NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours 200 marks

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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 (2 × 10 = 20)
[20]

QUESTION 2

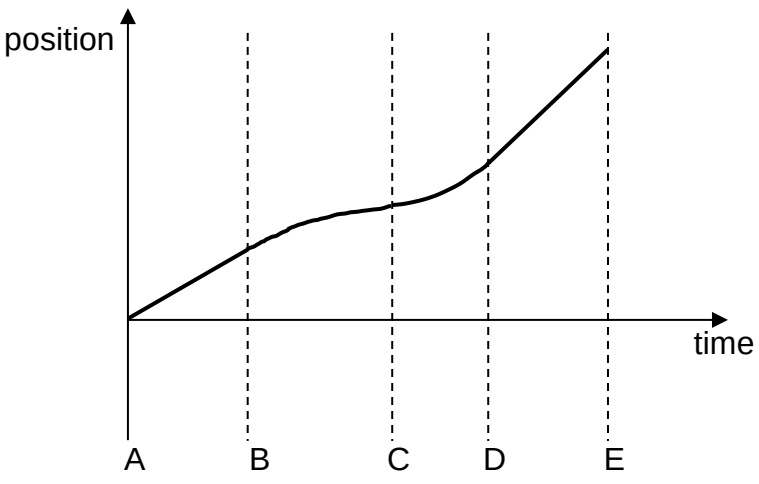
2.1 2.1.1 The resultant force on climber is zero. ✓✓ (2)

2.1.2 $T\cos 35 = w$ ✓
$T\cos 35$ ✓ $= 64(9{,}8)$ ✓
$\boldsymbol{T = 765{,}67\ N}$ ✓ (4)

2.1.3 $F = T\sin 35$ ✓
$F = (765{,}67)\sin 35$ ✓
$\boldsymbol{F = 439{,}17\ N}$ ✓ (3)

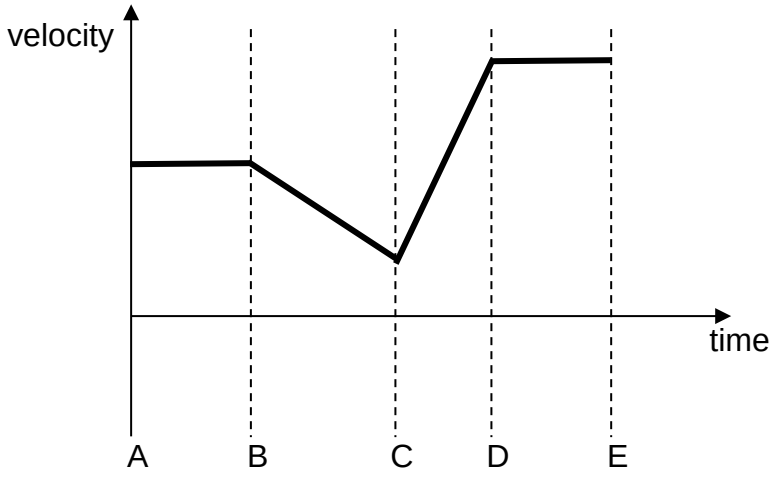
2.2 2.2.1 Velocity is the rate of change of position OR the rate of displacement OR the rate of change of displacement. ✓✓ (2)

2.2.2



(4)

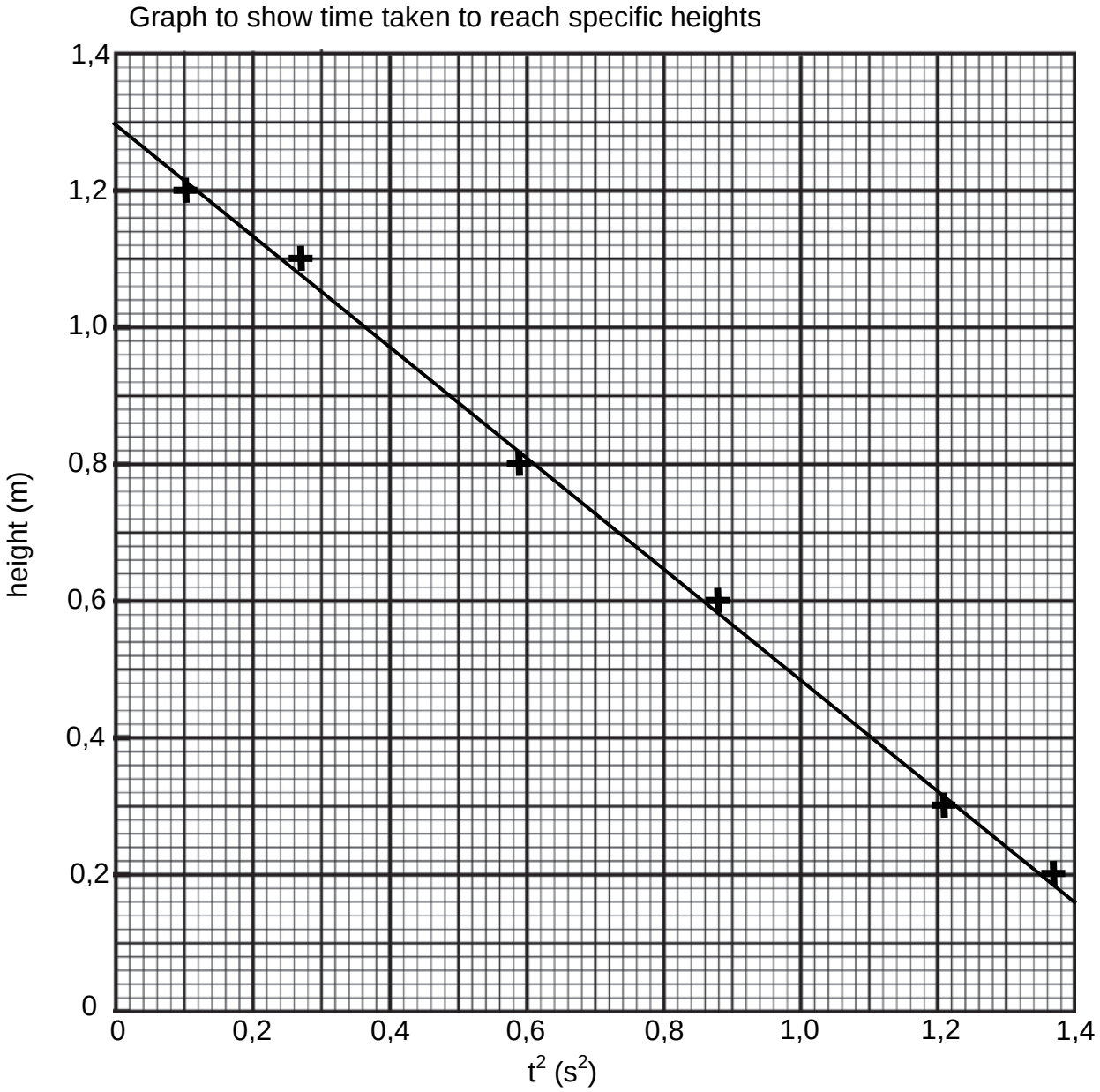
2.2.3



(4)
[19]

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 ✓ (6)



3.1.2 to obtain a straight line ✓✓ (2)

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) (5)

3.1.4 gradient $= \frac{1}{2}a$ ✓

$\frac{1}{2}a = -0,82$ ✓

$\boldsymbol{a = -1,63}$ **m·s^{-2}** ✓ (can ignore sign) (3)

3.1.5 height of drop = y-intercept ✓

height of drop = 1,30 m ✓ (2)

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 ✓ (6)

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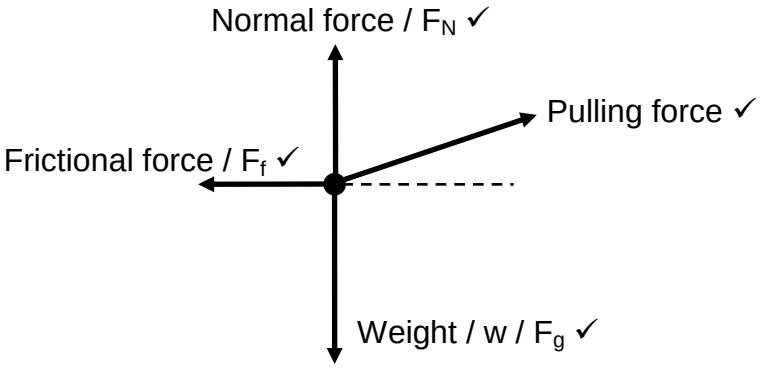
QUESTION 4

4.1 4.1.1



(4)

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. ✓✓ (2)

4.1.3 $F_{net} = ma$ ✓

$300\cos 20$ ✓ -180 ✓ $= 50a$ ✓

$\boldsymbol{a = 2{,}04\ m\cdot s^{-2}}$ ✓ (5)

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)

4.1.5 normal force decreases ✓

$F_{fk} = \mu_k F_N$ ✓

frictional force decreases ✓ (3)

4.2 4.2.1 No ✓✓ (2)

4.2.2 ●⟶ Frictional force / F_f ✓ Truck accelerating ✓ ⟹

(2)

4.2.3 $F_f^{max} = \mu_s F_N$ ✓

$F_f^{max} = (0{,}9)(200)(9{,}8)$ ✓

$\boldsymbol{F_f^{max} = 1\,764\ N}$ ✓ (3)

4.2.4 $F_f^{max} = ma$

$1764 = 200a$ ✓

$\boldsymbol{a = 8{,}82\ m\cdot s^{-2}}$ ✓ (3)

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4.2.5 $F_f = ma$

$\mu_k F_N = ma$ ✓

$(0,5)(200)(9,8) = 200a$ ✓

$\boldsymbol{a = 4,9\ m\cdot s^{-2}}$ ✓ (3)

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

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

T_{moving} is less than T_{rest} ✓✓ (2)

4.3.2 acceleration smaller than the acceleration due to gravity ✓✓ (2)

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QUESTION 5

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

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

$(0,02)(300) + 0 = (1,0 + 0,02)v$ ✓✓

$\boldsymbol{v = 5,88\ m\cdot s^{-1}}$ ✓ **East** ✓ (5)

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. (2)

5.1.4 $W = \Delta E_K$

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

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

$\boldsymbol{F_f = 4,41\ N}$ ✓ (4)

5.2 5.2.1 Mechanical energy is the sum of gravitational potential and kinetic energy at a point. ✓✓ (2)

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

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

$\boldsymbol{v = 7,03\ m\cdot s^{-1}}$ ✓ (5)

5.2.3 Impulse is the product of the net force and the contact time. ✓✓ (2)

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 ✓

$F_{net} = F_{ground} - mg$ ✓

$258,94 = F_{ground} - (0,60)(9,8)$ ✓

$\boldsymbol{F_{ground} = 264,82\ N}$ ✓ (7)

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QUESTION 6

6.1 6.1.1 Gravitational field is the force acting per unit mass. ✓✓ (2)

6.1.2 $g = \frac{F}{m}$ ✓

$g = \frac{125}{5}$ ✓

$\boldsymbol{g = 25\ m \cdot s^{-2}}$ ✓ (3)

6.1.3 $g = \frac{GM}{R^2}$ ✓

$25 = \frac{\left(6,7 \times 10^{-11}\right)M}{\left(7,0 \times 10^{7}\right)^2}$ ✓✓

$\boldsymbol{M = 1,83 \times 10^{27}\ kg}$ ✓ (4)

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. ✓ (2)

6.2.2 negative ✓✓ (2)

6.2.3 $F = \frac{kQ_1Q_3}{r^2}$ ✓

$0,012 = \frac{\left(9 \times 10^{9}\right)Q_1\left(2 \times 10^{-6}\right)}{\left(2,5\right)^2}$ ✓✓

$\boldsymbol{Q_1 = 4,17 \times 10^{-6}\ C}$ ✓ (4)

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QUESTION 7

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

7.1.2 $P = \frac{V^2}{R}$ ✓

$24 = \frac{12^2}{R}$ ✓

$\boldsymbol{R = 6\ \Omega}$ ✓ (3)

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

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

$R_P = 7{,}5\Omega$ ✓

$R_T = R_P + R$

$R_T = 7{,}5 + 4{,}5$ ✓

$\boldsymbol{R_T = 12\ \Omega}$ ✓ (5)

7.2.2 Ohm's law: Current through a conductor is directly proportional to the potential difference across the conductor at constant temperature. ✓✓ (2)

7.2.3 $emf = I(r + R)$ ✓

$24 = I(3 + 12)$ ✓✓

$\boldsymbol{I = 1{,}6\ A}$ ✓ (4)

7.2.4 $V_P = IR_P$ ✓

$V_P = (1{,}6)(7{,}5)$ ✓

$V_P = 12$ V ✓

$V = RI$

$12 = 10I$ ✓

$\boldsymbol{I = 1{,}2\ A}$ ✓ (5)

7.2.5 I decreases or V decreases ✓

$P = I^2R$ or $P = \frac{V^2}{R}$ ✓

Less heat dissipated ✓ (3)

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QUESTION 8

8.1 8.1.1 Q to P ✓✓ (2)

8.1.2 stronger magnetic field ✓✓ (2)

8.2 8.2.1 clockwise ✓✓ (2)

8.2.2 vertical ✓✓ (2)

8.3 8.3.1 split-ring commutator ✓✓ (2)

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) (3)

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) (3)

8.3.4 more turns on coil ✓✓
OR
stronger magnets ✓✓ (2)
[18]

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. (2)

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** ✓ (3)

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** ✓ (3)

9.2 9.2.1 $E = \dfrac{hc}{\lambda}$ ✓

$E = \dfrac{\left(6,6 \times 10^{-34}\right)\left(3 \times 18^{8}\right)}{557,7 \times 10^{-9}}$ ✓✓

$\boldsymbol{E = 3,55 \times 10^{-19}}$ **J** ✓ (4)

9.2.2 Energy emitted due to specific transitions between orbitals. ✓
Orbital energy levels are unique for each atom. ✓ (2)

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Total: 200 marks

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