NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2022

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.

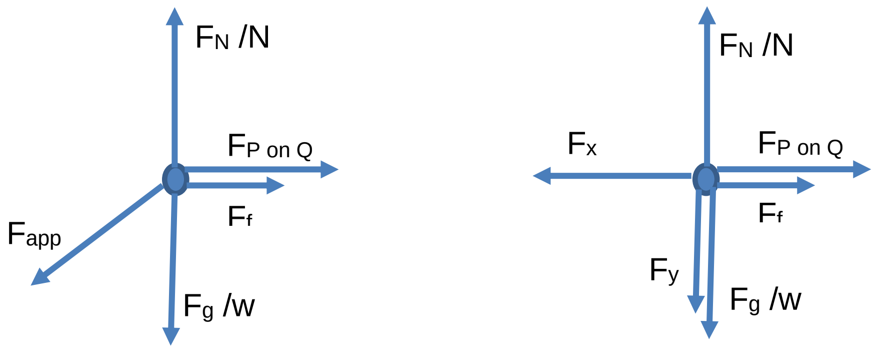
The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there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

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

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

QUESTION 2

2.1



FORCE	DESCRIPTION	MARKS
F_N /N	Normal force	X
F_f	Friction	X
F_g /w	Weight	X
$F_{P\ on\ Q}$	Force of block P on Q	X
F_{app}	Applied force F_x and F_y components	X

2.2 $\cos\theta = \frac{F_x}{F}$

$\cos 30° = \frac{F_x}{50}$

$Fx = 43{,}3$ N

2.3 The force parallel to the surface that opposes the motion of object and acts in the direction opposite motion the object.

2.4 $f_k = \mu_k N$

$6 = \mu_k(mg + 50 \sin 30°)$

$= \mu_k[(5)(9,8) + 50 \sin 30°)]$

$\mu_k = 0,081$

2.5 **Positive marking from Question 2.2**

For the 5 kg block

$F_{net} = ma$

$F_x + (-F_{P\ on\ Q}) + (-f_k) = ma$

$\underline{43,3 - F_{P\ on\ Q} - 6} = 5a$

$37,3 - F_{P\ on\ Q} = 5a$

$-F_{P\ on\ Q} = 5a - 37,3 \ldots (1)$

For the 2 kg block

$F_{net} = ma$

$F_{Q\ on\ P} - f_k = 2a$

$\underline{F_{Q\ on\ P} - 2 = 2a}$

$F_{Q\ on\ P} = 2a + 2 \ldots (2)$

$-F_{P\ on\ Q} = 5a - 37,3 \ldots (1)$

$F_{Q\ on\ P} = 2a + 2 \ldots \quad (2)$

$0 = 7a - 35,3 \ldots (1) + (2)$

$a = 5,043\ m{\cdot}s^{-2}$

$-F_{P\ on\ Q} = 5a - 37,3$

$-F_{P\ on\ Q} = \underline{5(5,043) - 37,3}$

$F_{P\ on\ Q} = 12,086\ N$

2.6 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, F_{net}, 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.

OR

Newton's Third Law:
When object **A** exerts a force on object **B**, object **B** simultaneously exerts an oppositely directed force of equal magnitude on object **A**.

QUESTION 3

3.1 $\frac{7,2 \times 10^3}{3\,600}$ = 2 m · s^{-1} (if only the answer is given, award two marks)

3.2 The total linear momentum of an isolated system remains constant (is conserved) in magnitude and direction.

3.3 **Positive marking from Question 3.1**

To the right is positive

$$\Sigma P_i = \Sigma P_f$$

$$m_1 v_i + m_2 v_i = (m_1 + m_2) v_f$$

$$\underline{(30 \times 10^3 \cdot 2) + (15 \times 10^3 \cdot 0) v_f} = \underline{(30 \times 10^3 + 15 \times 10^3) v_f}$$

$$v_f = 1{,}33' \text{ m·s}^{-1}$$

3.4 Impulse is the product of the resultant/net force acting on an object and the time that the resultant/net force acts on the object.

3.5 **Positive marking from Question 3.3**

$$F_{net}\Delta t = \Delta p$$

$$F_{net}\Delta t = mv_f - mv_i$$

$$F_{net} \cdot 0{,}2 = \underline{(1{,}33' \cdot 15 \times 10^3) - 0}$$

$$F_{net} = 100\,000\text{N } (99\,750\text{N}) \text{ to the right}$$

OR

$$F_{net}\Delta t = \Delta p$$

$$F_{net}\Delta t = mv_f - mv_i$$

$$F_{net} \cdot 0{,}2 = (\underline{1{,}33' \cdot 30 \times 10^3) - (2 \cdot 30 \times 10^3})$$

$$F_{net} = -100000\text{N}$$

$$F_{net} = 100000\text{N } (99\,750\text{N}) \text{ to the right}$$

3.6 100000N (99 750N), Newton's third Law

QUESTION 4

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

4.2 Mechanical energy is conserved.

$$\Sigma E_{mi} = \Sigma E_{mf}$$

$$mgh_i + \frac{1}{2}m\cdot v^2 = mgh_{second\ hill} + \frac{1}{2}m\cdot v^2$$

$$\underline{(800\cdot 9{,}8\cdot 48)+\tfrac{1}{2}\cdot 800\cdot 2^2} = \underline{800\cdot 9{,}8\cdot h_{second\ hill} + \tfrac{1}{2}800\cdot 14^2}$$

$$H_{second\ hill} = 38{,}2\ m$$

$\Delta h = h_i - h_f$
$\Delta h = 48 - 38{,}2$
$\Delta h = 9{,}8\ m$

4.3 $P = Fv$
$P = 4{,}2 \times 10^3 \cdot 2$
$P = 8\ 400$ W

Convert to hp

$\therefore hp = \frac{8\ 400}{746}$
$hp = 11{,}26 hp$

QUESTION 5

5.1 $\cos\ 3° = \dfrac{\frac{22}{2}}{l_{rope}}$

$l_{rope} = 11{,}015\ m$

$\Delta l = l_f - l_i$

$\Delta l = (11{,}015 \times 2) - 22$

$\Delta l = 0{,}03\ m$

5.2 $\sigma = \dfrac{F}{A}$

$\sigma = \dfrac{610}{7{,}069 \times 10^{-4}}$

$\sigma = 862922{,}62\ \text{Pa}$

$A = \pi r^2$

$A = \pi\left(\dfrac{0{,}03}{2}\right)^2$

$A = 7{,}069 \times 10^{-4}\ \text{m}^2$

5.3 **Positive marking from Question 5.1**

$\varepsilon = \dfrac{\Delta L}{L}$

$\varepsilon = \dfrac{0{,}03}{22}$

$\varepsilon = 0{,}00136$

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

5.5 **Positive marking from Question 5.2 and Question 5.3**

$K = \dfrac{\sigma}{\varepsilon}$

$K = \dfrac{862922{,}62}{0{,}00136}$

$K = 634501926{,}5\ \text{Pa}$

QUESTION 6

6.1 A

6.2 Pascal's law states that in a confined liquid at equilibrium, the pressure applied at a point is transmitted equally to the other parts of the liquid.

6.3 $A = \frac{225}{10\,000}$

$A = 0{,}0225\ m^2$ (if only the answer is given, award two marks)

6.4 **Positive marking from Question 6.3**

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

$A = \pi r^2$

$A = \pi(0{,}0175)^2$

$A = 9{,}62 \times 10^{-4} m^2$

$\frac{F_1}{9{,}62 \times 10^{-4}} = \frac{14{,}7}{0{,}0225}$

$F_2 = m \cdot g$

$F_2 = 1{,}5 \times 9{,}8$

$F_2 = 14{,}7N$

$F1 = 0{,}63N$

6.5 $MA = \frac{F2}{F1}$

$MA = \frac{14{,}7}{0{,}63}$

$MA = 23{,}33$

QUESTION 7

7.1 7.1.1 Temperature/amount of substance/time/incline

7.1.2 Type of substance

7.2 Honey

7.3 Viscosity is directly proportional to intermolecular forces. Honey has the smallest displacement during the 10s, thus the highest viscosity.
Thus, the strongest intermolecular forces.

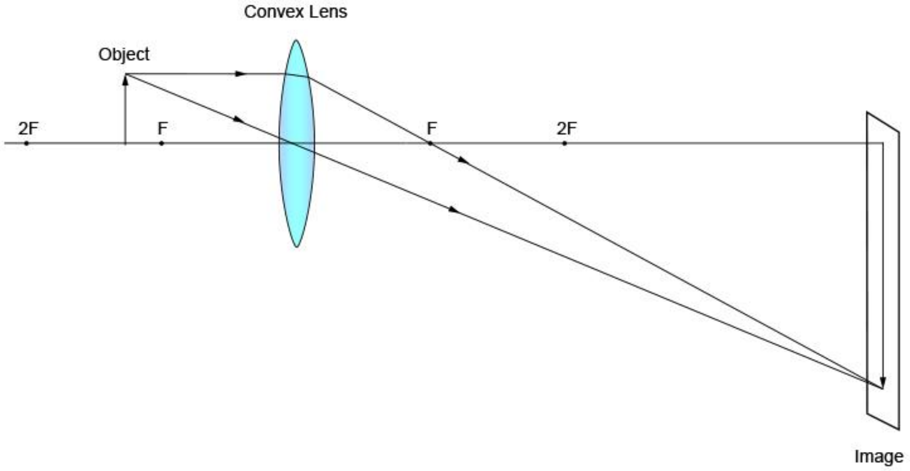
7.4 The displacement of the substances will increase during the same time interval/10s. Viscosity decreases with an increase in temperature.

QUESTION 8

8.1 8.1.1 Object length

8.1.2 Image length

8.2



	Description	MARKS
Lens	Correct lens (symbol or sketch)	X
Light rays	2 rays, parallel and through the optical centre	X
Principle axis	Principle axis drawn, F and 2F indicated	X
Image	Image forms further than 2F	X

8.3 **Image is:**
Inverted
larger than the object
forms beyond 2F
real **(any 3)**

8.4 A changing magnetic and electric field mutually perpendicular to each other and the direction of propagation of the wave.

8.5
$c = \lambda \cdot f$
$3 \times 10^{8} = 3 \times 10^{-7} \cdot f$
$f = 1 \times 10^{15}$ Hz

Ultraviolet light

8.6 **Positive marking from Question 8.5**

$E = h \cdot f$
$E = 6{,}63 \times 10^{-34} \cdot 1 \times 10^{15}$
$E = 6{,}63 \times 10^{-19}$ J

8.7 No medium to propagate
Travels at $3 \times 10^8 m \cdot s^{-1}$ in a vacuum
Interference and diffraction
Transverse waves
Transfers energy **(ANY TWO)**

QUESTION 9

9.1 The opposition to the flow of electric current.

9.2
$$\frac{1}{R_{||}} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{R_{||}} = \frac{1}{8} + \frac{1}{24}$$
$$\frac{1}{R_{||}} = 6\Omega$$

$R_T = R_3 + R_{||}$
$R_T = 6\Omega + 6\Omega$
$R_T = 12\Omega$

9.3 **Positive marking from Question 9.2**

$V = I \cdot R$
$24 = I \times 12$
$I = 2A$

9.4 **Positive marking from Question 9.2 and Question 9.3**

$V = I \cdot R$
$V = 2 \times 6$
$V = 12V$

9.5 **Positive marking from Question 9.4**

$V = I \cdot R$
$12 = I \times 24$
$I = 0{,}5A$

9.6 **OPTION 1**

Positive marking from Question 9.4
$P = V \cdot I$
$P = 12 \times 2$
$P = 24W$

$V_t = V_{AB} + V_{6\Omega}$
$24 = 12 + V_{6\Omega}$
$V_{6\Omega} = 12V$

OPTION 2

Positive marking from Question 9.3
$P = I^2 \cdot R$
$P = 2^2 \cdot 6$
$P = 24W$

OPTION 3

$$P = \frac{v^2}{R}$$
$$P = \frac{12^2}{6}$$
$P = 24W$

$V_t = V_{AB} + V_{6\Omega}$
$24 = 12 + V_{6\Omega}$
$V_{6\Omega} = 12V$

QUESTION 10

10.1 Electrical motor

10.2 Clockwise

10.3 Flemings left hand motor rule

10.4 Electrical to mechanical

10.5 Faraday's law states that when the magnetic flux linked with the coil changes, an emf is induced in the coil. The magnitude of the induced emf is directly proportional to the rate of change of magnetic flux.

10.6
$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$
$$\frac{240}{3\,000} = \frac{N_s}{1000}$$
N_s = 80 windings

Total: 150 marks