NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

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

QUESTION 2

2.1 2.1.1 The resultant force on climber is zero.
OR
Vector sum of all forces is zero

2.1.2 $T\cos 35 = w$
$T\cos 35 = 64(9,8)$
$\boldsymbol{T = 765,67\ N}$

OR $T\sin 55 = w$
$T\sin 55 = 627,2$
$T = 765,67\ \text{N}$

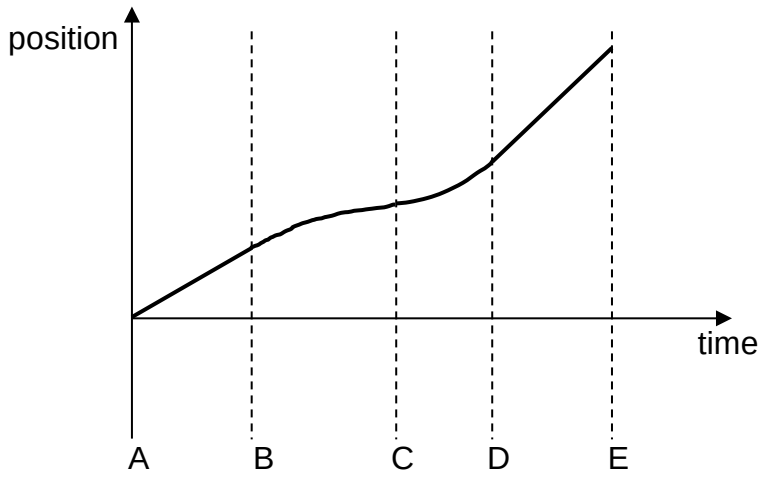
2.1.3 $F = T\sin 35$
$F = (765,67)\sin 35$
$\boldsymbol{F = 439,17\ N}$
OR
$\tan 35 = \frac{F}{w}$
$F = 627,2\ \tan 35$
$F = 439,17\ \text{N}$

OR $F = T\cos 55$
$F = 765,67\cos 55$
$F = 439,17\ \text{N}$

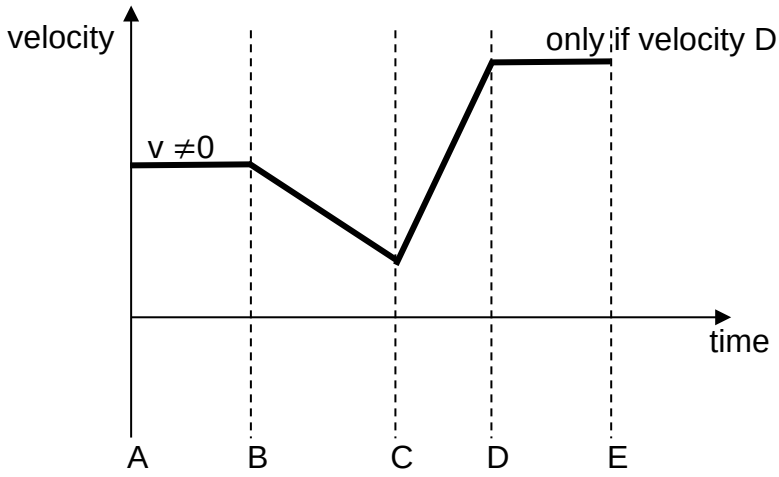
OR
$T^2 = F^2 + w^2$
$(765,67)^2 = F^2 + (627,2)^2$
$F = 439,17\ \text{N}$

2.2 2.2.1 Velocity is the rate of change of position OR the rate of displacement OR the rate of change of displacement.

2.2.2



2.2.3

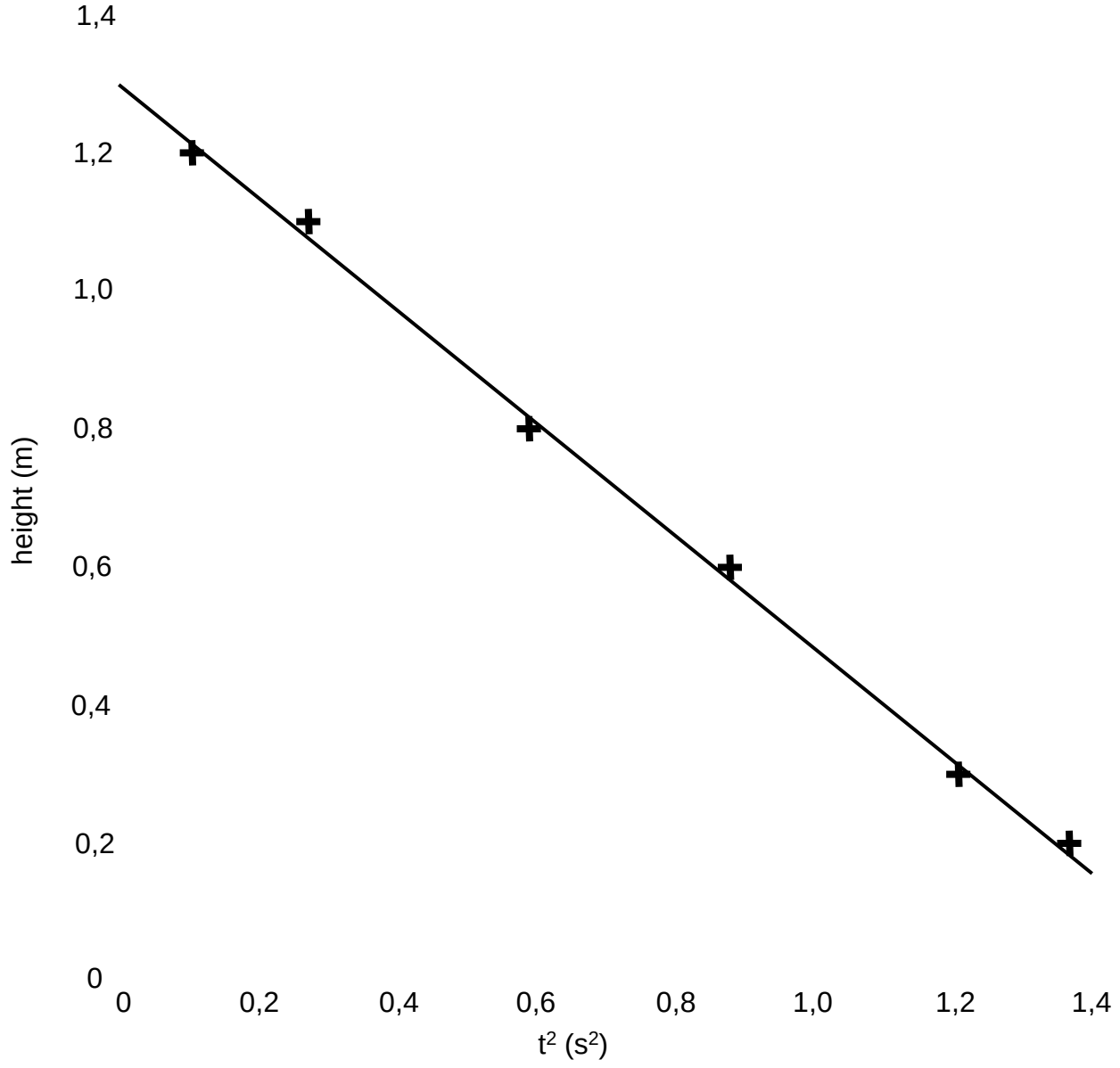


only if velocity DE > velocity AB

QUESTION 3

3.1 3.1.1 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^2 taken to reach specific heights



3.1.2 to obtain a straight line
OR
To be able to determine gradient

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

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

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

gradient = –0,82 m·s^{-2} (accept –0,74 to –0,90)

3.1.4 gradient $= \frac{1}{2}a$

$\frac{1}{2}a = -0,82$

$a = -1,63$ **m·s^{-2}** (can ignore sign)

3.1.5 height of drop = y-intercept
height of drop = 1,30 m

3.2 while accelerating: $v = u + at$
15 = 0 + 2,5t
t = 6 s

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

$s = 0 + \frac{1}{2}2,5(6)^2$

s = 45 m

at 15 m·s^{-1}: s = 100 – 45
s = 55 m

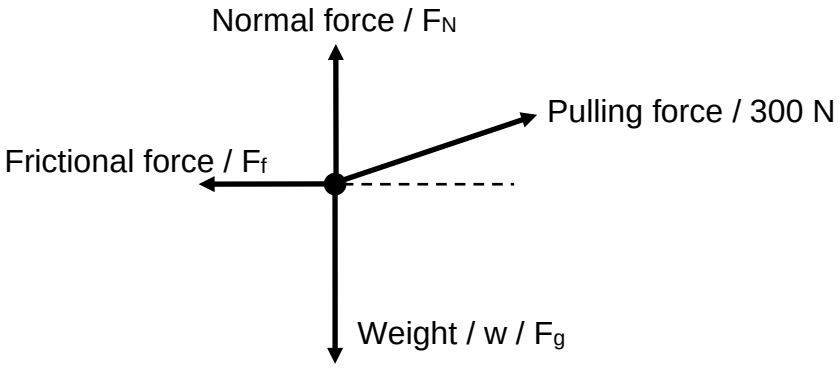
$s = ut + \frac{1}{2}at^2$

$55 = 15t$
t = 3,67 s

Total: $t = 6 + 3,67$
t = 9,67 s

QUESTION 4

4.1 4.1.1



4.1.2 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.

4.1.3 $F_{net} = ma$

$300\cos 20 \ -180 \ = 50a$

$\boldsymbol{a = 2{,}04 \ m{\cdot}s^{-2}}$

4.1.4 $F_N + 300\sin 20 = F_g$

$F_N + 300\sin 20 = 50(9{,}8)$

$\boldsymbol{F_N = 387{,}39 \ N}$

4.1.5 normal force decreases

$F_{fk} = \mu_k F_N$

frictional force decreases

4.2 4.2.1 No

4.2.2 ●⟶ Frictional force / F_f Truck accelerating ⟹

4.2.3 $F_f^{max} = \mu_s F_N$

$F_f^{max} = (0{,}9)(200)(9{,}8)$

$\boldsymbol{F_f^{max} = 1\,764 \ N}$

4.2.4 $F_f^{max} = ma$

$1764 = 200a$

$\boldsymbol{a = 8{,}82 \ m{\cdot}s^{-2}}$

4.2.5 $F_f = ma$

$\mu_k F_N = ma$

$(0,5)(200)(9,8) = 200a$

$\boldsymbol{a = 4,9\ m\cdot s^{-2}}$

4.3 4.3.1 at rest, $T_{rest} = mg$

Accelerating, $mg - T_{moving} = ma$

T_{moving} is less than T_{rest}

4.3.2 acceleration smaller than the acceleration due to gravity

QUESTION 5

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

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

$(0,02)(300) + 0 = (1,0 + 0,02)v$

$\boldsymbol{v = 5,88\ m\cdot s^{-1}}$ **East** OR to the right

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

5.1.4 $W = \Delta E_K$

$F_f s = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$F_f(4) = \frac{1}{2}(1,02)(0) - \frac{1}{2}(1,02)(5,88)^2$

$\boldsymbol{F_f = -4,41 N}$ (can ignore sign)

5.2 5.2.1 Mechanical energy is the sum of gravitational potential and kinetic energy at a point.

5.2.2 $(E_{mech})_{top} = (E_{mech})_{bottom}$

$\frac{1}{2}(0,60)(3,2)^2 + (0,60)(9,8)(2,0) = \frac{1}{2}(0,60)v^2$

$\boldsymbol{v = 7,03\ m\cdot s^{-1}}$

OR

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

$v^2 = (3,2)^2 + 2(9,8)(2)$

$\boldsymbol{v = 7,03\ m\cdot s^{-1}}$

5.2.3 Impulse is the product of the net force and the contact time.

5.2.4 $F_{net}\Delta t = m\Delta v$

$F_{net}(0,02) = (0,06)(1,6-(-7,03))$

$F_{net} = 258,94$ N

$F_{net} = F_{ground} - mg$

$258,94 = F_{ground} - (0,60)(9,8)$

$\boldsymbol{F_{ground} = 264,82}$ **N**

QUESTION 6

6.1 6.1.1 Gravitational field is the force acting per unit mass.

6.1.2 $g = \frac{F}{m}$

$g = \frac{125}{5}$

$\boldsymbol{g = 25}$ **m·s^{-2}**

6.1.3 $g = \frac{GM}{R^2}$

$25 = \frac{(6,7\times10^{-11})M}{(7,0\times10^{7})^2}$

$\boldsymbol{M = 1,83\times10^{27}}$ **kg**

6.2 6.2.1 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.

6.2.2 negative

6.2.3 $F = \frac{kQ_1Q_3}{r^2}$

$0,012 = \frac{(9\times10^{9})Q_1(2\times10^{-6})}{(2,5)^2}$

$\boldsymbol{Q_1 = 4,17\times10^{-6}}$ **C**

QUESTION 7

7.1 7.1.1 Resistance is a material's opposition to (the flow of) electric current.

7.1.2 $P = \frac{V^2}{R}$

$24 = \frac{12^2}{R}$

$\boldsymbol{R = 6\ \Omega}$

7.2 7.2.1 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_P} = \frac{1}{30} + \frac{1}{10}$

$R_P = 7{,}5\Omega$

$R_T = R_P + R$

$R_T = 7{,}5 + 4{,}5$

$\boldsymbol{R_T = 12\ \Omega}$

7.2.2 Ohm's law: Current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.

7.2.3 $emf = I(r + R)$

$24 = I(3 + 12)$

$\boldsymbol{I = 1{,}6\ A}$

7.2.4 $V_P = IR_P$

$V_P = (1{,}6)(7{,}5)$

$V_P = 12\ V$

$V = RI$

$12 = 10I$

$\boldsymbol{I = 1{,}2\ A}$

7.2.5 I decreases or V decreases

$P = I^2R$ or $P = \frac{V^2}{R}$

Less heat dissipated

QUESTION 8

8.1 8.1.1 Q to P

8.1.2 stronger magnetic field

8.2 8.2.1 clockwise

8.2.2 vertical

8.3 8.3.1 split-ring commutator

8.3.2 d.c. motor: input is a d.c. current
current causes a magnetic field
magnetic fields interact causing forces
forces rotate coil
commutator reverses current
coil rotates continuously
(any 3 of above points)

8.3.3 d.c. generator: input is force to rotate coil
coil experiences a change of flux per time
rate of change of flux induces emf
commutator allows changing connections to produce d.c.
(any 3 of above points)

8.3.4 more turns on coil
OR
stronger magnets
OR
For motor, increase current
For generator, increase speed or area of coil

QUESTION 9

9.1 9.1.1 Work function is the **minimum** amount of energy needed to emit an electron from the surface of a metal.

9.1.2 $W_0 = hf_0$

$6,9 \times 10^{-19} = 6,6 \times 10^{-34} f_0$

$\boldsymbol{f_0 = 1,05 \times 10^{15}}$ **Hz**

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

$8,8 \times 10^{-19} = 6,9 \times 10^{-19} + E_{K\,max}$

$\boldsymbol{E_{K\,max} = 1,9 \times 10^{-19}}$ **J**

9.2 9.2.1 $E = \dfrac{hc}{\lambda}$

$E = \dfrac{\left(6,6 \times 10^{-34}\right)\left(3 \times 10^{8}\right)}{557,7 \times 10^{-9}}$

$\boldsymbol{E = 3,55 \times 10^{-19}}$ **J**

9.2.2 Energy emitted due to specific transitions between orbitals.
Orbital energy levels are unique for each atom.

OR
Energy emitted due to specific transitions between orbitals.
Compare emission lines to those of a known element.

Total: 200 marks