NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2025

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours | 200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

1.1 A
1.2 C
1.3 D
1.4 C
1.5 B
1.6 D
1.7 A
1.8 B
1.9 C
1.10 A

QUESTION 2

2.1 Velocity is the rate of change of position.

OR

Velocity is the rate of displacement.

OR

Velocity is the rate of change of displacement.

2.2 40 $m \cdot s^{-1}$ North

2.3 Displacement is a change in position.

2.4 $v = u + at$

$\left(\frac{120}{3,6}\right) = 40 + a(14)$ LHS RHS

$a = -0,48\ m \cdot s^{-2}$ Both Formulae

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

$s = (40)(14) + \frac{1}{2}(-0,48)(14)^2$

s = 513,33 m

OR

$s = \frac{u+v}{2}.t$

$s = \frac{40 + \frac{120}{3,6}}{2}.(14)$

s = 513,33 m

2.5 $s = ut + \frac{1}{2}at^2$

$s = (0)(14) + \frac{1}{2}(3,5)(14)^2$

s = 343 m

2.6 $v = u + at$
$= (0) + (3,5)(14)$
$= 49\ m{\cdot}s^{-1}$

CAR: s = 33,33t

POLICE CAR: s + 170,33 = 49t

33,33t + 170,33 = 49t
t = 10,87 s

t_{total} = 24,87 s

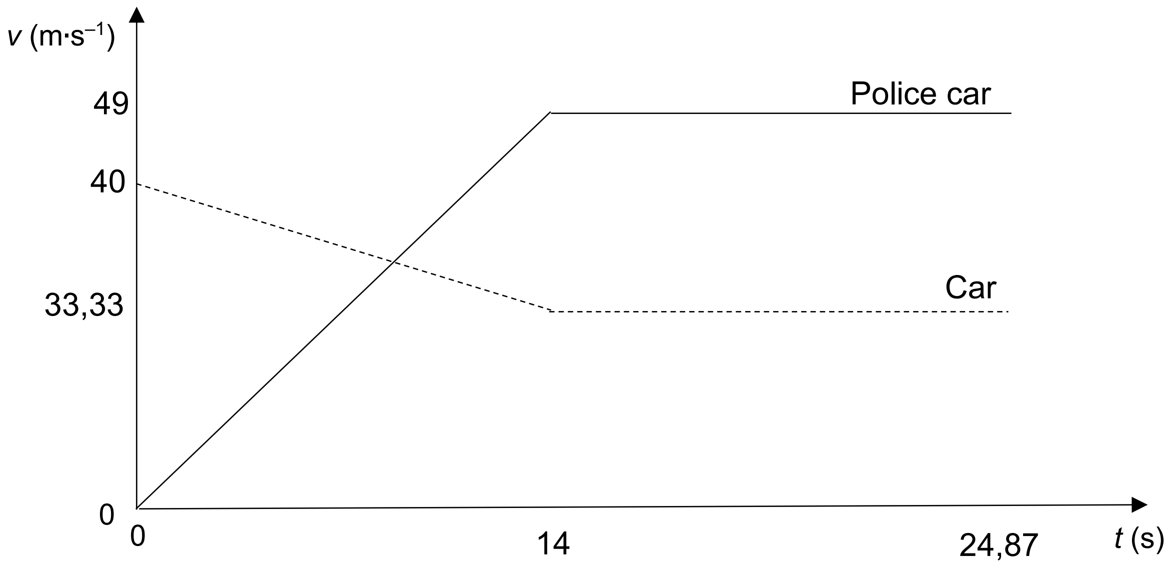
OR

$v = u + at$
$= (0) + (3,5)(14)$
$= 49\ m{\cdot}s^{-1}$

s = vt
(513,33 – 343) = (49-33,33)t
t = 10,87 s

t_{total} = 24,87 s

2.7



Police car graph initially increasing from 0
Car graph initially decreasing
Both graphs end with constant *y*-values
Police car's final velocity > Car's final velocity

QUESTION 3

3.1 1,1 m below

3.2 $v^2 = u^2 + 2as$
$(5)^2 = u^2 + 2(-9,8)(1,1)$
$u = 6,82\ m \cdot s^{-1}$

3.3 The total (linear) momentum of an isolated system remains constant.

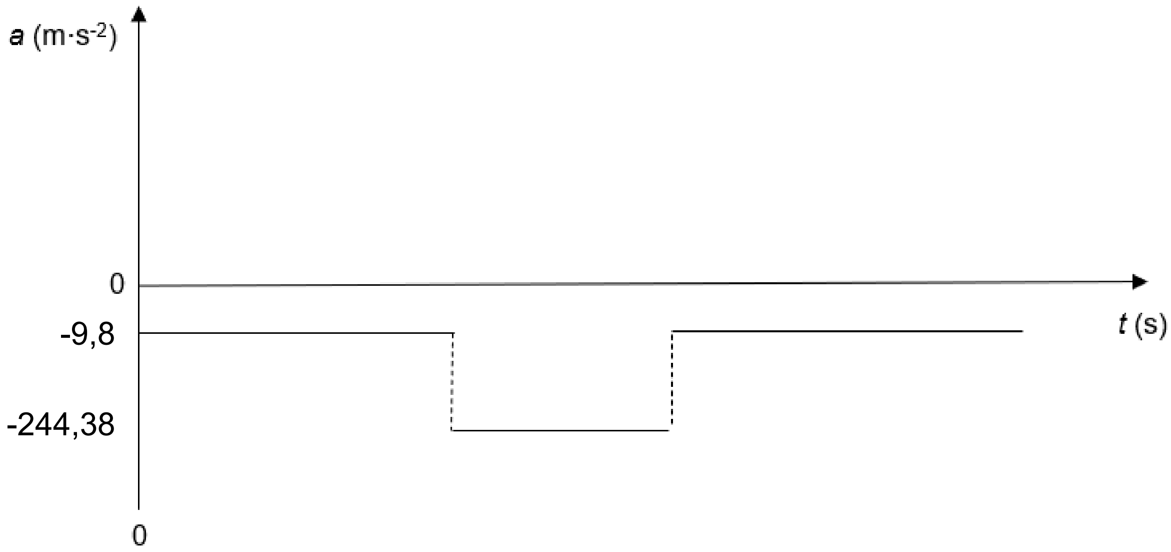
3.4 Total p_{before} = Total p_{after}
$(0,045)(5) + 0 = (0,045 + 0,255)v$
$v = 0,75\ m \cdot s^{-1}$ up

3.5 Rate of change of velocity.

3.6 $v^2 = u^2 + 2as$
$(0,75)^2 = (5)^2 + 2a(0,05)$
$a = -244,38\ m \cdot s^{-2}$

$a = 244,38\ m \cdot s^{-2}$ down

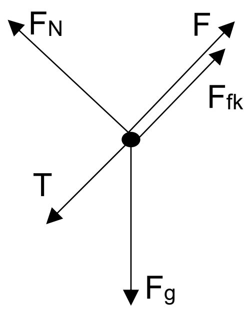
3.7



QUESTION 4

4.1 The gravitational force the Earth exerts on any object on or near its surface.

4.2



Key: F_N (Normal force)
T (Tension)
F_g (Weight)
F_{fk} (Friction)
F (Applied force)

4.3 **Block A:**
$F_{fk} = \mu_k F_N$
$F_{fk} = (0,2)(20 \times 9,8 \cos 40^o)$
$\mathbf{F_{fk} = 30,03\ N}$

4.4 15,02 N

4.5 **Block A:**
$F_{net} = ma$
$F_{g//} - F_{fk} - T = 20a$
(F_g sub) (F_{fk} & T sub)
$(20 \times 9,8 \sin 40^o) - 30,03 - T = 20a$

Block B:
$F_{net} = ma$
$F_{g//} + T - F_{fk} - F_{applied} = 10a$
(F_g & T sub) (F_{fk} & $F_{applied}$ sub)
$(10 \times 9,8 \sin 40^o) + T - 15,02 - 100 = 10a$

$(20 \times 9,8 \sin 40^o) - 30,03 - 20a = 10a - (10 \times 9,8 \sin 40^o) + 15,02 + 100$
$\mathbf{a = 1,46\ m \cdot s^{-2}}$
$\mathbf{T = 66,67\ N}$

4.6 Greater than

4.7
- Less than
- a is downwards
- F_{net} is also downwards
- $F_{net} = F_g - T$
  $\therefore F_g > T$ (Formula)

QUESTION 5

5.1 5.1.1 The rate at which work is done.

5.1.2 P = Fv
P = (50 × 9,8)(1,5)
P = 735 W

5.1.3 When connected to a 220 V power supply, the input power to the motor will be 1200 W.

5.1.4 $\text{efficiency} = \frac{\text{power}_{\text{out}}}{\text{power}_{\text{in}}} \times 100$

$\text{efficiency} = \frac{735}{1\,200} \times 100$ (coe from Q 5.1.2)

efficiency = 61,25%

5.2 5.2.1 Total p_{before} = Total p_{after}
(2)(6) + 0 = 0 + (3)v
v = 4 m·s^{-1}

5.2.2 $E_{ki} = \frac{1}{2}mv^2$

$E_{ki} = \frac{1}{2}(2)(6)^2$

$E_{ki} = 36$ J

$E_{kf} = \frac{1}{2}mv^2$

$E_{kf} = \frac{1}{2}(3)(4)^2$

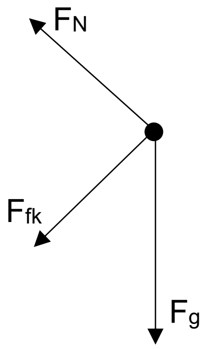
$E_{kf} = 24$ J

$\therefore E_{kf} \neq E_{ki}$

The collision was inelastic.

5.2.3 The force that opposes the motion of the object.

5.2.4



Key: F_N (Normal force)
F_g (Weight)
F_{fk} (Friction)

5.2.5 The work done by a net force on an object is equal to the change in the kinetic energy of the object.

5.2.6

$$W_{net} = \Delta E_k$$

$$(F_{g//} + F_{fk})\Delta x.\cos\theta = \frac{1}{2}(v^2 - u^2)$$

$$(3 \times 9{,}8.\sin 25° + 8)\left(\frac{h}{\sin 25°}\right).\cos 180° = \frac{1}{2}(3)(0^2 - 4^2)$$

$$\boldsymbol{h = 0{,}5\ \mathrm{m}}$$

OR

$$W_{net} = \Delta E_k$$

$$\left(F_{g//} + F_{fk}\right)\Delta x = \Delta E_k$$

$$(3 \times 9{,}8.\sin 25° + 8)\left(\frac{h}{\sin 25°}\right) = \frac{1}{2}(3)(4)^2$$

$$\boldsymbol{h = 0{,}5\ \mathrm{m}}$$

OR

$$Emech_{\text{bottom}} = Emech_{\text{top}} + W_f$$

$$\left(E_p + E_k\right)_{\text{bottom}} = \left(E_p + E_k\right)_{\text{top}} + W_f$$

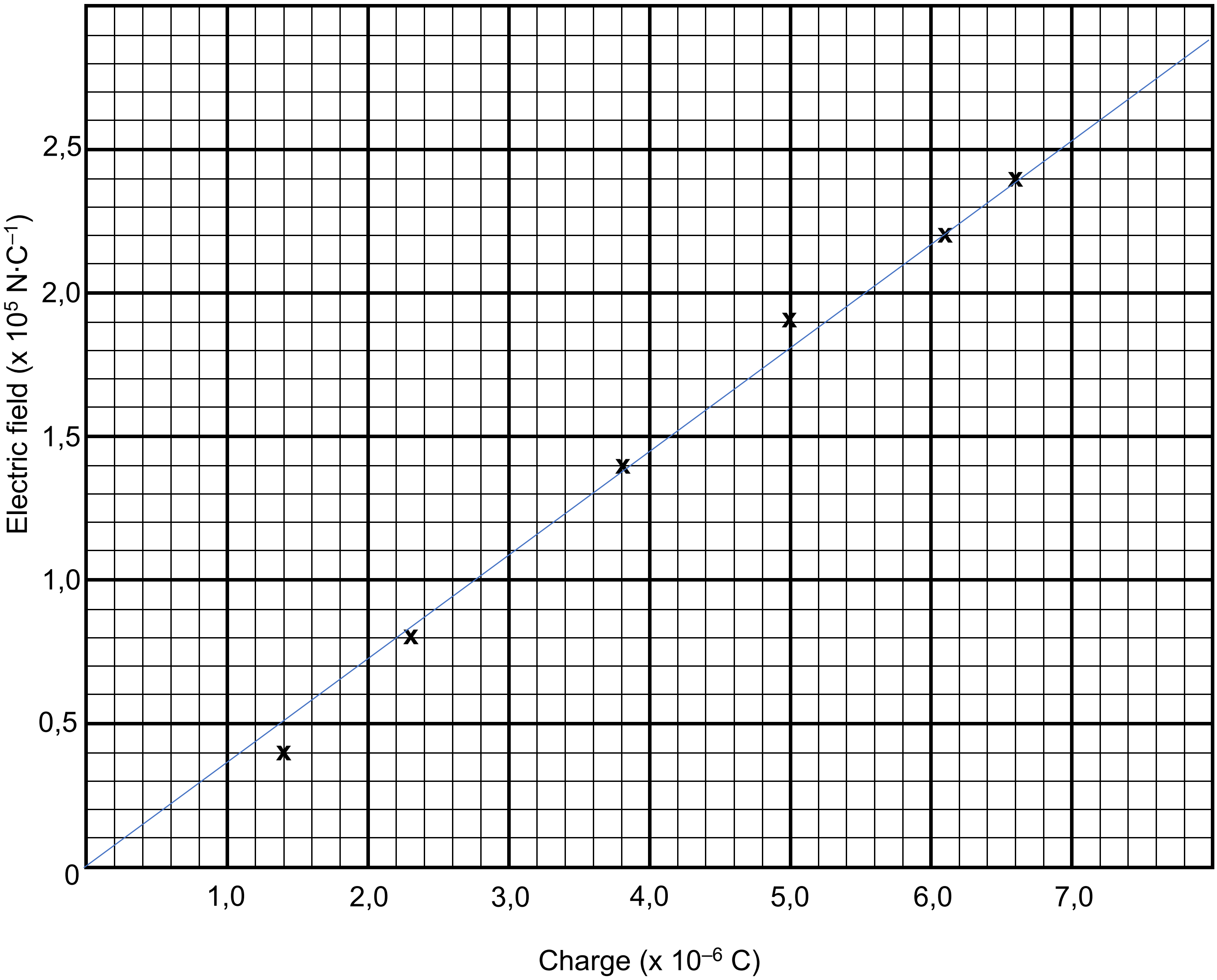
$$\frac{1}{2}(3)(4)^2 = 0 + (3)(9{,}8)h + 8\left(\frac{h}{\sin 25°}\right)$$

$$\boldsymbol{h = 0{,}5\ \mathrm{m}}$$

QUESTION 6

6.1 The force per unit positive charge.

6.2 Electric field vs Charge



Heading
Axes labels
Scale
Plotting
LOBF

6.3 $m = \frac{\Delta y}{\Delta x}$

$m = \frac{1,8 \times 10^{5} - 0}{5,0 \times 10^{-6} - 0}$

$\boldsymbol{m = 3,60 \times 10^{10}\ N \cdot C^{-2}}$ (accept $3,35 \times 10^{10} - 3,85 \times 10^{10}$)

6.4 $E = \frac{k}{r^2}Q$

$\therefore m = \frac{k}{r^2}$

$3,60 \times 10^{10} = \frac{9 \times 10^{9}}{r^2}$

$\boldsymbol{r = 0,5\ m}$

QUESTION 7

7.1 7.1.1 Rate of flow of charge.

7.1.2
- R_T decrease
- I_T increase
- $P_{L2} = I^2R_{L2}$ (OR any relevant equation with explanation)
  I increase while R_{L2} remains constant
- Brightness of L_2 will increase

7.2 7.2.1 The current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.

7.2.2 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_p} = \frac{1}{14} + \frac{1}{10}$$

$\therefore$ $\mathbf{R_p = 5,83\Omega}$

7.2.3 emf = I(R + r)
emf = 1,32(5,83 + 1)
emf = 9,02 V

OR

V = IR
V = (1,32)(6,83)
V = 9,02 V

7.2.4 $R_{top} : R_{bottom}$
14 : 10
$I_{top} : I_{bottom}$
10 : 14
0,55 A : 0,77 A

$V_2 = IR$
$V_2 = (0,55)(4)$
$\mathbf{V_2 = 2,2\ V}$

OR

$V_1 = \text{emf} - I_Tr$
$V_1 = (9,02) - (1,32)(1)$
$V_1 = 7,70$ V

$V_1 = I_1R$
$(7,7) = I_1(14)$
$I_1 = 0,55$ A

$V_2 = I_1R$
$V_2 = (0,55)(4)$
$\mathbf{V_2 = 2,2\ V}$

7.2.5 $W = I^2Rt$
$W = (0,55)^2(4)\ (2 \times 60)$
W = 145,2 J

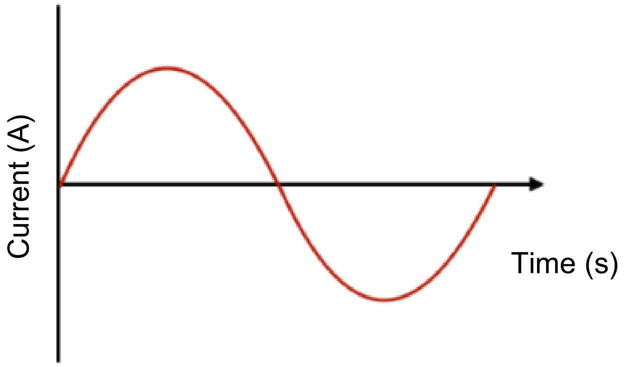
7.2.6 $V_3 = I_1R$
$V_3 = (0,55)(10)$
$\mathbf{V_3 = 5,5\ V}$

7.2.7
- R_T decrease
- I_T increase
- V_{lost} increase
- $\therefore$ V_{ext} (V_1) decreases

QUESTION 8

8.1 The emf induced is directly proportional to the rate of change of magnetic flux (flux linkage).

8.2



Shape Axes labels

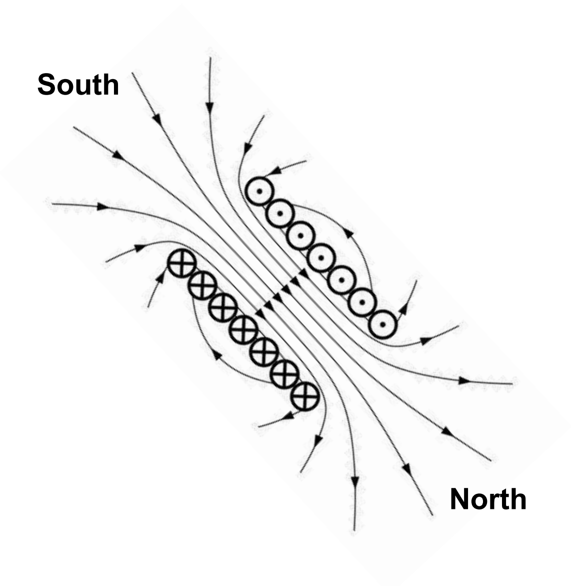
8.3
- The current in the primary coil causes a magnetic field.
- As the current changes, the magnetic field around the primary coil changes.
- This causes a changing magnetic flux through the secondary coil.

8.4
- $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ **OR** $\varepsilon \propto N$
- As the number of windings in the secondary coil is less than that in the primary coil, the emf of the secondary coil is also less than that applied to the primary coil.

8.5 Z

8.6 A

8.7



Polarity
Shape
Direction

QUESTION 9

9.1 It establishes the quantum theory and it illustrates the particle nature of light.

9.2 $E_{photons}$ must be greater than or equal to W_0 ($E_{photons} \geq W_0$)

9.3 $4,5 \times (1,6 \times 10^{-19})$ = **$7,2 \times 10^{-19}$ J**

9.4 $E = \frac{hc}{\lambda}$

$$E = \frac{(6,6 \times 10^{-34})(3 \times 10^{8})}{(200 \times 10^{-9})}$$

$\boldsymbol{E = 9,9 \times 10^{-19}}$ **J**

9.5 $E = W_0 + E_{k\ max}$

$$9,9 \times 10^{-19} = 7,2 \times 10^{-19} + \frac{1}{2}(9,1 \times 10^{-31})v_{max}{}^{2}$$

$\boldsymbol{v_{max} = 7,7 \times 10^{5}}$ **m·s⁻¹**

9.6 $P = \frac{W_{total}}{t}$

$(0,3 \times 10^{-3}) = \frac{W_{total}}{1}$ Method

$W_{total} = 3 \times 10^{-4}$ J

$\text{Number of photons} = \frac{W_{total}}{E_{photon}}$ Method

$$\text{Number of photons} = \frac{(3 \times 10^{-4})}{(9,9 \times 10^{-19})}$$

Number of photons **= $3,03 \times 10^{14}$ photons**

Total: 200 marks