KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P1 (PHYSICS)

COMMON TEST

JUNE 2023

MARKS: 150

TIME: 3 Hours

Stanmorephysics

This question paper consists of 15 pages and 3 data sheets.

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INSTRUCTIONS AND INFORMATION

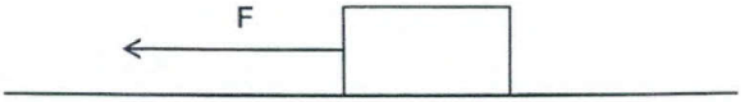
1. Write your NAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, 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. 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 et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1-1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 An object is moving to the left at constant velocity when a force F acts on it. The magnitude of the frictional force acting on the object is…



A zero.

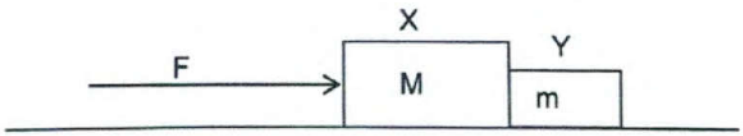
B smaller than F.

C equal to F.

D larger than F.

(2)

1.2 A horizontal force F is applied to the block X of mass M, which is in contact with another block Y of mass m on a smooth surface.



. The magnitude of the force exerted on block Y by block X is…

A $\frac{mF}{M}$

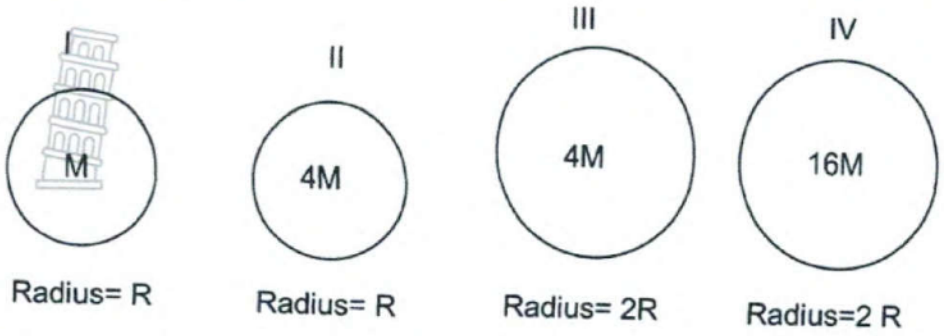
B $\frac{mM}{F}$

C $\frac{M+F}{m}$

D $\frac{mF}{M+m}$

(2)

1.3 Four planets I, II, III and IV are shown below. Their masses are M, 4M, 4M and 16M respectively.



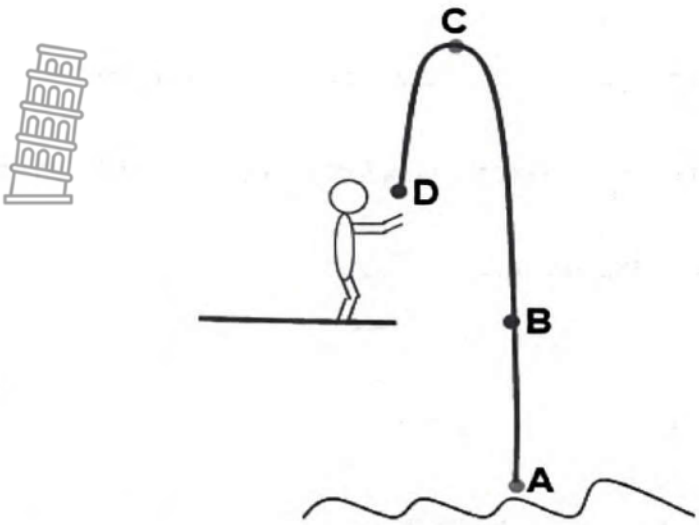
Which of the above planets will have the same gravitational accelerations?

A	I, III and IV
B	II, III and IV.
C	I and II III and IV
D	I and III II and IV

(2)

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1.4 A person dives from a high platform into a pool as shown below. Ignore the effect of air friction.



At which ONE of the positions A, B, C or D will the magnitude of his momentum be a maximum?

A Position A

B Position B

C Position C

D Position D

(2)

1.5 If the momentum of an object is doubled, then the kinetic energy of the object is …

A halved.

B doubled.

C three times greater.

D four times greater .

(2)

1.6 Consider the statements below:

I. Work is done on an object only when a force displaces the object in the direction of the force.

II. Total mechanical energy is conserved only in the absence of non-conservative forces.

III. The work done on an object by a net force is equal to the kinetic energy of the object.

Which of the above statements is/are TRUE?

A Only I.

B I and II only.

C II only.

D I, II and III. (2)

1.7 The hooter of a car emits sound waves of constant frequency as the car moves away from a stationary listener.

Which of the following properties of the sound waves heard by the listener will NOT change?

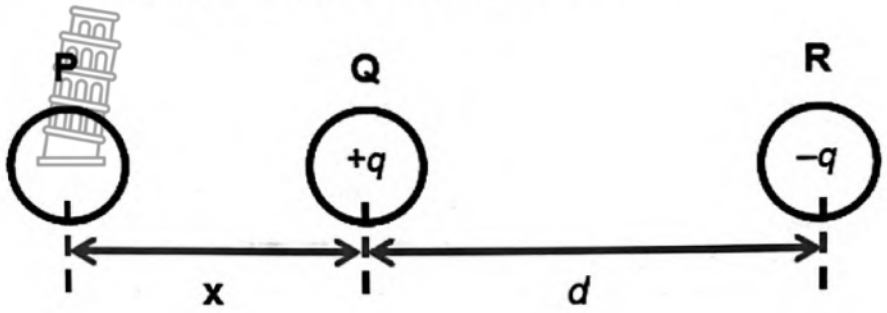
A Velocity

B Frequency

C Wavelength and frequency

D Frequency and loudness (2)

1.8 Three charged spheres, **P**, **Q** and **R** are arranged as shown below. **Q** is POSITIVELY charged. Spheres **Q** and **R** are a distance *d* from each other and carry charges of $+q$ and $-q$ respectively. The magnitude of the charge on sphere **P** is NINE times greater than that on sphere **Q**.

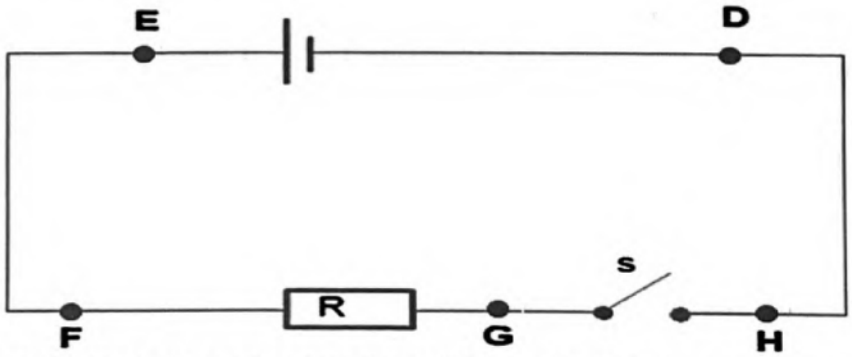


Which ONE of the following combinations of factors will cause the net electrostatic force on charge **Q** to be ZERO?

	Charge on sphere P	Distance X
A	Positive	4,5 *d*
B	Positive	3 *d*
C	Negative	4,5 *d*
D	Negative	3 *d*

(2)

1.9 A cell is connected to a resistor and an open switch. Five points are labelled D, E, F, G and H respectively.



A VOLTMETER has a ZERO reading if it is connected across points...

A ED

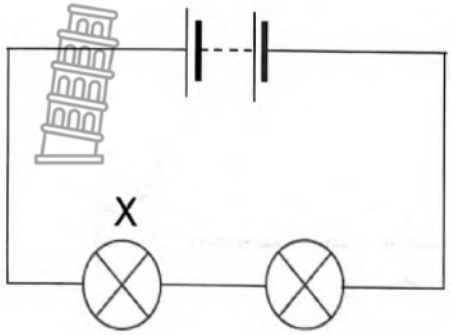
B FH

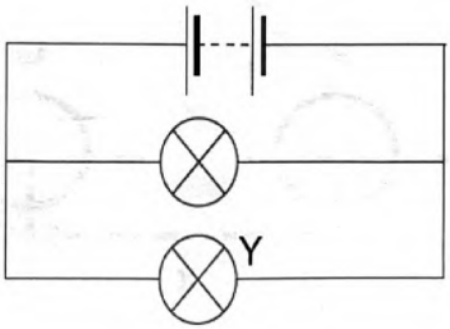
C FG

D GH

(2)

1.10 In the circuits below, the emf of the batteries is the same and all the light bulbs are identical. The resistance of the connecting wires and internal resistance of the batteries are negligible. The power in bulb X is P.





The power in bulb Y is...

A $\frac{1}{2}$P

B $\frac{1}{4}$P

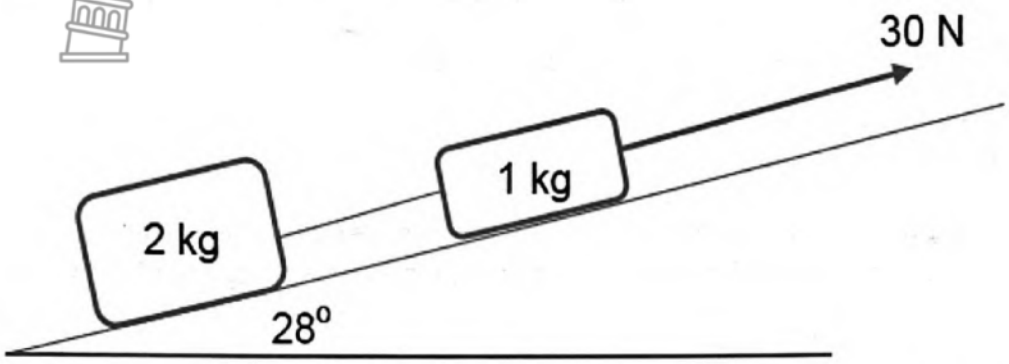
C 2P

D 4P

(2)
[20]

QUESTION 2

2.1 In the diagram below, a 2 kg block is connected to a 1 kg block by means of a light inextensible string. The blocks are pulled up an inclined plane, which forms an angle of 28^0 with the horizontal. The sides of the blocks which touch the inclined plane have the same area.



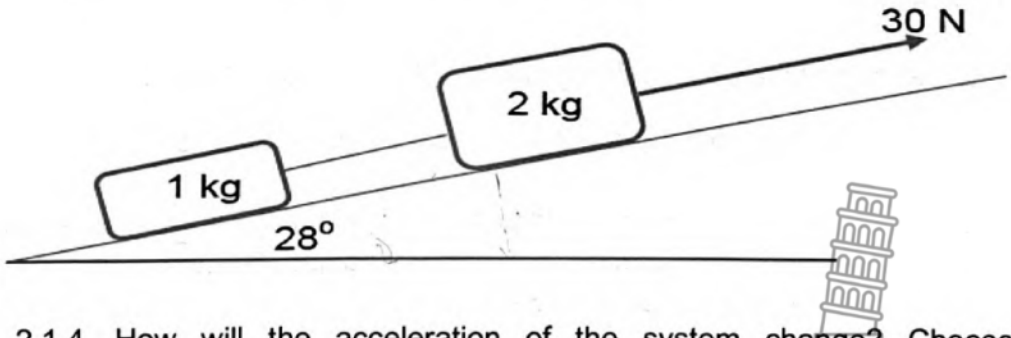
The kinetic frictional force between the 1 kg block and the inclined plane is 4 N while the kinetic frictional force between the 2 kg block and the inclined plane is 8 N.

2.1.1 State *Newton's Second Law of Motion* in words. (2)

2.1.2 Draw a labelled free-body diagram showing ALL the forces acting on the 1 kg block as it moves up the inclined plan. (5)

2.1.3 Calculate the magnitude of the tension in the string connecting the blocks by applying Newton's second law separately to each of the blocks. (5)

The two blocks are interchanged so that the SAME 30 N force is now acting on the 2 kg block along the inclined plane, as shown in the diagram below.



2.1.4 How will the acceleration of the system change? Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)

2.1.5 How will the tension in the string connecting the two blocks change? Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)

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2.2 The mass of the Sun is 330 000 times greater than that of the Earth. The distance between the centres of the Sun and the Earth is $1,38 \times 10^9$ m.

2.2.1 State *Newton's law of Universal Gravitation* in words. (2)

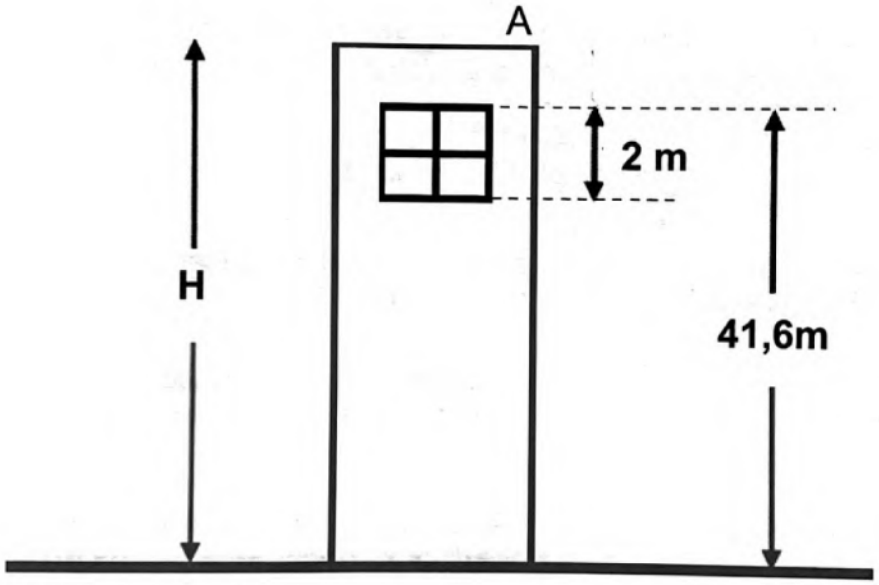
2.2.2 Calculate the gravitational force that the Sun exerts on the Earth. (4)

2.2.3 How will the gravitational force that the Earth exerts on the Sun compare to the answer calculated in QUESTION 2.2? Choose from: GREATER THAN, LESS THAN or EQUAL TO.
Name the law that supports your answer. (2)

[22]

QUESTION 3

A stone is thrown vertically upwards from the top of a tower (point A). The stone then, on its way down, passes point A after 3 seconds. Ignore the effects of air friction.



3.1 Define a *projectile* (2)

3.2 Calculate the magnitude of the velocity with which the stone was thrown. (3)

3.3 Calculate the maximum height above point A reached by the stone (3)

3.4 On its way down the stone takes 0,1 s to pass a window of length 2 m, as shown in the diagram above. The top of the window is at a height of 41,6 m from the ground. Calculate the height H of the tower. (7)

3.5 USING THE GROUND AS REFERENCE, sketch a position-time graph for the entire motion of the stone. Indicate the height of the tower. (3)

[18]

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QUESTION 4

4.1 A cricket ball of mass 0,15 kg is thrown vertically downwards with an initial speed of 8 $m \cdot s^{-1}$ from a height of 2,5m.

4.1.1 State the Law of *conservation of mechanical energy* in words. (2)

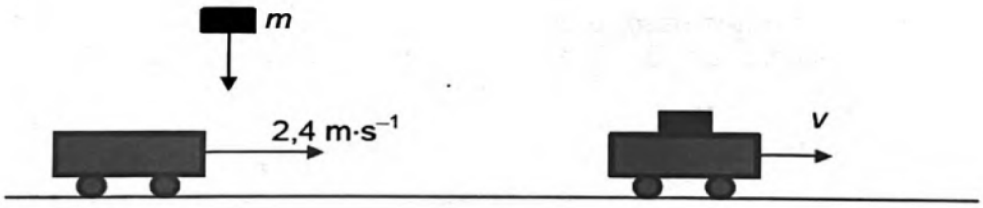
4.1.2 Using ENERGY PRINCIPLES, determine the velocity with which the ball strikes the ground. (4)

The ball bounces vertically off the ground and reaches a height H. The ball was in contact with the ground for 0,1 seconds. The ground exerts a force of 25,55 N on the ball.

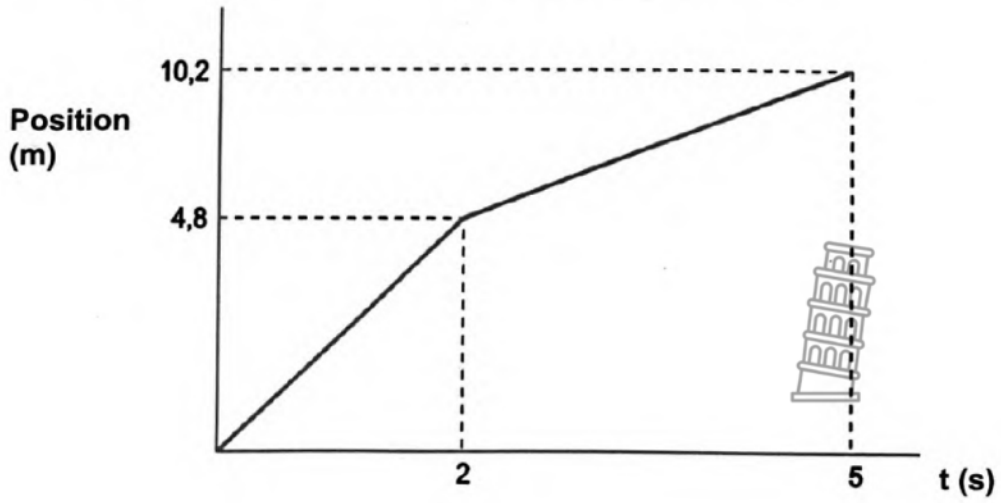
4.1.3 Define *Impulse* (2)

4.1.4 Calculate the height H (6)

4.2 Students are performing an experiment in the laboratory. A 0,9 kg trolley is travelling with a constant velocity of 2,4 $m \cdot s^{-1}$ on a long frictionless track when a block of mass **m** is dropped vertically onto it. The trolley with the block on it moves with velocity **v** as shown in the diagram.



The following position vs time graph for the trolley is drawn.



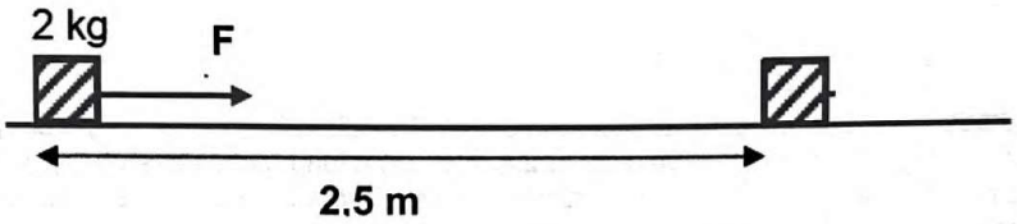
4.2.1 USE THE GRAPH to determine the magnitude of the velocity of the trolley after the block is dropped on the trolley. (3)

4.2.2 State the *principle of conservation of linear momentum* in words. (2)

4.2.3 Calculate the mass **m** of the block. (4)
[23]

QUESTION 5

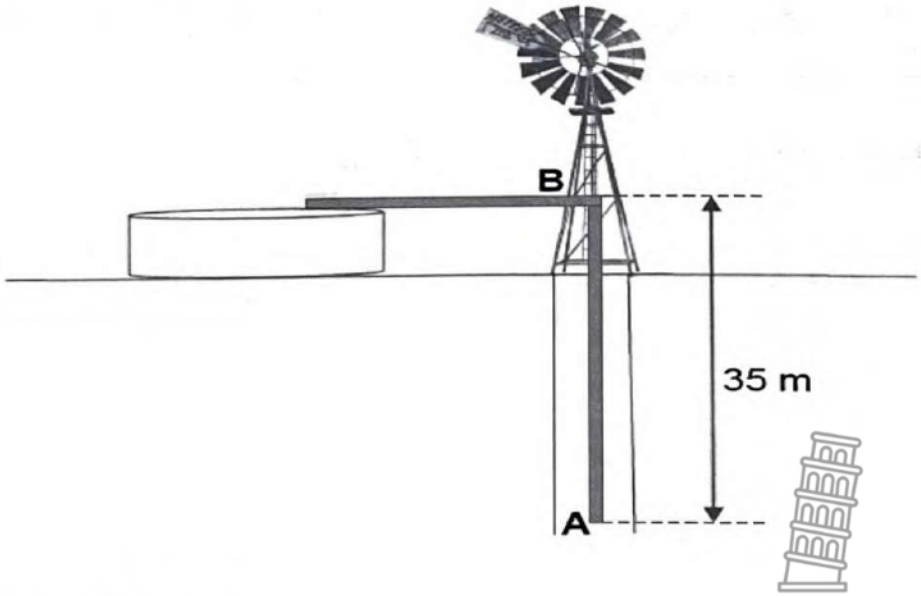
5.1 A cart of mass 2 kg is travelling with an initial speed of 1,5 $m \cdot s^{-1}$ when it is pulled by a horizontal force F of unknown magnitude over a distance of 2,5 m. A frictional force of 26 N acts on the cart as it moves. The cart reaches a speed of 4 $m \cdot s^{-1}$.



5.1.1 State the *work-energy theorem* in words. (2)

5.1.2 Using ENERGY PRINCIPLES, calculate the magnitude of the force F (4)

5.2 A windmill on a farm is used to pump stationary water, from point A, in a well. The water flows past point B, 35 m above point A, at a speed of 2,1 $m \cdot s^{-1}$.



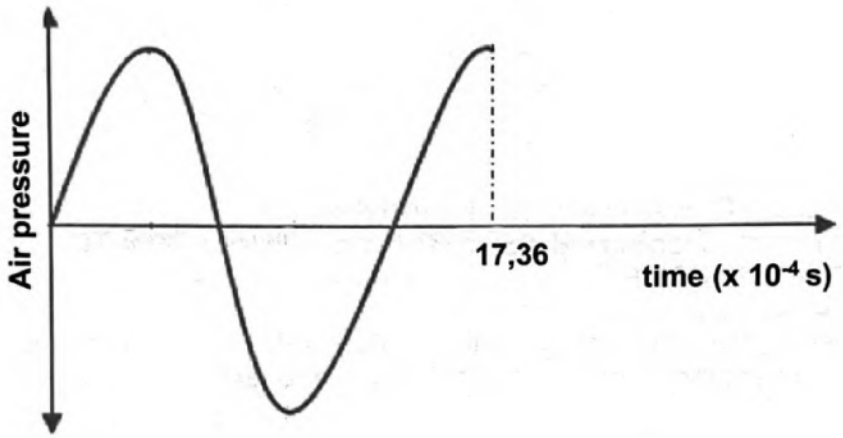
5.2.1 Define a *non-conservative force*. (2)

5.2.2 The pump in the windmill is rated at 500 W. Calculate the mass of water flowing past point B every minute. (5)
[13]

QUESTION 6

6.1 The siren of a car emits sound waves of frequency 650 Hz. The car is driven at constant speed along a straight horizontal road . A detector placed on the side of the road registers changes in the pressure of the air caused by the sound waves.

AIR PRESSURE VS TIME



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

6.1.1 State the *Doppler effect* in words. (2)

6.1.2 Is the car moving TOWARDS or AWAY FROM the detector? Motivate your answer by means of a calculation. (3)

6.1.3 Calculate the speed of the car. (4)

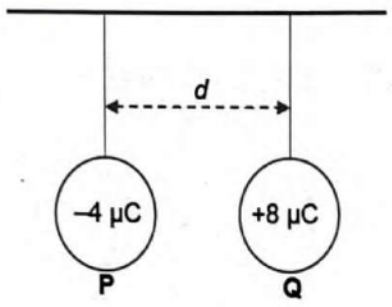
6.1.4 State TWO applications of the Doppler effect in medicine. (2)

6.2 The spectral lines observed for a distant star show that the star is moving away from the Earth. Explain, by referring to frequency, how one can deduce that the star is moving away from the Earth. (2)
[13]

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QUESTION 7

7.1 Two identical metal spheres, **P** and **Q** are suspended from a wooden bar by light inextensible strings as shown in the diagram below. The distance between the centres of the spheres is *d* metres. The charge on the spheres are –4 µC and +8 µC respectively.



7.1.1 Sphere **Q** experiences an electrostatic force.
In which direction will sphere **Q** move? Choose from: TO THE LEFT or TO THE RIGHT. (1)

The spheres are now brought into contact with each other and are then separated by distance *d* metres again. The spheres exert a force of 0,8N on each other.

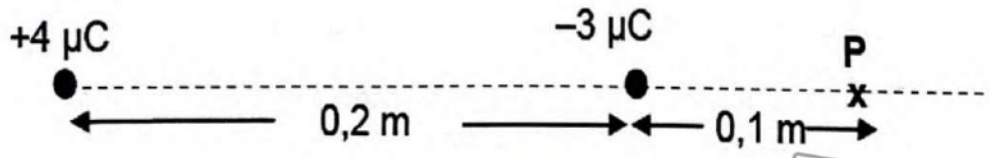
7.1.2 Calculate the net charge on each sphere (2)

7.1.3 Draw the electric field pattern due to the two spheres. (3)

7.1.4 Calculate the number of electrons transferred during contact. (2)

7.1.5 Calculate the distance ,*d*, between the two spheres. (4)

7.2 Charges of +4 µC and –3 µC are placed a distance 0,2 m apart on a straight line, as shown below. Point **P** is located 0,1 m to the right of the –3 µC charge.



7.2.1 Define *electric field at a point*. (2)

7.2.2 Calculate the net electric field at point **P** (5)

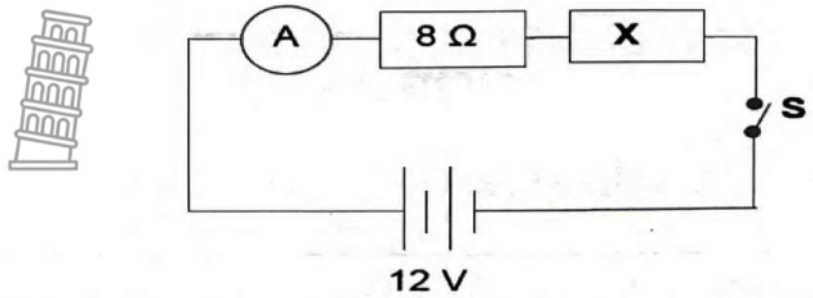
A sphere carrying a charge of +6 µC is now placed at point P. It experiences an initial acceleration of magnitude 5×10^2 m·s^{-2}.

7.2.3 Calculate the mass of this sphere. (3)
[22]

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QUESTION 8

8.1 The circuit below is used in an experiment to determine the resistance of resistor X.



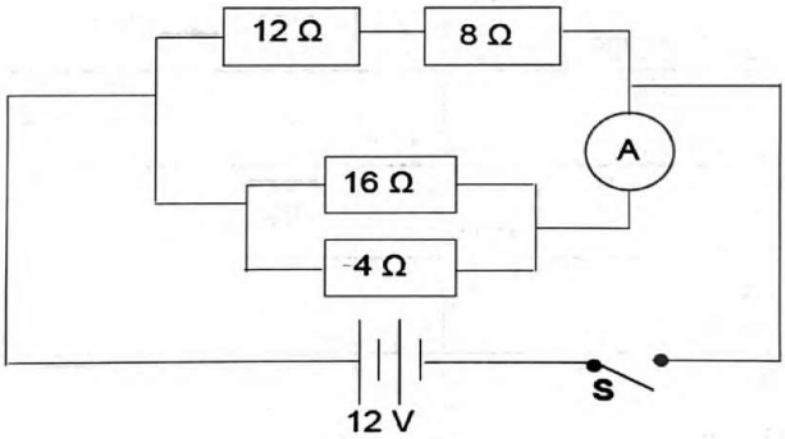
The 12 V battery has negligible internal resistance. When switch S is closed, the reading on the ammeter is 0,5 A.

8.1.1 State *Ohm's law* in words. (2)

8.1.2 Calculate the resistance of resistor X. (4)

8.1.3 During the experiment the switch is closed for very short periods of time. Give a reason for this. (1)

8.2 Study the circuit below. The battery has an emf of 12 V with negligible internal resistance.



Switch S is closed.

8.2.1 Write down the potential difference across the 4 Ω resistor. (1)

8.2.2 Calculate the reading on the ammeter. (4)

8.2.3 Calculate the energy dissipated in the 12 Ω resistor in 2 minutes. (4)

8.2.4 The 12 Ω resistor is now removed from the circuit. How will the reading on the ammeter be affected?Choose form INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

[19]

TOTAL: 150

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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 van Aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6{,}38 \times 10^{6}\ m$



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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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = h\frac{c}{\lambda}$
$E = W_0 + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

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ELECTROSTATICS/*ELEKTROSTATIKA*

$F=\frac{kQ_1Q_2}{r^2}$	$E=\frac{kQ}{r^2}$
$V=\frac{W}{q}$	$E=\frac{F}{q}$
$n=\frac{Q}{e}$ *or/of* $n=\frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R=\frac{V}{I}$	emf (ε) $= I(R+r)$ emk (ε) $= I(R+r)$
$R_s=R_1+R_2+\ldots$ $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}+\ldots$	$q=I\Delta t$
$W=Vq$ $W=VI\Delta t$ $W=I^2R\Delta t$ $W=\frac{V^2\Delta t}{R}$	$P=\frac{W}{\Delta t}$ $P=VI$ $P=I^2R$ $P=\frac{V^2}{R}$

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