NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2023

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, withoutthe benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

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

QUESTION 2

2.1 Acceleration is the *rate of change of velocity*.

2.2 car B

2.3 $a = \text{gradient of velocity–time graph}$

$$= \frac{0 - 30}{20 - 6}$$

$= –2,14\ m \cdot s^{-2}$

$= 2,14\ m \cdot s^{-2}$ [magnitude only so ignore sign]

OR $a = \frac{v - u}{t}$

$$= \frac{0 - 30}{14}$$

$= –2,14\ m \cdot s^{-2}$

= **$2,14\ m \cdot s^{-2}$** [magnitude only so ignore sign]

2.4 Same velocity

2.5 $s = \text{area under velocity–time graph}$

$$= (30)(6) + \frac{1}{2}(14)(30)$$

= 180 + 210

s = **390 m**

OR $s = vt + \frac{1}{2}(u+v)t$

$s = (30)(6) \ + \frac{1}{2}(30+0)15$

s = **390 m**

OR $s = vt + \left[ut + \frac{1}{2}at^2\right]$

$s = (30)(6)\left[30(14) + \frac{1}{2}(-2{,}14)(14)^2\right]$

s = **390 m**

2.6 displacement of B:

$s = \textit{area under velocity–time graph}$

$= (20)(20) \ + \frac{1}{2}(2)(20)$

= 400 + 20

s = **420 m**

OR $s = vt + \frac{1}{2}(u+v)t$

$s = (20)(20) \ + \frac{1}{2}(20+0)2$

s = **420 m**

420 – 390 = 30 m

The cars were **30 m** apart at time 0 s.

2.7 Car A.

QUESTION 3

3.1 3.1.1 $v = u + at$

$= 12 + (3,2)(3)$

= **21,6 m·s^{-1}**

3.1.2 $s = ut + \frac{1}{2}at^2$

$= (12)(3) + \frac{1}{2}(3,2)(3)^2$

= **50,4 m**

OR

$s = \frac{1}{2}(u + v)t$

$s = \frac{1}{2}(12 + 21{,}6)3$

= **50,4 m**

OR

$v^2 = u^2 + 2as$

$21{,}6^2 = (12)^2 + 2(3,2)s$

= **50,4 m**

3.2 3.2.1 The change in position.

3.2.2 0 m

3.2.3 average speed = $\frac{\text{distance}}{\text{time}}$

$= \frac{42{,}2}{3{,}25}$ *for conversion*

= **12,98 km·h^{-1}**

OR average speed = $\frac{\text{distance}}{\text{time}}$

$= \frac{42\,200}{(180 + 15)(60)}$ *for conversion*

= **3,61 m·s^{-1}**

3.2.4 The single vector which has the same effect as the original vectors acting together.

3.2.5 $s^2 = 10^2 + 14^2$

$s = 17,20$ km

$\tan\theta = \frac{14}{10}$ **OR** $\tan\theta = \frac{10}{14}$

$\theta = 54,46°$ $\theta = 35,54°$

s = 17,20 km

at 54,46° S of W OR 35,54° W of S OR bearing 215,54°

QUESTION 4

4.1 $E_K = \frac{1}{2}mv^2$

$= \frac{1}{2}(0,3)(6)^2$

$= \mathbf{5,4\ J}$

4.2 $v^2 = u^2 + 2as$

$6^2 = 0^2 + 2(9,8)s$

$s = \mathbf{1,84\ m}$

OR $E_{K(\text{top})} + E_{P(\text{top})} = E_{K(\text{surface})} + E_{P(surface)}$

$0 + mgh_{(\text{top})} = 5,4 + 0$

$(0,3)(9,8)h_{(\text{top})} = 5,4$

$h_{(\text{top})} = \mathbf{1,84\ m}$

4.3 $v = u + at$

$6 = 0 + (9,8)t$

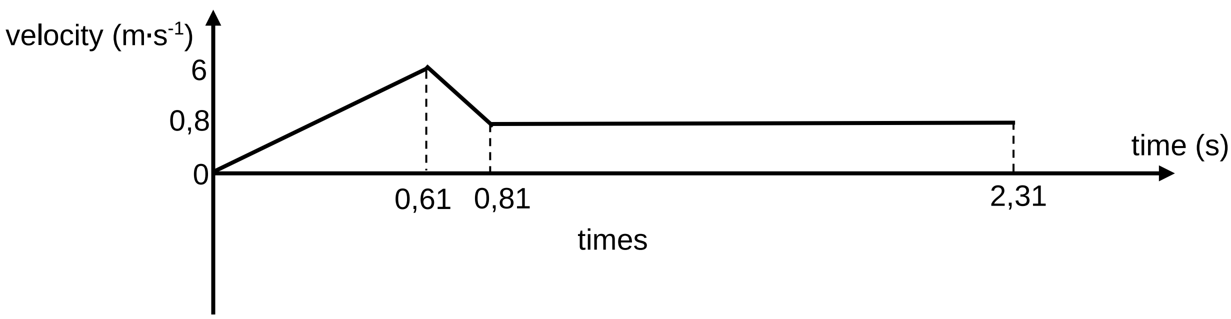
$t = \mathbf{0,61\ s}$

OR $s = \frac{1}{2}(u + v)t$

$1,8 = \frac{1}{2}(0 + 6)t$

$t = \mathbf{0,61\ s}$

4.4



4.5 Impulse is the product of the net force and the time for which it acts.

4.6 $F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{(0,3)(0,8)-(0,3)(6)}{0,2}$

$F_{net} = -7,8$

$F_{net} = \mathbf{7,8}$ **N upwards**

4.7

$F_{water\ on\ stone}$ / upward force by water on stone ✓

$F_{Earth\ on\ stone}$ or F_g / weight / gravitational force ✓

Lose one of these marks if F_{water} not > F_g

4.8 $F_{net} = F_{water} - mg$ OR $\vec{F}_{water} + \vec{F}_g = \vec{F}_{net}$

$7,8 = F_{water} - (0,3)(-9,8)$

$F_{water} = 7,8 + 2,94$

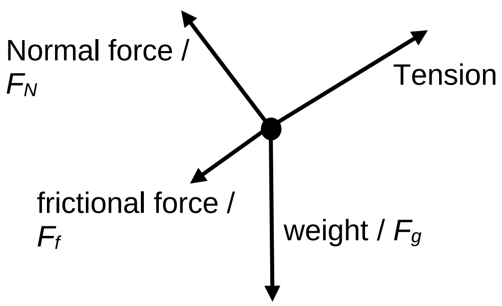
$F_{water} = \mathbf{10,74}$ **N**

4.9 The upward force by the water is equal in magnitude to the downward pull of the Earth and so the stone experiences no net force and no longer accelerates.

QUESTION 5

5.1 The force that opposes the motion of an object.

5.2



5.3 $F_N = F_{g(\text{perp})} = mg.\cos\theta$

$= (2)(9,8).\cos 20^\circ$

= **18,42 N**

5.4 $F_f = \mu F_N$

$= (0,4)18,42$

= **7,37 N**

5.5 $F_T - (F_f + mg.\sin 20^\circ)$ = ma

OR $F_T + (-7,37) + (2)(-9,8).\sin 20^\circ = (2)a$

OR $-F_T + 7,37 + 2(-9,8).\sin 20^\circ = (2)(-a)$

5.6 $T + (-7,37) + 2(-9,8).\sin 20^\circ = (2)a$ for 2 kg block (up slope is +)

$-T + 3(9,8) = (3)a$ for 3 kg block (down is +)

$3(9,8) - (3)a + (-7,37) + 2(-9,8).\sin 20^\circ = 2a$

$29,4 - 3 - 7,37 - 6,70 = 2a$

5a = 15,33

a = **3,07 m·s⁻²**

$T = 3(3,98) - 3a$

$T = 3(3,98) - 3(3,07)$

***T* = 20,19 N**

5.7 The product of the displacement and the component of the force parallel to the displacement.

5.8 $\Delta E_{th} = F_f \cdot s$

$= 7{,}37(0{,}3)$

= **2,21 J**

5.9 $F_{net} \cdot s = \Delta E_k$

$(20{,}19 - 6{,}70 - 7{,}37)(0{,}3) = \Delta E_k$

$\Delta E_k =$ **1,84 J**

OR $F_{net} \cdot s = \Delta E_k$

$mas = \Delta E_k$

$2(3{,}07)(0{,}3) = \Delta E_k$

$\Delta E_k =$ **1,84 J**

5.10 $mg.\sin\theta + F_f = F_{net}$

$6{,}70 + 7{,}37 = (2)a$ (down is positive)

a = **7,04 m·s^{-2}** down the slope

QUESTION 6

6.1 6.1.1 Two point charges in free space or air exert forces on each other. The force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges.

6.1.2 $F_g = mg$

$= (2 \times 10^{-3})(9,8)$

$= \mathbf{0,0196\ N} \qquad (19,6 \times 10^{-3}\ \text{N})$

6.1.3 $F = \dfrac{kq_1q_2}{r^2}$

$19,6 \times 10^{-3} = \dfrac{(9 \times 10^9)(5 \times 10^{-9})(q)}{(3 \times 10^{-3})^2}$

q = **3,92 × 10⁻⁹ C** (3,92 nC)

6.2 6.2.1 Force acting per unit mass.

6.2.2 $g = G\dfrac{M}{r^2}$

$g = (6,7 \times 10^{-11})\dfrac{6,4 \times 10^{23}}{(3,4 \times 10^6)^2}$

= **$3,71\ \text{m·s}^{-2}$** or N.kg^{-1}

6.2.3 $F = \dfrac{GM_1M_2}{r^2}$

$\dfrac{(6,7 \times 10^{-11})(550)(6,4 \times 10^{23})}{(3,4 \times 10^6 + 31,6 \times 10^6)^2}$

F = **19,25 N**

QUESTION 7

7.1 Current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.

7.2 $V = IR$

$= (0,6)(7)$

= **4,2 V**

7.3 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_P} = \frac{1}{3} + \frac{1}{7}$

R

7.4 The rate of flow of charge.

7.5 $I_{bulb} = \frac{V_{bulb}}{R_{bulb}} = \frac{4,2}{3}$ = 1,4 A

$I_{total} = I_{bulb} + I_{10\Omega}$

= 1,4 + 0,6

= 2 A

7.6 $P = I^2R$

= $2^2 \cdot 12$

= **48 W**

7.7 $emf = I(R + r)$

$30 = 2(2,1 + 12 + r)$

r = **0,9 •**

OR $V_{12\Omega} = (2)(12) = 24V$

$V_{load} = 24 + 4,2 = 28,2V$

$V_{load} = emf - Ir$

$28,2 = 30 - 2r$

r = **0,9 •**

7.8 $W = \frac{v^2t}{R} = \frac{4,2^2}{3}(3 \times 60)$ = **1058,4 J**

$W = VIt = (4,2)(1,4)(3 \times 60)$ = **1058,4 J**

$W = I^2Rt = (1,4)^2(3)(3 \times 60)$ = **1058,4 J**

7.9 Decrease

7.10 The total resistance decreases, so the current increases ($V = IR$), so lost volts increase and so V_{term} decreases ($V_{term} = emf - Ir$) *equation used in context*

QUESTION 8

8.1 Slip rings

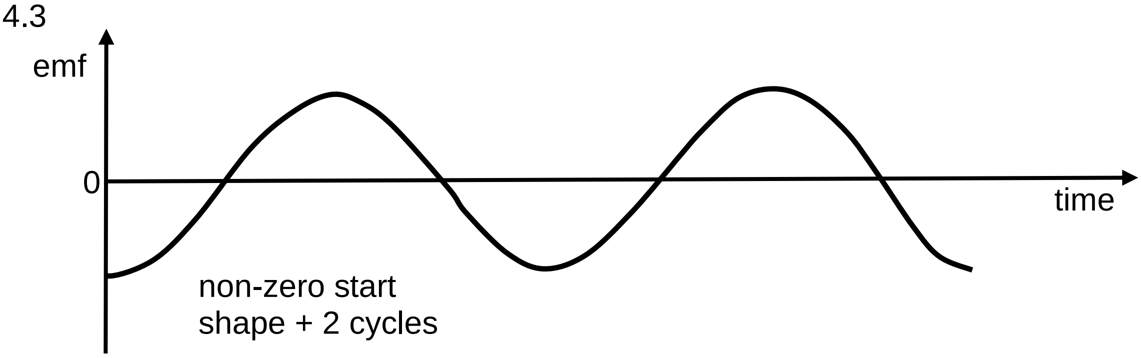
8.2 The magnetic flux changes as the coil is rotated which induces an *emf* which causes a current.

8.3 Y to X

8.4 8.4.1 horizontal position

8.4.2 When the angle between the magnetic flux density and the normal to the loop of the area of the coil is 90°, then Φ = 0.
OR
The flux through the coil is 0.

8.4.3



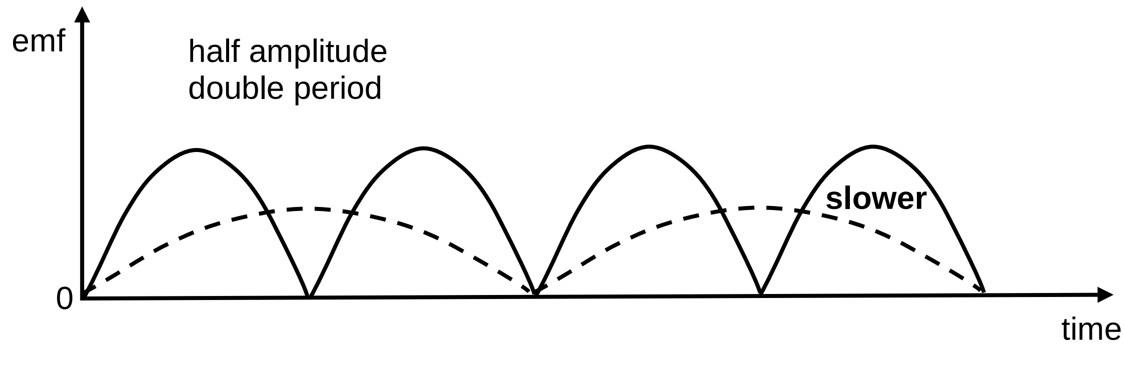
8.5 $\frac{N_S}{N_P} = \frac{V_S}{V_P}$

$\frac{N_S}{20} = \frac{240}{8}$

N_S = **600 turns**

8.6 An alternating current produces a changing magnetic flux, while a direct current does not.

8.7

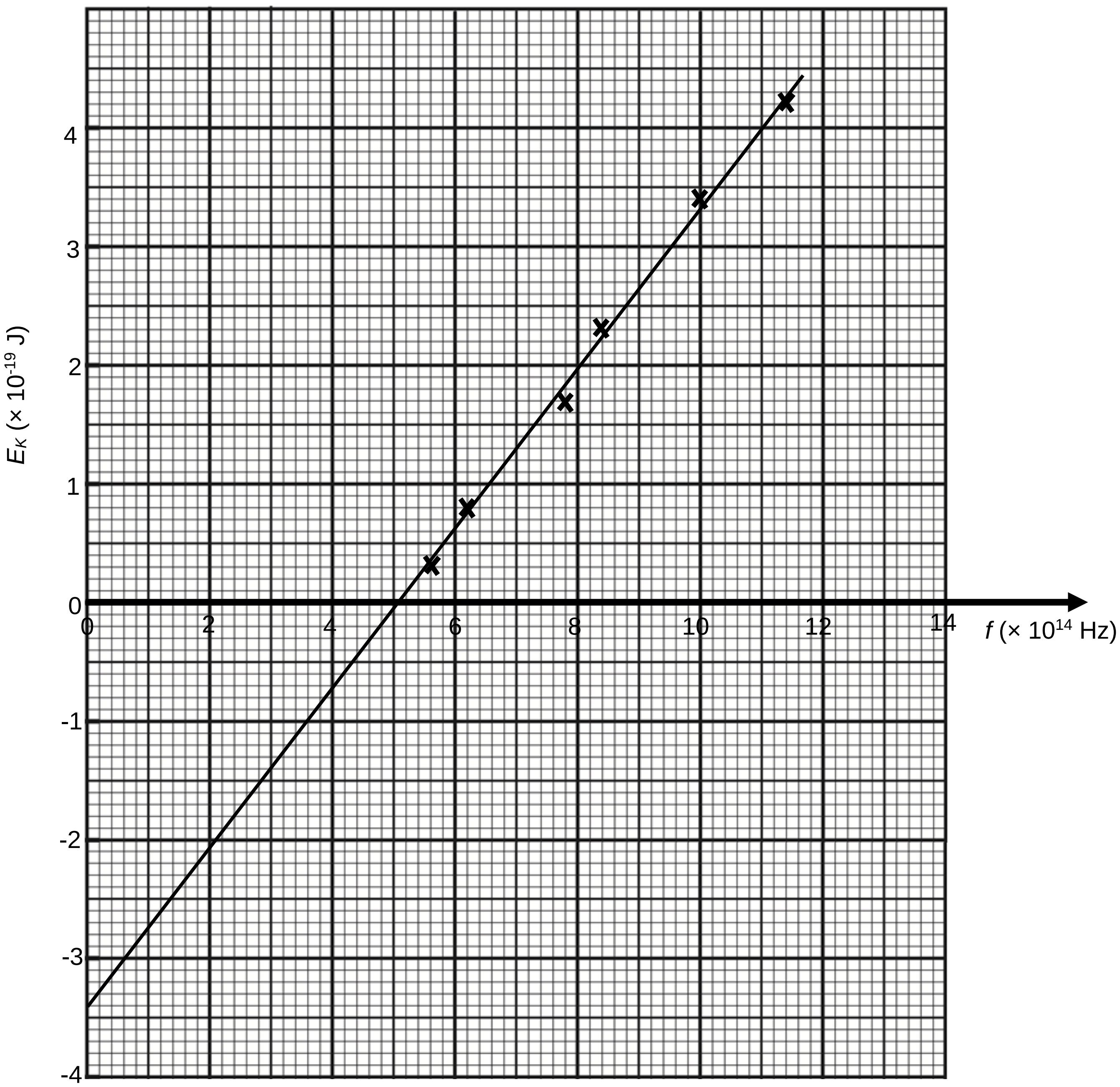


8.8 change slip rings for a split-ring commutator
OR connect a bridge rectifier

QUESTION 9

9.1 Heading
y-axis title and unit
y-axis scale (plotted points > $\frac{1}{2}$ graph paper)
plotted points
line of best fit

Graph showing the frequency of incident light vs the kinetic energy of the ejected electrons.



9.2 Minimum frequency of incident radiation at which electrons will be emitted from a particular metal.

9.3 $5,1 \times 10^{14}$ Hz (accept $5,0 \times 10^{14}$ to $5,2 \times 10^{14}$)

9.4 gradient $= \frac{\Delta y}{\Delta x}$

$$gradient = \frac{values\ from\ y\text{-}axis}{values\ from\ x\text{-}axis}$$

(values must be from LOBF on graph – not data points)

gradient = 6,6 × 10^{-34} J·s (accept 6,4 × 10^{-34} to 6,8 × 10^{-34})

9.5 $E_K = hf - W_o$
h = gradient
h = as above

9.6 work function

Total: 200 marks