higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(First Paper)
NQF LEVEL 3

(10021003)

21 November 2018 (X-Paper)
09:00–12:00

Nonprogrammable calculators and drawing instruments may be used.

This question paper consists of 11 pages, 1 graph paper and 1 formula sheet.

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TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write your EXAMINATION NUMBER and the EXAM CENTRE NUMBER in the space provided in the ANSWER BOOK.
5. Show formulae and substitutions in ALL calculations.
6. Accurately approximate ALL final answers to TWO decimal places.
7. Write neatly and legibly.

NCV

SECTION A

QUESTION 1

Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Physical quantity represented by $C.s^{-1}$

1.2 Area under a velocity-time graph

1.3 State of an object when the net force acting on the object is zero

1.4 Variable resistor in an electric circuit

1.5 Physical property of sound represented by the amplitude of sound waves

(5 × 1) **[5]**

QUESTION 2

Choose a description from COLUMN B that matches a term in COLUMN A. Write only the letter (A–I) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Acceleration	A	parallel plates
2.2	Converging lens	B	resistors in parallel
2.3	Uniform field	C	real image only
2.4	Transformers	D	area under v-t graph
2.5	Potential dividers	E	real and virtual image
		F	positive point charge
		G	electromagnetic induction
		H	slope of v-t graph
		I	resistors in series

(5 × 1) **[5]**

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QUESTION 3

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 When the velocity of a moving object decreases, its acceleration is zero.

3.2 In the equation $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$, the unit for $\frac{1}{2}a\Delta t^2$ is metres.

3.3 Radio waves travel at the same speed as sound waves.

3.4 Long-sightedness can be rectified by using diverging lenses.

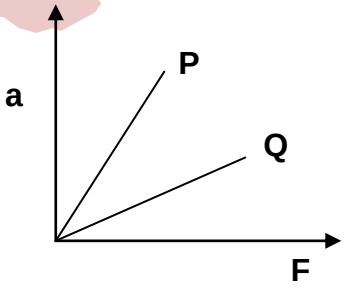
3.5 If the current in a circuit increases, the internal resistance of the battery does not change.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

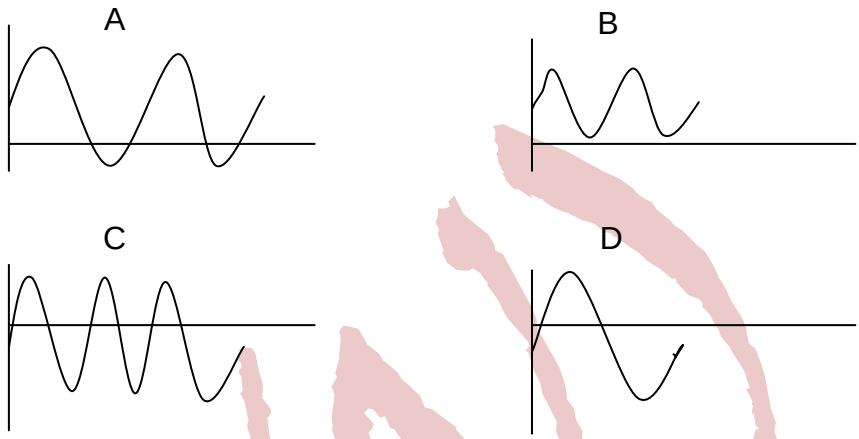
4.1 In an investigation of Newton's second law, graphs of acceleration (a) versus force (F) were obtained for two bodies P and Q as shown below.



Which ONE of the following statements is true:

A The two bodies have equal masses.
B Body Q has a smaller mass.
C Body P has a smaller mass.
D It is not possible to determine from the graphs which mass is greater.

4.2 Which ONE of the following sound wave forms has the highest pitch:



4.3 A boy with a mass of 50 kg stands on a bathroom scale in a lift.

If the scale reading is 480 N, the lift can only be …

A stationary.
B accelerating.
C moving up with constant speed.
D moving down with constant speed.

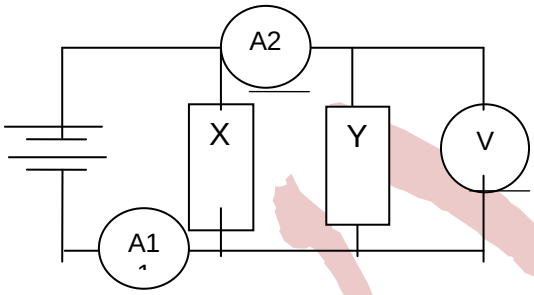
4.4 The magnitude of the electrostatic force between two identical charged spheres is F.

If the charge on one of the spheres is doubled and the distance between them halved, the new electrostatic force between them will be …

A 8F.
B F.
C ½F.
D 4F.

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4.5 In the circuit diagram below, the internal resistance of the battery is negligible. The resistance of X is twice the resistance of Y.



If the reading on A1 is 6 A, the reading on A2 will be …

A 6 A.
B 2 A.
C 3 A.
D 4 A.

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5: MEASUREMENTS

5.1 Give the units of each of the following quantities:

5.1.1 Velocity

5.1.2 Capacitance

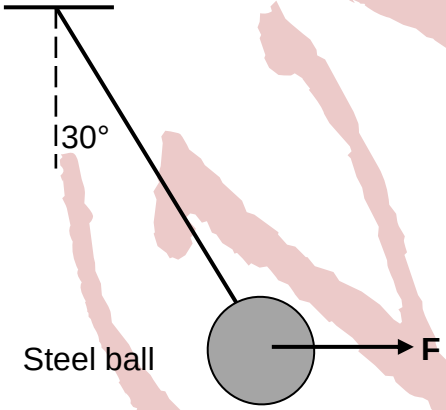
(2 × 1) (2)

5.2 In the equation $F = \frac{kQ_1Q_2}{r^2}$ give the scientific name of each symbol. (4)

[6]

QUESTION 6: MECHANICS

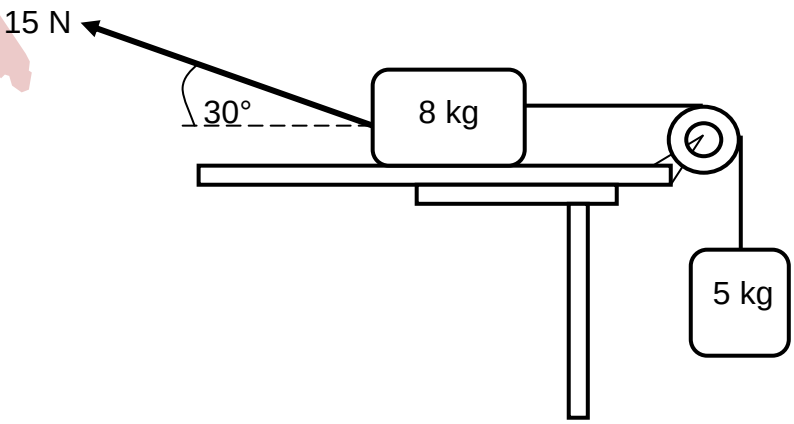
6.1 The simplified diagram below shows a heavy steel ball used to demolish old buildings. The ball weighs 2 500 N and is held by a strong cable. The rope is pulled back through an angle of 30° by a horizontal force F and is held stationary, momentarily, before being released.



6.1.1 Draw a labelled free-body diagram showing the forces acting on the ball. (3)

6.1.2 Determine, by means of accurate construction, the magnitude of the force F. Use a scale of 1 cm to represent 500 N. (7)

6.2 A block with a mass of 8 kg resting on a rough horizontal table is connected by a light inextensible string over a light frictionless pulley to another block with a mass of 5 kg. The 5 kg block hangs vertically as shown in the diagram below. A 15 N force is applied to the 8 kg block at an angle of 30° to the horizontal, causing the block to slide to the left. Ignore the effect of air friction.



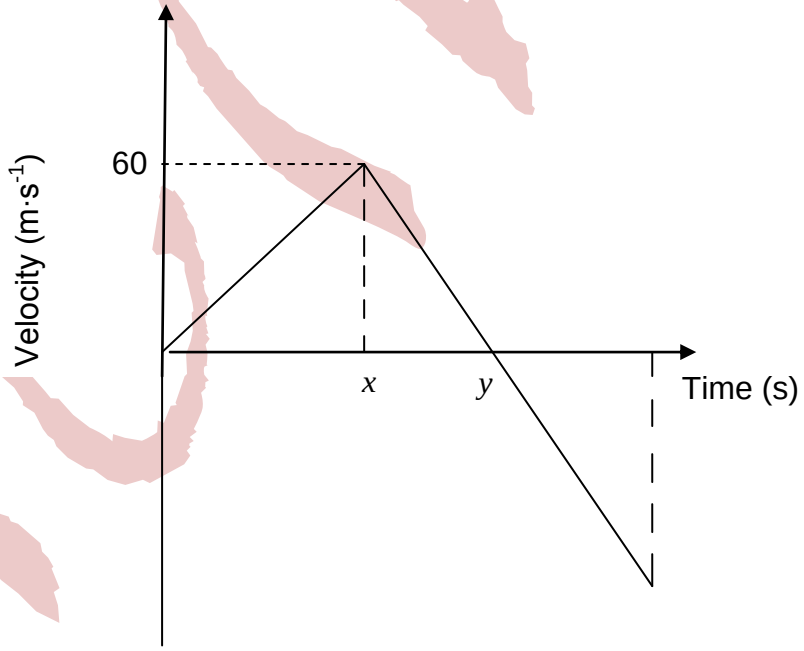
6.2.1 State Newton's second law of motion in words. (2)

6.2.2 Calculate the magnitude of each of the following:

(a) The vertical component of the 15 N applied force (3)

(b) The tension in the string connecting the TWO blocks if the frictional force between the block and surface is 17,73 N (6)

6.3 A small rocket is launched vertically upwards from rest and it moves with constant acceleration. It reaches a height of 800 m when the fuel is finished. The moment the fuel is finished, the rocket is moving upwards at 60 $m \cdot s^{-1}$. The velocity-time graph shows the motion of the rocket from the moment it is launched until it reaches the ground again. Ignore air resistance.



6.3.1 Without using the equations of motion, calculate the value of x on the graph. (4)

6.3.2 Use the graph to calculate the acceleration of the rocket before the fuel is finished. (4)

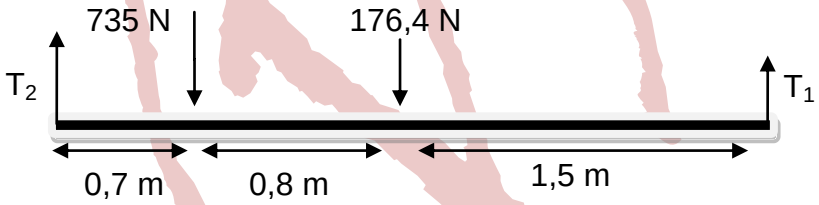
[29]

QUESTION 7

7.1 A screwdriver with an arm length of 45 cm is used to turn a screw that fastens the hinge of a door. A carpenter applies a force of 450 N to try and open the screw.

Calculate the torque of the screwdriver. (3)

7.2 A handyman fixes a 3 m log in the garage roof by two tension ropes, T_1 and T_2, to store his tools. Two loads 735 N and 176,4 N are then mounted on the log as indicated in the diagram below.



7.2.1 Calculate the tension forces on T_1 and T_2. (8)

7.2.2 Does the storage log balance when the loads are mounted? Show the calculation. (4)

7.3 A crate with a mass of 500 kg is lifted vertically upward by a cable attached to a Helicopter. Ignore the mass of the cable and determine the tension in the cable if the crate:

7.3.1 Moves upwards at a constant velocity (4)

7.3.2 Accelerated upwards at 2 $m.s^{-2}$ (4)

[23]

QUESTION 8: WAVES, SOUND AND LIGHT

8.1 At a cricket match a batsman hits the ball with great force but the sound of the impact is heard by a spectator only two seconds after the ball had made contact with the bat. The speed of sound in air is 343 $m.s^{-1}$.

8.1.1 What type of wave is a sound wave? (1)

8.1.2 Explain why the spectator did not hear the sound at the same time that he saw the shot. (2)

8.1.3 Calculate how far the spectator was sitting from the batsman. (4)

8.1.4 If the wavelength of the sound waves is 10 mm, calculate the frequency of the sound waves. (3)

8.2 A student cannot read the writing on a chalkboard from the back of a room but she can read the writing in the book in front of her.

8.2.1 Draw a ray diagram that indicates how an image is formed in her eye for her condition. (3)

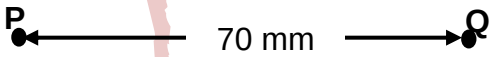
8.2.2 After her condition was corrected, an object with a height of 5 cm, located at a distance of 3 m from her, has a magnification of 0,05.

Calculate the size of the image formed on her retina. (4)

8.3 What is the speed of a light ray through ethanol with a refractive index of 1,36? (3)
[20]

QUESTION 9: ELECTROMAGNETISM

9.1 Two identical small metal spheres, P and Q, are 70 mm apart from their centres. The magnitude of charge on sphere P is +3 nC and on sphere Q -2 nC.



9.1.1 Sketch the electric field pattern between the TWO charges. (3)

9.1.2 Calculate the electrostatic force that sphere P exerts on sphere Q. (4)

9.1.3 Calculate the electrical potential energy of the system of the TWO charges. (4)

9.2 A capacitor consists of plates with dimensions 10 cm × 2 cm. The plates are 1 mm apart.

9.2.1 Calculate the capacitance of this capacitor. (4)

9.2.2 How will the capacitance in QUESTION 9.2.1 change in each of the following cases? Write only 'Increases', 'Decreases' or 'Remains the same'.

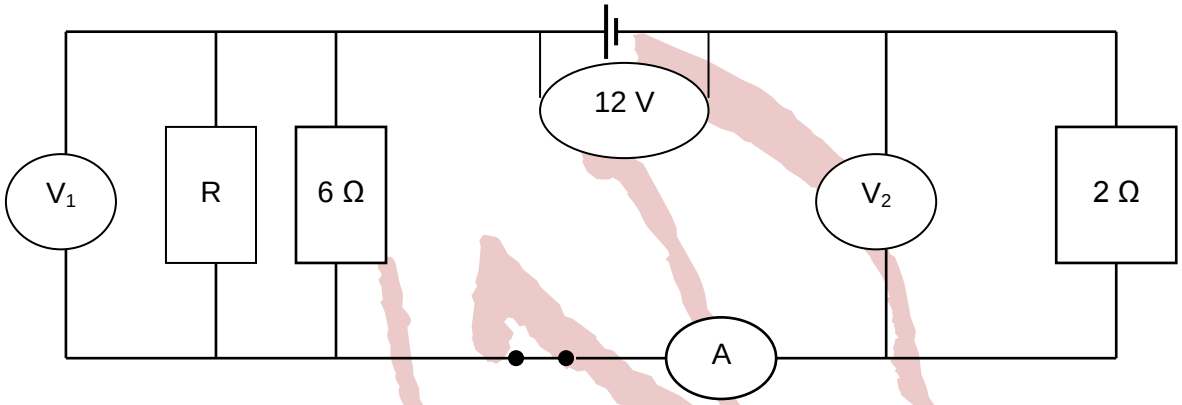
(a) Smaller plates are used

(b) The distance between the plates is increased (2 × 1) (2)
[17]

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QUESTION 10: ELECTRIC CIRCUITS

In the circuit below, the battery has negligible internal resistance and an emf of 12 V. The ammeter reads 2 A.



10.1 What is the relationship between resistance and current in an electric circuit? (2)

10.2 Calculate:

10.2.1 The resistance of the circuit (3)

10.2.2 The resistance of resistor R (5)

10.2.3 The reading on voltmeter V_1 (3)

10.3 The 2-ohm resistor burns out.

How will the following change? Write 'Increases', 'Decreases' or 'Remains the same' and explain the answer in each case.

10.3.1 The reading on V_2 (3)

10.3.2 The reading on A (4)

[20]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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FORMULA SHEET

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m{\cdot}s^{-2}$
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	$9{,}11 \times 10^{-31}\ kg$
Permittivity of free space	0ε	$8{,}85 \times 10^{-12}\ F{\cdot}m^{-1}$

TABLE 2: FORMULAE

MECHANICS

$v = u + at$	$F = Gm_1m_2/r^2$
$v^2 = u^2 + 2as$	$E_p = mgh$
$s = ut + 1/2\,at^2$	$MA = load/effort$
$F = mg$	$VR = S_E/S_R$
$F = ma$	$W = F \times S$
$\tau = \perp F.S$	$Efficiency = MA/VR$
$E_k = 1/2\,mv^2$	

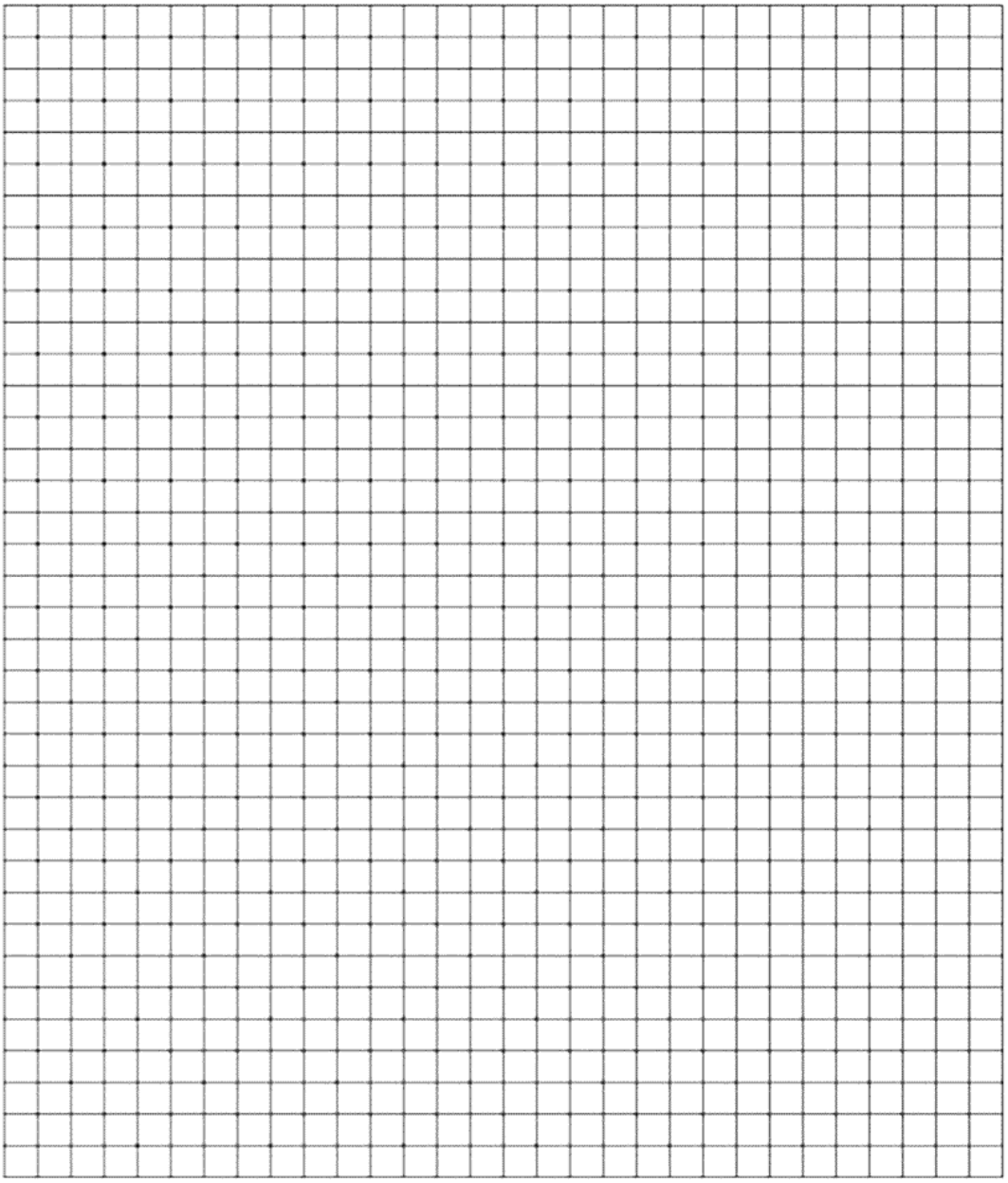
WAVES, SOUND AND LIGHT

$v = f\lambda$
$T = 1/f$

MAGNETISM AND ELECTRICITY

$R_T = R_1 + R_2 + R_3 + ...$	$Q = It$
$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + ...$	$E = IR + Ir$
$V = IR$	$V = W/Q$
$F = kQ_1Q_2/r^2$	$E = F/q$
$E = kQ/r^2$	$E = V/d$
$C = \in_0 A/d$	$P = VI$
$C = Q/V$	$V_1/V_2 = N_1/N_2 = I_2/I_1$
$U = kQ_1Q_2/r$	

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