NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2019

TECHNICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours | 150 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.

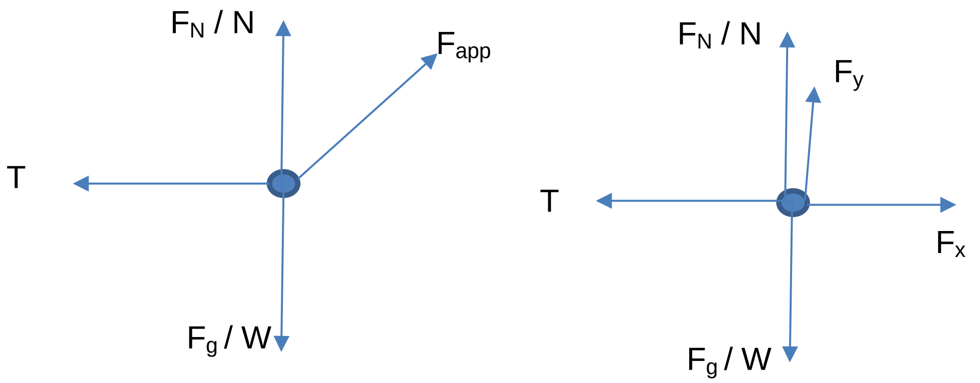
The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

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

QUESTION 2

2.1



FORCE	DESCRIPTION	MARKS
FN / N	Normal force	
Fapp /	Applied force / Fx and Fy components	
Fg / W	Weight	
T	Tension in the rope	

2.2 When a net force is applied to an object of mass, m, it accelerates the object in the direction of the net force.

Or

When a net force, Fnet, is applied to an object of mass, m, it accelerates in the direction of the net force. The acceleration, a, is directly proportional to the net force and inversely proportional to the mass.

Or

(In terms of momentum)
The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force.

2.3 (to the right is +)

5 kg trolley

$F_{net} = ma$

$F_x + (-T) = ma$

$50\cos 30° - T = 5a$ -------- 1

$-T = 5a - 43,3$

$T = 10a$

$0 = 15a - 43,3$

$a = 2,89\,m{\bullet}s^{-2}$ to the Right

10kg trolley

$F_{net} = ma$

$T = ma$

$T = 10a$ -------- 2

Or

$-10a = 5a - 43,3$

$-15a = -43,3$

$a = 2,89\,m{\bullet}s^{-2}$

2.4 **Positive marking from Question 2.3**

$-T = 5a - 43,3$

$-T = (5 \times 2,89) - 43,3$

$T = 28,85N$

Or

$T = 10a$

$T = 10 \times 2,89$

$T = 28,9N$

2.5 The rate at which velocity changes.

2.6 If resistance is taken into account F_{net} will decrease.
According to Newton's second law $F_{net} \propto a$
Thus acceleration will also decrease.

QUESTION 3

3.1 t = 1,5 s

3.2 Displacement per time interval remains constant, thus velocity is constant.

3.3 The total linear momentum of an isolated system remains constant in magnitude and direction.

3.4 $\Sigma_{p_i} = \Sigma_{p_f}$ (to the west is +)

$m_{x+y}v_i = m_x v_f + m_y v_f$

$(0,25+0,75)(0) = (0,25)(-5) + (0,75)v_f$

$v_f = -1,67 m{\bullet}s^{-1}$

$\therefore v_f = 1.67 m{\bullet}s^{-1}$ to the east

$v = \frac{\Delta v}{\Delta t}$

$v = \frac{2,88-1,38}{0,6-0,3}$

$v = 5\ m{\bullet}s^{-1}$ ✓

3.5 Impulse is the product of the net force acting on an object and the time the net force acts on the object.

3.6 **Positive marking from Question 3.4**

$F_{net}{\bullet}\Delta t = m_y v_f - m_y v_i$

$F_{net}{\bullet}0,3 = (0,75)(-1,67) - (0,75)(0)$

$F_{net} = -4,18 N$

$\therefore F_{net} = 4,18 N\ east$

3.7 3.7.1 An elastic collision is a collision where momentum and kinetic energy are conserved.
Or
Elastic collision:
$\Sigma_{p_i} = \Sigma_{p_f}$ and $\Sigma E_{K\ before} = \Sigma E_{K\ after}$

3.7.2 An inelastic collision is a collision where only momentum is conserved.
Or
Inelastic collision:
$\Sigma_{p_i} = \Sigma_{p_f}$ and $\Sigma E_{K\ before} \neq \Sigma E_{K\ after}$

QUESTION 4

4.1 Energy is the ability to do work.

4.2 $E_k = \frac{1}{2} m \cdot v^2$

$E_k = \frac{1}{2}(8)(10^2)$

$E_k = 400\text{ J}$

4.3 $f_k = \mu_k F_N$

$f_k = \mu_k (m \cdot g)$

$f_k = (0{,}15)(8 \cdot 9{,}8)$

$f_k = 11{,}56\text{ N}$

4.4 **Positive marking from Question 4.3**

$W_{f_K} = f_K \cdot \Delta X \cdot cos\theta$

$W_{f_K} = 11{,}56 \cdot 6 \cdot cos180°$

$W_{f_K} = -70{,}56\text{ J}$

QUESTION 5

5.1 Power is the rate at which work is done (or energy is expended).

5.2 $F_g = m \cdot g$

$F_g = 1500 \cdot 9{,}8$

$F_g = 14700\ \text{N}$

5.3 **Positive marking from Question 5.2**

$P = F \cdot v$

$P = 14700\ \ 2$

$P = 24900\ W$

5.4 **Positive marking from Question 5.3**

$1\,hp = 746W$

$x\ hp = 29400W$

$x = \dfrac{29400 \times 1}{746}$

$x = 39{,}41\ hp$ (if only the answer is given, award 2 marks)

5.5 $E_p = mgh$

$E_p = 1500 \cdot 9{,}8 \cdot 7{,}5$

$E_p = 110250\ \text{J}$

5.6 The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant.

5.7 **Positive marking from Question 5.5**

Mechanical energy is conserved

$(E_P + E_K)_B = (E_P + E_K)_A$

$mgh + \frac{1}{2}mv_i^{\,2} = mgh + \frac{1}{2}mv_f^{\,2}$

$(110250 + 0) = (1500 \cdot 9{,}8 \cdot 6) + \left(\frac{1}{2}1500 \cdot v_f^{\,2}\right)$

$v_f = 5{,}42 m \cdot s^{-1}$

QUESTION 6

6.1 Within the limit of elasticity, stress is directly proportional to the strain.

6.2 $K = \frac{\sigma}{\varepsilon}$

$K = \frac{5 \times 10^{6}}{5 \times 10^{-4}}$

$K = 1 \times 10^{10}$ Pa

The most appropriate material would be wood.

6.3 $\varepsilon = \frac{\Delta L}{L}$

$5 \times 10^{-4} = \frac{\Delta L}{0,12}$

$\Delta L = 6 \times 10^{-5}$ m

6.4 Stress is internal restoring force per unit area of a body.

6.5 $\sigma = \frac{F}{A}$

$5 \times 10^{6} = \frac{9800}{A}$

$A = 1{,}96 \times 10^{-3}\ m^{2}$

QUESTION 7

7.1 Viscosity is the property of the fluid to oppose relative motion between the two adjacent layers.

7.2 20W–30

7.3 It's a (multi-grade) winter oil
At cold temperatures (0°) the oil's viscosity is the same as a SAE 10
At 100 °C the viscosity of the oil is the same as a SAE 30

QUESTION 8

8.1 In a continuous liquid at equilibrium, the pressure applied at a point is transmitted equally to the other parts of the liquid.

8.2 $A = \pi r^2$

$$A = \pi \left(\frac{11{,}8 \times 10^{-2}}{2} \right)^2$$

$$A = 0{,}19 m^2$$

8.3 **Positive marking from Question 8.2**

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{319}{3{,}02 \times 10^{-4}} = \frac{F_2}{0.19}$$

$$F_2 = 200695{,}36 N$$

QUESTION 9

9.1 Capacitance of a capacitor is the amount of charge it can store per volt.

9.2
- The charge held depends on the applied voltage across the plates.
- The capacitance increases as the total area of the opposing surfaces of the plates increases.
- The capacitance increases as the distance between the plates decreases.
- The capacitance depends upon the **dielectric** material

(Any 3 of the factors)

9.3 $C = \frac{k\varepsilon_0 A}{d}$

$$C = \frac{1 \cdot 8{,}85 \times 10^{-12} \cdot (0{,}02 \times 0{,}02)}{0{,}003}$$

$$C = 1{,}18 \times 10^{-12} F$$

$$C = \frac{Q}{V}$$

Both equations

$$1{,}18 \times 10^{-12} = \frac{6 \times 10^{-11}}{V}$$

$$V = 50{,}85 V$$

QUESTION 10

10.1 AMMETER.

10.2 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.

10.3 $V_1 = 4{,}5V$

10.4 $V = IR$
$4{,}5 = I \cdot 6$
$I = 0{,}75\ A$

10.5 The rate at which electrical energy is converted in an electric circuit.

10.6 $P = \frac{V^2}{R}$
$P = \frac{4{,}5^2}{6}$
$P = 3{,}38$ W **Positive marking from Question 10.4**

$P = VI$
$P = 4{,}5 \times 0{,}75$
$P = 3{,}38$ W **Positive marking from Question 10.4**

$P = I^2R$
$P = 0{,}75^2 \times 6$
$P = 3{,}38$ W

QUESTION 11

11.1 11.1.1 AC Generator

11.1.2 The principle of electromagnetic induction

11.1.3
- More windings on the coil
- Stronger magnets
- Greater rate of change of the magnetic flux / increase rotation speed (**Any one of the three factors**)

11.1.4 Slip rings

11.2 11.2.1 AB

11.2.2 $\frac{N_S}{N_P} = \frac{V_S}{V_P}$

$\frac{N_S}{1000} = \frac{4,5}{240}$

$N_S = 18,75 \textit{ windings}$

Total: 150 marks