higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(First paper)
NQF LEVEL 4

23 November 2022

This marking guideline consists of 15 pages.

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SECTION A

QUESTION 1

1.1 Velocity/Speed
1.2 Alternating (current)
1.3 Gear
1.4 Elastic collision
1.5 Inversely proportional/Inverse proportion/Inverse

(5 × 1) **[5]**

QUESTION 2

2.1 J
2.2 E
2.3 H
2.4 G
2.5 K

(5 × 1) **[5]**

QUESTION 3

Marking guideline: 2 marks for True
No marks for False
No marks if the statement is written in the negative
2 marks for correct statement

3.1 True✓✓

3.2 False✓

The photoelectric effect confirms that light has a particle nature.
The photoelectric effect confirms the quantum theory.✓

3.3 True✓✓

3.4 False✓

When a projectile reaches maximum height, its (instantaneous) velocity is zero.
When a projectile reaches maximum height, the object temporarily comes to rest (the velocity turns to zero), acceleration is 9,8 $m \cdot s^{-2}$ (downwards)✓

3.5 False✓

Silicon doped with boron produces p-type semiconductors.✓

(5 × 2) **[10]**

QUESTION 4

4.1 D
4.2 D
4.3 B
4.4 A
4.5 C

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5: MEASUREMENTS AND HAZARD SYMBOLS

5.1 5.1.1 Marking guideline: 1 mark for relationship
1 mark for constant temperature

The potential difference across the ends of a conductor is directly proportional to the current in the conductor provided the temperature is kept constant.✓ The potential difference increases when the current increases provided the temperature does not change/is kept constant.✓ (2)

5.1.2 Potential difference (1)

5.1.3 $R = \frac{V}{I}$✓ $= \frac{4,5}{0,02}$✓ $= 225\ \Omega$✓ (3)

5.2 $225\ \text{nC} = 225 \times 10^{-9}\ \text{C}$ **OR** $2,25 \times 10^{-7}\ \text{C}$ (1)
[7]

QUESTION 6: FREE-FALLING BODIES

6.1 $T = 2 \times 1,2 = 2,4\ s$ (1)

6.2 6.2.1 OPTION 1 (Take upwards as +ve)

$v_f = v_i + a\Delta t$✓
0✓ $= v_i + (-9,8)(1,2)$✓
$v_i = 11,76\ m{\cdot}s^{-1}$✓

OPTION 2 (Take upwards as -ve)

$v_f = v_i + a\Delta t$✓
0✓$= v_i + (9,8)(1,2)$✓
$v_i = -11,76\ m{\cdot}s^{-1}$✓ (4)

POSITIVE MARKING FROM Q 6.2.1 TO Q 6.2.2

6.2.2 OPTION 1 (Take upwards as +ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(-37,24)_f^2$✓ $= (11,76)_i^2 + 2(-9,8)\Delta x$✓
$\Delta y = -63,7\ m$

Height of building $(H_1) = 63,7\ m$✓

OPTION 2 (Take upwards as -ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(37,24)_f^2$✓ $= (-11,76)_i^2 + 2(9,8)\Delta y$✓
$\Delta y = 63,7\ m$

Height of building $(H_1) = 63,7\ m$✓

OPTION 3 (Take upwards as +ve)

$\Delta y = v_i\Delta t + \frac{1}{2}\ a\Delta t^2$✓
$\Delta y = (-11,76)(2,6)$✓ $+ \frac{1}{2}(-9,8)(2,6)^2$✓
$\Delta y = -63,7\ m$

Height of building $(H_1) = 63,7\ m$ ✓

OPTION 4 (Take upwards as -ve)

$\Delta y = v_i\Delta t + \frac{1}{2}\ a\Delta t^2$✓
$\Delta y = (11,76)(2,6)$✓ $+ \frac{1}{2}(9,8)(2,6)^2$✓
$\Delta y = 63,7\ m$

Height of building $(H_1) = 63,7\ m$ ✓ (4)

6.2.3 OPTION 1 (Take upwards as +ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(0)_f^2$ ✓ $= V_i^2 + 2(-9{,}8)(31{,}99)$✓
$V_i = 25{,}04\ \text{m·s}^{-1}$✓

OPTION 2 (Take upwards as -ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(0)_f^2$ ✓ $= V_i^2 + 2(9{,}8)(-31{,}99)$✓
$V_i = 25{,}04\ \text{m·s}^{-1}$✓

Marking guideline: In options 3 and 4 the ball is assumed to fall from its maximum height reached after rebound.

OPTION 3 (Take upwards as +ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(V)_f^2$ ✓ $= (0)_i^2 + 2(-9{,}8)(-31{,}99)$✓
$V_f = 25{,}04\ \text{m·s}^{-1}$✓

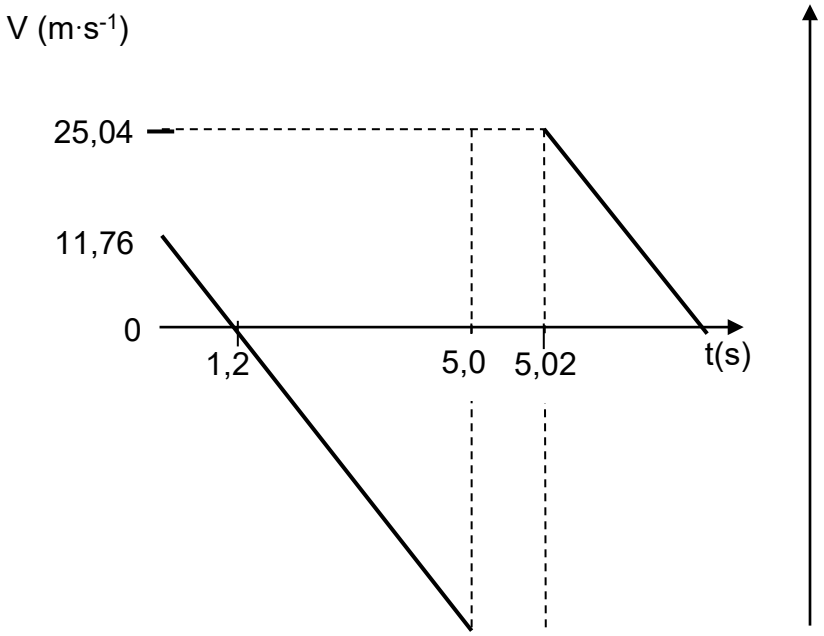
OPTION 4 (Take upwards as -ve)

$V_f^2 = V_1^2 + 2a\Delta y$✓
$(V)_f^2$ ✓ $= (0)_i^2 + 2(9{,}8)(31{,}99)$✓
$V_f = 25{,}04\ \text{m·s}^{-1}$✓ (4)

6.3 6.3.1 No (1)

6.3.2
- The force of gravity is not the only force acting on the ball.
- There are two forces acting on the ball.
- The ground exerts a force on the ball. (Any 1 × 1) (1)

6.4



Marking guideline:

1 mark for correct labels inclusive of units on both axes

1 mark for initial velocity of projection (11,76 $m \cdot s^{-1}$) and rebound velocity (25,04 $m \cdot s^{-1}$)

1 mark for time at max height (1,2 s) and time interval when ball was in contact with the ground

1 mark for shape of each graph (-1 if lines are not parallel) (5)

[20]

QUESTION 7: MOMENTUM

7.1 7.1.1 Marking guideline: 1 mark for appropriate equation; 1 mark for correct substitution; 1 mark for correct answer with units and direction

OPTION 1 (Take downwards as +ve)

$\Delta p = p_f - p_i$
$\Delta p = mV_f - mV_i$✓
$= (0,6)(-1,6) - (0,6)(7)$✓
$= -5,16$
$= 5,16\ kg{\cdot}m{\cdot}s^{-1}$ upwards✓

OPTION 2 (Take downwards as +ve)

$\Delta p = p_f - p_i$
$\Delta p = mV_f - mV_i$
$= m[V_f - V_i]$✓
$= (0,6)[(-1,6) - (7)]$✓
$= -5,16$
$= 5,16\ kg{\cdot}m{\cdot}s^{-1}$ upwards✓

OPTION 3 (Take downwards as -ve)

$\Delta p = p_f - p_i$
$\Delta p = mV_f - mV_i$✓
$= (0,6)(1,6) - (0,6)(-7)$✓
$= 5,16\ m{\cdot}s^{-1}$
$= 5,16\ kg{\cdot}m{\cdot}s^{-1}$ upwards✓ (3)

POSITIVE MARKING FROM Q 7.1.1 TO Q 7.1.2 (options 3 & 6)

7.1.2 OPTION 1 (Take downwards as +ve)

$F_{net}{\cdot}\Delta t = mV_f - mV_i$✓
$F_{net}(0,08) = (0,6)(-1,6) - (0,6)(7)$✓
$F_{net} = -64,5\ N$
$F_{net} = 64,5\ N$✓

OPTION 2 (Take downwards as +ve)

$F_{net}{\cdot}\Delta t = m[V_f - V_i]$✓
$F_{net}(0,08) = (0,6)[(-1,6) - (7)]$✓
$F_{net} = -64,5\ N$
$F_{net} = 64,5\ N$✓

OPTION 3 (Take downwards as +ve)

$F_{net}{\cdot}\Delta t = \Delta p$✓
$F_{net}(0,08) = -5,16$✓
$F_{net} = -64,5$
$F_{net} = 64,5\ N$✓

OPTION 4 (Take downwards as -ve)

$$F_{net}\cdot\Delta t = mV_f - mV_i\checkmark$$
$$F_{net}(0{,}08) = (0{,}6)(1{,}6) - (0{,}6)(-7)\checkmark$$
$$F_{net} = 64{,}5\ N\checkmark$$

OPTION 5 (Take downwards as -ve)

$$F_{net}\cdot\Delta t = m[V_f - V_i]\checkmark$$
$$F_{net}(0{,}08) = (0{,}6)[(1{,}6) - (-7)]\checkmark$$
$$F_{net} = 64{,}5\ N\checkmark$$

OPTION 6 (Take downwards as -ve)

$$F_{net}\cdot\Delta t = \Delta p\checkmark$$
$$F_{net}(0{,}08) = 5{,}16\checkmark$$
$$F_{net} = 64{,}5\ N\checkmark$$ (3)

7.2 Greater (1)
[7]

QUESTION 8: WORK, ENERGY AND POWER

8.1
- Power is the work done per unit time or per second.
- Power is the rate of doing work.
- Power is the rate of transferring/transforming energy. (Any 1 × 2) (2)

8.2 8.2.1 OPTION 1

$$W = \text{gain in } E_p = mgh\checkmark$$
$$= (1\,000)(9{,}8)(30)\checkmark$$
$$= 294\,000\ J/2{,}94 \times 10^5\ J\checkmark$$

OPTION 2

$$W_{nc} = \Delta E_k + \Delta E_p$$
$$= \tfrac{1}{2}m(V_f^2 - V_i^2) + mg(h_f - h_i)\checkmark$$
$$= \tfrac{1}{2}(1\,000)(0) + (1\,000)(9{,}8)(30 - 0)\checkmark$$
$$= 0 + 294\,000$$
$$= 294\,000\ J\ /\ 2{,}94 \times 10^5\ J\checkmark$$

OPTION 3

$$W_{net} = \Delta E_k$$
$$W_T + W_{Fg} = \Delta E_K$$
$$W_T + (-\Delta E_p) = \Delta E_K$$
$$W_T - mg(h_f - h_i) = \tfrac{1}{2}m(V_f^2 - V_i^2)\checkmark$$
$$W_T - (1\,000)(9{,}8)(30 - 0) = \tfrac{1}{2}(1\,000)(0)\checkmark$$
$$W_T = 294\,000\ J/2{,}94 \times 10^5\ J\checkmark$$

OPTION 4

$$W_{net} = \Delta E_k$$
$$W_T + W_{Fg} = \Delta E_K$$
$$W_T + F_g \cdot \Delta x \cos\theta = \Delta E_K \checkmark$$
$$W_T + mg \cdot \Delta x \cos 180° = \tfrac{1}{2}m(V_f^2 - V_i^2) \checkmark$$
$$W_T + (1\,000)(9{,}8)(-1) = \tfrac{1}{2}(1\,000)(0)$$
$$W_T = 294\,000 \text{ J} / 2{,}94 \times 10^5 \text{ J} \checkmark$$ (3)

POSITIVE MARKING FROM Q 8.1.1 TO Q 8.1.2

8.2.2 Marking guideline: 1 mark for appropriate equation; 1 mark for correct substitution; 1 mark for correct answer with units

OPTION 1

$$P = \frac{W}{\Delta t} \checkmark = \frac{294\,000}{20} \checkmark = 14\,700 \text{ W } \textbf{OR } 1{,}47 \times 10^4 \text{ W} \checkmark$$

OPTION 2

$$P = F \cdot V_{av} \checkmark$$
$$= mg\left[\frac{\Delta x}{\Delta t}\right] = (1\,000)(9{,}8)\left[\frac{30}{20}\right] \checkmark = 14\,700 \text{ W } \textbf{OR } 1{,}47 \times 10^4 \text{ W} \checkmark$$ (3)

8.3 OPTION 1

$$F_{net} = F_g + F_f = mg + F_f = (1\,000)(9{,}8) + (-1500) = 8\,300 \text{ N} \checkmark$$

$$W_{net} = \Delta E_k \checkmark \text{ Equation for work} \checkmark$$
$$F_{net}\,\Delta x \cos\Theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$(8\,300)(30)\cos 0° = \tfrac{1}{2}(1\,000)V_f^2 - \tfrac{1}{2}(1\,000)(0^2) \checkmark$$
$$V_f = 22{,}32 \text{ m·s}^{-1} \checkmark$$

OPTION 2

$$W_{net} = \Delta E_k \checkmark \text{ Equation for work} \checkmark$$
$$W_{Ff} + W_{Fg} = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$F_g \Delta x cos\theta + F_f \Delta x cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$(1\,000)(9{,}8)(30)\cos 0° + (1\,500)(30)\cos 180° \checkmark = \tfrac{1}{2}(1\,000)V_f^2 - \tfrac{1}{2}(1\,000)(0^2) \checkmark$$
$$294\,000 - 45\,000 = \tfrac{1}{2}(1000)V_f^2$$
$$V_f = 22{,}32 \text{ m·s}^{-1} \checkmark$$

OPTION 3

$$W_{nC} = \Delta E_k + \Delta E_p \checkmark \text{ Equation for work} \checkmark$$
$$W_{Ff} = \tfrac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$$
$$F_f \Delta x cos\theta = \tfrac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$$
$$(1\,500)(9{,}8)(30)\cos 180° \checkmark = \tfrac{1}{2}(1\,000)(V_f^2 - 0) + (1\,000)(9{,}8)(30 - 0) \checkmark$$
$$V_f = 22{,}32 \text{ m·s}^{-1} \checkmark$$ (5)

[13]

QUESTION 9: MECHANICAL ADVANTAGE

9.1 IMA = 7 (1)

9.2 9.2.1

$$\text{Efficiency} = \frac{AMA}{IMA}(100)\checkmark$$
$$90 = \frac{AMA}{7}(100)\checkmark$$
$$AMA = 6{,}3\checkmark$$ (3)

POSITIVE MARKING FROM Q 9.2.1 TO Q 9.2.2

9.2.2 $$\text{Actual mechanical advantage (AMA)} = \frac{\text{Load (input force)}}{\text{Effort (output force)}}\checkmark$$

$$6{,}3 = \frac{\text{Load}}{300}\checkmark$$
$$\text{Load} = 1\,890\text{ N}\checkmark$$

$$\text{Load} = \text{mg}$$
$$1\,890 = \text{m}(9{,}8)$$
$$\text{mass} = 192{,}857\text{ kg}\checkmark$$ (4)

[8]

QUESTION 10: WAVES, LIGHT AND SOUND

10.1 The Doppler effect is the change✓ in the frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different✓ velocities relative to the medium of sound propagation. (2)

10.2 No (1)

10.3
- The relative motion between the sound source and the listener/driver is zero.
- The velocity of the sound source (ambulance) is equal to the velocity of the listener (driver).
- The velocity of the driver listener relative to the bus/sound source is zero.

(Any 1 × 2) (2)

10.4

<u>OPTION 1</u>

$V = f\lambda$
$340 = f\,(0{,}42)$
$f = 809{,}52$ Hz

$112\ \text{km}\cdot h^{-1} = \frac{112 \times 1\,000}{3\,600} = 30\ \text{m}\cdot\text{s}^{-1}$

OR

$112\ \text{km}\cdot h^{-1} = \frac{112}{3{,}6} = 30\ \text{m}\cdot\text{s}^{-1}$✓

$F_L = \frac{v \pm v_L}{v \pm v_S} F_S$✓

$809{,}52$✓ $= \frac{v}{v-30}$ ✓$(708{,}33)$✓

Speed of sound in air (v)
$= 240\ \text{m}\cdot\text{s}^{-1}$✓

<u>OPTION 2</u>

$112\ \text{km}\cdot h^{-1} = \frac{112 \times 1\,000}{3600} = 30\ \text{m}\cdot\text{s}^{-1}$
OR
$112\ \text{km}\cdot h^{-1} = \frac{112}{3{,}6} = 30\ \text{m}\cdot\text{s}^{-1}$✓

$F_L = \frac{v \pm v_L}{v \pm v_S} F_S$ ✓

$\frac{340}{0{,}42}$✓ $= \frac{v}{v-30}$ ✓$(708{,}33)$✓

Speed of sound in air (v)
$= 240\ \text{m}\cdot\text{s}^{-1}$✓

(6)
[11]

QUESTION 11: PHOTOELECTRIC EFFECT

11.1 11.1.1 Frequency/Colour of incident light

11.1.2
- Intensity/Brightness of (incident light)
- Work function of metal/cathode

(Any ONE) (2 × 1) (2)

11.2
- The maximum kinetic energy of the ejected photoelectrons increase if/when the frequency of the incident light increases above the threshold frequency.
- When the frequency of the incident light increases above the threshold frequency, the maximum kinetic energy of the ejected photoelectrons increase.

(Any 1 × 2) (2)

Marking guideline:

Maximum kinetic energy of the photoelectrons is proportional to the frequency of the incident light. (1/2)
Maximum kinetic energy of the photoelectrons is directly proportional to the frequency of the incident light. (0/2)

11.3 $W_0 = 3{,}5 \times 10^{-19}$ J (2)

POSITIVE MARKING FROM Q 11.3 TO Q 11.4

11.4 OPTION 1

$E = W_0 + E_K$✓
$\frac{hc}{\lambda} = W_0 + ½ mv^2$ ✓
$\frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{\lambda}$✓ $= 3{,}5 \times 10^{-19}$✓ $+ ½\ 9{,}11 \times 10^{-31}(1{,}01 \times 10^6)^2$✓
$\lambda = 2{,}44 \times 10^{-7}$ m ✓

OPTION 2

$E = W_0 + E_K$✓
$E = W_0 + ½ mv^2$
$E = 3{,}5 \times 10^{-19} + ½\ 9{,}11 \times 10^{-31}(1{,}01 \times 10^6)^2$✓
$E = 8{,}147 \times 10^{-19}$ J

$E = \frac{hc}{\lambda}$ ✓
$8{,}147 \times 10^{-19}$✓ $= \frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{\lambda}$ ✓
$\lambda = 2{,}44 \times 10^{-7}$ m✓

OPTION 3

$E_K = ½ m v^2$
$= ½\ 9{,}11 \times 10^{-31}(1{,}01 \times 10^6)^2$✓
$= 4{,}647 \times 10^{-19}$ J

$E = W_0 + E_K$✓
$E = 3{,}5 \times 10^{-19} + 4{,}647 \times 10^{-19}$
$E = 8{,}147 \times 10^{-19}$ J✓

$E = \frac{hc}{\lambda}$✓
$8{,}147 \times 10^{-19}$✓ $= \frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{\lambda}$
$\lambda = 2{,}44 \times 10^{-7}$ m✓

(6)
[12]

QUESTION 12: ELECTRICITY

12.1 12.1.1 $V_{(10\Omega)} = I\,R_{(10\Omega)}$✓
$20 = I\,(10)$✓
$I = 2\ \text{A}$✓ (3)

POSITIVE MARKING FROM Q 12.1.1 TO Q 12.1.2

12.1.2 $Q = I\,\Delta t$✓
$Q = (2)(5 \times 60)$✓
$Q = 600\ \text{C}$✓ (3)

12.1.3
- Opposition to the flow of charges
- Ratio of potential difference to the current in a conductor

(Any 1 × 2) (2)

12.1.4

OPTION 1	OPTION 2
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$✓	$R_s = R_1 + R_2 = 20 + 36{,}67 = 56{,}67\ \Omega$
$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{56{,}67}$ ✓	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$✓
$R_p = 8{,}5\ \Omega$✓	$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{56{,}67}$✓
	$R_p = 8{,}5\ \Omega$✓

(3)

POSITIVE MARKING FROM Q 12.1.1 & Q 12.1.4 TO Q 12.1.5(a)

12.1.5 (a) $\text{E} = \text{I}\,(\text{R} + \text{r})$✓
$\text{E} = 2\,(10 + \text{r})$✓
$\text{E} = 2{,}3\,(8{,}5 + \text{r})$✓

$2\,(10 + \text{r}) = 2{,}3\,(8{,}5 + \text{r})$
$\text{Internal resistance (r)} = 1{,}5\ \Omega$ ✓ (4)

POSITIVE MARKING FROM Q12.1.5 (a) TO Q12.1.5 (b)

(b)

OPTION 1	OPTION 2
$\text{E} = \text{I}\,(\text{R} + \text{r})$	$\text{E} = \text{I}\,(\text{R} + \text{r})$
$\text{E} = 2\,(10 + 1{,}5)$✓	$\text{E} = 23\,(8{,}5 + 1{,}5)$✓
$\text{E} = 23\ \text{V}$✓	$\text{E} = 23\ \text{V}$✓

(2)

12.1.6 Decrease✓ (1)

12.1.7 OPTION 1

$$I = \frac{E}{R + r}$$

The circuit current is inversely proportional to the circuit resistance.
The circuit resistance decreases.✓
The circuit current increases.✓

$$V_{int} = I\,r$$

V_{int} is directly proportional to the current in the battery.
V_{int} increases.
V_{ext} decreases.✓

$$P = \frac{V^2}{R}\ ✓$$

Power is directly proportional to the voltage.
Power dissipated decreases.

OPTION 2

The circuit resistance decreases.✓
The circuit current increases.✓

But the 10 Ω resistor is now in parallel. The current passing through will decrease.✓

$$P = I^2\,R✓$$

Power is directly proportional to the current.
Power dissipated decreases. (4)

12.2 OPTION 1

$$P_{ave} = V_{rms}\ I_{rms}✓$$
$$2\ 200 = (220)\ I_{rms}✓$$
$$I_{rms} = 10\ \text{A}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$
$$10 = \frac{I_{max}}{\sqrt{2}}✓$$
$$I_{max} = 14{,}14\ \text{A}✓$$

OPTION 2

$$P_{ave} = V_{rms}\ I_{rms}✓$$
$$2\ 200 = (220)\ I_{rms}✓$$
$$I_{rms} = \frac{2\ 200}{220}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$
$$\frac{2\ 200}{220} = \frac{I_{max}}{\sqrt{2}}✓$$
$$I_{max} = 14{,}14\ \text{A}✓$$

(4)
[26]

QUESTION 13: ELECTRIC MOTORS

13.1 Motor (1)

13.2
- Electrical energy is converted/transformed/changed into mechanical energy.
- A cell supplies (electrical) energy to turn the coil. (Any 1 × 2) (2)

13.3 BC (1)

13.4 Commutator/Split-ring commutator (1)

13.5 Anticlockwise (1)
[6]

QUESTION 14: ELECTRONICS

14.1 $\frac{V_p}{V_s} = \frac{N_p}{N_s}$✓ (or any other acceptable form of the turns ratio)
$\frac{3}{V_s} = \frac{1\,000}{6\,000}$✓
$V_s = 18\ \text{V}$✓ (3)

POSITIVE MARKING FROM Q 14.1 TO Q 14.2

14.2 $\text{V}_{\text{rms}} = I_{rms}\,R$
$18 = I_{rms}\,(1\,200)$✓
$I_{rms} = 0{,}015\ \text{A}$✓ (2)
[5]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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