education

Department of Education
FREE STATE PROVINCE

# CONTROL TEST

# GRADE 12

# PHYSICAL SCIENCES

**MARCH 2025**

**MARKS: 100**

**TIME: 2 HOURS**

**This paper consists of 12 pages and two information sheets.**

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**INSTRUCTIONS AND INFORMATION**

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SIX questions. Answer ALL questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

1.1 The equivalent unit of force is …

A $kg \cdot m \cdot s^{-1}$.

B $kg \cdot m \cdot s^{-2}$.

C $kg \cdot m \cdot s$.

D $kg \cdot m^{-1}$. (2)

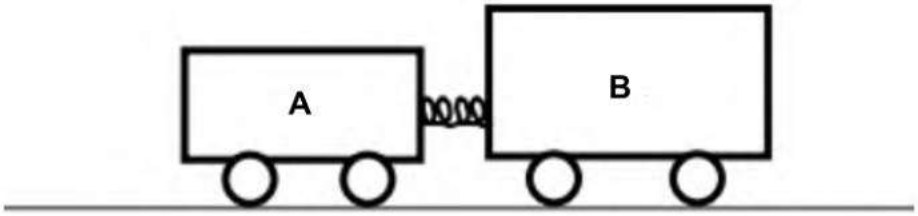
1.2 A learner drops two identical cell phones, **A** and **B**, from the same height. Cell phone **A** falls on a concrete floor and its screen breaks and cell phone **B** falls on a woollen carpet and its screen does not break.

Which one of the following combinations is CORRECT for cell phone **B** compared to cell phone **A** for the same change in momentum?

| | TIME OF CONTACT WITH CARPET | NET FORCE ON CELL PHONE B |
|---|---|---|
| A | Larger | Larger |
| B | Smaller | Larger |
| C | Larger | Smaller |
| D | Smaller | Smaller |

(2)

1.3 Two trolleys, **A** and **B**, with masses $\frac{1}{2}m$ and $2m$ respectively are connected by the spring as shown in the diagram below. The trolleys are initially at rest. Ignore all types of friction.




When the spring is released, both trolleys have a momentum with a magnitude of $p$. Trolley **B** moves with a velocity of $v$ to the right. The magnitude of the velocity of trolley **A** will be:

A $v$

B $\frac{1}{2}v$

C $2v$

D $4v$ (2)

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1.4 An object is thrown vertically upwards. Which one of the following regarding the object's acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

A $0\ m{\cdot}s^{-2}$

B $-9{,}8\ m{\cdot}s^{-2}$, downwards

C $9{,}8\ m{\cdot}s^{-1}$, downwards

D $9{,}8\ m{\cdot}s^{-2}$, downwards (2)

1.5 A ball is dropped from rest and reaches a velocity $v$ after it has travelled 3 $m$. What will the magnitude of the velocity of the ball be after it has travelled 9 $m$? Ignore the effects of friction.

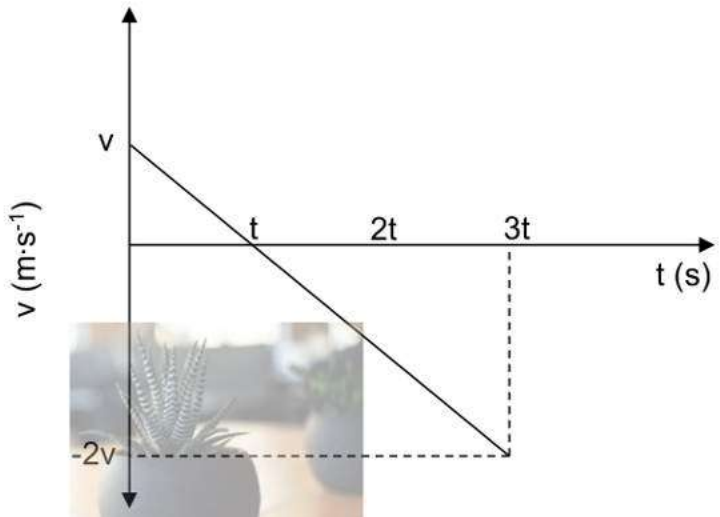
A $\frac{1}{3}v$

B $\sqrt{3}v$

C $3v$

D $6v$ (2)

1.6 The velocity versus time graph below represents the movement of an object that is initially projected vertically upwards. Ignore the effects of friction.




The displacement of the object after ***2t*** is …

A 0

B $\frac{1}{2}vt$

C $vt$

D $-\frac{3}{2}vt$ (2)

1.7 $CH_3COOCH_2CH_2CH_3$ is a condensed structural formula of …

A pentanoic acid.

B propyl ethanoate.

C ethyl propanoate.

D methyl butanoate. (2)

1.8 The list below has IUPAC names of compounds with five carbons.

(i) Methyl butanoate.
(ii) Pentanoic acid.
(iii) Pentan-3-one
(iv) 2-methylbutanal

A Functional isomer of pentanal is … only.

A (iii) and (iv)

B (ii) and (iii)

C (iii)

D (iv) (2)

1.9 Which molecular formula of an organic compound is similar to the EMPIRICAL FORMULA of butanoic acid AND to which homologous series does the compound belong?

| | MOLECULAR FORMULA | HOMOLOGOUS SERIES |
|---|---|---|
| A | $C_4H_8O_2$ | Carboxylic acid |
| B | $C_2H_4O$ | Carboxylic acid |
| C | $C_2H_4O$ | Aldehydes |
| D | $C_2H_4O_2$ | Esters |

(2)

1.10 Which compound has the lowest boiling point?

A 2,2-dimethylpropane.

B 2-methylbutane.

C 2-chlorobutane.

D Butan-1-ol. (2)

**[20]**

## QUESTION 2

Toolbox **A** of mass *6 kg* is joined by an inextensible string to toolbox **B** with the mass of *4 kg*. A pulling force of **F** is exerted on **A** to accelerate the boxes to the left. The coefficient of kinetic friction on the boxes is *0,3* and *0,2* respectively. Both toolboxes accelerate at *5,852* $m \cdot s^{-2}$ to the left.




2.1 State Newton second law of motion in words. (2)

2.2 Draw a free body diagram showing all forces acting on toolbox **B**. (4)

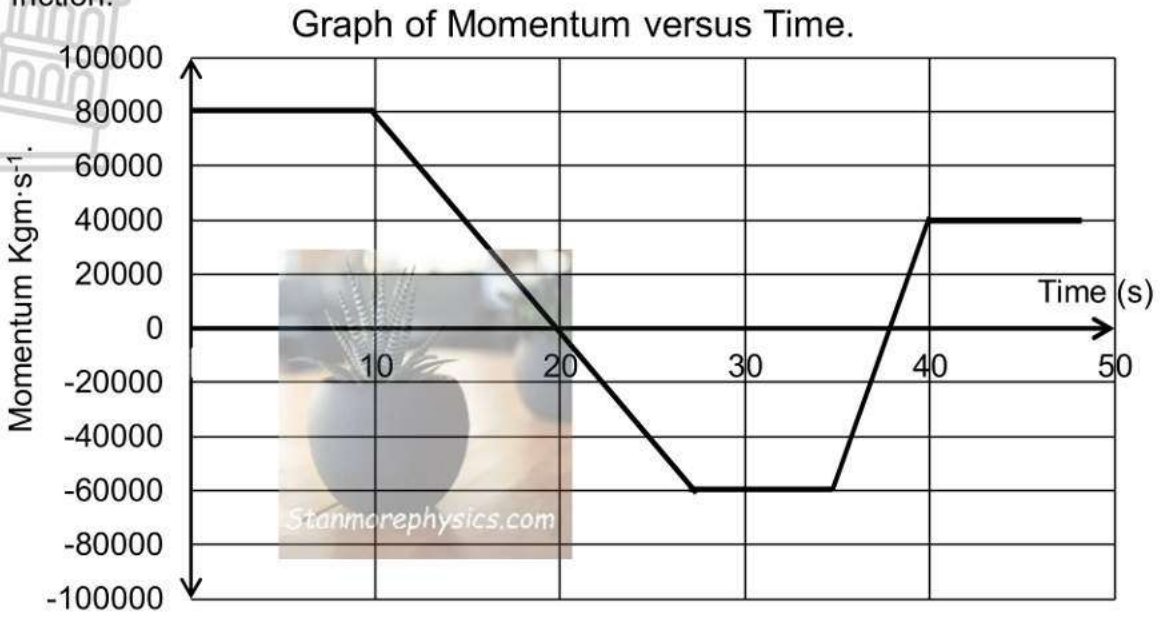
2.3 Calculate the magnitude of the pulling force ***F*** acting on the 6 kg box. (6)

2.4 Write down the reaction force to the weight of toolbox **A**. (2)

**[14]**

## QUESTION 3

The following graph shows the change in **momentum** of a truck over a period of time. The truck is initially moving EASTWARDS in a straight line. Ignore the effects of friction.




3.1 Define the term *momentum*. (2)

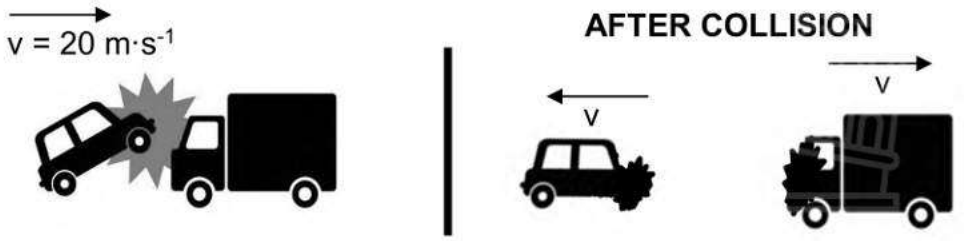
3.2 Write down the:

3.2.1 direction of the truck at t = 30 s. (2)

3.2.2 magnitude of the net force acting on the truck for the first 10 s. (1)

3.3 Explain your answer to QUESTION 3.2.2. (3)

3.4 The truck collides with a car at t = 35 s. The car has a mass of *2000 kg* and is moving at a constant velocity of *20 m·s$^{-1}$* east before the collision. After the collision, the car has a velocity to the west.




3.4.1 The ACCELERATION of the truck, between t = 35 s and t = 40 s, is *4 m·s$^{-2}$* east. Calculate the mass of the truck. (5)

3.4.2 Calculate the velocity of the truck before the collision. (3)

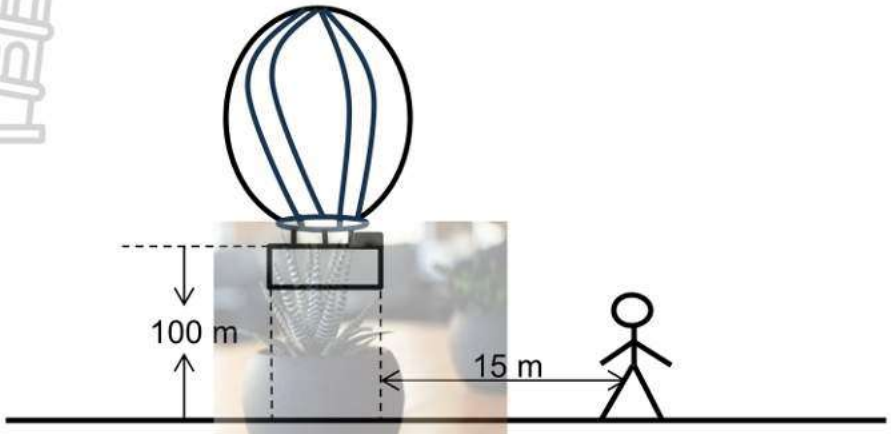
The sum of the kinetic energy of the car and truck after the collision is $1,06 \times 10^6$ J.

3.4.3 Prove by means of a calculation whether the collision between the car and the truck is *ELASTIC* or *INELASTIC*. (4)
**[20]**



## QUESTION 4

A hot-air balloon is moving vertically upwards at a constant speed of *12 m·s$^{-1}$*.
A camera is accidentally dropped from the balloon at a height of *100 m* as shown in the diagram below. Ignore the effects of friction.




4.1 Is the hot-air ballon a projectile while it is moving upwards?
Write YES or NO and give a reason for your answer. (2)

4.2 What is the velocity of the camera immediately after it is dropped from the hot-air ballon. (2)

4.3 Calculate the time taken by the camera to reach its maximum height. (3)

4.4 Calculate the distance between the hot-air balloon and the camera when the camera is at its maximum height. (5)

4.5 A jogger running at a constant speed of 3 m·s$^{-1}$, is 15 m away from the hot-air balloon as shown in the above diagram. If the jogger sees the camera at the same instant it is dropped from the balloon, will he be able to catch the camera before it strikes the ground?

Support your answer by means of a calculation. (6)

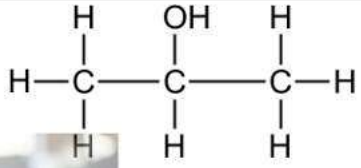
4.6 Draw a sketch graph of velocity versus time for the entire motion of the camera.

Indicate the following on the graph:
- Initial velocity
- Time taken to reach the maximum height (3)

**[21]**

## QUESTION 5

Consider the compounds **V**, **W**, **X**, **Y** and **Z** in the table below.

| | **COMPOUNDS** |
|---|---|
| **V** | 2-methylpropane |
| **W** | $CH_3CCCH(CH_2CH_3)CH_3$ |
| **X** |  |
| **Y** | $C_6H_{12}O_2$ |
| **Z** | $CH_3CHBrCH_2CH_2CH(CH_2CH_3)CH(CH_3)CH_3$ |

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5.1 Write down a LETTER for a compound that is:

5.1.1 an unsaturated hydrocarbon. (1)

5.1.2 a haloalkane. (1)

5.1.3 a chain isomer of butane. (1)

5.2 Write down the NAME of the functional group of compound **X**. (1)

5.3 Give the IUPAC name of:

5.3.1 a positional isomer of **X.** (2)

5.3.2 compound **Z.** (3)

5.4 Draw a structural formula of compound **W**. (2)

5.5 Compound is **Y** a straight chain carboxylic acid. For compound **Y**, write down the:

5.5.1 general formula of the homologous series to which it belongs. (1)

5.5.2 condensed structural formula. (2)

**[14]**

## QUESTION 6

A group of learners investigate the factors that affect the melting points of organic compounds **A**, **B**, **C** and **D**. Compound **D** has an unknown melting point **X**.
All these compounds have comparable molecular masses.

| | COMPOUND | MELTING POINT (ºC) |
|---|---|---|
| **A** | 2-methylbutane | - 159,77 |
| **B** | Butan-2-ol | - 115 |
| **C** | Propanoic acid | - 21 |
| **D** | 2-fluorobutane | **X** |

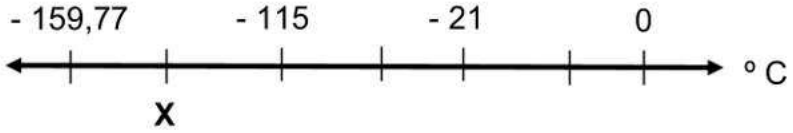
6.1 Define the term melting point. (2)

6.2 Give the independent variable for this investigation. (1)

6.3 What type of alcohol is compound **B**? Only write down PRIMARY, SECONDARY OR TERTIARY and give a reason for your answer. (2)

6.4 Is compound **C** a liquid or solid at 0°C? (1)

6.5 On the number line below (not drawn to scale), the unknown melting point is at a position as shown below. Write down a complete explanation for this.




(5)
**[11]**

**GRAND TOTAL: 100**

# DATA FOR PHYSICAL SCIENCES GRADE 12
# PAPER 1 (PHYSICS)

## TABLE 1: PHYSICAL CONSTANTS

| NAME | SYMBOL | VALUE |
|---|---|---|
| Acceleration due to gravity | g | $9,8\ m{\cdot}s^{-2}$ |
| Universal gravitational constant | G | $6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$ |
| Speed of light in a vacuum | c | $3,0 \times 10^{8}\ m{\cdot}s^{-1}$ |
| Planck's constant | h | $6,63 \times 10^{-34}\ J{\cdot}s$ |
| Coulomb's constant | k | $9,0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$ |
| Charge on electron | e | $-1,6 \times 10^{-19}\ C$ |
| Electron mass | $m_e$ | $9,11 \times 10^{-31}\ kg$ |
| Mass of the Earth | M | $5,98 \times 10^{24}\ kg$ |
| Radius of the Earth | $R_E$ | $6,38 \times 10^{6}\ m$ |

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## TABLE 2: FORMULAE

### MOTION

| | |
|---|---|
| $v_f = v_i + a\Delta t$ | $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ |
| $v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$ | $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ |

### FORCE

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$ |
| $F = \frac{Gm_1m_2}{d^2}$ OR $F = \frac{Gm_1m_2}{r^2}$ | $g = \frac{GM}{d^2}$ OR $g = \frac{GM}{r^2}$ |

### WORK, ENERGY AND POWER

| | |
|---|---|
| $W = F\Delta x\cos\theta$ | $U = mgh$ OR $E_P = mgh$ |
| $K = \frac{1}{2}mv^2$ OR $E_k = \frac{1}{2}mv^2$ | $W_{net} = \Delta K$ OR $W_{net} = \Delta E_k$<br>$\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$ |
| $W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$ |
| $P_{ave} = Fv_{ave}$ | |

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## TABLE 3: THE PERIODIC TABLE OF ELEMENTS

| 1 (I) | 2 (II) | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 (III) | 14 (IV) | 15 (V) | 16 (VI) | 17 (VII) | 18 (VIII) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,1 H 1 | | | | | | | | | | | | | | | | | 2 He 4 |
| 1,0 Li 3 7 | 1,5 Be 4 9 | | | | | | | | | | | 2,0 B 5 11 | 2,5 C 6 12 | 3,0 N 7 14 | 3,5 O 8 16 | 4,0 F 9 19 | Ne 10 20 |
| 0,9 Na 11 23 | 1,2 Mg 12 24 | | | | | | | | | | | 1,5 Aℓ 13 27 | 1,8 Si 14 28 | 2,1 P 15 31 | 2,5 S 16 32 | 3,0 Cℓ 17 35,5 | Ar 18 40 |
| 0,8 K 19 39 | 1,0 Ca 20 40 | 1,3 Sc 21 45 | 1,5 Ti 22 48 | 1,6 V 23 51 | 1,6 Cr 24 52 | 1,5 Mn 25 55 | 1,8 Fe 26 56 | 1,8 Co 27 59 | 1,8 Ni 28 59 | 1,9 Cu 29 63,5 | 1,6 Zn 30 65 | 1,6 Ga 31 70 | 1,8 Ge 32 73 | 2,0 As 33 75 | 2,4 Se 34 79 | 2,8 Br 35 80 | Kr 36 84 |
| 0,8 Rb 37 86 | 1,0 Sr 38 88 | 1,2 Y 39 89 | 1,4 Zr 40 91 | Nb 41 92 | 1,8 Mo 42 96 | 1,9 Tc 43 | 2,2 Ru 44 101 | 2,2 Rh 45 103 | 2,2 Pd 46 106 | 1,9 Ag 47 108 | 1,7 Cd 48 112 | 1,7 In 49 115 | 1,8 Sn 50 119 | 1,9 Sb 51 122 | 2,1 Te 52 128 | 2,5 I 53 127 | Xe 54 131 |
| 0,7 Cs 55 133 | 0,9 Ba 56 137 | La 57 139 | 1,6 Hf 72 179 | Ta 73 181 | W 74 184 | Re 75 186 | Os 76 190 | Ir 77 192 | Pt 78 195 | Au 79 197 | Hg 80 201 | 1,8 Tℓ 81 204 | 1,8 Pb 82 207 | 1,9 Bi 83 209 | 2,0 Po 84 | 2,5 At 85 | Rn 86 |
| 0,7 Fr 87 | 0,9 Ra 88 226 | Ac 89 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ce 58 140 | Pr 59 141 | Nd 60 144 | Pm 61 | Sm 62 150 | Eu 63 152 | Gd 64 157 | Tb 65 159 | Dy 66 163 | Ho 67 165 | Er 68 167 | Tm 69 169 | Yb 70 173 | Lu 71 175 |
| Th 90 232 | Pa 91 | U 92 238 | Np 93 | Pu 94 | Am 95 | Cm 96 | Bk 97 | Cf 98 | Es 99 | Fm 100 | Md 101 | No 102 | Lr 103 |

KEY

Atomic number

Electronegativity → 29 / 1,9 Cu / 63,5 ← Symbol

Approximate relative atomic mass

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