NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION MARCH 2017

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours | 200 marks

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QUESTION 1 MULTIPLE CHOICE

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

[20]

QUESTION 2 KINEMATICS

2.1 *Velocity is rate of displacement OR rate of change of position OR rate of change of displacement.* (2)

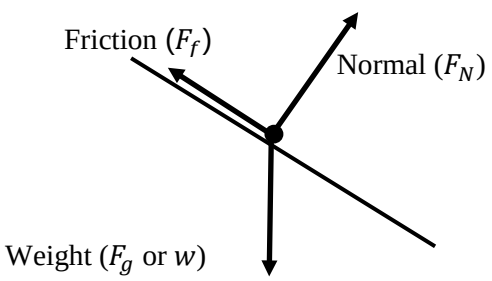
2.2 *Acceleration is the rate of change of velocity.* (2)

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

a = $\frac{2,2 - 2,0}{1}$ 2,2 = 2,0 + a(1)

a = 0,2 m·s^{-2} **a = 0,2 m·s^{-2}** (3)

2.4



(3)

2.5
$$F_{net} = ma$$
$$mg \sin 35° - F_f = (30)(0,2)$$
$$\boldsymbol{F_f} = \mathbf{162,63\ N}$$
(5)

2.6 distance = area under v–t graph

distance = $\frac{1}{2}(2)(2) + \frac{1}{2}(1)(0,2) + (1)(2)$

distance = 4,1 m (4)

2.7 $v = u + at$
$0 = 2,2 - 1,1t$
t = **2 s** (3)

2.8 $v^2 = u^2 + 2as$ OR s = area under v–t graph

$0 = (2,2)^2 + 2(-1,1)s$ s = $\frac{1}{2}(2)(2,2)$

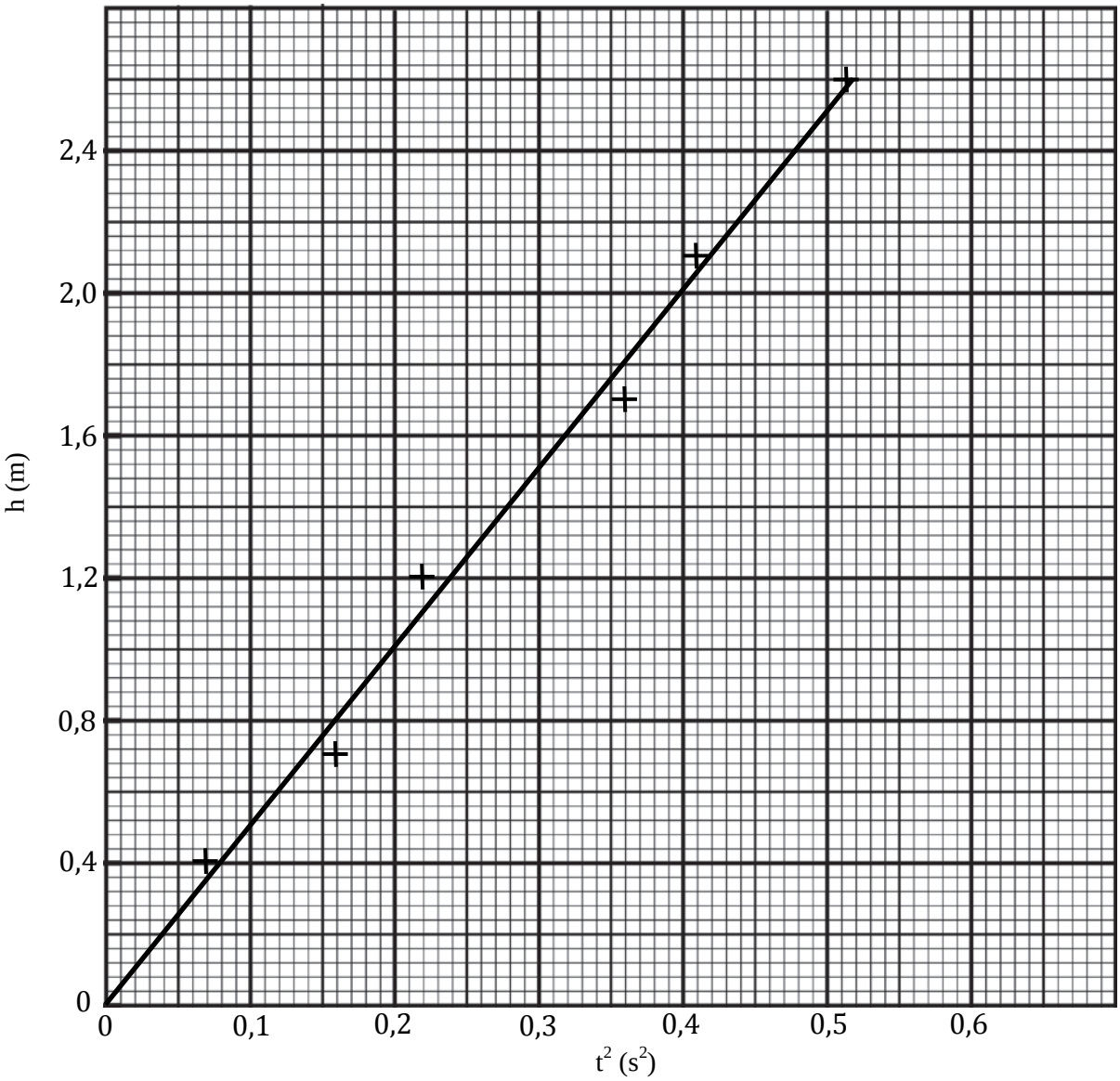
***s* = 2,2 m** ***s* = 2,2 m** (3)

[25]

QUESTION 3 KINEMATICS

3.1 To carry out analysis, a straight line is needed to determine gradient/show relationship. The graph of h vs t yields a curved line while h vs t^2 is linear. (3)

3.2 Graph of h vs t^2



Heading
y-axis title and unit
x-axis title and unit
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)

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

Gradient = $\frac{values\ \ from\ \ y-axis}{values\ \ from\ \ x-axis}$ (–1 if not shown on graph)

Gradient = 4,84 (allow 4,58–5,10) (4)

3.4 $h = \frac{1}{2}at^2$ (2)

3.5 slope $= \frac{1}{2}a$

$4{,}84 = \frac{1}{2}a$

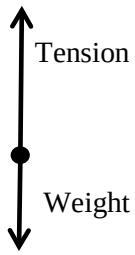
$\boldsymbol{a = 9{,}68\ m \cdot s^{-2}}$ (2)

3.6 Same graph as acceleration due to gravity (g) is independent of the mass of the falling object. (2)

[19]

QUESTION 4 NEWTON'S LAWS

4.1



Tension > weight

(3)

4.2 *When a <u>net force</u> is applied on an object of mass m, 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.*

OR *Net force is directly proportional to rate of change of momentum.* (2)

4.3 For block A:

$F_{net} = ma$

$mg - T = ma$

$3\,(9{,}8) - T = 3a$

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

For block B:

$T - mg = ma$

$T - 2\,(9{,}8) = 2a$

(5)

4.4 $T = 2(1{,}96) + 2(9{,}8)$

$\boldsymbol{T = 23{,}56\ N}$ (2)

4.5 $W = mg$

$\boldsymbol{W = 19{,}6\ N}$ (2)

4.6 *Mechanical energy is the sum of gravitational potential energy and kinetic energy at a point.* (2)

4.7 No external forces or friction are acting on block B once A has hit the floor. (2)

4.8 E_K of B when A hits ground $= E_P$ of B at top

$\frac{1}{2}(2)(3{,}96)^2 = (2)(9{,}8)h$

$h = 0{,}80$ m

height above ground = 4 + 0,8

height above ground = 4,8 m (4)

[22]

QUESTION 5 FORCE, WORK, ENERGY AND POWER

5.1 $F_{up} = 2T \sin 65°$
$F_{up} = 2(7\ 000) \sin 65°$
$\boldsymbol{F_{up}}$ **= 12 688,31 N** (3)

5.2 *Resultant vector is the single vector that has the same effect as the original vectors acting together.* (2)

5.3 $F_{net} = F_{up} - w$
$4\ 000 = 12\ 688{,}31 - w$
$w = 8\ 688{,}31$ N

$w = mg$
$8\ 688{,}3 = m\,(9{,}8)$
$\boldsymbol{m}$ **= 886,56 kg** (5)

5.4 *Work-energy theorem states that the <u>work done by a net force</u> on an object is equal to the <u>change in kinetic energy of the object</u>.* (2)

5.5 $W_{net} = \Delta E_K$
$W_{net} = \frac{1}{2}(320)(19^2 - 0)$
$\boldsymbol{W_{net}}$ **= 57 760 J** (3)

5.6 $W_{mech} = \Delta E_K + \Delta E_P$
$W_{mech} = 57\ 760 + (320)(9{,}8)(25)$
$W_{mech} = 57\ 760 + 78\ 400$
$\boldsymbol{W_{mech}}$ **= 136 160 J** (5)

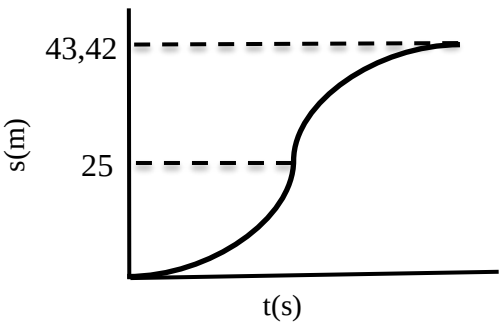
5.7 $F_{applied} \cdot s = 136\ 160$
$F_{applied}(25) = 136\ 160$
$\boldsymbol{F_{applied}}$ **= 5 446,4 N** (4)

5.8 $v^2 = u^2 + 2as$
$0 = 19^2 + 2(-9{,}8)s$
$s = 18{,}42$ m

OR
$136\ 160 = mgh$
$136\ 160 = (320)(9{,}8)h$
$\boldsymbol{h}$ **= 43,42 m**

height = 18,42 + 25
height = **43,42 m** (4)

5.9



axes labelled
values indicated

(4)
[32]

QUESTION 6 FIELDS

6.1 6.1.1 *Newton's Law of Universal Gravitation: Every particle in the universe attracts every other particle with a force that is <u>directly proportional to the product of their masses</u> and <u>inversely proportional to the square of the distance</u> (between their centres).* (2)

6.1.2 $F_J = \frac{GM_J m_s}{r^2}$

$F_J = \frac{(6{,}7\times10^{-11})(1{,}9\times10^{27})(2{,}2\times10^{3})}{(3{,}9\times10^{11})^2}$

$\boldsymbol{F_J = 1{,}84\times10^{-3}}$ **N** (3)

6.1.3 $F_S = \frac{GM_s m_s}{r^2}$

$F_S = \frac{(6{,}7\times10^{-11})(5{,}7\times10^{26})(2{,}2\times10^{3})}{(4{,}2\times10^{11})^2}$

$\boldsymbol{F_S = 4{,}76\times10^{-4}}$ N

$F_{net} = F_J - F_S$

$F_{net} = 1{,}84\times10^{-3} - 4{,}76\times10^{-4}$

$F_{net} = 1{,}36\times10^{-3}$ N

$F_{net} = ma$

$1{,}36\times10^{-3} = 2{,}2\times10^{3}a$

$a = 6{,}2\times10^{-7}\ m\cdot s^{-2}$

(6)

6.2 6.2.1 *Electric field is the force per unit <u>positive</u> charge.* (2)

6.2.2 $E = \frac{kQ}{r^2}$

$312\ 500 = \frac{(9\times10^{9})(5\times10^{-9})}{r^2}$

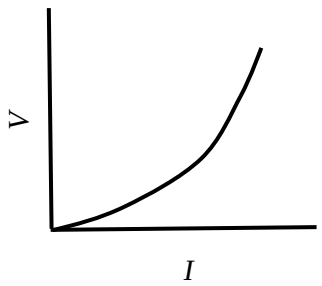
r = 0,012 m (3)

[16]

QUESTION 7 ELECTRIC CIRCUITS

7.1 7.1.1 No, a filament light bulb is non-ohmic. The current through the filament is not directly proportional to the potential difference across the filament (or does not obey Ohm's law) as resistance changes with temperature. (3)

7.1.2



Labelled axes
Correct curve

(2)

7.1.3 $P = I^2R$
The resistance of the bulb > resistance of the wires
So even for same current $P_{bulb} > P_{wires}$ (3)

7.2 7.2.1 *Power is the rate of doing work.* (2)

7.2.2 $P = VI$
$60 = 24\,I$
$\boldsymbol{I = 2{,}5\ A}$ (3)

7.2.3 *Ohm's law states that the current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.* (2)

7.2.4 $V = RI$
$V = (7)(2{,}5)$
$\boldsymbol{V = 17{,}5\ V}$ (3)

7.2.5 $V_{volt} = 24 - 17{,}5$
$\boldsymbol{V_{volt} = 6{,}5\ V}$ (2)

7.2.6 $V = IR$
$6{,}5 = 3I$
$I = 2{,}17\ A$

$I_R = I_{total} - I_{7\Omega}$
$I_R = 2{,}5 - 2{,}17$
$\boldsymbol{I_R = 0{,}33A}$ (5)

7.2.7 $V = IR$
$6{,}5 = R\,(0{,}33)$
$\boldsymbol{R = 19{,}70\ \Omega}$ (3)

[28]

QUESTION 8 ELECTRODYNAMICS

8.1 8.1.1 Motor as electrical energy → mechanical energy (2)

8.1.2 PQRS (2)

8.1.3 North (2)

8.1.4 Down (2)

8.1.5 No, there is no split ring commutator
so when PQ is next to pole B, force on wire is up. (3)

8.2 8.2.1 gravitational potential energy to kinetic energy AND electrical energy. (3)

8.2.2 *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)

8.2.3 clockwise (2)

8.2.4 No, Peter's magnet will reach the ground first; induced current in the ring will set up a magnetic field to oppose the magnet falling. The acceleration of the magnet falling through the ring will be less than *g*. (4)

[22]

QUESTION 9 PHOTONS AND ELECTRONS

9.1 *Threshold frequency is the <u>minimum frequency</u> of incident radiation at which electrons will be emitted from a particular metal.* (2)

9.2 $E = hf$
$E = (6{,}6 \times 10^{-34})(4{,}4 \times 10^{14})$
$\boldsymbol{E = 2{,}90 \times 10^{-19}\ \text{J}}$ (3)

9.3 If $f > f_0$ then E_K max increases as frequency increases.
If $f < f_0$ then E_K max is zero and no electrons are ejected. (3)

9.4 B
f_0 is double as W_0 is double, therefore greater *x* intercept.
Slope = *h* therefore constant slope (4)

9.5
$$hf = W_0 + E_{K\,max}$$
$$(6{,}6 \times 10^{-34})(15 \times 10^{14}) = 2\,(2{,}90 \times 10^{-19}) + E_{K\,max}$$
$$\mathbf{E_{K\,max} = 4{,}1 \times 10^{-19}\ J}$$ (4)

[16]

Total: 200 marks

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