NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2022

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 A
1.4 B
1.5 C
1.6 D
1.7 A
1.8 D
1.9 D
1.10 B

QUESTION 2

2.1.1 A, D, G for all (1 mark if only 2 given; 1 if only D given)

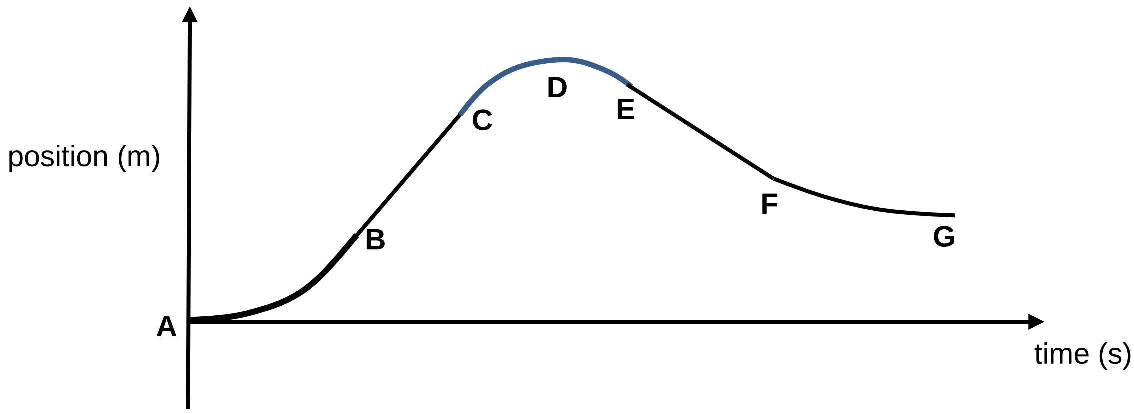
2.1.2 B–C

2.1.3 D–G

2.1.4 Acceleration is the rate of change of velocity.

2.1.5 C–E

2.1.6



2.2

$s_{\text{child}} + s_{\text{puppy}} = 100$

$2{,}0\,t + 2{,}5\,t = 100$

$t = 22{,}22\ s$

$s_{\text{child}} = 2{,}0(22{,}22)$

$\mathbf{s_{child} = 44{,}44\ m}$

OR

$$t_{child} = \frac{s_{child}}{v_{child}}$$

$$= \frac{s_{child}}{2{,}0}$$

$$t_{puppy} = \frac{s_{puppy}}{v_{puppy}}$$

$$= \frac{(100 - s_{child})}{2{,}5}$$

$$\frac{s_{child}}{2{,}0} = \frac{(100 - s_{child})}{2{,}5}$$

$$2{,}5\, s_{child} = 2{,}0(100 - s_{child})$$

$$\mathbf{s_{child} = 44{,}44\ m}$$

QUESTION 3

3.1 $v = u + at$

$0 = u + (-9,8)(0,8)$

$\boldsymbol{u = 7,84\ m \cdot s^{-1}}$

OR

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

$0 = u(1,6) + \frac{1}{2}(-9,8)(1,6)^2$

$\boldsymbol{u = 7,84\ m \cdot s^{-1}}$

Could choose down to be positive throughout.

3.2 $s = ut + \frac{1}{2}at^2$

$= (7,84)(0,8) + \frac{1}{2}(-9,8)(0,8)^2$

$\boldsymbol{s = 3,14\ m}$

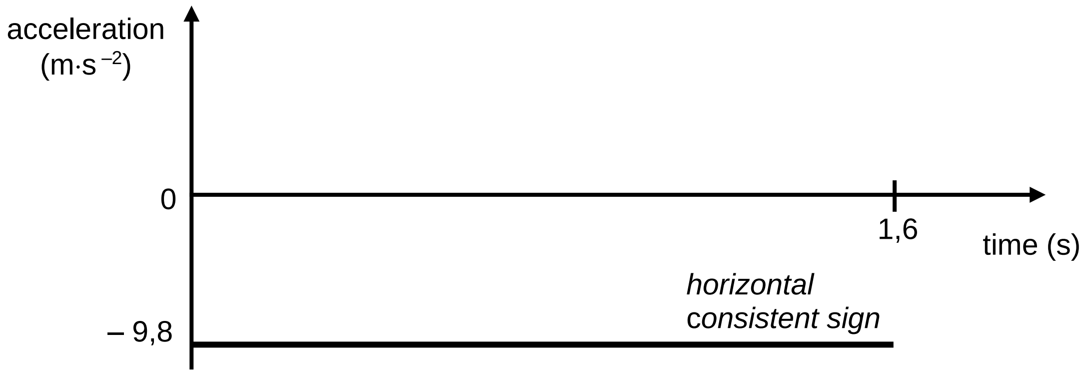
OR

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

$0^2 = (7,84)^2 + 2(-9,8)s$

$\boldsymbol{s = 3,14\ m}$

3.3



3.4 $s = ut + \frac{1}{2}at^2$

$s = (5)(1,2) + \frac{1}{2}(-9,8)(1,2)^2$

$s = -1,06\ m$

$\boldsymbol{s = 1,06\ m}$

3.5 $v = u + at$

$v = 5 + (-2,8)(1,2)$

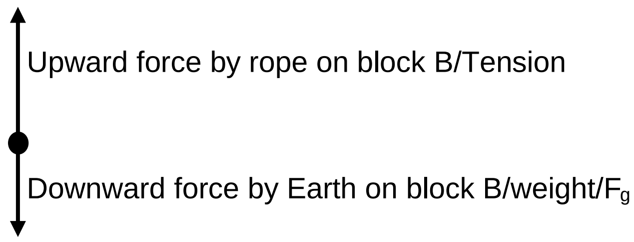
$v = -6,76\ m \cdot s^{-1}$

$\boldsymbol{v = 6,76\ m \cdot s^{-1}}$

QUESTION 4

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

4.2



4.3 When a net force acts on an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

OR

The net force acting on an object is equal to the rate of change of momentum.

4.4 $F_{net} = T - F_{g(B)} = m_B a$

OR

$F_{net} = T - m_B g = m_B a$

4.5 $T + 6(-9,8) = (6)a$ for block B (anticlockwise is positive)

$-T + 8(9,8) = (8)a$ for block A (anticlockwise is positive)

$$8(9,8) - (8)a + 6(-9,8) = 6a$$
$$78,4 - 8a - 58,8 = 6a$$
$$14a = 19,6$$
$$\boldsymbol{a = 1,4\ \mathrm{m{\cdot}s^{-2}}}$$

$$T + 6(-9,8) = 6(1,4)$$
$$\boldsymbol{T = 67,2\ \mathrm{N}}$$

4.6 $s = ut + \frac{1}{2}at^2$

$$0,6 = (0)t + \frac{1}{2}(1,4)t^2$$
$$\boldsymbol{t = 0,93\ \mathrm{s}}$$

QUESTION 5

5.1

$$(p_{total})_{before} = (p_{total})_{after}$$
$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$
$$2(3) + 5(1,5) = 2v_1 + 5(2,5)$$
$$\boldsymbol{v_i = 0,5\ m\cdot s^{-1}\ \text{right}}$$

5.2 Both experience same magnitude of force; NLIII

5.3 Neither NL2

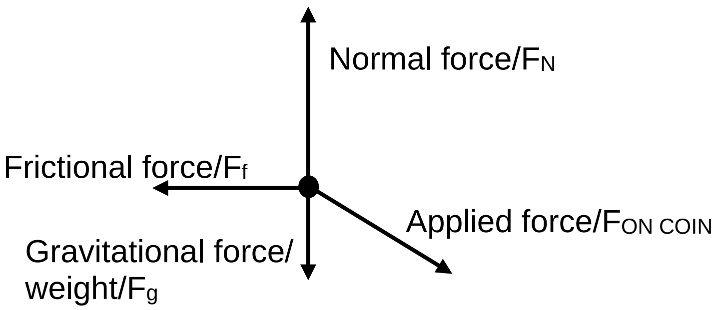
5.4 The product of the net force and the time for which it acts.

5.5

$$F_{net} = \frac{\Delta p}{\Delta t}$$
$$F_{net} = \frac{(5)(0) - 5(2,5)}{0,2}$$
$$F_{net} = -62,5$$
$$\boldsymbol{F_{net} = 62,5\ N}$$

QUESTION 6

6.1



6.2 $F_{vert} = F.\sin\theta$

$F_{vert} = 25.\sin 15$

$\boldsymbol{F_{vert} =}$ **6,47 N**

$F_{vert} = F.\cos\theta$

$F_{vert} = 25.\cos 75$

$\boldsymbol{F_{vert} =}$ **6,47 N**

6.3 The perpendicular force exerted by a surface on an object in contact with it.

6.4 $F_N = F_g + F_{app,vert}$ *(as scalars)*

$F_N =$ (0,01)(9,8) + 6,47

$\boldsymbol{F_N =}$ **6,57 N**

6.5 $F_{fk} = \mu F_N$

$F_{fk} =$ (0,6)(6,57)

$\boldsymbol{F_{fk} =}$ **3,94 N**

6.6 $F_{net} = F_{app,hor} - F_{fk}$ *(as scalars)*

$F_{net} = 25\cos 15° + (–3,94)$

$\boldsymbol{F_{net} =}$ **20,21 N**

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

6.8 $F_{net} \cdot s = \Delta E_K$

$20,21(0,2) = \Delta E_K$

$\boldsymbol{\Delta E_K =}$ **4,04 J**

6.9 $\Delta E_{th} = F_f \cdot s$

$\Delta E_{th} = 3,94(0,2)$

$\boldsymbol{\Delta E_{th} =}$ **0,79 J**

QUESTION 7

7.1 7.1.1 Every particle with mass in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

7.1.2

$$F = \frac{GM_1M_2}{r^2}$$

$$3,6 = \frac{(6,7\times10^{-11})(360)(6,0\times10^{24})}{r^2}$$

$$r^2 = \frac{(6,7\times10^{-11})(360)(6,0\times10^{24})}{3,6}$$

$$r = 2,00 \times 10^8 \text{ m}$$

height above surface $= 2,00 \times 10^8$ m – $6,4 \times 10^6$
$=$ **$1,94 \times 10^8$ m**

7.1.3

$$g = \frac{F}{m}$$

$$g = \frac{3,6}{360}$$

$$\boldsymbol{g = 0,01 \text{ m·s}^{-2}}$$

OR

$$g = G\frac{M}{r^2}$$

$$g = (6,67\times10^{-11})\frac{6,0\times10^{24}}{(200\times10^6)^2}$$

$$\boldsymbol{g = 0,01 \text{ m·s}^{-2}}$$

7.2 7.2.1 Z

7.2.2 Y

7.2.3

$$F = \frac{kq_1q_2}{r^2}$$

$$F = \frac{(9\times10^9)(2\times10^{-6})(6\times10^{-6})}{(5\times10^{-2})^2}$$

$$\boldsymbol{F = 43,2 \text{ N}}$$

7.2.4 $$charge\ per\ sphere = \frac{total\ system\ charge}{2}$$

$$= \frac{(+6 \times 10^{-6} + +2 \times 10^{-6})}{2}$$

$$= \mathbf{4 \times 10^{-6}\ C}$$

7.2.5 $$electrons\ transferred = \frac{change\ in\ charge}{charge\ per\ electron}$$

$$= \frac{2 \times 10^{-6}}{1{,}6 \times 10^{-19}}$$

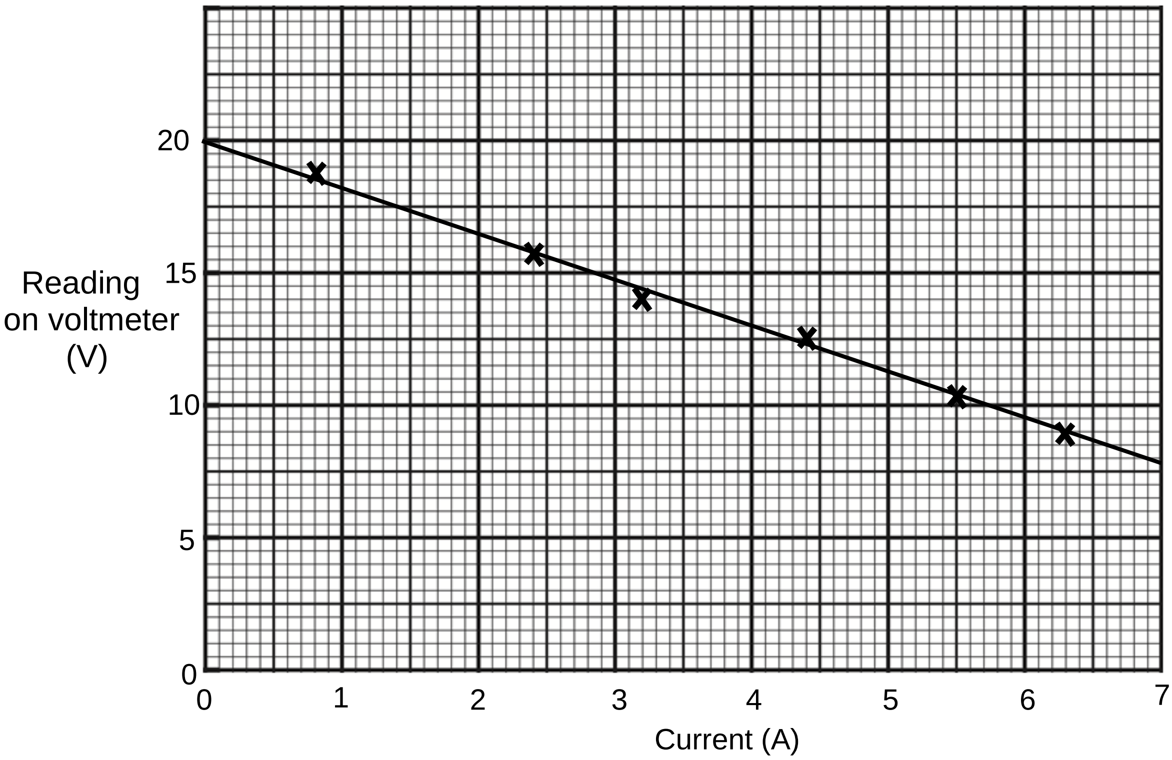
$$= 1{,}25 \times 10^{13} \text{ electrons}$$

7.2.6 from A to B

QUESTION 8

8.1 8.1.1 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 reading on the voltmeter vs the current through the circuit.



8.1.2 $gradient = \frac{\Delta y}{\Delta x}$

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

(values must be from LOBF on graph – not data points)
gradient = –1,75 Ω (accept 1,6 to 1,9)
[unit must be given Ω or $V \cdot A^{-1}$]

8.1.3 $V_{load} = emf - Ir$
OR $V_{term} = -rI + emf$
$gradient = -r$
$\boldsymbol{r = 1{,}75\ \Omega}$

8.1.4 **20 V** (y-intercept)

8.1.5 $emf = I(R + r)$

$20 = 4(R + 1{,}75)$

$\boldsymbol{R} = \mathbf{3{,}25\ \Omega}$

OR Read off V = 13 V

$V = IR$

$13 = (4)R$

$\boldsymbol{R} = \mathbf{3{,}25\ \Omega}$

8.2 8.2.1 $P = \frac{V^2}{R}$

$60 = \frac{12^2}{R}$

$\boldsymbol{R} = \mathbf{2{,}4\ \Omega}$

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

8.2.3 $R_{TOTAL} = \frac{V}{I} = \frac{12}{6} = 2\ \Omega$

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

$\frac{1}{2} = \frac{1}{R} + \frac{1}{2{,}4}$

$\boldsymbol{R} = \mathbf{12\ \Omega}$

OR

$I_{bulb} = \frac{V_{bulb}}{R_{bulb}} = \frac{12}{2{,}4} = 5A$ **OR** $I_{bulb} = \frac{P}{V_{bulb}} = \frac{60}{12} = 5\text{ A}$

$\therefore I_R = 6A - 5A = 1A$

$R = \frac{V_R}{I_R} = \frac{12}{1}$

$\boldsymbol{R} = \mathbf{12\ \Omega}$

8.2.4 $W = \frac{V^2 t}{R} = \frac{12^2}{12}(2 \times 60) = \mathbf{1\ 440\ J}$

OR

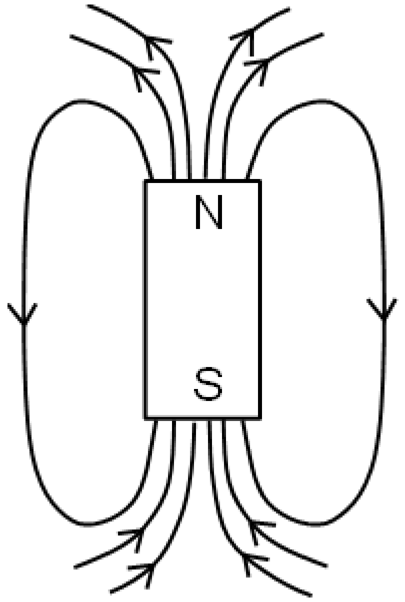
$W = VIt = (12)(1)(2 \times 60) = \mathbf{1\ 440\ J}$

OR

$W = I^2 Rt = 1^2(12)(2 \times 60) = \mathbf{1\ 440\ J}$

QUESTION 9

9.1 9.1.1



direction of arrows shape of field symmetry

9.1.2 The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic field.

9.1.3 clockwise

9.1.4 Falling magnet causes strength of magnetic field in coil to increase, so the coil experiences a change in flux.
Change in flux induces an emf, which produces an electric current in the metal ring.

9.1.5 moving the magnet faster

OR

dropping the magnet from a greater height

9.1.6 The product of the number of turns on the coil and the flux through the coil.

9.1.7 The induced current would be much greater as a coil has more turns/loops.

9.2 9.2.1 into the page

9.2.2
- Move the loop into the magnetic field **OR** move the loop out of the magnetic field
- With the loop in the field, change the shape of the wire loop
- With the loop in the field, rotate the loop.

Any 2

QUESTION 10

10.1 The photons from the UV radiation have enough energy to eject electrons.

10.2 The minimum amount of energy needed to emit an electron from the surface of a metal.

10.3 $4{,}3 \times 1{,}6 \times 10^{-19}$

$= \mathbf{6{,}88 \times 10^{-19}\ J}$

10.4
$$hf = W_0 + E_{K(\text{max})}$$
$$\left(6{,}6 \times 10^{-34}\right)\left(15 \times 10^{14}\right) = 6{,}88 \times 10^{-19} + E_{K(\text{max})}$$
$$\boldsymbol{E_{K(\text{max})} = 3{,}02 \times 10^{-19}\ \mathrm{J}}$$

10.5
$$E_{K(\text{max})} = \frac{1}{2}mv^2$$
$$3{,}02 \times 10^{-19} = \frac{1}{2}\left(9{,}1 \times 10^{-31}\right)v^2$$
$$\boldsymbol{v = 8{,}15 \times 10^{5}\ \mathrm{m \cdot s^{-1}}}$$

10.6 When the electrons are ejected from the zinc disc, the electroscope becomes increasingly positive and the positively charged leaves repel one another.

Total: 200 marks