Neap

Trial Examination 2023

Suggested Solutions

QCE Physics Units 1&2

Paper 1

SECTION 1 – MULTIPLE-CHOICE QUESTIONS

	A	B	C	D
1.	○	●	○	○
2.	○	●	○	○
3.	○	○	○	●
4.	●	○	○	○
5.	○	●	○	○
6.	○	●	○	○
7.	●	○	○	○
8.	○	○	●	○
9.	○	○	●	○
10.	○	○	○	●
11.	○	○	●	○
12.	○	●	○	○
13.	●	○	○	○
14.	○	○	○	●
15.	●	○	○	○
16.	●	○	○	○
17.	○	○	○	●
18.	●	○	○	○
19.	○	●	○	○
20.	○	●	○	○

QUESTION 1 B

B is correct and **A** is incorrect. The formula to convert Celsius to Kelvin is $T_K = T_C + 273$. Under standard laboratory conditions (SLC), the melting point of water is 0°C (or 273 K) and the boiling point is 100°C (or 373 K).

C and **D** are incorrect. These options state 0 K, which is absolute zero, not the melting point of water.

QUESTION 2 B

Velocity is measured in metres per second (m s^{-1}), acceleration is measured in metres per second per second (m s^{-2}), heat energy is measured in joules (J) and momentum is measured in kilogram metres per second (kg m s^{-1}). Temperature, not heat energy, can be measured in Kelvin (K). Force, not momentum, is measured in Newtons (N).

QUESTION 3 D

D is correct. All the figures in 230.000560°C are significant as they place the decimal point, making the value more accurate.

A is incorrect. This option only considers the non-zero values in the temperature as significant figures.

B is incorrect. This option counts the number of decimal places.

C is incorrect. This option does not consider the last zero as a significant figure.

QUESTION 4 A

A is correct. There is no net force and no net acceleration vertically; therefore, the vertical forces (lift and weight) are equal and opposite. Similarly, there is no net force and no net acceleration horizontally; therefore, the horizontal forces (drag and thrust) are equal and opposite.

B is incorrect. This option shows the forces pointing towards the object, which is incorrect.

C is incorrect. The vertical forces in this option are not equal and opposite.

D is incorrect. This option disregards drag and lift and only shows the directions of the motion described in the question.

QUESTION 5 B

B is correct. When multiplying, the final answer is given to the smallest number of significant figures in the values being multiplied. In this case, the length has the smallest number of significant figures (one significant figure). Therefore, the volume is:

$$V = 1 \times 2.02 \times 3.14159$$
$$= 6 \text{ m}^3$$

A is incorrect. This option uses the unit m^2, which is not a unit of measurement for volume.

C and **D** are incorrect. These options use the largest number of significant figures in the values being multiplied. Option **C** also uses an incorrect unit.

QUESTION 6 B

B is correct. The law of reflection states that the angle of incidence is equal to the angle of reflection.

A is incorrect. Ray P has an angle that is smaller than the angle of incidence.

C and **D** are incorrect. Rays R and S have angles that are larger than the angle of incidence. Ray S also does not demonstrate reflection.

QUESTION 7 A

A is correct. This is the definition of specific latent heat.

B is incorrect. This option does not consider the unit mass.

C is incorrect. This option defines specific heat capacity.

D is incorrect. This option defines specific heat capacity incorrectly as it does not consider the unit mass.

QUESTION 8 C

C is correct. Radiation does not require the movement of matter; it transfers heat by light, which is an electromagnetic wave with no mass.

A is incorrect. Conduction is the most common method of heat transfer in solids.

B is incorrect. Convection is the most common method of heat transfer in liquids and gases.

D is incorrect. Conduction requires the mechanical collision between matter particles and so cannot occur in a vacuum.

QUESTION 9 C

C is correct.

$$\begin{aligned}\text{efficiency} &= \frac{\text{useful energy}}{\text{total energy}} \times 100 \\ &= \frac{5000}{5000+1250} \times 100 \\ &= 80\%\end{aligned}$$

A is incorrect. This option calculates $\frac{1250}{5000+1250}$.

B is incorrect. This option calculates $\frac{1250}{5000}$.

D is incorrect. This option is not physically possible and calculates $\frac{5000}{1250}$.

QUESTION 10 D

Gamma radiation has the greatest penetrating ability as it has no charge or mass. Beta particles are electrons (beta negative) or positrons (beta positive) and have charges of 1+ or 1– respectively. Alpha radiation has a charge of 2+, which is greater than the charges of beta particles and gamma radiation and thus means that it has the greatest ionisation ability. It also has the greatest mass as it comprises four nucleons (two neutrons and two protons).

QUESTION 11 C

C is correct. Ammeters must be in series in a circuit. Point Q is in series and measures the total current, so this is where the ammeter should be positioned. Point P measures the voltage across the sole battery, so this is where the voltmeter should be positioned. Since the circuit is parallel only, point S would also be a valid position to measure the total voltage.

A is incorrect. Both points S and P measure the total voltage in the parallel circuit, so the ammeter cannot be positioned at point S.

B is incorrect. Point R measures the current through only one of the resistors, so the ammeter cannot be positioned there.

D is incorrect. Point R is in series in the circuit and so cannot measure voltage; therefore, the voltmeter cannot be positioned there.

QUESTION 12 B

B is correct. This is the definition of internal energy.

A is incorrect. This option defines chemical energy.

C is incorrect. The internal energy of a thermal system relates to a change in mechanical energy (that is, the sum of kinetic and potential energies).

D is incorrect. The internal energy of a thermal system includes both kinetic and potential energies.

QUESTION 13 A

A is correct. According to the first law of thermodynamics, when energy passes into or out of a system, the change in the energy of the system obeys the law of conservation; that is, energy is neither created nor destroyed.

B is incorrect. This option outlines the zeroth law of thermodynamics.

C is incorrect. This statement is not one of the laws of thermodynamics.

D is incorrect. This statement is related to the zeroth law of thermodynamics.

QUESTION 14 D

D is correct. This is the definition of binding energy.

A is incorrect. This option relates to mass–energy equivalence, not binding energy.

B is incorrect. This option relates to chemical energy on an atomic scale, not the nuclear model.

C is incorrect. Binding energy is released when a nucleus is formed, not disassembled.

QUESTION 15 A

A is correct. The student is describing Einstein's mass–energy equivalence relationship: $\Delta E = \Delta mc^2$.

B is incorrect. The zeroth law of thermodynamics relates to thermal equilibrium.

C is incorrect. Calorimetry is the science of measuring energy transfers between objects or in chemical reactions.

D is incorrect. Mass defect relates to changes in mass, not energy specifically; however, it is often used in conjunction with Einstein's mass–energy equivalence relationship.

QUESTION 16 A

A is correct. This relationship is false because R_1 and R_2 are combined to effectively act as one resistor in the series circuit. As such, their voltage is equal; therefore, the true statement is $V_{AB} = V_1 + V_3$.

B and **C** are incorrect. These statements are true. According to Kirchhoff's current law, the current in is equal to the current out.

D is incorrect. This statement is true. Voltages in parallel are equal to each other.

QUESTION 17 D

D is correct.

$$\begin{aligned}\text{number of electrons} &= \frac{\text{total charge}}{\text{charge per electron}} \\ &= \frac{-2.5}{-1.60 \times 10^{-19}} \\ &= 1.6 \times 10^{19}\end{aligned}$$

A is incorrect. This option is a physically impossible value for an elementary particle such as the electron.

B is incorrect. This option has an incorrect exponent of 18.

C is incorrect. This option is the number of electrons in a charge of –1 C.

QUESTION 18 A

A is correct. Graph W shows displacement that exponentially increases over time, which indicates acceleration. Graph Z shows a velocity that decreases over time, which indicates deceleration (that is, negative acceleration).

B, **C** and **D** are incorrect. Graph X shows a velocity that is constant over time, which indicates no acceleration. Graph Y shows a displacement that has a constant rate of change over time, which indicates a constant velocity and hence no acceleration.

QUESTION 19 B

B is correct.

$$R_{\text{total}} = \left(12^{-1} + 6.0^{-1}\right)^{-1} + 4.0$$
$$= 8.0\ \Omega$$

A is incorrect. This option does not inverse the sum of the inverses of the parallel resistors.

C is incorrect. This option finds the difference between the parallel resistors, then applies the difference in series with the 4 Ω resistor.

D is incorrect. This option adds all the resistor values together.

QUESTION 20 B

B is correct.

$$N = N_0\left(\frac{1}{2}\right)^n$$
$$= 2.4\times10^{12}\left(\frac{1}{2}\right)^4$$
$$= 1.5\times10^{11}\ \text{nuclei}$$

A is incorrect. This option calculates the nuclei that remain after five half-lives.

C is incorrect. This option calculates the nuclei that remain after three half-lives.

D is incorrect. This option has an incorrect exponent of 12.

SECTION 2

QUESTION 21 (4 marks)

The conservation of momentum must be used as the collision is inelastic. This means that kinetic energy is not conserved.

momentum before collision = momentum after collision

$$m_1 v_1 + m_2 v_2 = m_{\text{total}} v_{\text{final}}$$
$$(10 \times 10) + \big(20 \times (-20)\big) = (10 + 20) \times v_{\text{final}}$$
$$-300 = 30 v_{\text{final}}$$
$$v_{\text{final}} = -10$$
$$= 10 \text{ m s}^{-1} \text{ west}$$

(–10 indicates that the final velocity is 10 m s^{-1} in same direction as the 20 kg ball, which is west.)

[4 marks]

1 mark for recognising that the problem involves the conservation of momentum. Note: This mark may be implied by subsequent working.

1 mark for substituting into the formula. Note: Responses must note that the directions are different (either using logic or sign convention) to obtain this mark.

1 mark for determining the magnitude of the velocity.

1 mark for determining the direction of the velocity.

Note: Do not accept follow-through errors, except for direction interpretation.

QUESTION 22 (7 marks)

a)
$$E_{K_B} = E_{K_A} - \text{GPE}$$
$$\frac{1}{2} m v_B^2 = \frac{1}{2} m v_A^2 - mgh$$
$$\frac{1}{2} v_B^2 = \frac{1}{2} v_A^2 - gh$$
$$v_B^2 = v_A^2 - 2gh$$
$$v_B = \sqrt{v_A - 2gh}$$
$$= \sqrt{22.7^2 - 2 \times 9.8 \times 25}$$
$$= 5.0 \text{ m s}^{-1}$$

[3 marks]

1 mark for recognising that the problem involves the conservation of energy. Note: This mark may be implied by subsequent working.

1 mark for substituting into the appropriate formula.

1 mark for determining the speed.

b) The collision is inelastic, so momentum is conserved.

Letting the mass of one cart be m, and velocity be v gives:

$$\sum(mv)_{\text{before}} = \sum(mv)_{\text{after}}$$
$$22.7m = 3mv$$
$$v = \frac{22.7}{3}$$
$$= 7.6 \text{ m s}^{-1}$$

[2 marks]
1 mark for recognising that the collision is inelastic or that the problem involves momentum (that is, energy is not conserved). Note: This may be implied by subsequent working.
1 mark for determining the final speed.

c) $u = 0 \text{ m s}^{-1}; v = 22.7 \text{ m s}^{-1}; s = 13 \text{ m}; a = ?$

$$v^2 = u^2 + 2as$$
$$22.7^2 = 0^2 + 2(a)(13)$$
$$a = 20 \text{ m s}^{-2}$$

[2 marks]
1 mark for substituting into the formula.
1 mark for determining the acceleration.

QUESTION 23 (4 marks)

a) Resistor 1's data is linear for currents greater than 4 mA. Linear data obeys Ohm's Law and thus is ohmic. Resistor 2's data is non-linear for currents greater than 4 mA. Non-linear data does not obey Ohm's Law and thus is non-ohmic.

[2 marks]
1 mark for explaining that resistor 1's data is linear.
1 mark for explaining that resistor 2's data is non-linear.

b) **Method 1: A non-zero data point and Ohm's Law**

$$V = IR$$
$$8 = 0.008R$$
$$R = 1000 \ \Omega$$

[2 marks]
1 mark for substituting into the formula.
1 mark for determining the resistance.

Method 2: Gradient and Ohm's Law

$$\text{gradient} = \frac{\Delta V}{\Delta I} = R$$
$$= \frac{8 - 0}{0.008 - 0}$$
$$= 1000 \ \Omega$$

[2 marks]
1 mark for substituting into the formula.
1 mark for determining the resistance.

QUESTION 24 (7 marks)

a) i) The sprinter moves 60 m away from the starting line at a (constant) velocity of 6 m s^{-1}.

[1 mark]

1 mark for describing the displacement and velocity. Note: Responses must refer to the direction to obtain the mark.

ii) The sprinter remains stationary; therefore, their displacement does not change and their velocity is zero.

[1 mark]

1 mark for describing the displacement and velocity. Note: Responses that refer to circular paths should not receive marks, as the running track is straight.

iii) The sprinter moves 100 m towards the starting point at a (constant) velocity of 5 m s^{-1}.

[1 mark]

1 mark for describing the displacement and velocity. Note: Responses must refer to the direction to obtain the mark.

b) $$\text{average velocity} = \frac{\text{net displacement}}{\text{change in time}}$$
$$= \frac{0}{60}$$
$$= 0 \text{ m s}^{-1}$$

[2 marks]

1 mark for identifying that the net displacement is zero.
1 mark for finding the average velocity. Note: Direction is not required to obtain this mark.

c) $$\text{average speed} = \frac{\text{total distance}}{\text{change in time}}$$
$$= \frac{2 \times 100}{60}$$
$$= 3 \text{ m s}^{-1}$$

[2 marks]

1 mark for identifying that the total distance travelled is 200 m (100 m away from and 100 m towards the starting point).
1 mark for calculating the average speed.

QUESTION 25 (8 marks)

a) An open-ended instrument has an antinode at the end of its standing wave. A stringed or closed-end instrument has a node at the end of its standing wave. Since this standing wave has a node at the start and end, the instrument must be stringed.

[3 marks]
1 mark for explaining when an antinode occurs.
1 mark for explaining when a node occurs. Note: Responses must relate this to both stringed and closed-end instruments to obtain this mark.
1 mark for explaining that the instrument is stringed. Note: Responses must explain the identification to obtain this mark.
Note: Responses may also use wording such as fixed-string or stretched-string.

b) Standing waves occur when two waves with matching amplitude and wavelengths/frequencies travel in opposite directions through a medium. They continuously interfere constructively or destructively, and appear to stand still due to the net effect of the superposition of each wave. In standing waves, nodes occur where interference results in a net zero amplitude/displacement, and antinodes occur where interference results in the net greatest amplitude/displacement.

[5 marks]
1 mark for explaining how standing waves occur.
1 mark for describing how standing waves interfere constructively or destructively.
1 mark for describing the net effect.
1 mark for explaining how nodes occur in standing waves.
1 mark for explaining how antinodes occur in standing waves.

