Education and Sport Development
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NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper
4. Leave ONE line between two subsections, for example between QUESTION 2.1 and QUESTION 2.2
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
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. 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 (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

USE THE INFORMATION BELOW TO ANSWER QUESTION 1.1 AND QUESTION 1.2

An object is thrown upwards with a velocity of 5 $m \cdot s^{-1}$.

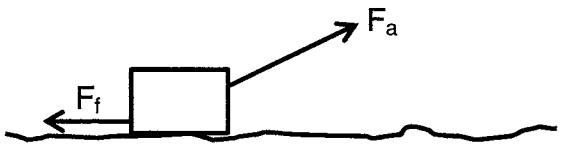
1.1 Which ONE of the following gives the magnitude of the velocity of the object at its maximum height?

A 0
B 5
C 4,9
D 9,8 (2)

1.2 The height reached by the object when its velocity is *2* $m \cdot s^{-1}$ can be determined in ONE single step. The equation below that can be used to find this is ...

A $v_f = v_i + g\Delta t$
B $v_f^2 = v_i^2 + 2g\Delta y$
C $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$
D $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ (2)

1.3 A constant force F_a acts on an object, causing it to move at a **constant speed** over a rough horizontally surface as shown in the diagram below.

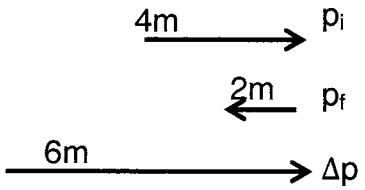


How does the force of friction F_f compare to F_a?

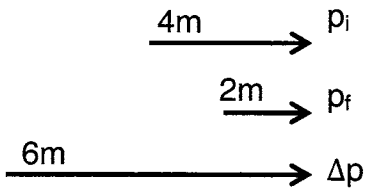
A $F_f = F_a$
B $F_f > F_a$
C $F_f < F_a$
D $F_f = 0$ (2)

1.4 A ball of mass *m*, moving horizontally to the right, strikes the wall with a velocity of 4 $m \cdot s^{-1}$.The ball rebounds in the opposite direction with a velocity of 2 $m \cdot s^{-1}$. Which ONE of the options below correctly represents the momentum vectors of the initial momentum (p_i), the final momentum (p_f) and the change in momentum (Δp) of the ball in $kg \cdot m \cdot s^{-1}$?

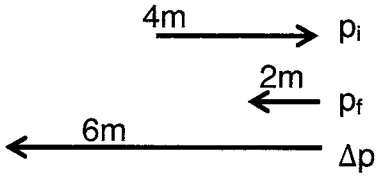
A



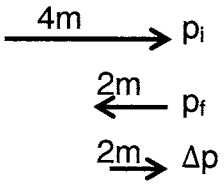
B



C

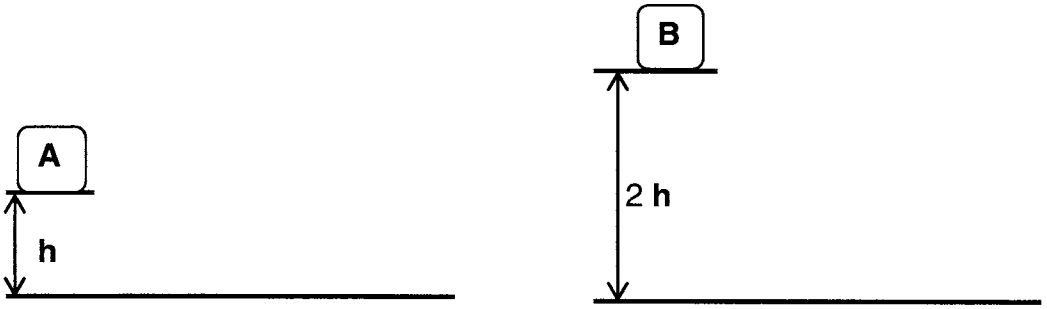


D



(2)

1.5 In the diagram below, two identical blocks **A** and **B**, each with mass *m*, are placed in the positions as shown below.



How does the gravitational potential energy (U) of the blocks compare?

A $U_A = ½ U_B$

B $U_A = U_B$

C $U_A = \sqrt{2}\ U_B$

D $U_A = 2\ U_B$ (2)

1.6 The Doppler effect is observed …

A only with sound waves.

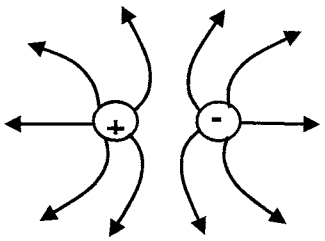
B only with light waves.

C with both sound and light waves.

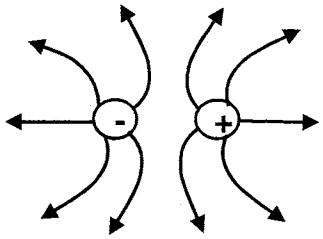
D neither with light nor sound waves. (2)

1.7 Which ONE of the diagrams below shows the correct electric field pattern between two equal, but opposite charges?

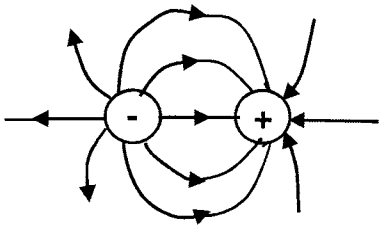
A



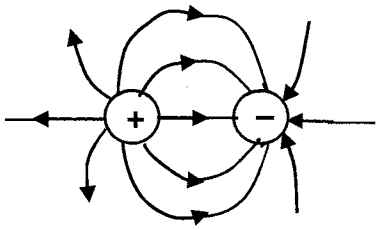
B



C



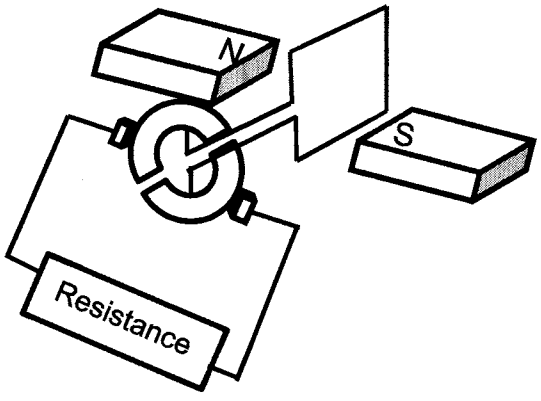
D



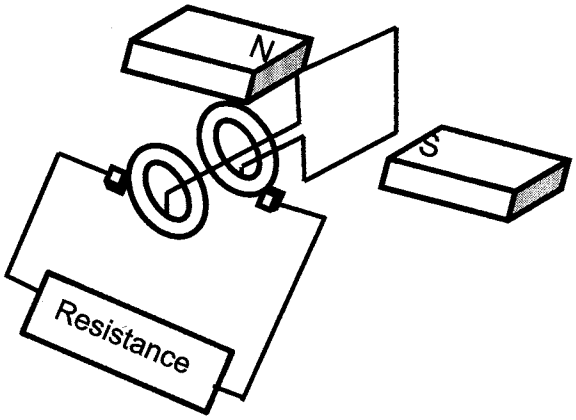
(2)

1.8 Two types of generators are shown in the diagram below:

Generator 1



Generator 2



What type of current is produced by each generator when connected to an external resistance?

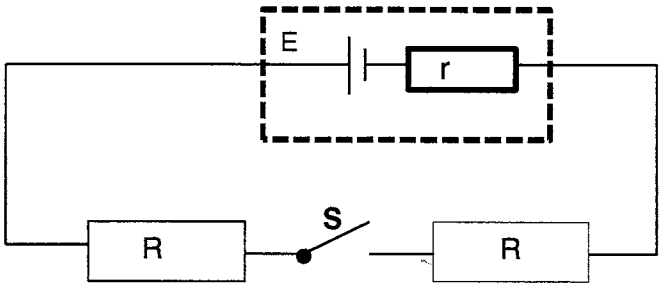
A Both produce direct current.

B Both produce alternating current.

C Generator 1 produces alternating current and Generator 2 produces direct current.

D Generator 1 produces direct current and Generator 2 produces alternating current. (2)

1.9 A battery, with an emf *E* and internal resistance *r*, is connected to a switch *S* and two identical resistors in series. Each resistor has resistance *R*.



Which one of the following statements is CORRECT when the switch **S** is closed?

A The voltmeter reading is 0,5*E* when an ideal voltmeter is connected across one resistor.

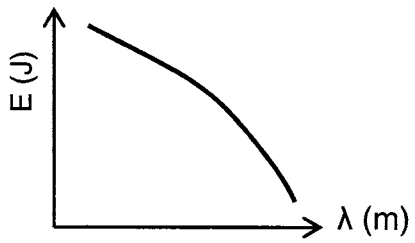
B The voltmeter reading is *E* when an ideal voltmeter is connected across the two resistors.

C The voltmeter reading is *E* when an ideal voltmeter is connected across the battery.

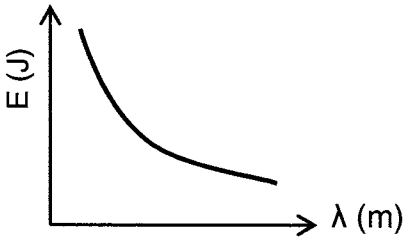
D The voltmeter reading is less than *E* when an ideal voltmeter is connected across the battery. (2)

1.10 Which ONE of the following graphs best shows how photon energy E varies with the wavelength (λ) of the light?

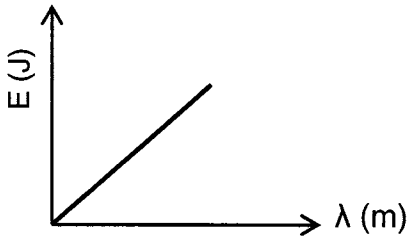
A



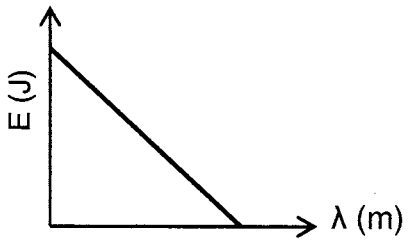
B



C



D

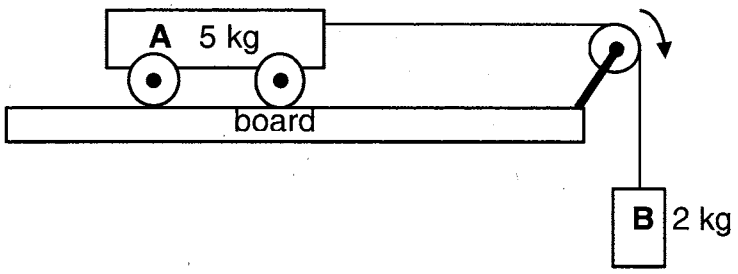


(2)

[20]

QUESTION 2 (Start on a new page.)

A dynamics trolley **A** of mass 5 kg is placed on a horizontal board. It is connected to block **B** of mass 2 kg by a light, inextensible string over a frictionless pulley as shown in the diagram below. Ignore any effects of air resistance.



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

2.2 Assuming no frictional force acts between the wheels of the trolley and the surface. Calculate:

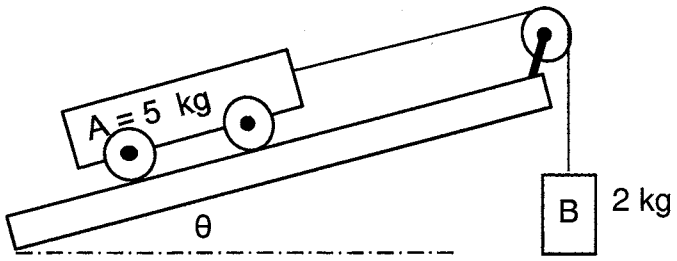
2.2.1 The magnitude of the acceleration of the trolley. (5)

2.2.2 The tension in the string. (2)

Experimental results however showed that the actual acceleration of the trolley was 2 $m \cdot s^{-2}$.

2.3 Calculate the magnitude of the frictional force on the trolley. (4)

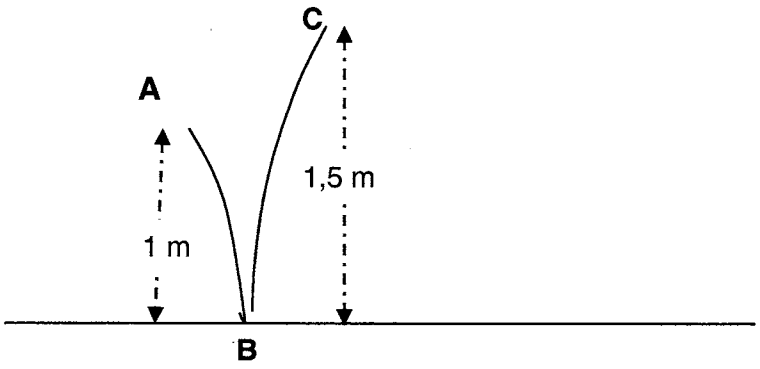
2.4 The trolley is modified to eliminate the effects of friction. The pulley end of the board is now raised so that the board makes an angle θ with the horizontal.



Calculate the value of angle θ so that the trolley remains at rest. (5)
[18]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically downwards from point **A** at a height of 1 m above the ground. It strikes the ground at point **B,** bouncing to point **C,** which is 1,5 m from the ground. See the diagram below. Ignore any effects of friction.



3.1 What is the value of the kinetic energy of the ball at point **C**? (1)

3.2 State the *principle of conservation of mechanical energy* in words. (2)

3.3 Using ENERGY PRINCIPLES ONLY, determine the velocity with which the ball was thrown from point **A**. (5)

3.4 Determine the time taken by the ball to reach the ground at point **B**. (4)

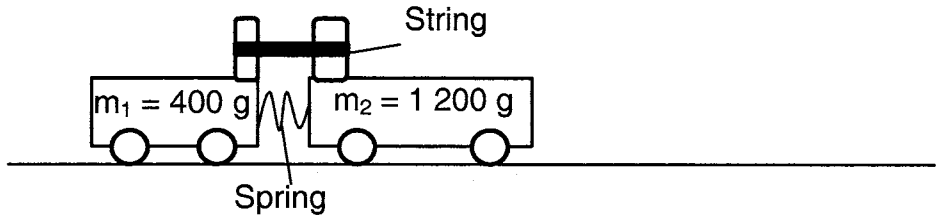
Assume that the collision with the floor is elastic.

3.5 The ball reaches the height **C** after the first bounce. Compare the height to which the ball will rise after it is allowed to bounce for a second time, to the previous height **C.** Write HIGHER THAN POINT **C**, EQUAL TO POINT **C** or LESS THAN POINT **C**. (1)

[13]

QUESTION 4 (Start on a new page.)

Two carts, m_1 and m_2 of masses 400 g and 1 200 g are free to move on a frictionless horizontal surface. The carts are joined by a compressed spring and tied together by a string. The carts are initially at rest as shown in the figure below.



When the string between them is cut, the spring between them is released. The carts then move away from each other.

4.1 While the spring is expanding:

4.1.1 Compare the magnitudes of the forces acting on carts m_1 and m_2 at any instant.

Write $F_{m1} > F_{m2}$, $F_{m1} < F_{m2}$ or $F_{m1} = F_{m2}$ (1)

4.1.2 Name the law or principle used to obtain the above answer. (1)

4.2 After the spring has expanded:

4.2.1 How do the magnitudes of the velocity of the carts m_1 and m_2 compare?

Write $v_{m1} > v_{m2}$, $v_{m1} < v_{m2}$ or $v_{m1} = v_{m2}$ (1)

4.2.2 Name the law or principle applied to obtain the above answer. (1)

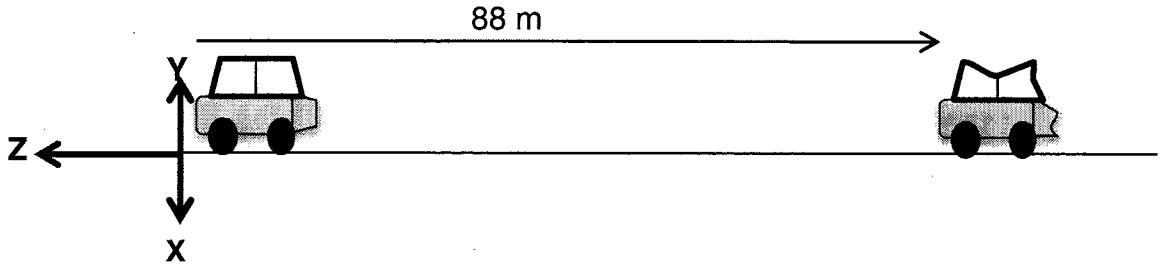
4.3 If 0,225 J of energy is imparted to the carts when the spring between them is released, show that the final speed of m_2 is 0,31 $m \cdot s^{-1}$. Assume that there was no loss of energy. (6)

[10]

QUESTION 5 (Start on a new page.)

During an accident the driver applies the brakes to bring a car to rest. The combined mass of the driver and the car is 800 kg.

The investigators at the accident scene, measure the length of the car's skid marks on the level road to be 88 m. The coefficient of kinetic friction on the road was estimated to be 0,42.



The forces acting on the car while braking, is shown as **X, Y** and **Z** in the figure above.

5.1 Identify and name the force marked **Y**. (1)

5.2 Which ONE of the above forces is a conservative force? (1)

5.3 What is the magnitude of the work done by force **Y**? (1)

5.4 Which ONE of the above forces does negative work on the car? (1)

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

5.6 Determine the magnitude of the frictional force acting between the wheels of the car and the road surface to bring it to rest. (3)

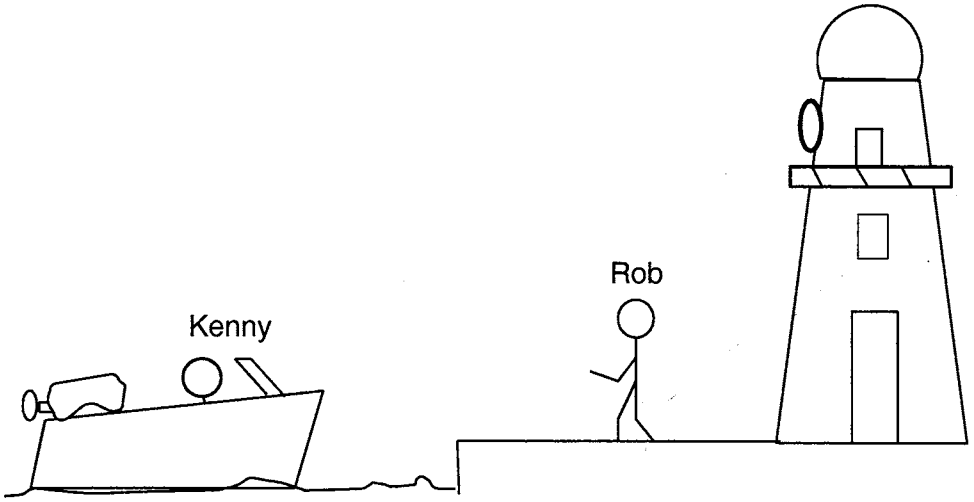
5.7 Using the WORK-ENERGY PRINCIPLE ONLY, determine the speed of the car just before the driver slammed on (and locked) the brakes. (4)

[13]

QUESTION 6 (Start on a new page.)

Kenny is driving his speedboat towards a light house. The fog horn from the light house blows with a frequency of 180 Hz. The apparent frequency of sound received by Kenny is 188 Hz.

Rob his friend, stands in front of the light house, as shown in the diagram below. Use the speed of sound as 340 $m \cdot s^{-1}$.



6.1 State the Doppler effect in words. (2)

6.2 What is the frequency of the sound received by Rob? (1)

6.3 Explain the answer to QUESTION 6.2 above. (2)

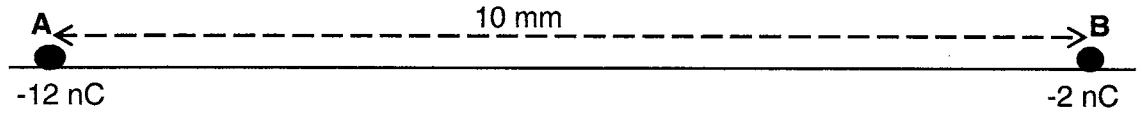
6.4 How would the wavelength of the sound wave produced by the fog horn change if the frequency of the wave were lower than 180 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

6.5 Give a reason for the answer to QUESTION 6.4. (2)

6.6 Calculate the speed of the boat as it approaches the light house. (5)
[13]

QUESTION 7 (Start on a new page.)

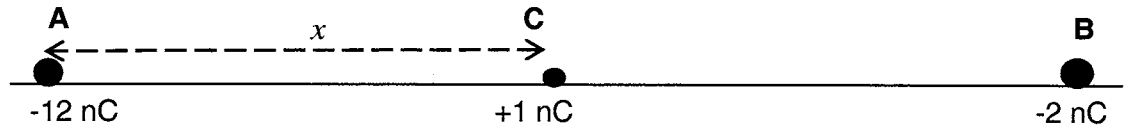
Point charge **A** of -12 nC is 10 mm from point charge **B** of -2 nC along the same straight line.



7.1 State *Coulomb's law* in words. (2)

7.2 Calculate the magnitude of the electrostatic force between **A** and **B**. (4)

A third charge **C** of +1 nC is now placed in between **A** and **B** at a distance of x mm from **A**, as shown in the diagram below.

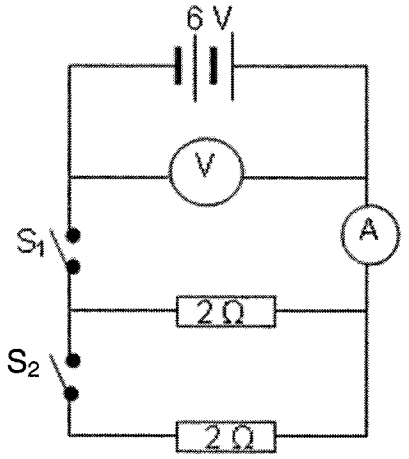


7.3 Calculate the distance x in metres if the resultant electrostatic force experienced by charge **C** due to the presence of **A** and **B,** is zero. (6)
[12]

QUESTION 8 (Start on a new page.)

Two resistors, each of resistance 2 Ω, are connected in parallel to a 6 V battery of negligible internal resistance in circuit 1 below. S_1 and S_2 are two switches connected in the circuit as shown below.

Circuit 1

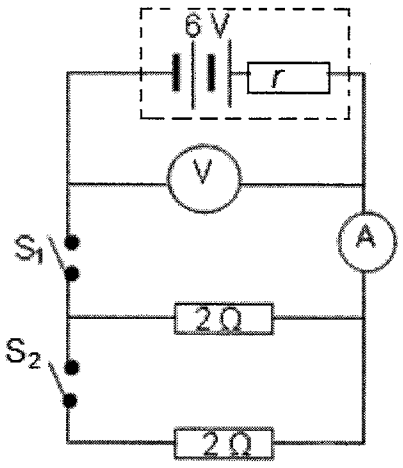


8.1 What is the reading on the voltmeter in circuit **1** when switch S_1 and S_2 are both open? (1)

8.2 With switches S_1 and S_2 **closed** in circuit 1, determine the reading on the ammeter. (5)

Circuit **2** below is identical to circuit **1**, but the 6 V battery has an internal resistance *r*.

Circuit 2



When only switch S_1 is closed in circuit **1**, its ammeter reading will be the same as the ammeter reading on circuit **2** with both its switches closed.

8.3 Calculate the internal resistance of the battery. (6)

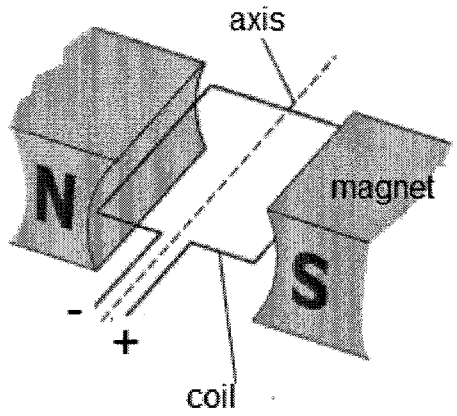
8.4 Consider circuit **2.** How does the voltmeter reading when both S_1 and S_2 are closed, compare to when only S_1 is closed? Write GREATER THAN, SAME AS or SMALLER THAN. (1)

8.5 Explain the answer to QUESTION 8.4 above. (3)

[16]

QUESTION 9 (Start on a new page.)

The diagram shows part of a simple electric motor.

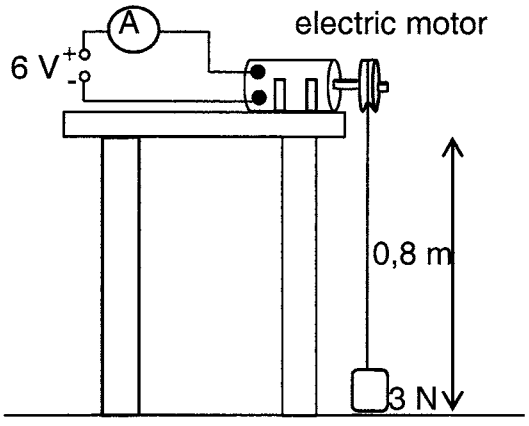


The motor is connected to a DC. power supply.

9.1 When the motor is switched on, the coil rotates. In which direction will the coil rotate? Write down only CLOCKWISE or ANTICLOCKWISE. (1)

9.2 Suggest ONE change which would result in coil turning in the opposite direction. (1)

The electric motor is connected to a power supply of emf 6 V. It lifts a load of 3 N through a height of 0,8 m in 2 s. See the diagram below.



9.3 Determine the reading on the ammeter if 80% of the electrical energy in the motor is converted into lifting the load at a constant speed to a height of 0,8 m. (6)

[8]

QUESTION 10 (Start on a new page.)

Two identical bulbs $\mathbf{B_1}$ and $\mathbf{B_2}$ are connected to two different power sources.

In Figure 1 the bulb $\mathbf{B_1}$ is connected to a 12 V DC power source.
In Figure 2 the bulb $\mathbf{B_2}$ is connected to a 12 V_{max}, 25 Hz AC power source.

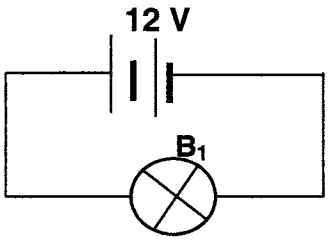


Figure 1

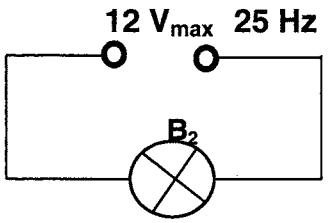


Figure 2

10.1 Which ONE of the bulbs $\mathbf{B_1}$ or $\mathbf{B_2}$ will glow the brightest? (1)

10.2 Perform a calculation to justify the answer to QUESTION 10.1. (3)

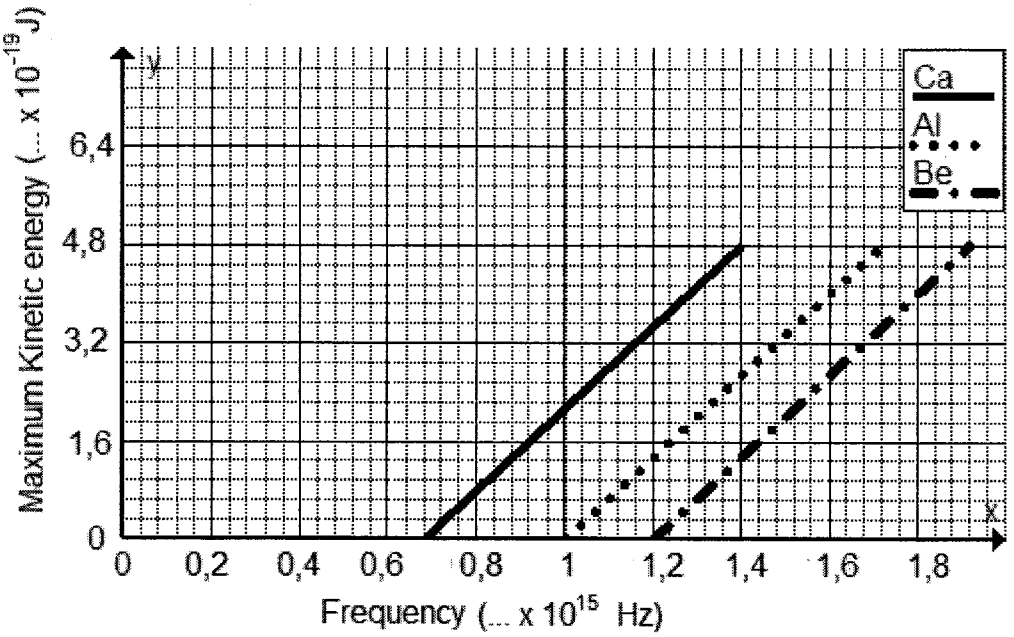
10.3 What is the ratio of the power in bulb $\mathbf{B_1}$ (figure 1) to $\mathbf{B_2}$ (figure 2)? (3)

10.4 Sketch a graph of the voltage output (V) vs time (t) for ONE complete cycle of the AC power source above. Show the maximum value and the time on your axes. (5)

[12]

QUESTION 11 (Start on a new page.)

When electromagnetic radiation shines on metals, electrons may be emitted. The maximum kinetic energy of emitted electrons is plotted against radiation frequency for three metals Calcium (Ca), Aluminium (Al) and Beryllium (Be) is as shown in the graph below.



11.1 Name the phenomenon described above. (1)

11.2 Define in words the term *cut-off frequency*. (2)

11.3 Determine the cut-off frequency for the Beryllium (Be) metal. (1)

11.4 What physical quantity does the gradient of these graphs represent? (1)

11.5 What is the minimum energy the incident light must have in order to emit electrons from the surface of the Calcium (Ca) metal? (3)

11.6 When electromagnetic radiation of wavelength 187 nm shines on one of the metals indicated in the graph, the maximum kinetic energy of the electrons is found to be 4×10^{-19} J.
Use the relevant calculations to identify the metal. (7)
[15]

TOTAL: 150

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 gravitasiekonstante*	G	$6,67 \times 10^{-11}\ N.m^2.kg^{-2}$
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	$6,38 \times 10^6\ m$

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*

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

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

ALTERNATING CURRENT/ *WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms} I_{rms}$ / $P_{gemiddeld} = V_{wgk} I_{wgk}$ $P_{ave} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$ $P_{ave} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$