NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2019

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

QUESTION 2

2.1 2.1.1 Velocity is the rate of change of position **OR** the rate of displacement **OR** the rate of change of displacement.

2.1.2 $\mathbf{12\ m\cdot s^{-1}}$ **North**

2.1.3 $s = \text{area under v-t graph}$

$s = \frac{1}{2}(10)(12) + (25-10)(12)$

$s = 240\text{ m}$

$\text{average v} = \frac{\text{total } s}{\text{total } t}$

$\text{average v} = \frac{240}{25}$

$\mathbf{average\ v = 9{,}6\ m\cdot s^{-1}}$

2.1.4 Acceleration is the rate of change of velocity.

2.1.5 $a = \text{ slope of v-t graph OR } \frac{\Delta v}{\Delta t}$

$a = \frac{12-0}{10-0}$

$\boldsymbol{a = 1{,}2\ \mathbf{m\cdot s^{-2}}}$

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

$s = (0{,}37)t$

Matthew: $s = 0 + \frac{1}{2}(0{,}91)(t-1{,}8)^2$

Combined: $(0{,}37)t = \frac{1}{2}(0{,}91)(t-1{,}8)^2$

$\boldsymbol{t = 3{,}48\ \mathbf{s}}$

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

$s = 0{,}37(t + 1{,}8)$

Matthew: $s = 0 + \frac{1}{2}(0{,}91)t^2$

Combined: $0{,}37(t + 1{,}8) = \frac{1}{2}(0{,}91)t^2$

$t = 1{,}68$ s

Helen: $t = 1{,}8 + 1{,}68$

$\boldsymbol{t = 3{,}48}$ **s**

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

$s = (0{,}37)(1{,}8)$

$s = 0{,}66$ m

Matthew: $s = 0 + \frac{1}{2}(0{,}91)t^2$

Combined: $0{,}66 + 0{,}37t = \frac{1}{2}0{,}91t^2$

$t = 1{,}68$ s

Helen: $t = 1{,}8 + 1{,}68$

$\boldsymbol{t = 3{,}48}$ **s**

QUESTION 3

3.1 3.1.1 A is greater than B, speed = gradient of position-time graph and gradient A > gradient B.

3.1.2 Yes 4 s (accept 3 s – 5 s)

3.1.3 Object A

3.2 3.2.1 $s = ut + \frac{1}{2}at^2$

$s = 2(4,32) + \frac{1}{2}(-9,8)(4,32)^2$

$s = -82,81\text{ m}$

$\therefore$ **Helicopter 82,81 m above trampoline**

3.2.2 $v = u + at$

$v = 2 + (-9,8)(4,32)$

$v = -40,34$

v = 40,34 m·s^{-1} down

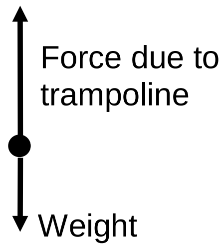
OR $v^2 = u^2 + 2as$

$v^2 = 2^2 + 2(-9,8)(-82,81)$

$v = 40,34$

v = 40,34 m·s^{-1} down

3.2.3

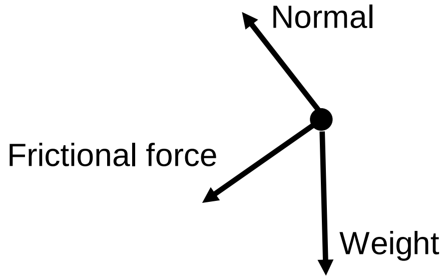


Force due to trampoline > force due to weight

3.2.4 Upward as he is launched back into the air
OR
Upward as he experiences a net force up

QUESTION 4

4.1 4.1.1



4.1.2 $F_{g\,||slope} = mg\sin\theta$

$52{,}52 = 48(9{,}8)\sin\theta$

$\sin\theta = 0{,}111$

$\boldsymbol{\theta = 6{,}41°}$

4.1.3 $F_N = mg\cos\theta$

$F_{fk} = \mu_k F_N$

$F_{fk} = (0{,}12)(48)(9{,}8)\cos(6{,}41)$

$\boldsymbol{F_{fk} = 56{,}10\ \mathrm{N}}$

4.1.4 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.

4.1.5 $F_{net} = ma$

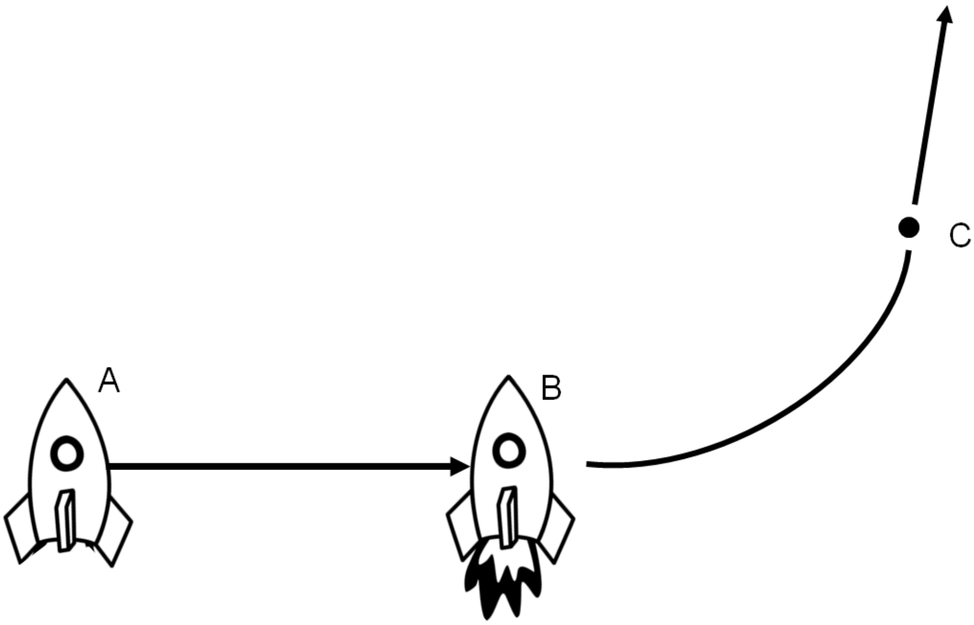
$F_{g\,||slope} + F_{fk} = ma$

$52{,}52 + 56{,}10 = 48a$

$\boldsymbol{a = 2{,}26\ \mathrm{m \cdot s^{-2}}}$ **down slope**

4.1.6 Greater from A to B
Friction and component of weight in the same direction
So resultant force is more
OR
Less from B to A
As friction acting up slope, opposite to component of weight
So resultant force is less

4.2 Answer Sheet



4.2.1 Point C
BC parabola

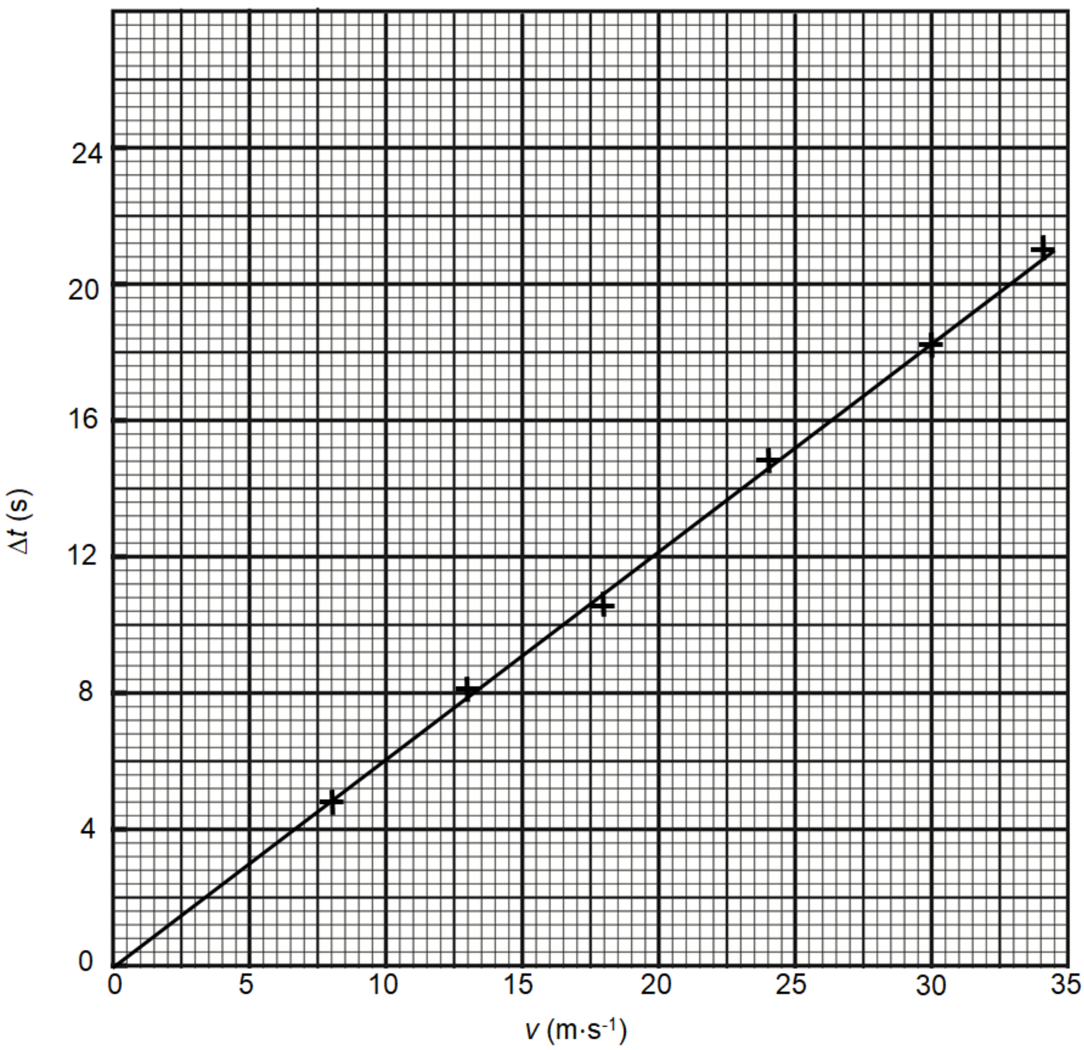
4.2.2 Straight line onwards from C
In same direction as before C

QUESTION 5

5.1 5.1.1 Velocity

5.1.2 Graph – on answer sheet
Heading
y-axis title and unit
x-axis title and unit
scale (plotted points > $\frac{1}{2}$ graph paper)
plotted points
line of best fit

Graph to show time taken to stop vs initial velocity



5.1.3 gradient $= \dfrac{\Delta y}{\Delta x}$

gradient $= \dfrac{\Delta y}{\Delta x}$

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

gradient = 0,61 $s^2 \cdot m^{-1}$ (accept 0,57 – 0,66)

5.1.4 $F_{net}\Delta t = m\Delta v$

$F_{net}\Delta t = m(0 - v)$

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

5.1.5 gradient $= -\dfrac{m}{F_{net}}$

$0,61 = -\dfrac{m}{-140}$

$\mathbf{m = 85,4\ kg}$

5.2 5.2.1 Kinetic energy is the energy an object has as a result of the object's motion.

5.2.2 At bottom: $E_K = \dfrac{1}{2}mv^2$

$E_K = \dfrac{1}{2}(60)(7,5)^2$

$\boldsymbol{E_K = 1\,687,5\ \mathrm{J}}$

5.2.3 At top: $E_P = mgh$

$E_P = (60)(9,8)(2,8)$

$\boldsymbol{E_P = 1\,646,4\ \mathrm{J}}$

5.2.4 Work done vs friction $= 1\,687,5 - 1\,646,4$

work done vs friction = 41,1 J

5.2.5 $\sin 25 = \dfrac{2,8}{s}$

$s = 6,63\ \mathrm{m}$

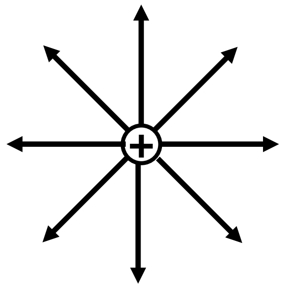
$W_{friction} = F_f s$

$41,1 = F_f(6,63)$

$\boldsymbol{F_f = 6,20\ \mathrm{N}}$

QUESTION 6

6.1 6.1.1



- pattern
- direction

6.1.2 Coulomb's law states that 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.

6.1.3 $F_{up} = F_{down}$

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

$$\frac{(9\times10^{9})(30\times10^{-9})(100\times10^{-9})}{h^2} = (1{,}5\times10^{-3})(9{,}8)$$

$\boldsymbol{h = 0{,}043\ \mathrm{m}}$

6.2 6.2.1 $E_{6\mu C} = \dfrac{kQ}{r^2}$

$$E_{6\mu C} = \frac{(9\times10^{9})(6\times10^{-6})}{(0{,}09)^2}$$

$\boldsymbol{E_{6\mu C} = 6{,}67\times10^{6}\ \mathrm{N\cdot C^{-1}}}$

6.2.2 $E_{-2\mu C} = \dfrac{kQ}{r^2}$

$$E_{-2\mu C} = \frac{(9\times10^{9})(2\times10^{-6})}{(0{,}04)^2}$$

$E_{-2\mu C} = 1{,}125\times10^{7}\ \mathrm{N\cdot C^{-1}}$

$E_{net} = 1{,}125\times10^{7} - 6{,}67\times10^{6}$

$\boldsymbol{E_{net} = 4{,}58\times10^{6}\ \mathrm{N\cdot C^{-1}}}$ **towards charges or right**

QUESTION 7

7.1 7.1.1 The potential difference is the work done per unit positive charge.

7.1.2 15 V

7.1.3 15 V

7.1.4 $V_1 = emf - Ir$ so as switch closes, I increases, more lost volts.
OR
$V_1 = emf - V_{lost}$ is lost volts, as switch closes, $I \neq 0,$ more lost volts.

7.1.5
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{R_P} = \frac{1}{6} + \frac{1}{12}$$
$$\boldsymbol{R_P = 4\ \Omega}$$

7.1.6
$$V = IR_T$$
$$10{,}5 = I(1+4)$$
$$\boldsymbol{I = 2{,}1\ \mathrm{A}}$$

7.1.7
$$V = emf - Ir$$
$$10{,}5 = 15 - 2{,}1r$$
$$\boldsymbol{r = 2{,}14\ \Omega}$$

7.2 7.2.1
$$P = \frac{V^2}{R}$$
$$100 = \frac{50^2}{R}$$
$$\boldsymbol{R = 25\ \Omega}$$

7.2.2
$$P = VI$$
$$100 = 50I$$
$$\boldsymbol{I = 2\ \mathrm{A}}$$
OR
$$P = I^2R$$
$$100 = I^2(25)$$
$$\boldsymbol{I = 2\ \mathrm{A}}$$
OR
$$I = \frac{V}{R}$$
$$I = \frac{50}{25}$$
$$\boldsymbol{I = 2\ \mathrm{A}}$$

7.2.3
$$V = R_T I$$
$$220 = (R+25)2$$
$$\boldsymbol{R = 85\ \Omega}$$

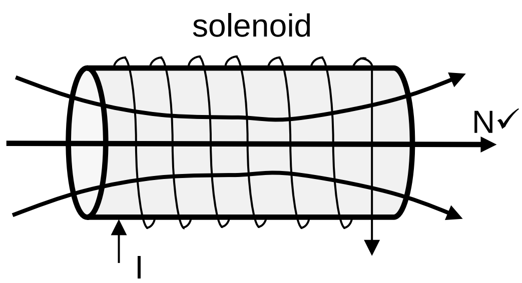
QUESTION 8

8.1 8.1.1 Into the page.

8.1.2 In the same direction as B field shown
half the magnitude (only if weaker)

8.2 Generator
Transformer
(Microphone)
(Induction stove)
Any 2 correct

8.3 8.3.1



Direction
Pattern

8.3.2 Faraday's law states that the emf induced is directly proportional to the rate of change of magnetic flux (flux linkage).

8.3.3 No relative movement – rate of change of flux is zero

8.3.4 Move coil or solenoid relative to each other.
Rotate the coil so effective area changes.
Continuously change the current in the solenoid.

[21]

QUESTION 9

9.1 Threshold frequency is the **minimum** frequency of incident radiation at which electrons will be emitted from a particular metal.

9.2 $c = f\lambda$

$3\times10^{8} = f_0\left(583\times10^{-9}\right)$

$\boldsymbol{f_0 = 5{,}15\times10^{14}}$ **Hz**

9.3 $W_0 = hf_0$

$W_0 = \left(6{,}6\times10^{-34}\right)\left(5{,}15\times10^{14}\right)$

$\boldsymbol{W_0 = 3{,}40\times10^{-19}}$ **J**

9.4 $\dfrac{hc}{\lambda} = W_0 + E_{Kmax}$

$\dfrac{\left(6{,}6\times10^{-34}\right)\left(3\times10^{8}\right)}{450\times10^{-9}} = 3{,}40\times10^{-19} + E_{Kmax}$

$\boldsymbol{E_{Kmax} = 1\times10^{-19}}$ **J**

9.5 9.5.1 Higher intensity has no effect.

9.5.2 Higher intensity increases the number of ejected electrons.

Total: 200 marks