NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2016

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 C
1.2 B
1.3 D
1.4 A
1.5 D
1.6 C
1.7 B
1.8 A
1.9 B
1.10 A (2 × 10 = 20)

[20]

QUESTION 2

2.1 Acceleration is the rate of change of velocity. (2)

2.2 $a =$ slope of v-t graph OR $\frac{\Delta v}{\Delta t}$ OR $v = u + at$

$a = \frac{230,4 - 0}{120 - 0}$ $230,4 = 0 + a(120)$

$\boldsymbol{a = 1,92\ \mathrm{m \cdot s^{-2}}}$ **Up** $\boldsymbol{a = 1,92\ \mathrm{m \cdot s^{-2}}}$ **Up** (4)

2.3 **Velocity is up and decreasing in magnitude OR slowing down.**
Acceleration is down and constant in magnitude. (4)

2.4 $\mathbf{297,64\ s}$ (-1 for no unit) (2)

2.5 Speed is the rate of change of distance. (2)

2.6 $v^2 = u^2 + 2as$

$v^2 = 0 + 2(9,8)(55165,34 - 6000)$

$\boldsymbol{v = 981,65\ \mathrm{m \cdot s^{-1}}}$ (3)

2.7 $v^2 = u^2 + 2as$

$1 = 981,65^2 + 2a(6000)$

$\boldsymbol{a = -80,30\ \mathrm{m{\cdot}s^{-2}}}$ (3)

2.8

–1 if Thrust ≤ weight

NB: label for weight may be w or F_g

(2)

2.9 $F_{net} = ma$

$\text{Thrust} - (5800)(9,8) = 5800(80,30)$

Thrust = 522 580,0 N up (if rounded off in Question 2.7)

OR

Thrust = 522 599,17 N up (if not rounded off in Question 2.7) (5)

OR

$$F_{net} = \frac{m(v-u)}{\Delta t}$$

$$F_{net} = \frac{5\,800(1-981,65)}{12,21}$$

$$F_{net} = 465\,828,83$$

$$T - 5800(9,8) = 465\,828,83$$

$$\boldsymbol{T = 522\,580} \textbf{ N up}$$

(5)

OR

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

$$\big(T - 5\,800(9,8)\big)6\,000 = \frac{1}{2}(5\,800)(1^2 - 981,65^2)$$

$$\boldsymbol{T = 522\,597,2} \textbf{ N up}$$

(5)

[27]

QUESTION 3

3.1 3.1.1 D, E (–1 per additional answer) (2)

3.1.2 A, D, E (–1 per additional answer) (3)

3.1.3 C (–1 per additional answer) (1)

3.1.4 E (–1 per additional answer) (1)

3.1.5 Child B and C at the same position.
OR Child B passed Child C at point P
OR Child B and C collided. (2)

3.2 3.2.1 Distance is the length of path travelled. (2)

3.2.2 $s = ut + \frac{1}{2}at^2$ OR $s = vt$

$6 = 2(t) + 0$

$\boldsymbol{t = 3\ \mathbf{s}}$ (3)

3.2.3 $s = ut + \frac{1}{2}at^2$

$s = 4(3) + 0$

$\boldsymbol{s = 12\ \mathbf{m}}$ (2)

3.2.4 $16\ \text{m} - 12\ \text{m}$ **= 4 m away** (2)

3.2.5 $s = ut + \frac{1}{2}at^2$

$16 = 4(3) + \frac{1}{2}a(3)^2$

$\boldsymbol{a = 0{,}89\ m \cdot s^{-2}}$ (3)

[21]

QUESTION 4

4.1 22 N (-1 no unit) (2)

4.2 Frictional force due to a surface is **the force that opposes the motion of the object** and acts parallel to the surface with which the object is in contact. (2)

4.3 22 N (same answer as 4.1) (2)

4.4
$$F_f = \mu N$$
$$22 = (0,2)N$$
$$N = 110 \text{ N}$$

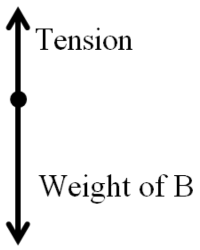
$$w_A + w_C = 110$$
$$44 + w_C = 110$$
$$\boldsymbol{w_C = 66 \text{ N}}$$
(5)

4.5 When a net (resultant) force is applied to an object of mass, m, it accelerates the object in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass.

OR

The net force acting on an object is equal to the rate of change of momentum. (2)

4.6



(force diagram -1)

(2)

4.7 Block B:
$$F_{net} = ma$$
$$w_B - T = \frac{w_B}{g}a$$
$$22 - T = \frac{22}{9,8}(2,3)$$
$$\boldsymbol{T = 16,84 \text{ N}}$$
(4)

4.8 Block A:
$$T - F_f = ma$$
$$16,84 - F_f = \frac{44}{9,8}(2,3)$$
$$\boldsymbol{F_f = 6,51 \text{ N}}$$
(3)

4.9
- Normal force is less as Block C has been removed.
- Kinetic friction is less than static friction as surfaces are no longer 'stuck' or $\mu_K < \mu_S$.

(4)

[26]

QUESTION 5

5.1 5.1.1 The total (linear) momentum of an **isolated system/in the absence of external forces** remains **constant** (is conserved). (2)

5.1.2 $(p_{total})_{before} = (p_{total})_{after}$

$1,2(8) + 0 = 1,2(4) + 0,5v$

$\boldsymbol{v = 9,6\ m \cdot s^{-1}}$ (4)

5.1.3 $\Delta p_Y = m(v-u)$

$\Delta p_y = 1,2(4-8)$

$\Delta p_y = -4,8$

$\boldsymbol{\Delta p_y = 4,8\ kg \cdot m \cdot s^{-1}}$ **west** (4)

5.1.4 $F_{net} = \dfrac{\Delta p_y}{\Delta t}$

$F_{net} = \dfrac{4,8}{1,5 \times 10^{-3}}$

$\boldsymbol{F_{net} = 3200\ N}$

OR

$a = \frac{\Delta v}{\Delta t}$

$a = \frac{4-8}{(2,5-1)\times 10^{-3}} = -2666,7$ m.s^{-2}

$F_{net} = ma$ for both formulae

$F_{net} = 1,2(2\ 666,7)$

$\boldsymbol{F_{net} = 3\ 200\ N}$

OR For Cart Y:

$F_{net}\Delta t = m\Delta v$

$F_{net}(1,5 \times 10^{-3}) = 1,2(4-8)$

$F_{net} = 3\ 200$ N

For Cart X:

$F_{net}\Delta t = m\Delta v$

$3\ 200(1,5 \times 10^{-3}) = 0,5(v_x)$

$v_x = 9,6$ m.s^{-1} (4)

5.2 5.2.1 $E_K = \frac{1}{2}mv^2$

$= \frac{1}{2}(70)(15)^2$

$\boldsymbol{= 7\ 875\ J}$ (3)

5.2.2 $E_p = mgh$

$= (70)(9,8)(30)$

$\boldsymbol{= 20\ 580\ J}$ (3)

5.2.3 $W_{vs\ \ friction} = F_f s$

$W_{vs\ \ friction} = (12)(450)$

$\boldsymbol{W_{vs\ \ friction} = 5\ 400\ J}$ (3)

5.2.4 $\left(E_{mech}\right)_{top} = \left(E_{mech}\right)_{bottom} + W_{vs\ friction}$

$$20\ 580 + 7\ 875 = \frac{1}{2}(70)v^2 + 5400$$

$$\boldsymbol{v = 25{,}67\ \mathbf{m \cdot s^{-1}}}$$

OR

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

$$(70 \times 9{,}8 \times sin\theta - 5\ 400)(450) = \frac{1}{2}70(v^2 - 15^2)$$

$$\boldsymbol{v = 25{,}67\ \mathbf{m.s^{-1}}}$$

OR

$$W_{nc} = \Delta E_K + \Delta E_P$$

$$-5400 = \Delta E_K - 20580$$

$$\Delta E_K = 15\ 180\ \text{J}$$

$$\frac{1}{2}70(v^2 - 15^2) = 15180$$

$$\boldsymbol{v = 25{,}67\ \mathbf{m.s^{-1}}}$$

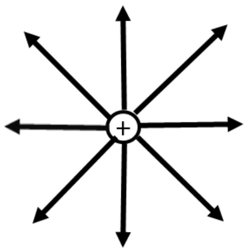
(4)

[27]

QUESTION 6

6.1 Electric field is the **force per unit (positive) charge**. (2)

6.2

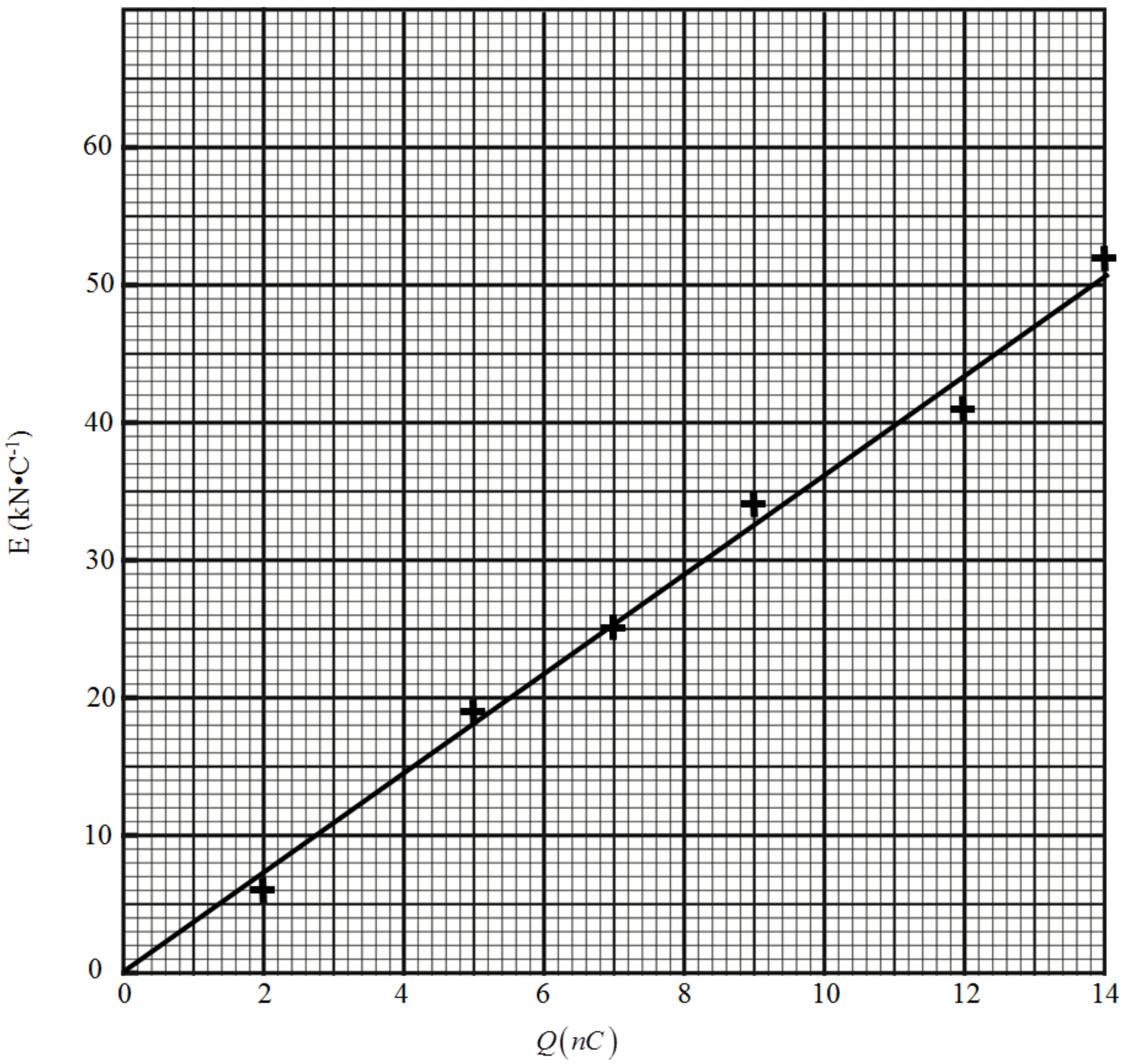


- Direction
- Radial Lines

(2)

6.3 Electric field is directly proportional to the charge. (two correct variables how electric field depends on charge) (2)

6.4 Graph to show Electric Field vs Charge (Answer Sheet).



Heading
y-axis title and unit
y-axis scale (plotted points $> \frac{1}{2}$ graph paper, scale must be in sensible multiples)
Plotted points (all 6 points plotted within half small block)
Line of best fit (with a ruler) (6)

6.5 Gradient $= \frac{\Delta y}{\Delta x}$

Gradient $= \frac{\text{values from } y\text{-axis}}{\text{values from } x\text{-axis}}$ (–1 if not shown on line of best fit)

Gradient = $3,67 \times 10^{12}$ (allow $3,30 \times 10^{12} - 4,04 \times 10^{12}$)
Gradient = 3,67 kN.C^{-1}.nC^{-1} (4)

6.6 $E = \frac{kQ}{r^2}$

gradient $= \frac{k}{r^2}$

$3,67 \times 10^{12} = \frac{9 \times 10^9}{r^2}$

$\boldsymbol{r = 0,050}$ **m** (3)

[19]

QUESTION 7

7.1 7.1.1 Resistance is a material's opposition to electric current. (2)

7.1.2 $\frac{1}{R_{||}} = \frac{1}{R_1} + \frac{1}{R_2}$ OR $R_{||} = \frac{\text{product}}{\text{sum}}$

$\frac{1}{R_{||}} = \frac{1}{6} + \frac{1}{10}$ $R_{||} = \frac{6 \times 10}{6 + 10}$

$R_{||} = 3,75\,\Omega$ $R_{||} = 3,75\,\Omega$

$R_T = 4 + 3,75$

$\boldsymbol{R_T = 7,75\ \Omega}$ (5)

7.1.3 Current is the rate of flow of charge. (2)

7.1.4 $V = R_T I$

$V = (7,75)(3)$

$\boldsymbol{V = 23,25\ V}$ (3)

7.1.5 $V = emf - Ir$

$23,25 = 26 - 3r$

$\boldsymbol{r = 0,92\ \Omega}$ (3)

7.1.6 Total R in circuit increases

Total I decreases

but $V = emf - Ir$

$\therefore V$ increases (4)

7.1.7 $I_{total} = 0\,A$

$V = emf - Ir$ OR no lost volts

$\boldsymbol{V = 26}$ **V** (3)

7.2 $emf = Ir + IR$

$emf = 2r + 2(2)$

$emf = 3r + 3(1)$

solve simultaneously

$\boldsymbol{r = 1\ \Omega}$

$\boldsymbol{emf = 6}$ **V** (5)

[27]

QUESTION 8

8.1 8.1.1 Out of page (2)

8.1.2 Current
Magnetic field
Length of conductor in the field (any two) (2)

8.2 8.2.1 The emf induced is directly proportional to the rate of change of magnetic flux (flux linkage). (2)

8.2.2
- Current in primary coil produces a magnetic flux in the core
- As current in primary coil is alternating current, magnetic flux in core is changing
- The secondary coil picks up the changing magnetic flux
- By Faraday's law, changing flux induces an emf in secondary coil. (4)

8.2.3 Power is constant, so high voltage means low current $(P = VI)$
Smaller current means less energy loss as $P = I^2R$ (4)

8.2.4
$$\frac{N_S}{N_P} = \frac{V_S}{V_P}$$
$$\frac{N_S}{N_P} = \frac{765}{20}$$
$$\boldsymbol{\frac{N_S}{N_P} = 38,25}$$
(3)

8.2.5 Step-up Transformer (2)

[19]

QUESTION 9

9.1 Work function is the **minimum** amount of energy needed to emit an electron from the surface of a metal. (2)

9.2 $E = \frac{hc}{\lambda}$ OR $f = \frac{c}{\lambda}$ and $E = hf$

$E = \frac{(6,6\times10^{-34})(3\times10^{8})}{296\times10^{-9}}$

$f = \frac{3\times10^{8}}{296\times10^{-9}} = 1,01\times10^{15}$

and $E = (6,6\times10^{-34})(1,01\times10^{15})$

$\boldsymbol{E = 6,69\times10^{-19}\ \text{J}}$ $\boldsymbol{E = 6,69\times10^{-19}\ \text{J}}$ (3)

9.3 Sodium and Aluminium (-1 per wrong answer listed) (2)

9.4 $hf = W_0 + E_{K\,max}$

$6,69\times10^{-19} = 3,94\times10^{-19} + E_{K\,max}$

$\boldsymbol{E_{K\,max} = 2,75\times10^{-19}\ \text{J}}$ (3)

9.5 No, intensity increases the number of photons/electrons, and energy of electrons of photons/electrons is not affected by intensity.

OR

No, frequency same, energy not affected by intensity. (4)

[14]

Total: 200 marks