NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION – MARCH 2018

# PHYSICAL SCIENCES: PAPER I

## MARKING GUIDELINES

Time: 3 hours | 200 marks

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**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.**

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## QUESTION 1

1.1 A
1.2 D
1.3 D
1.4 A
1.5 D
1.6 B
1.7 A
1.8 C
1.9 C
1.10 B (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 = $\frac{3,20}{0,5}$ 3,20 = 0 +a(0,5)

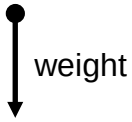
**a = 6,40 m·s$^{-2}$** **a = 6,40 m·s$^{-2}$** (3)

2.3 s = area under v-t graph

s = $\frac{1}{2}(0,5)(3,20)$

**s = 0,8 m** (3)

2.4

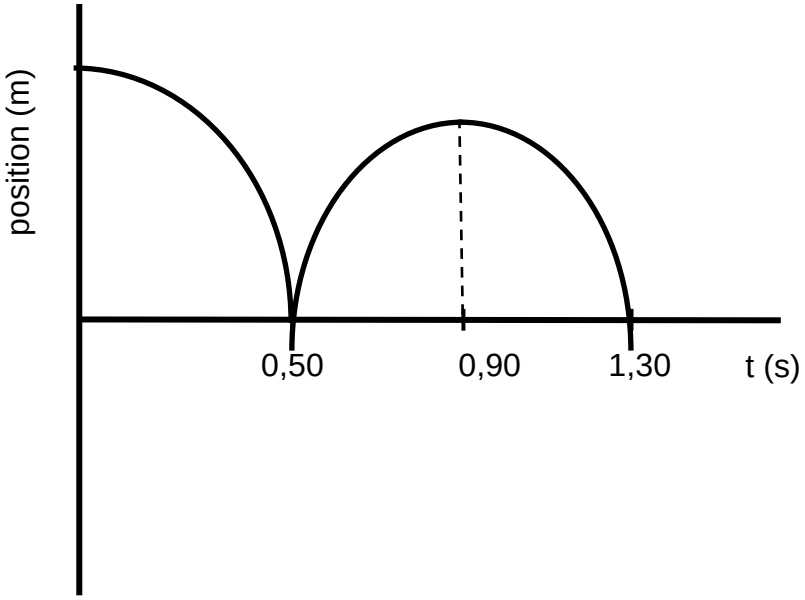



(2)

2.5 Inelastic as it doesn't bounce back to the same height. (2)

2.6 **2,56 m·s$^{-1}$** (2)

2.7




(3)

2.8 Earth: $g = \frac{GM}{R^2}$ $\quad 9,8R^2 = GM$

Planet: $g_P = \frac{GM}{R_P^2}$ $\quad 6,4R_P^2 = GM$

$6,4R_P^2 = 9,8R^2$

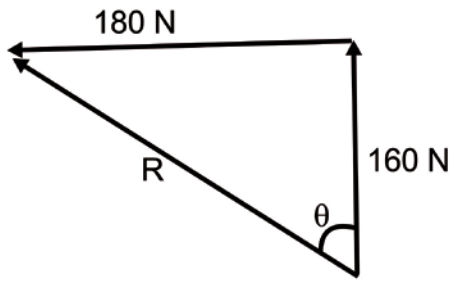
$R_P = \sqrt{\frac{9,8}{6,4}}R$

$\boldsymbol{R_P = 1,24\ R}$ (4)

**[21]**

## QUESTION 3

3.1 3.1.1




$R = \sqrt{160^2 + 180^2}$ $\quad \tan\theta = \frac{180}{160}$

$\boldsymbol{R = 240,83\ \text{N}}$ $\quad \boldsymbol{\theta = 48,37°}$ **W of N** (4)

3.1.2 $v^2 = u^2 + 2as$

$0 = 18^2 + 2(-2,5)s$

$\boldsymbol{s = 64,8\ \text{m}}$ (3)

3.1.3 $s_{west} = 64,8 \sin 48,37$
$s_{west} = 48,43$ m West (misses goal mouth)

$s_{north} = 64,8 \cos 48,37$
$s_{north} = 43,05$ m North (crosses goal line)

No goal (5)

3.2 3.2.1 $s = ut + \frac{1}{2}at^2$
$-104,40 = v_b(6) + \frac{1}{2}(-9,8)(6)^2$
$\boldsymbol{v_b = 12\ \mathrm{m \cdot s^{-1}}}$ (4)

3.2.2 **12 m · s⁻¹ up** (2)

3.2.3 $v^2 = u^2 + 2as$
$0 = 12^2 + 2(-9,8)s$
$s = 7,35$ m

max height $= 104,40 + 7,35$
**max height = 111,75 m** (5)

3.2.4 $s = ut + \frac{1}{2}at^2$
$s = (12)(6) + 0$
$s = 36$ m

height of balloon $= 104,40 + 36$
**height of balloon = 140,40 m** (4)
**[27]**

## QUESTION 4

4.1 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. (2)

4.2 left hand side: $F_{net} = ma$

$(0,6)(9,8) - T = (0,6)a$

right hand side: $T - (0,4)(9,8) = (0,4)a$ (3)

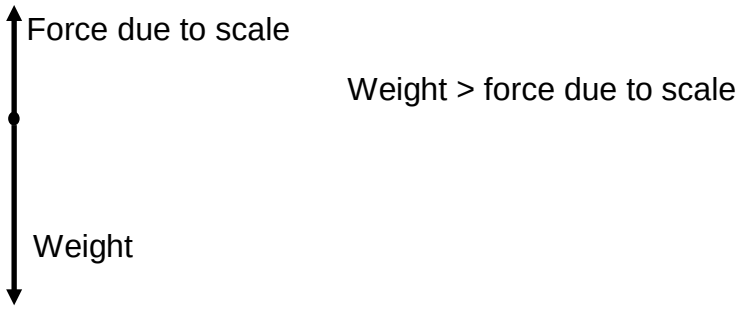
4.3 adding: $(0,2)(9,8) = 1,0a$

$\boldsymbol{a = 1,96\ \mathrm{m \cdot s^{-2}}}$

subst: $T = (0,4)(1,96) + (0,4)(9,8)$

$\boldsymbol{T = 4,70\ \mathrm{N}}$ (2)

4.4




(3)

4.5 $mg - F = ma$

$(0,5)(9,8) - F = (0,5)(1,96)$

$\boldsymbol{F = 3,92\ \mathrm{N}}$ (3)

4.6 When object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object A. (2)

4.7 0,5 kg mass on scale pan (2)

**[17]**

## QUESTION 5

5.1 5.1.1 The total (linear) momentum of an isolated system remains constant (is conserved). (2)

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

$(0,005)(200) + 0 = (0,195 + 0,005)v$

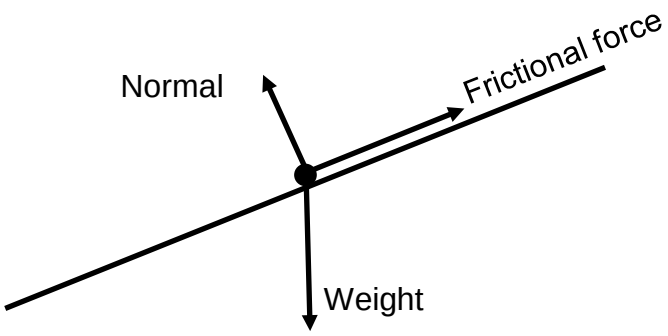
$\boldsymbol{v = 5\ \mathrm{m \cdot s^{-1}}}$ (4)

5.1.3 $(E_K + E_P)_{before} = (E_K + E_P)_{after}$

$\frac{1}{2}(0,2)(5)^2 + 0 = 0 + (0,2)(9,8)h$

$\boldsymbol{h = 1,28\ \mathrm{m}}$ (4)

5.2 5.2.1




(3)

5.2.2 The normal (2)

5.2.3 $E_K = \frac{1}{2}mv^2$

$E_K = \frac{1}{2}(70)(4)^2$

$\boldsymbol{E_K = 560\ \text{J}}$ (3)

5.2.4 $F_{net} = mg\sin 20 - F_f$

$F_{net} = (70)(9{,}8)\sin 20 - 190$

$F_{net} = 234{,}63 - 190$

$\boldsymbol{F_{net} = 44{,}63\ \text{N}}$ (3)

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. (2)

5.2.6 $F_{net} \cdot s = \Delta E_K$

$(44{,}63)(18) = (E_K)_L - 560$

$(E_K)_L = 1363{,}34\ \text{J}$

$\frac{1}{2}mv^2 = 1363{,}34$

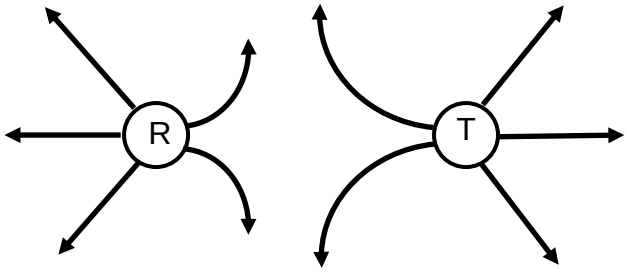
$\frac{1}{2}(70)v^2 = 1363{,}34$

$\boldsymbol{v = 6{,}24\ \text{m}\cdot\text{s}^{-1}}$ (5)

**[28]**

## QUESTION 6

6.1




Direction
Shape
Zero point closer to R (3)

6.2 $q = \frac{1}{2}(6\text{nC} + 10\text{nC})$

**$q$ = 8nC** (2)

6.3 no of electrons $= \frac{2 \times 10^{-9}}{1{,}6 \times 10^{-19}}$

**no of electrons $= 1{,}25 \times 10^{10}$** (2)

6.4 **From R to T** (2)

6.5 The force between two charges is **directly proportional to the product of the charges** and **inversely proportional to the distance between the charges squared**. (2)

6.6 $F_{6nC} = \frac{kq_1q_2}{r^2}$

$F_{6nC} = \frac{(9 \times 10^9)(6 \times 10^{-9})(5 \times 10^{-9})}{(0{,}7)^2}$

$F_{6nC} = 5{,}51 \times 10^{-7}$ N

$F_{10nC} = \frac{(9 \times 10^9)(10 \times 10^{-9})(5 \times 10^{-9})}{(1{,}1)^2}$

$F_{10nC} = 7{,}07 \times 10^{-7}$ N

$F_{net} = F_{10nC} - F_{6nC}$

**$F_{net} = 1{,}56 \times 10^{-7}$ N** (6)

**[17]**

## QUESTION 7

7.1 7.1.1 emf is the total energy supplied per coulomb of charge by the cell. (2)

7.1.2 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_P} = \frac{1}{20} + \frac{1}{30}$

$R_P = 12\Omega$

$R_T = 12 + 33$

$\boldsymbol{R_T = 45\,\Omega}$ (5)

7.1.3 $emf = I(R + r)$

$28 = I(45 + 7)$

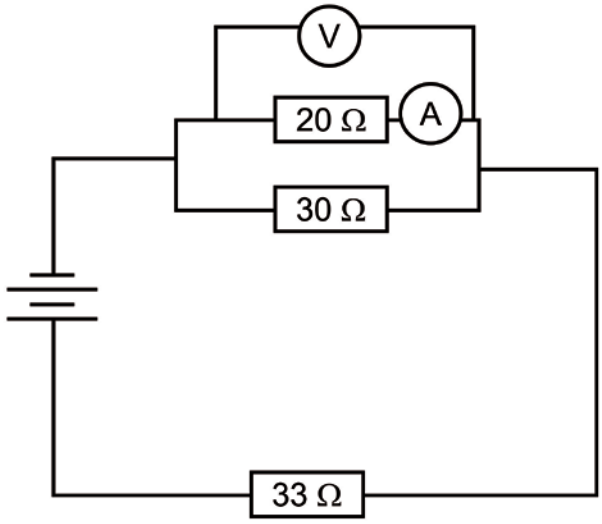
$\boldsymbol{I = 0{,}54}$ **A** (3)

7.1.4 $V = emf - Ir$

$V = 28 - (0{,}54)(7)$

$\boldsymbol{V = 24{,}23}$ **V** (3)

7.1.5 Ammeter in series with 20 Ω
Voltmeter in parallel with 20 Ω

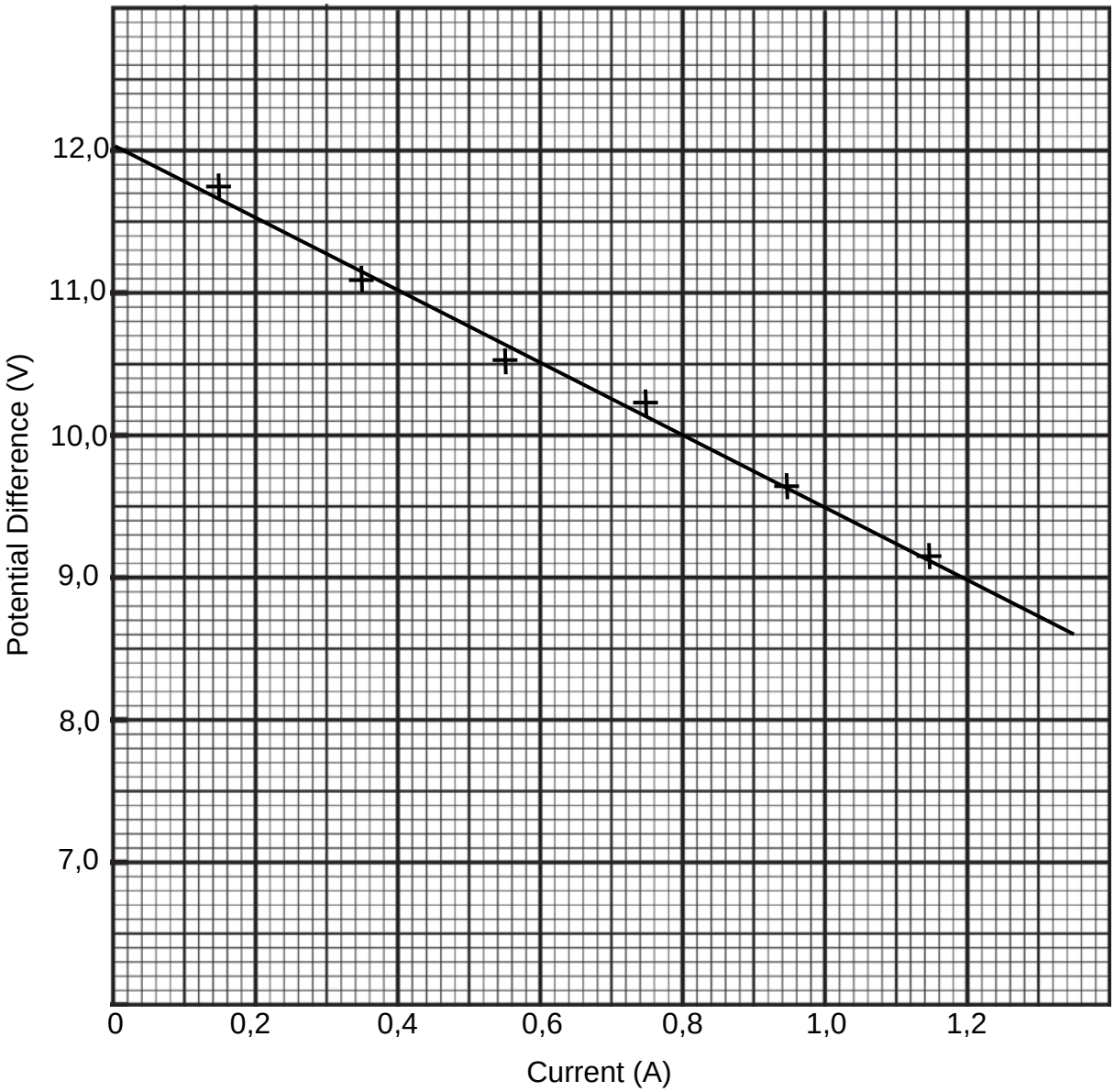



(4)

7.2 7.2.1 Potential difference is the work done per unit **positive** charge. (2)

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

Graph to show terminal potential difference vs current




(6)

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

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

**Gradient = –2,52 (allow –2,67 to –2,37)** (4)

7.2.4 $V = emf - Ir$
$V = (-r)I + emf$

slope $= -r$
$-r = -2{,}52$
$\boldsymbol{r = 2{,}52\,\Omega}$ (2)

7.2.5 the emf (2)
**[33]**

## QUESTION 8

8.1 Y to X (2)

8.2 Motor: electrical energy → mechanical (kinetic) energy
Generator: mechanical (kinetic) → electrical energy (2)

8.3 8.3.1 Into the page (2)

8.3.2 Increase current
Increase strength of magnets
Increase length of wire in field
(Any 2) (2)

8.3.3 When the conductor is parallel to the field lines (2)

8.4 8.4.1 Magnetic flux linkage is the product of the number of turns on the coil and the flux through the coil. (2)

8.4.2 Magnetic flux changes as the coil rotates.
Faraday's law states that a changing magnetic flux induces an emf.
An induced emf in a closed circuit means a current in the circuit. (4)

8.4.3 Lenz's Law: *The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux*. (2)

8.4.4 P to Q (2)
**[20]**

## QUESTION 9

9.1 9.1.1 $E = hf$

$E = \left(6,6\times10^{-34}\right)\left(9,1\times10^{14}\right)$

$\boldsymbol{E = 6,01\times10^{-19}\ \text{J}}$ (3)

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

9.1.3 $hf = W_0 + E_{K\,max}$

$6,01\times10^{-19} = 3,5\times10^{-19} + E_{K\,max}$

$E_{K\,max} = 2,51\times10^{-19}\ \text{J}$

$\frac{1}{2}\left(9,1\times10^{-31}\right)v^2 = 2,51\times10^{-19}$

$v^2 = 5,52\times10^{11}$

$\boldsymbol{v = 7,43\times10^{5}\ \text{m}\cdot\text{s}^{-1}}$ (4)

9.2 9.2.1 A photon is a particle of light.
OR A photon is a packet/quantum of energy. (2)

9.2.2 $E = \frac{hc}{\lambda}$

$E = \frac{\left(6,6\times10^{-34}\right)\left(3\times10^{8}\right)}{524\times10^{-9}}$

$\boldsymbol{E = 3,78\times10^{-19}\ \text{J}}$ (3)

9.2.3 $3,78\times10^{-19}\ \text{J} = 2,36\ eV$

$E_5 - E_2 = 2,36$

$E_5 = -2,81 + 2,36$

$\boldsymbol{E_5 = -0,45\ \text{eV}}$ (3)

**[17]**

**Total: 200 marks**

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