Basic Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: PHYSICS (P1)

COMMON TEST

JUNE 2015

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 75

TIME : 1, 5 hours

This question paper consists of 8 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name in the appropriate spaces on the **ANSWER BOOK**.
2. This question paper consists of SIX questions.
3. Answer ALL the questions 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 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.
11. Give brief motivations, discussions, etcetera 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. Write only the letter (A - D) next to the question number (1.1 – 1.5) in the ANSWER BOOK, for example 1.8 E.

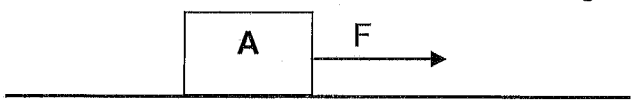
1.1 Which of the following physical quantities is the same as the change in momentum?

A Resultant force
B Impulse
C Acceleration
D Work (2)

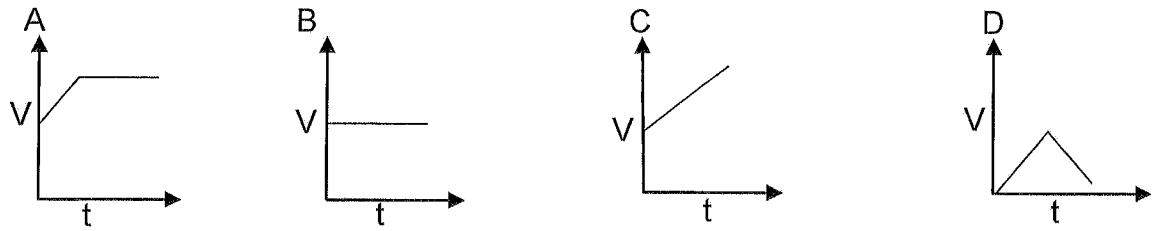
1.2 A golf ball is hit vertically upwards. What is the acceleration of the golf ball at the highest point its trajectory?

A 9,8 $m.s^{-2}$ upward
B 9,8 $m.s^{-2}$ downward
C 6,9 $m.s^{-2}$ horizontal
D 0 $m.s^{-2}$ (2)

1.3 An object, A, is tied to a string and is pulled by a constant force F along a horizontal frictionless surface. After a while the string breaks.



Which of the following graphs shown below represents the velocity – time graph of object A before and after the string breaks?



(2)

1.4 A car is travelling with a speed of x $m.s^{-1}$. If the speed of the car is doubled, the kinetic energy of the car will now be?

A two times greater
B two times smaller
C four times greater
D four times smaller (2)

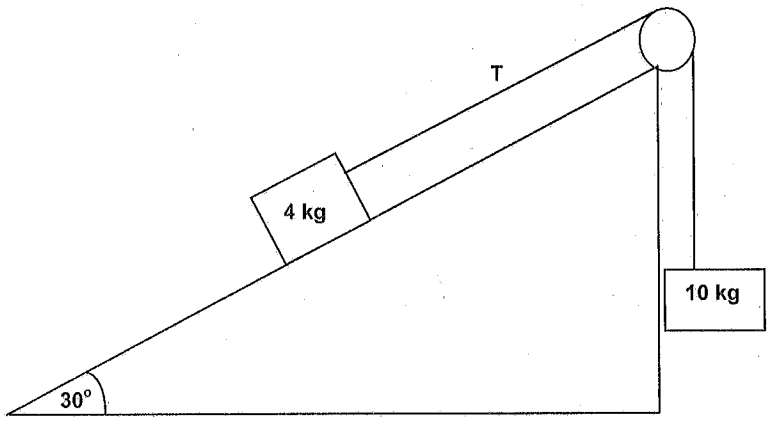
1.5 The acceleration due to gravity at a point on the surface of the Earth is g. What would be the gravitational acceleration on the surface of another planet of the same mass, but which has double the diameter of the Earth?

A 4 g
B 2 g
C ½ g
D ¼ g (2)

[10]

QUESTION 2 (Start on a new page)

A 4 kg bock is placed on an incline plane as shown below. It is attached to a 6kg block by an inextensible cord that passes over a frictionless pulley.



A frictional force of 12 N exists between the 4 kg block and the surface as it moves. The tension in the cord is T.

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

2.2 Draw separate, labelled free body diagrams for EACH block showing all forces acting on them . (6)

2.3 By applying Newton's Second Law of motion, separately to each of the blocks, determine the:

2.3.1 acceleration of the blocks. (5)

2.3.2 tension, T, in the cord. (2)

2.4 Determine the coefficient of kinetic friction for the 4kg mass and the surface. (3)

2.5 The angle of inclination was increased to 35°, how will this affect the following? Choose from **INCREASE, DECREASE or REMAIN THE SAME.**

2.5.1 μ_k (1)

2.5.2 tension T (1)

[20]

QUESTION 3 (Start on a new page)

A cricket ball is thrown vertically upwards at a velocity of 20 $m.s^{-1}$ from the top of the building that is 120 m high from the ground level. After reaching a maximum height it falls past the top of the building and hits the ground. (Ignore the effects of friction).

3.1 What is a projectile? (1)

3.2 Calculate the maximum height above the building reached by the ball. (3)

3.3 For how long was the ball in the air? (3)

3.4 Using ENERGY PRINCIPLES ONLY, determine the speed of the ball on hitting the ground. **(NO marks will be awarded for using kinematic equations)**. (5)
[12]

QUESTION 4 (Start on a new page)

A man of mass 65 kg on roller-skates is holding an iron bar of mass 4 kg in his hands. He is moving forward on a frictionless horizontal track at a speed of 2 $m \cdot s^{-1}$.

In order to increase his speed, he throws the iron bar away from himself at a speed of 5 $m \cdot s^{-1}$. Ignore friction.

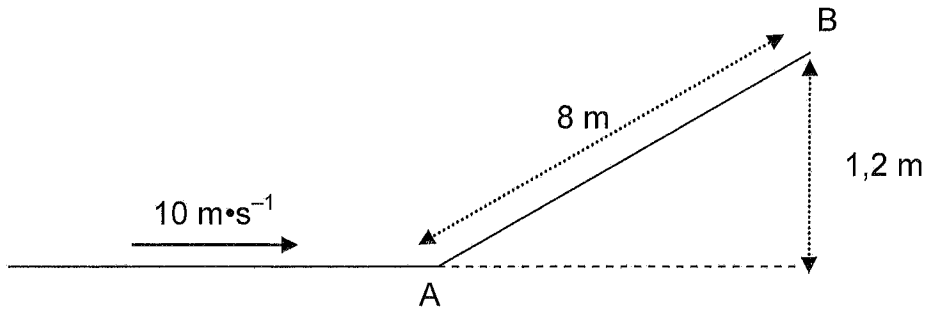
4.1 State the *Principle of the conservation of momentum* in words. (2)

4.2 In which direction should the man throw the iron bar for him to get a maximum increase in his velocity? (2)

4.3 Calculate the velocity of the man immediately after throwing the bar. (5)
[9]

QUESTION 5 (Start on a new page)

Ronald, a cyclist, is free-wheeling (moving without peddling) along a horizontal surface at a constant speed of 10 $m \cdot s^{-1}$. He reaches the bottom of the ramp (position A) .The ramp has a height of 1,2 m and a length of 8 m. While free-wheeling up the ramp, he experiences a frictional force of 18 N. The total mass of the cyclist and cycle is 55 kg.



5.1 Is the cyclist mechanical energy conserved as he moves from point A to point B?

Give reason for your answer. (2)

5.2

5.2.1 What is a conservative force? (2)

5.2.2 Name the conservative force acting on the cyclist as he moves. (1)

5.3. Calculate the kinetic energy of the cyclist:

5.3.1 at position A. (3)

5.3.2 at the top of the ramp, using the WORK-ENERGY THEOREM. (6)
[14]

QUESTION 6 (Start on a new page)

A siren of a train emits sound waves at a frequency of 555 Hz. A sound detector registers the wavelength of the wave to be 0,71 m.

Assume that the speed of sound in air is 340 $m \cdot s^{-1}$.

6.1 Is the train approaching or moving away from the sound detector? Show how you arrived at the answer. (5)

6.2 Calculate the speed of the train. (4)

Using large telescopes like the Southern African Large Telescope (SALT) in the Karoo, astronomers can study the light from distant galaxies. In 1929 Edwin Hubble found that the light from distant galaxies undergo a red shift.

6.3 What does the redshift tell us about the Universe? (1)
[10]

TOTAL: 75

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Mass of earth *Massa op aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of earth *Radius van aarde*	R_E	$6,38 \times 10^{3}\ km$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{d^2}$	$g = G\frac{M}{d^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$ or/ of $K_{max} = \frac{1}{2}mv_{max}^2$	

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PHYSICAL SCIENCES P1

MEMORANDUM

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GRADE 12

MARKS: 75

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N.B. This memorandum consists of 6 pages including this page.

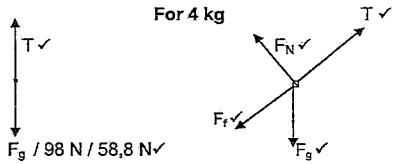
Question 1

1.1	B	✓✓	(2)
1.2	B	✓✓	(2)
1.3	A	✓✓	(2)
1.4	C	✓✓	(2)
1.5	D	✓✓	(2)
			[10]

Question 2

2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object. ✓✓ (2)

2.2 **For 10 kg or 6 kg** **For 4 kg**



(6)

2.3.1 $F_{net} = \Sigma F = ma$ ✓

$T + (-F_{g//}) + (-F_f) = 4a$

$T - mgSin\Theta - F_{fr} = 4a$

$T + (-4 \times 9,8 \times \sin 30° - 12) = 4a$ ✓

$T = 4a + 31,6$ 1

$F_{net} = ma = mg + (-T)$

$10a = 10 \times 9.8 - T$ ✓

$T = 98 - 10a$ 2

$(4a + 31,6) = (98 - 10a)$ ✓

$a = 4,74\ m.s^{-2}$ ✓ (5)

IF 6 KG USED

$F_{net} = ma = mg + (-T)$

$6a = (6 \times 9.8) - T$ ✓

$T = 58,8 - 6a$ 2

$(4a + 31,6) = (58,8 - 6a)$ ✓

$a = 2,72\ m.s^{-2}$ ✓

Positive marking from 2.3.1

2.3.2 $10a = (10 \times 9,8) - T$ +

$T = 98 - 10 \times 4,74$ ✓

$T = 50,60$ N ✓

IF 6KG USED

$6a = (6 \times 9,8) - T$

$T = (6 \times 9,8) - 6(2,72)$ ✓ $= 42,48$ N ✓ (2)

2.4 $f_k = \mu_k N$ ✓

$$\mu_k = \frac{12 \checkmark}{4 \times 9,8 \cos 30°}$$

$= 0,353$ ✓ (3)

2.5.1 Remain the same. ✓ (1)

2.5.2 Increases ✓ (1)

[20]

Question 3

3.1 an object upon which the only force acting is the force of gravity. ✓ (1)

3.2 $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = (20)^2 + 2(-9,8)\Delta y$ ✓

$-400 = -19,6\,\Delta y$

$\Delta y = 20,41$ m ✓ (3)

3.3 $\Delta y = v_i\Delta t + \frac{1}{2}at^2$ ✓

$-120 = 20t + \frac{1}{2}(-9,8)t^2$ ✓

$t = 7,39$ s ✓ (3)

OR

Time to max height: $v_f = v_i + at$

$0 = 20 + (-9,8)t$

$t = 2,04$s ✓

Max height to original point = 2,04s ✓

Time to ground from original point:

$\Delta y = v_i t + \frac{1}{2}at^2$

$-120 = -20t + \frac{1}{2}(-9,8)t^2$

$t = 3,31$s

time = 2,04 + 2,04 + 3,31

= 7,39s ✓

3.4 E_T (top) = E_T (bottom)

$(mgh + \frac{1}{2}mv_i^2) = (mgh + \frac{1}{2}mv_f^2)$ ✓

$(120 \times 9,8)$ ✓ + $\frac{1}{2}(20)^2$ ✓ = $0 + \frac{1}{2}v^2$ ✓

$v = 52,46\ m{\cdot}s^{-1}$ ✓ (5)

OR

From maximum height

E_T (top) = E_T (bottom)

$(mgh + \frac{1}{2}mv_i^2) = (mgh + \frac{1}{2}mv_f^2)$ ✓

$(140,41 \times 9,8)$ ✓ + (0 = 0) ✓ + $\frac{1}{2}v^2$ ✓

$v = 52,46\ m.s^{-1}$ ✓

NB: Don't penalise if zero omitted

[12]

Question 4

4.1 The total linear momentum of a closed system remains constant (is conserved). ✓✓ (2)

4.2 horizontally backwards ✓✓ 2 or 0 (2)

4.3 total momentum before = total momentum after ✓

$(m_1 + m_2)\,u = m_1 v_1 + m_2 v_2$

$(65 + 4)\,2$ ✓ $= (4 \times (-5) + 65.\ v_2)$ ✓

$v_2 = 2{,}43\ m{\cdot}s^{-1}$ ✓ forward ✓ (5)

[9]

Question 5

5.1. E_{mech} is not conserved. ✓ This is not an isolated system / there is friction ✓ (2)

5.2.1 a force for which the work done in moving an object between two points is independent of the path taken. ✓✓ (2)

5.2.2 Gravitational force. ✓ (1)

5.3.1. $E_k = \frac{1}{2}mv^2$ ✓

$= \frac{1}{2}(55)(10)^2$ ✓

$= 2\,750$ J ✓ (3)

5.3.2 Wnet = Δ Ek ✓

$W_g \quad W_{g//} \quad W_N \quad W_f \quad K_f \quad K_i$ ✓

$0 + [(mg\sin\theta).\Delta x \cos 180°] + 0 + F_f \Delta x \cos 180° = K_f - 2750$ ✓

$0 + (-646{,}8)$ ✓ $+ 0 + (-144)$ ✓ $= K_f - 2750$

$K_f = 1959{,}2$J ✓ (6)

OR

Wnet = ΔEk

$W_g + W_{fric} = K_f - K_i$

$F_g \Delta x \cos 98.63 + (-144) = K_f - 2750$

$-647 - 144 + 2750 = K_f$

$K_f = 1959$J

[14]

Question 6

6.1 $v = f\lambda$ ✓

$340 = f\,(0{,}71)$ ✓

$f = 478{,}87$ Hz ✓

The frequency of the sound detected by the listener is smaller / less than ✓ the frequency of the source ($f_L < f_s$), the train is moving away ✓ from the listener. (5)

6.2 **positive marking from 6.1**

$f_L = \left[\frac{v \pm v_L}{v \pm v_s}\right] f_s$ ✓

$478{,}87 = \left[\frac{340 + 0}{340 + v}\right]$ ✓ 555 ✓

$v = 54{,}05\ m.s^{-1}$ ✓ (4)

6.3 The universe is expanding ✓ (1)

[10]

TOTAL: 75