (32)

8. X-rays and visible light are both part of the electromagnetic spectrum.

(*i*) full range of all types of frequencies/wavelengths/energies of electromagnetic radiation

(*ii*) high voltage, heat source, cathode, anode, target, vacuum

(*iii*) $E = qV$
$E = 1.04 \times 10^{-14}$ J

(*iv*) penetrating ability

(*v*) telescope, collimator, slit, table, scale

(*vi*) focus the telescope to accept parallel rays, the length of the collimator, the width of the slit, level the table, focus cross hairs

(vi) $n\lambda = d \sin\theta$

$d = 1.67 \times 10^{-6}$ (m)

$\theta = 44.835°$

$\lambda = 588$ nm

(vii) width of the slits is too big / wavelength of X-rays too short

9. (i) activity is proportional // A = λN

to the number of nuclei present // notation

(*ii*) time taken

for half the nuclei present in a radioactive sample to decay (12)

(*iii*) gamma radiation

neutral

(*iv*) into the page (12)

(*v*) atoms with equal numbers of protons / atoms with same atomic number

different number of neutrons / different mass number

(*vi*) $U_{92}^{235} \rightarrow Th_{90}^{231} + He_{2}^{4}$

(*vii*) A = λN

$T_{½} = \frac{\ln 2}{\lambda}$

$T_{½}$ = 2.22 x 10^{16} s (23)

(*viii*) 6 half lives

(*ix*) 4.23 x 10^{9} years (9)

10. (*i*) heating, chemical

(ii) apparatus

method

result

(*iii*) work done // V = W/q

per unit charge // notation

(*iv*) $V_{max} = \sqrt{2}\, V_{RMS}$

V_{max} = 325 V

() axes labelled

correct shape

(*vi*) electromagnetic induction

(*vii*) $\frac{V_o}{V_i} = \frac{N_S}{N_P}$

N_s = 6

(*viii*) $\phi = BA$

Change in flux = 2.18 x 10^{-7} Wb

T = 1/f = 7.87 x 10^{-6} s

$V_{induced} = -n\ \frac{d\phi}{dt}$

$V_{induced}$ = 4.44 V

11.

(*i*) violet, indigo, blue, green, yellow, orange, red

correct order (6)

(*ii*) lower wavelength light is scattered more (lower wavelength blue is seen) (6)

(*iii*) water droplets, sunlight, correct angle, sun at your back (6)

(*iv*) 1.011 au = 1.512×10^{11} m / v = s/t

t = 8.41 min (6)

(*v*) $E = mc^2$

$m_{difference} = 9.79 \times 10^{30}$ kg

$E = 8.8 \times 10^{-13}$ J (9)

(*vii*) radiation coming from the sun is high energy / short wavelength / high frequency and travels straight through the atmosphere

radiation reradiated from the Earth is lower energy / longer wavelength / lower frequency

gases in the atmosphere can reflect this radiation back to the Earth (9)

(*viii*) yes // no

the Earth would be too cold for humans without it // it is causing overheating of the Earth. (5)

(ix) $E = hf$ / $f = 1.5 \times 10^{14}$ (Hz)

$E = 9.93 \times 10^{-20}$ J (6)

(x) total internal reflection (3)

12. Answer either part (*a*) **or** part (*b*).

(*a*)

(*i*) anti-electron (3)

(*ii*) sold state detector / Geiger Muller tube(6)

(*iii*) γ / hf

$= e^+ + e^- / = 2hf$ (6)

(*iv*) fundamental particle

does not feel the strong nuclear force (6)

(*v*) $F = \frac{Gm_1m_2}{d^2} / g = \frac{Gm}{d^2}$

W = 21820 N (6)

(*vi*) $E = mc^2$ / 1 eV = 1.6×10^{-19} J

m = 1.21×10^{-23} kg (6)

(*vii*) (a) baryon

(b) neutral

(viii) A kaon can be made of a down and an anti-strange quark.

(a) meson

(b) neutral (10)

(*ix*) $F = mv^2/r$ / $F = Bqv$

$mv^2/r = Bqv$

$v = Bqr/m$ (9)

(x) velocity is proportional to the radius (4)

(*b*)

(*i*) resistivity

between a good conductor and a good insulator (6)

(*ii*) label axes

correct shape (6)

(*iii*) alternating current goes in, current flowing in one direction is blocked and the only current flowing in the other direction comes out (6)

(*iv*) four diodes

arrangement (7)

(*v*) capacitor (3)

(*vi*) Describe with the aid of a labelled diagram the basic structure of a bi-polar transistor.

diagram

2 layers of p-type material with n-type between the layers

collector, base, emitter (6)

(*vii*) resistance of the thermistor is high

base current flows

collector current flows / led lights (9)

(*viii*) Logic gates are the basic building blocks of digital electronic circuits. Draw a circuit showing how a transistor can be used to make a logic NOT gate.

transistor, two resistors

arrangement

input voltage, output voltage indicated (9)

(*ix*)

Input 1	**Input 2**	**Output**
0	0	0
0	1	1
1	0	1
1	1	1

(4)

13.

(*a*) transfer of energy

between two bodies with the same natural frequencies (7)

(*b*) Describe a laboratory experiment to demonstrate resonance.

apparatus/diagram

method

result (7)

(*c*) $T = 2\pi\sqrt{\frac{l}{g}} = 2.46\ (s)$

f = 0.41 Hz (7)

(*d*) two antinodes

one node (7)

(*e*) λ = 0.6 (m)

c = f λ

f = 572 Hz (7)

(*f*) one photon gives all its energy to one electron

if photon energy is greater than the work function, electron is emitted with kinetic energy

if photon energy is less than the work function, electron is not emitted (7)

(*g*) electrons orbit a positive nucleus
electrons are only allowed orbit at specific energy levels (7)

(*h*) $He_2^4 + He_2^4 + He_2^4 \rightarrow C_6^{12}$

(7)

14.

(*a*) (*i*) distance in a given direction (4)

(*ii*) constant acceleration (3)

(*ii*) Derive the formula: $s = ut + \frac{1}{2}at^2$.

$v = u + at$ / $v^2 = u^2 + 2as$ / $s = \frac{(u+v)}{2}t$

$(u + at)^2 = u^2 + 2as$ // $s = \frac{(u+(u+at))}{2}t$

$s = ut + \frac{1}{2}at^2$ (9)

(*iii*) a) $s = (ut + \frac{1}{2}at^2) = 44.1$ m

b) $(s =) vt_{sound} = ut_{stone} + \frac{1}{2}at_{stone}^2$ / $t_{stone} = t$ & $t_{sound} = 3 - t$

$4.9t^2 + 343t - 1029 = 0$

$t = 40.68$ m (12)

(*b*) (*i*) ratio of potential difference // $V = I R$

to current // notation (6)

(*iii*) voltage source, 4 resistors

galvanometer

arrangement (9)

(*iv*) galvanometer reads zero (3)

(*v*) $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

$R_{wire} = 7.5\ \Omega$ (6)

(*v*) example: temperature control, fail safe device (4)

(*c*) (*i*) apparent change in frequency

due to relative motion between the source and the observer (6)

(*ii*) apparatus / diagram

method

result (9)

(iii) $f' = \frac{fc}{c \pm u}$

$\frac{f'_{away}(c+u)}{c} = \frac{f'_{towards}(c-u)}{c} / \; u = c\frac{(f'_{towards} - f'_{away})}{(f'_{away} + f'_{towards})}$

u = 18.49 m s^{-1} (9)

(i*v*) f = 286.7 Hz (4)

(*d*) (*i*) Define capacitance.

charge // C = q/V

per unit volt // notation (6)

(*ii*) apparatus/diagram

method

result (9)

(*iii*) parallel lines

direction indicated (6)

(*iv*) $C = \frac{\varepsilon A}{d}$

C = 1.32 x 10^{-13} F (7)