



HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- PHYSICS



SEPTEMBER 2018

TIME: 3 HRS
TOTAL 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
SECTION B (130)

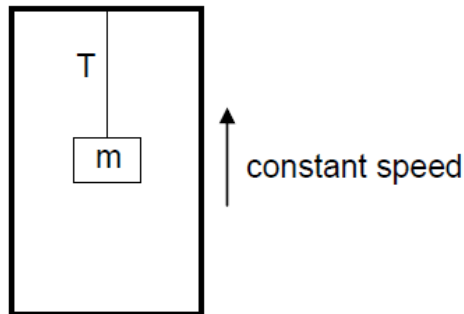
Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A

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.

- 1.1 An object, of mass m , hangs at the end of a string from the ceiling of a lift cage. The lift is moving upward at CONSTANT SPEED. The acceleration due to gravity is g .



Which ONE of the following statements regarding the tension (T) in the string is CORRECT?

The tension T ...

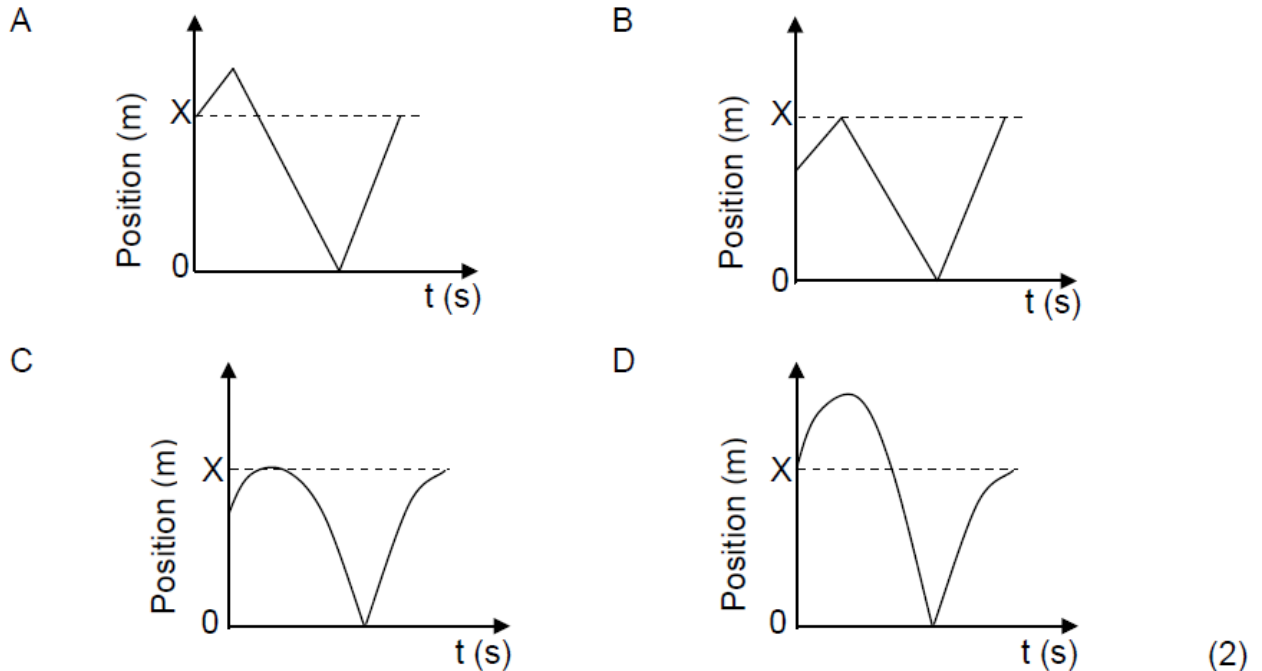
- A will be equal to mg .
 - B will be less than mg .
 - C will be greater than mg .
 - D cannot be determined without knowing the speed of the lift cage. (2)
- 1.2 Two hypothetical planets, X and Y, have the same mass. The diameter of planet Y is twice that of planet X.

If the acceleration due to gravity on the surface of planet X is g , then the acceleration due to gravity on the surface of planet Y will be ...

- A $\frac{g}{16}$
- B $\frac{g}{4}$
- C $\frac{g}{2}$
- D $2g$ (2)

- 1.3 A ball is projected vertically upwards from a *height X above the ground*. After some time, the ball falls to the ground and bounces back to the same height from which it was projected. Ignore friction and assume that there is a negligible time lapse during the collision of the ball with the ground.

Which ONE of the following is the CORRECT position-time graph for the motion of the ball as described above?



- 1.4 Which ONE of the following statements is always TRUE for *inelastic collisions* in an isolated system?

- A Both momentum and kinetic energy are conserved.
- B Both momentum and kinetic energy are not conserved.
- C Momentum is conserved, but kinetic energy not.
- D Kinetic energy is conserved, but momentum not. (2)

- 1.5 When the net work done on an object is positive (greater than zero), the ...

- A kinetic energy of the object is zero.
- B kinetic energy of the object is increasing.
- C kinetic energy of the object is decreasing.
- D kinetic energy of the object remains unchanged. (2)

- 1.6 A police car with its siren wailing is moving away from a stationary observer at constant speed. The siren emits a sound of constant frequency.

Which of the following characteristics associated with the sound of the siren, as perceived by the observer, is/are CORRECT?

- (i) The speed remains the same.
- (ii) The frequency increases.
- (iii) The wavelength increases.
- (iv) The pitch decreases.

A (iii) only

B (i), (iii) and (iv)

C (i) and (iii) only

D (i) and (ii) only

(2)

- 1.7 The magnitude of the electric field at a point P from a positive point charge q is $x \text{ N}\cdot\text{C}^{-1}$.

Which ONE of the statements below regarding this electric field is CORRECT?

A A + 1 C charge placed at P will experience a force of magnitude $x \text{ N}$ directed away from q .

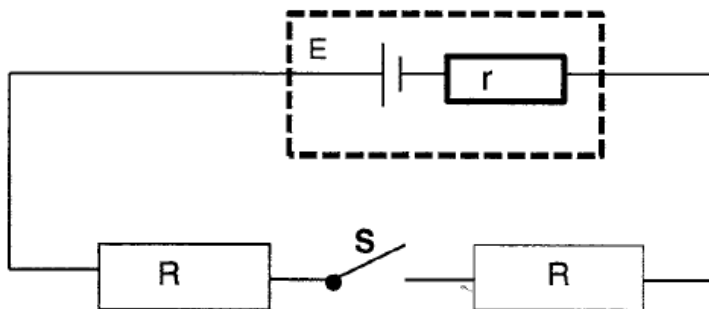
B The force on a + 2 C charge placed at P will have a magnitude $\frac{1}{4}x \text{ N}$ directed away from q .

C A + 1 C charge placed at P will experience a force of magnitude $x \text{ N}$ directed towards q .

D The force on a + 2 C charge placed at P will have a magnitude $\frac{1}{4}x \text{ N}$ directed towards q .

(2)

- 1.8 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 $0,5E$ 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)

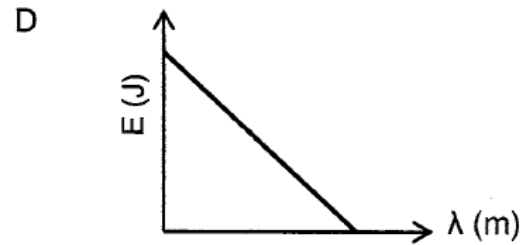
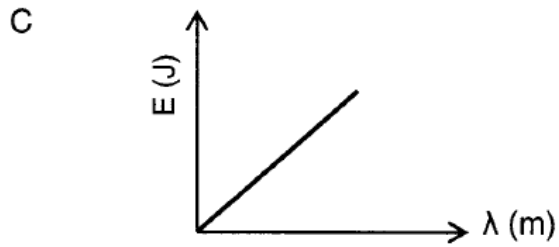
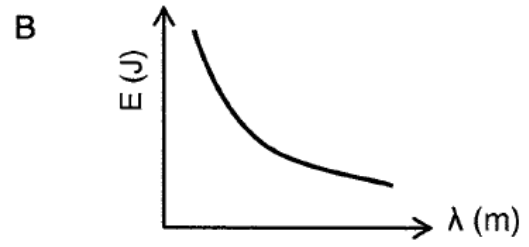
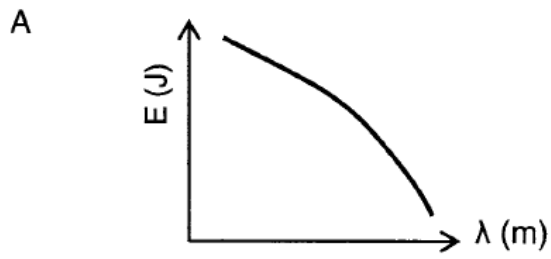
- 1.9 Some learners decided to build a small electrical generator in the laboratory. They then used this generator to investigate how the magnitude of the induced emf would change as the magnetic field strength changed.

Which ONE of the following is CORRECT regarding the variables for the investigation?

	DEPENDENT VARIABLE	INDEPENDENT VARIABLE	CONTROL VARIABLE
A	Magnitude of induced emf	Number of turns of coil of generator	Magnetic field strength
B	Number of turns of coil of generator	Magnitude of induced emf	Magnetic field strength
C	Magnitude of induced emf	Magnetic field strength	Number of turns of coil of generator
D	Magnetic field strength	Number of turns of coil of generator	Magnitude of induced emf

(2)

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



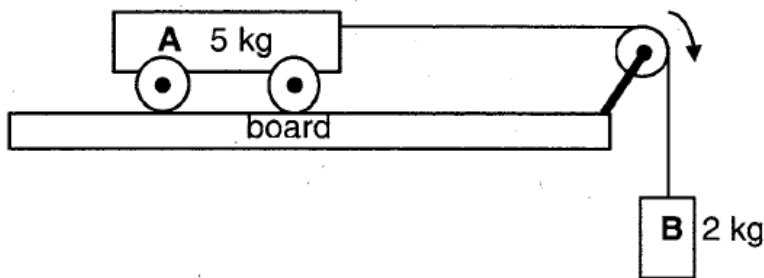
(2)
[20]

SECTION B
Instructions

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitution in all calculations.
Round off your final numerical answers to TWO decimal places

Question 2

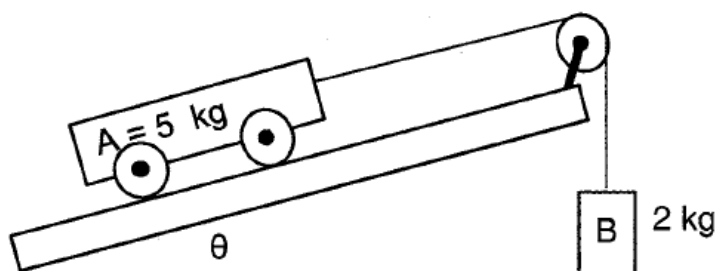
A dynamics trolley **A** of mass 5 kg is placed on a horizontal board. It is connected to block **B** of mass 2 kg by a light, inextensible string over a frictionless pulley as shown in the diagram below. Ignore any effects of air resistance.



- 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 $2 \text{ m}\cdot\text{s}^{-2}$.

- 2.3 Calculate the magnitude of the frictional force on the trolley. (6)
- 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.

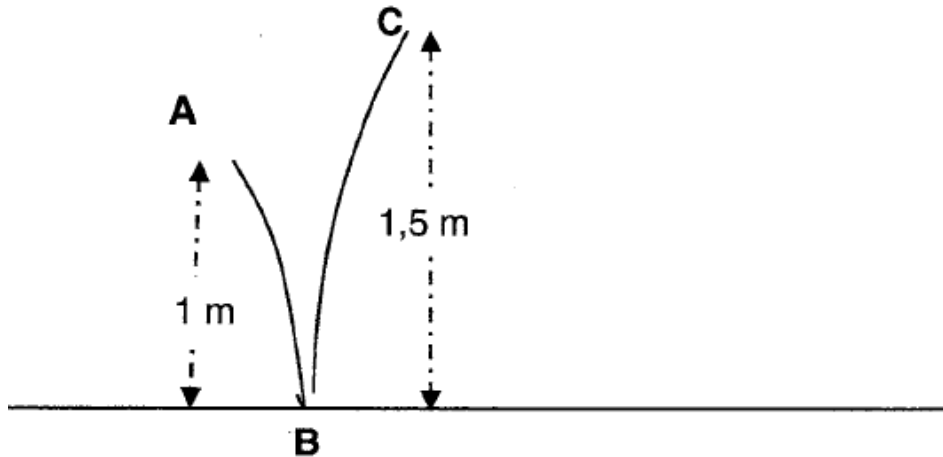


Calculate the value of angle θ so that the trolley remains at rest. (5)

[20]

Question 3

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 a maximum height of 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 is thrown from point A. Assume no energy is lost during the collision with the floor. (5)
- 3.4 Determine the time taken by the ball to reach the ground at point B. (4)
- 3.5 Draw a velocity-time graph for the motion of the ball from point A to C. Show All calculated values on the graph. (4)

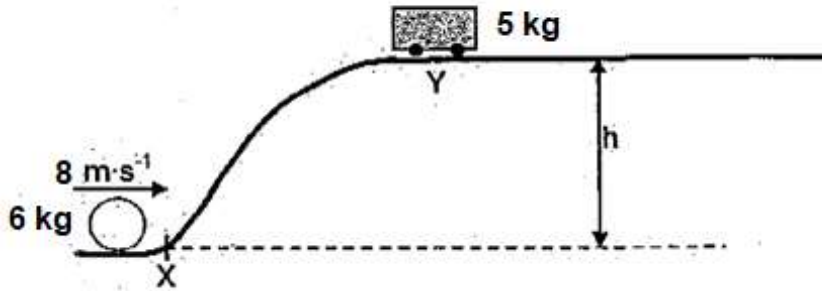
Assume that the collision with the floor is elastic.

- 3.6 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)

(1)
[17]

Question 4

The diagram below shows a stationary trolley of mass 5 kg on a horizontal surface at point Y. A steel ball mass of 6 kg is projected up the slope. At point X the steel ball has a velocity of 8 m s^{-1} to the right. The steel ball collides with the trolley at point Y. Ignore the effects of friction.

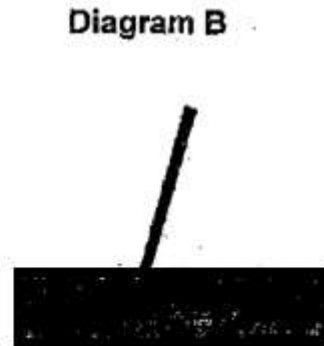
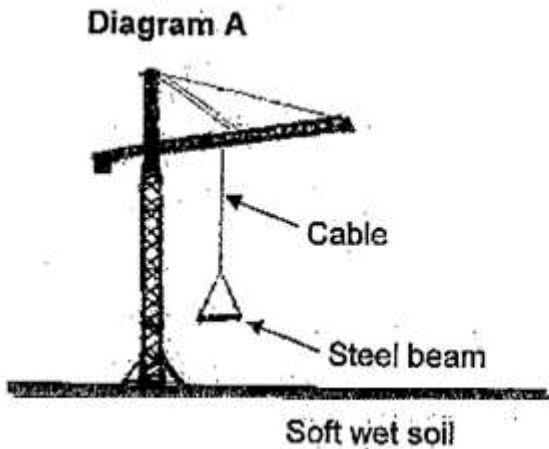


Immediately after the collision the trolley has a velocity of $1,5 \text{ m s}^{-1}$ to the right and the steel ball has a velocity of $0,5 \text{ m s}^{-1}$ to the left.

- 4.1 Calculate the magnitude of the velocity of the steel ball just before impact. (5)
- 4.2 State the law of conservation of mechanical energy in words. (2)
- 4.3 Use the law of conservation of mechanical energy and calculate the height of the horizontal surface above X. (4)
- 4.4 Explain in words what is meant by an elastic collision. (2)
- [13]**

Question 5

A cable is used to lift a steel beam of mass 115 kg as shown in diagram A. The cable breaks and the beam falls to the ground and gets stuck in the soft wet soil as shown in diagram B.



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

The end of the beam hits the ground first with a downward velocity of 22ms^{-1} . This end penetrates the ground to a depth of 0.8m.

5.2 Use the work-energy theorem and calculate magnitude of the net force exerted on the beam in order to stop it when it hits the ground. (5)

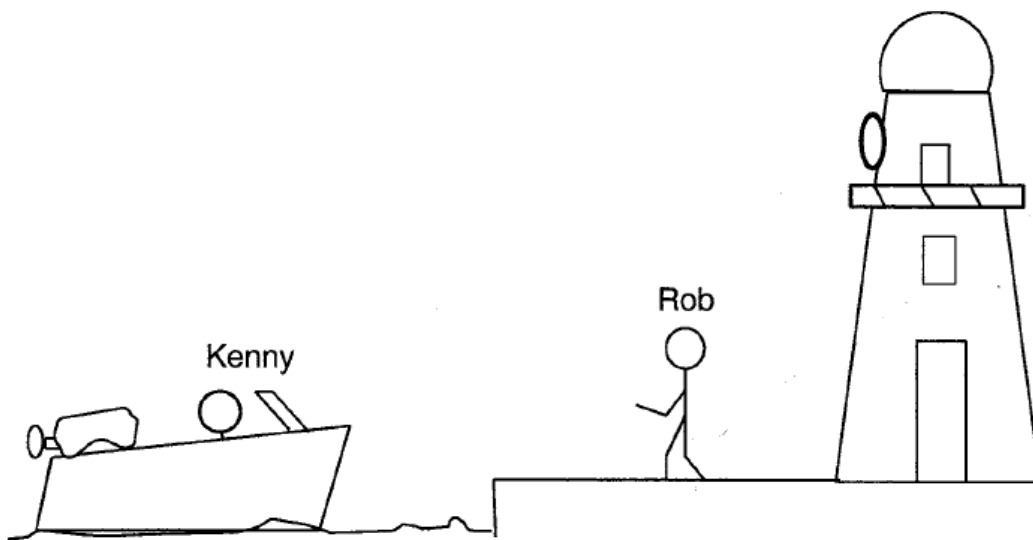
5.3 If the ground was hard and dry at the time of the accident, how would the net force, calculated in QUESTION 5.2, change? Write INCREASES, DECREASES or STAYS THE SAME. Explain your answer by referring to time, impulse and net force. (4)

[11]

Question 6

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.

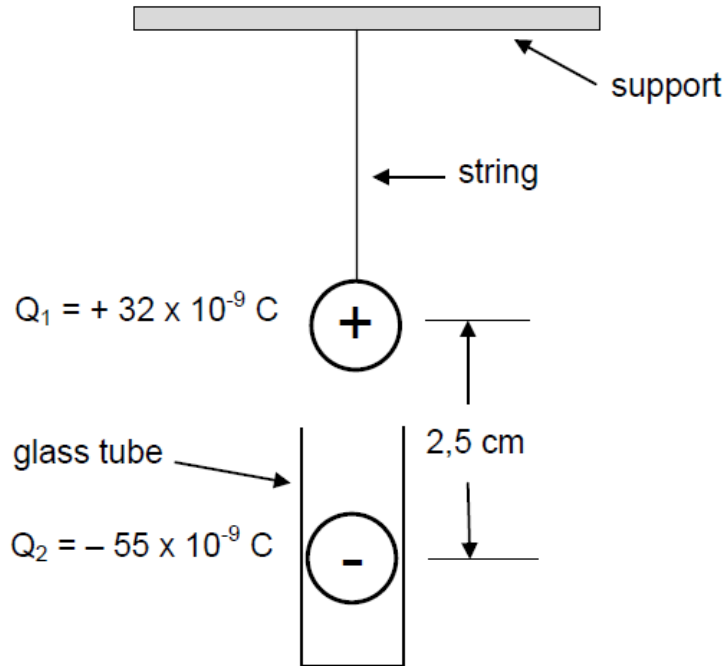
Rob his friend, stands in front of the light house, as shown in the diagram below. Use the speed of sound as $340 \text{ m}\cdot\text{s}^{-1}$.



- 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

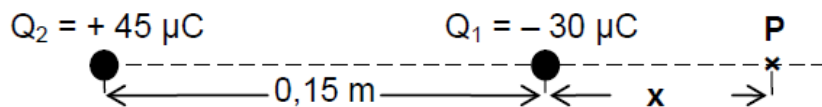
A small sphere, Q_1 , with a charge of $+ 32 \times 10^{-9} \text{ C}$, is suspended from a light string secured to a support. A second, identical sphere, Q_2 , with a charge of $- 55 \times 10^{-9} \text{ C}$, is placed in a narrow, cylindrical glass tube vertically below Q_1 . Each sphere has a mass of 7 g. Both spheres come to equilibrium when Q_2 is 2,5 cm from Q_1 , as shown in the diagram. Ignore the effects of air friction.



- 7.1 Draw a labelled free-body diagram showing all the forces acting on sphere Q_1 . (3)
- 7.2 Calculate the magnitude of the tension in the string. (5)
- [8]**

Question 8

- 8.1 Define *electric field at a point* in words. (2)
- 8.2 Draw the electric field pattern for two identical positively charged spheres placed close to each other. (3)
- 8.3 A $- 30 \mu\text{C}$ point charge, Q_1 , is placed at a distance of 0,15 m from a $+ 45 \mu\text{C}$ point charge, Q_2 , in space, as shown in the diagram below. The net electric field at point **P**, which is on the same line as the two charges, is zero.

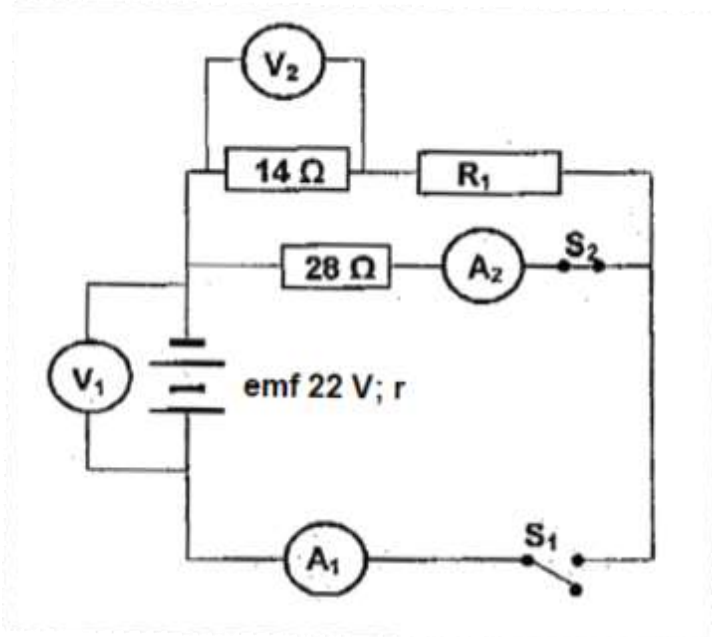


Calculate x , the distance of point **P** from charge Q_1 .

(5)
[10]

Question 9

The circuit diagram below consists of a battery of emf 22 V, an internal resistance r and two resistors having a resistance of $14\ \Omega$ and $28\ \Omega$ as well as R_1 of unknown resistance.



9.1 Write down Ohm's law in words. (2)

9.2 With switch S_1 open and switch S_2 closed, what is the reading on:

9.2.1 Voltmeter V_1 (1)

9.2.2 Voltmeter V_2 (1)

9.2.3 Ammeter A_1 (1)

With both switch S_1 and switch S_2 closed, voltmeter V_1 has a reading of 21 V and V_2 has a reading of 7 V.

9.3 What is the potential difference across resistor R_1 ? Give a reason for your answer. (2)

9.4 Calculate the reading on ammeter A_2 . (3)

9.5 Calculate the internal resistance r of the battery. (4)

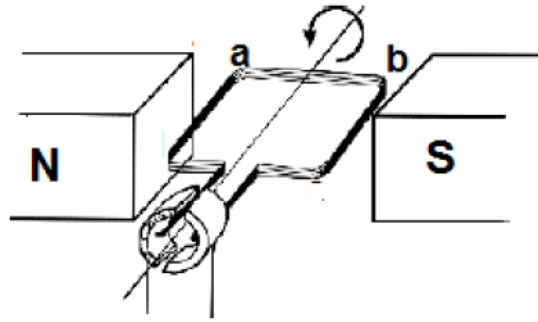
Switch S_2 is now opened while switch S_1 stays closed. The reading on voltmeter V_1 changes.

9.6 How does the reading on voltmeter V_1 change? Write INCREASES, DECREASES or STAYS THE SAME. Explain your answer in full. (4)

[18]

Question 10

10.1 A part of a simplified DC motor is shown in the sketch below.



- 10.1.1 In which direction (**a to b**, OR **b to a**) is the current flowing through the coil if the coil rotates anticlockwise as indicated in the diagram? (1)
- 10.1.2 Name the rule you used to answer QUESTION 10.1.1. (1)
- 10.1.3 Which component in the diagram must be replaced in order for the device to operate as an AC generator? (1)

10.2 An electrical device of resistance $400\ \Omega$ is connected across an AC generator that produces a maximum emf of $430\ \text{V}$. The resistance of the coils of the generator can be ignored.

- 10.2.1 State the energy conversion that takes place when the AC generator is in operation. (2)
- 10.2.2 Calculate the root mean square value of the current passing through the resistor. (5)

[10]

Question 11

11.1 In an experiment on the photoelectric effect, light is incident on the surface of a metal and electrons are ejected.

11.1.1 What does the photoelectric effect indicate about the nature of light? (1)

11.1.2 The intensity of the light is increased. Will the maximum speed of the ejected electrons INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)

The wavelength corresponding with the threshold frequency is referred to as *threshold wavelength*.

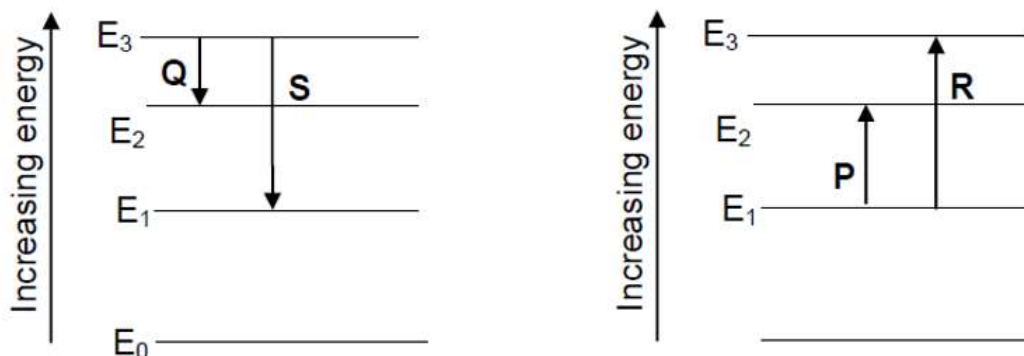
The table below gives the values of threshold wavelengths for three different metals.

METAL	THRESHOLD WAVELENGTH (λ_0) IN METRES
Silver	$2,88 \times 10^{-7}$
Calcium	$4,32 \times 10^{-7}$
Sodium	$5,37 \times 10^{-7}$

In the experiment using one of the metals above, the maximum speed of the ejected electrons was recorded as $4,76 \times 10^5 \text{ m}\cdot\text{s}^{-1}$ for light of wavelength 420 nm.

11.1.3 Identify the metal used in the experiment by means of suitable calculations. (5)

11.2 The simplified energy diagrams showing the possible electron transitions in an atom are shown below.



Using the letters **P**, **Q**, **R** and **S**, identify the lines that CORRECTLY show transitions that will result in the atom giving off an EMISSION SPECTRUM.

(2)

[10]

Total 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

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

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

$F_{\text{net}} = ma$	$p = mv$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$

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 $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$	

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 $W_o = hf_o$ and/en $E_k = \frac{1}{2} mv^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ 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)
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

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