LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE EXAMINATION

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

Work, energy, and power

08 April 2025

MARKS: 35

TIME: 60 Minutes

This question paper consists of 6 pages.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of THREE questions. Answer ALL the 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 subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1-1.5) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following is an example of a *conservative force*?

A Applied force

B Tensional force

C Air resistance

D Gravitational force (2)

1.2 The kinetic energy of a certain object **A** is **X**. The velocity and the mass of another object **B** are BOTH double that of **A**.

Which ONE of the following CORRECTLY represents the kinetic energy of object **B**?

A 3**X**

B 4**X**

C 6**X**

D 8**X** (2)

1.3 Which ONE of the following is the BEST indication that mechanical energy is conserved?

A $W_{net} = \Delta E_k$

B $\Delta E_p = -\Delta E_k$

C $\Delta E_p = \Delta E_k$

D $W_{nc} = \Delta E_p$ (2)

1.4 After getting on the Makhado-Polokwane free way, a sports car accelerates from 5 m ·s^{-1} to 25 m ·s^{-1}.

Its kinetic energy increases by a factor of …

A 35

B 30

C 25

D 20 (2)

1.5 Two steel balls with the *same mass* are released from two different points which are at different heights on a building.

Neglect the effects of air resistance.

When the balls are 1 m above the ground, they BOTH have the SAME …

A potential energy.

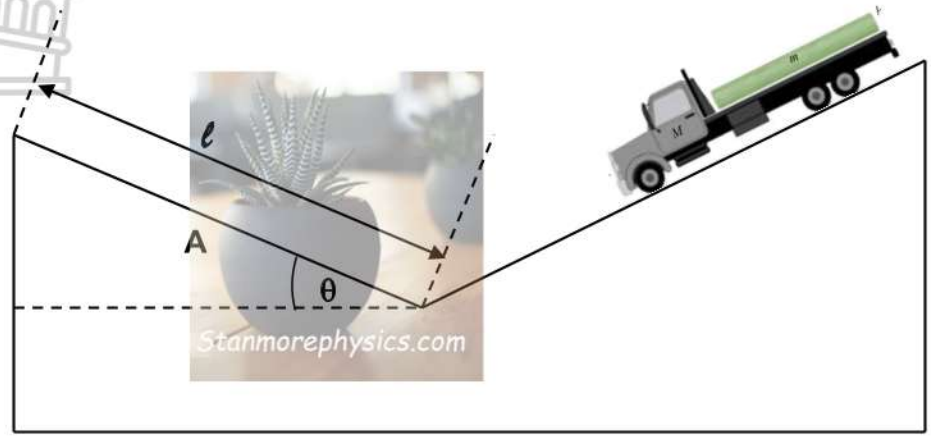
B kinetic energy.

C instantaneous speed.

D instantaneous velocity. (2)
[10]

QUESTION 2 (Start on a new page)

In the diagram below, a 1,2 x 10^4 kg runway truck with failed brakes is moving downgrade at 36,11 $m \cdot s^{-1}$ just before the driver steers it up a frictionless emergency escape ramp with an inclination of $\theta = 15°$, as shown in the diagram below.



Assume the truck is a particle.

2.1 Define the term *conservative force*. (2)

2.2 Classify frictional force as a CONSERVATIVE or a NON-CONSERVATIVE force. (1)

2.3 Draw a labelled free-body diagram for the truck as it passes point **A**. (2)

2.4 Calculate the MINIMUM LENGTH ℓ that the ramp must have if the truck is to stop along it. (5)

2.5 Does the minimum length ℓ INCREASE, DECREASE or REMAIN THE SAME if the:

2.5.1 Truck's mass is decreased (1)

2.5.2 Truck's speed is decreased (1)

[12]

QUESTION 3 (Start on a new page)

The force **F**, acting at 30° to the horizontal, causes the 6 kg block to accelerate at 2 m·s^{-2} when the frictional force is 3 N.

3.1 Define the term *frictional force*. (2)

3.2 Draw a labelled free-body diagram for the block whilst in motion. (4)

3.3 state the *Work-energy Theorem* in words. (2)

3.4 Use the **Work-energy Theorem** to calculate the magnitude of the force **F**. (5)

[13]

TOTAL : [35]

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MARKING GUIDLINES

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QUESTION 1

1.1 D ✓✓ (2)

1.2 D ✓✓ (2)

1.3 B ✓✓ (2)

1.4 C ✓✓ (2)

1.5 A ✓✓ (2)

[10]

QUESTION 2

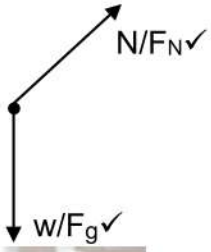
2.1 A force for which the work done in moving an object between two points is independent of the path taken.✓✓

OR:

A force for which the work done is path-independent.✓✓ (2)

2.2 Non-conservative (1)

2.3



F_N Normal force
F_g Gravitational force

(2)

2.4

$W_{net} = \Delta E_k$✓
$W_w + W_{F_N} = \Delta E_k$
$(mg\sin\theta)\Delta x\cos\beta + 0 = \frac{1}{2}m(v_f^2 - v_i^2)$
$(1,2 \times 10^4)(9,8)$✓$(\sin 15°)\cdot \ell \cdot \cos 180°$✓$= \frac{1}{2}(1,2 \times 10^4)(0^2 - 36,11^2)$✓
$(-30437,1197)\ell = -7823592,6$
$\therefore \ell = 257,0411615$ m✓

(5)

2.5.1 Remain the same✓ (1)

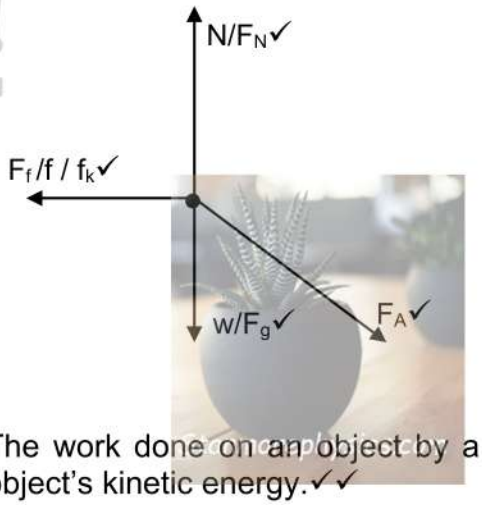
2.5.2 decrease✓ (1)

[12]

QUESTION 3

3.1 The force that opposes the motion of an object and which acts parallel to the surface.✓✓ (2)

3.2



F_N	Normal force
F_A	Applied force
F_g	Gravitational force
f_k	Kinetic frictional force

(4)

3.3 The work done on an object by a net force is equal to the change in the object's kinetic energy.✓✓

OR:

The net work done on an object is equal to the change in the object's kinetic energy.✓✓ (2)

3.4

OPTION 1:

$W_{net} = W_F + W_f + W_N + W_w$

$F_{net} \cdot \Delta x \cos\alpha$✓ $= F \cdot \Delta x \cos\theta + f \cdot \Delta x \cos\beta + 0 + 0$

$ma\cos\alpha = F\cos\theta + f\cos\beta$

$(6)(2)(\cos 0°)$✓ $= F(\cos 30°)$✓ $+ (3)(\cos 180°)$✓

$12 = F(\cos 30°) - 3$

$15 = F\cos 30°$

$\frac{15}{\cos 30°} = F$

$\therefore F = 17{,}3205$ N✓

OPTION 2:

$v_f^2 = v_i^2 + 2a\Delta x$

$v_f^2 - v_i^2 = 2a\Delta x$

$W_{net} = \Delta E_k$✓

$W_f + W_f + W_N + W_w = \frac{1}{2}m(v_f^2 - v_i^2)$

$F\Delta x\cos\theta + f\Delta x\cos\beta + 0 + 0 = \frac{1}{2}m(2a\Delta x)$

$F\Delta x\cos\theta + f\Delta x\cos\beta = ma\Delta x$

$F\cos\theta + f\cos\beta = ma$

$F\cos 30°$✓ $+ (3)(\cos 180°)$✓ $= (6)(2)$✓

$F(\cos 30°) - 3 = 12$

$F(\cos 30°) = 15$

$F = \frac{15}{\cos 30°}$

$F = 17{,}3205$✓

(5)

[13]

TOTAL: [35]