HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 1- Physics

SEPTEMBER 2015
TIME: 3 HRS **Total 150**

Instructions

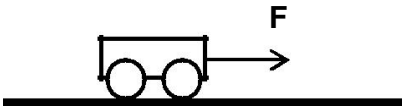
1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

   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 and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places.

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) of the answer next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 A trolley moves on a flat, horizontal surface when a constant force, F, is applied to it.



For the above trolley, which **ONE** of the following physical quantities will **ALWAYS** remain constant while the trolley is moving?

A momentum
B acceleration
C kinetic energy
D gravitational potential energy

(2)

1.2 An object, moving vertically upwards, reaches a maximum height and falls back to the ground. Ignore air resistance. Which **ONE** of the following statements is **TRUE**? The object experiences an acceleration which ….

A is always downwards
B is first upwards and then downwards
C is first downwards and then upwards
D decreases first and then increases

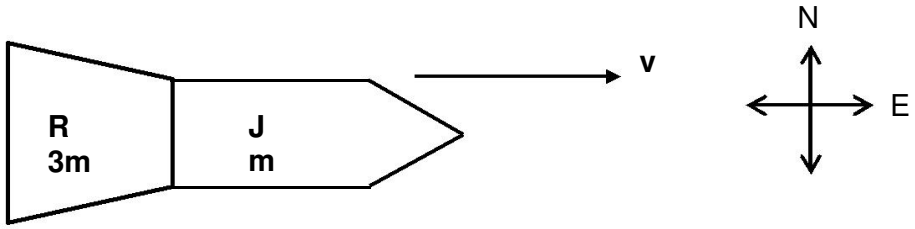
(2)

1.3 A satellite experiences a gravitational force of magnitude **F** on the surface of the earth. The radius of the earth is **R**. The satellite now circles the earth at an unknown height <u>above</u> the surface of the earth and experiences a gravitational force of magnitude ¼ **F**. This unknown height is ….

A **R**
B 2 **R**
C 3 **R**
D 4 **R**

(2)

1.4 A spacecraft, made up of two modules R and J of masses **3m** and **m** respectively, is travelling horizontally at a velocity **v** due east. An explosion causes the two modules to separate.



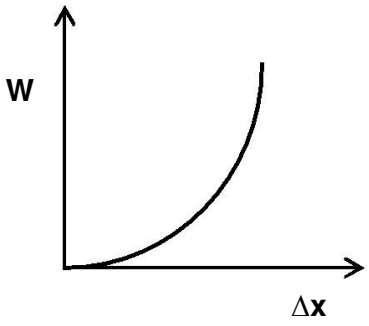
Module J continues in its original direction immediately after the explosion with a velocity of 3**v**. What will be the **magnitude and direction** of module R's velocity immediately after the explosion?

	Magnitude of velocity of R	**Direction of R after explosion**
A	1 **v**	East
B	1 **v**	West
C	⅓ **v**	East
D	⅓ **v**	West

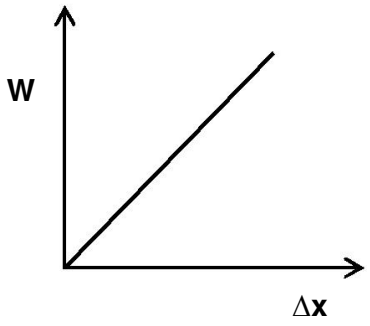
(2)

1.5 A car moves from rest in a straight line under the influence of a constant net force. Which **ONE** of the following graphs best represents the net work done (**W**) on the car in relation to its displacement (Δ**x**)?

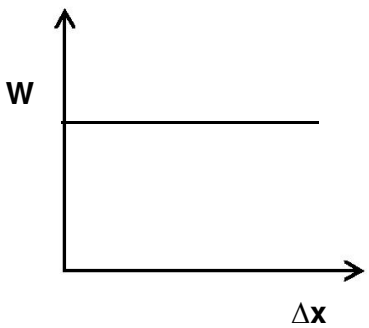
A



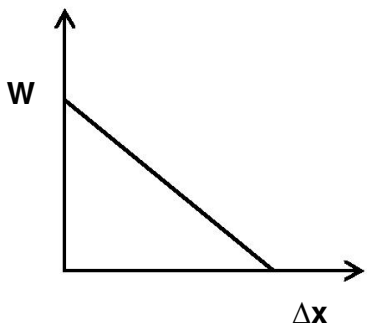
B



C



D



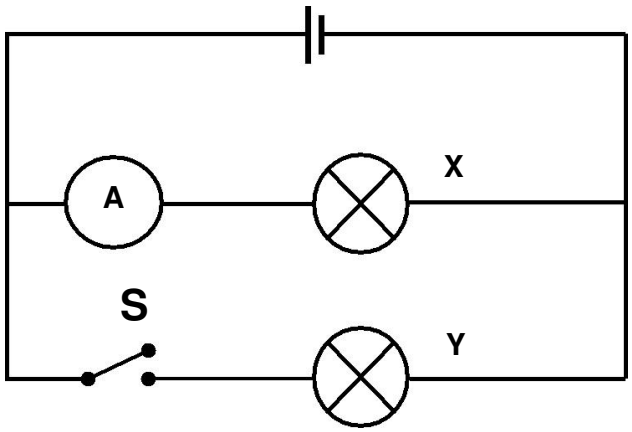
(2)

1.6 In which direction will the visible spectrum shift during a red shift?

A towards the blue end of the spectrum.
B to light of a shorter wavelength.
C to light of a lower frequency.
D. to light of a higher energy.

(2)

1.7 In the circuit shown below, bulbs X and Y are identical.

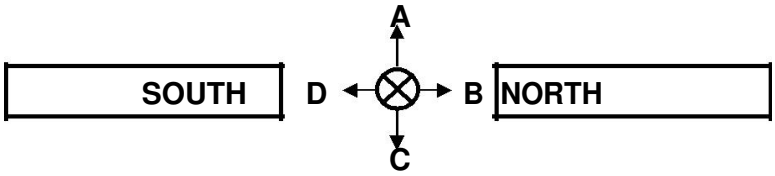


Which **ONE** of the following correctly describes the initial change in total resistance and the reading on the ammeter when switch S is closed?

	R (Total Resistance)	**I (Ammeter Reading)**
A	decreases	unchanged
B	increases	unchanged
C	increases	decreases
D	decreases	increases

(2)

1.8 Two strong bar magnets are arranged with the North and South poles facing each other as shown in the diagram below. A current – carrying conductor carries conventional current into the plane of the paper when placed between the poles of two magnets.

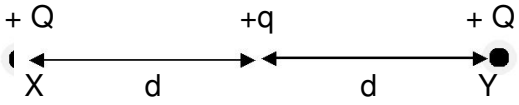


The conductor will experience a force towards ……

A **A**
B **B**
C **C**
D **D**

(2)

1.9 A small test charge +q is placed exactly half way between two identical positive charges, X and Y, each with a charge + Q, as shown below.

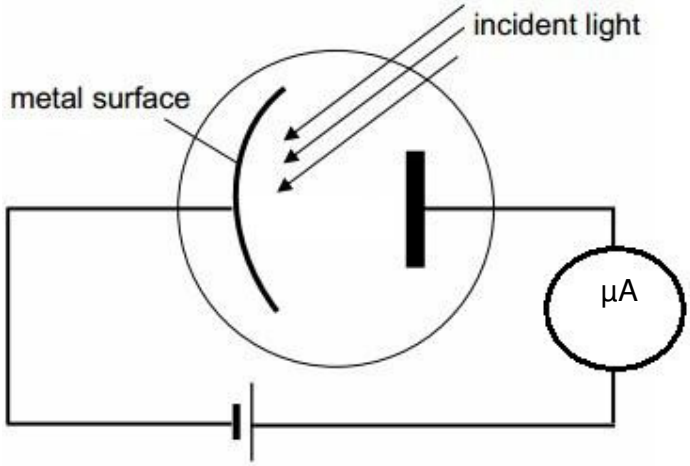


The test charge +q will

A remain where it is
B move towards X
C move towards Y
D move vertically downwards
.

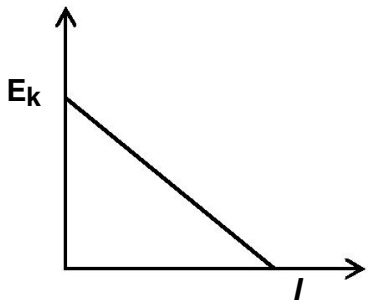
(2)

1.10 Monochromatic blue light is incident on a metal surface as shown in the circuit diagram drawn below. The intensity, ***I*,** of the incident blue light is gradually **INCREASED**.

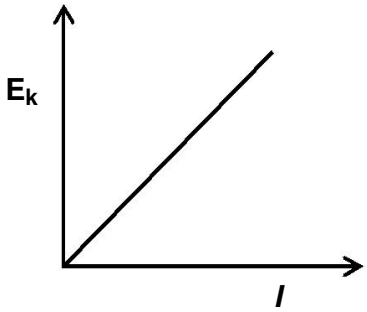


Which **ONE** of the following graphs could represent the kinetic energy (**E_K)**, of the photoelectrons, ejected by the metal surface, as a function of the intensity (***I***)?

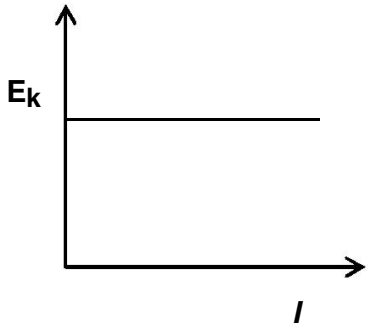
A



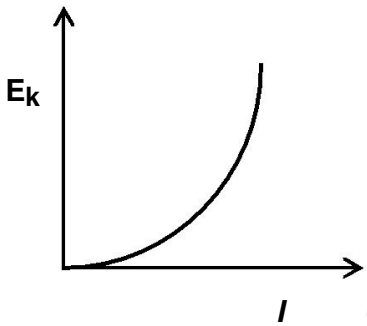
B



C



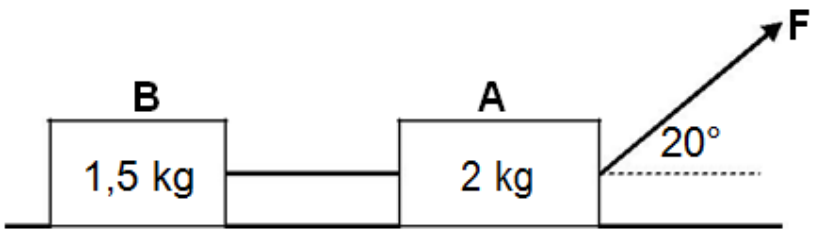
D



(2)

Question 2

A light inelastic string connects two blocks of mass 1,5 kg and 2 kg respectively. A force is applied at an angle of 20° on block A.



If a force F of 8,25 N is applied on block A, the blocks move at a CONSTANT VELOCITY on the rough surface.

2.1 Calculate the horizontal component of the applied force F. (3)

2.2 Calculate the magnitude of the normal force acting on block A. (3)

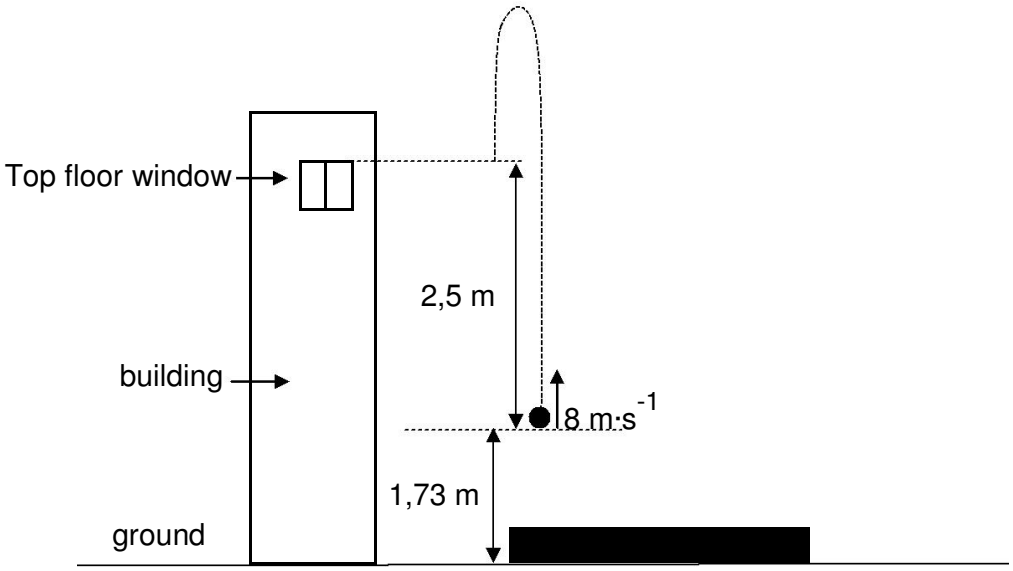
2.3 Calculate the coefficient of kinetic friction between the blocks and the rough surface. (3)

2.4 How will the frictional force of block A change if the angle of the force changes to 15°? Write down INCREASE, DECREASES or REMAINS THE SAME. (1)

[10]

QUESTION 3

Asanda, who is standing on a platform, throws a small metal ball vertically upward, from a height of 1,73 m above the ground, into the air at 8 $m \cdot s^{-1}$. The ball travels pass the top of the building and returns to Asanda's hand which is still at 1,73 m above the ground. Ignore the effects of friction. **Use upwards motion as positive.**



3.1 With what speed does the ball strike Asanda's hand? (1)

3.2 Use an equation of motion to calculate the maximum height that the ball reaches above the ground.

(4)

3.3 If a window on the top floor of the building is at a height of 2,5 m above Asanda's hand, calculate the time taken for the ball, from the moment it was thrown, to pass the top of the window on its return to Asanda's hand.

(5)

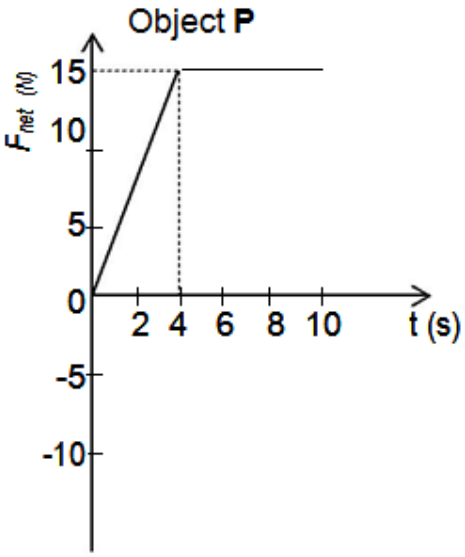
3.4 Taking upward direction as positive, draw a sketch graph of position versus time for the ball's motion from the moment it left Asanda's hand until it lands back into her hands. Indicate all relevant position values. Use Asanda's hand as the reference.

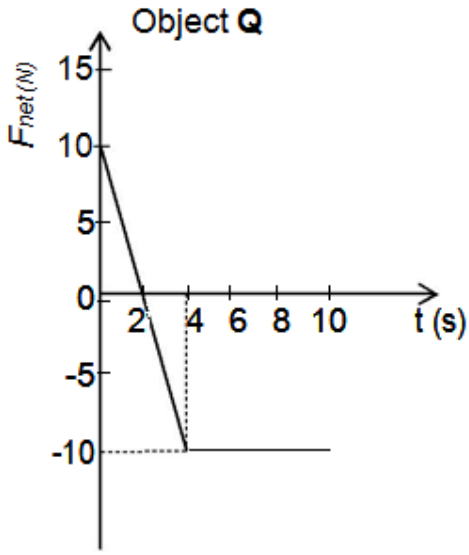
(4)

[14]

Question 4

Two identical objects P and Q with a mass of 12 kg each, are moving side by side with an initial velocity of 5,5 $m.s^{-1}$ east on a horizontal surface.
The following graphs show the net force experienced by each object respectively during the same time interval.





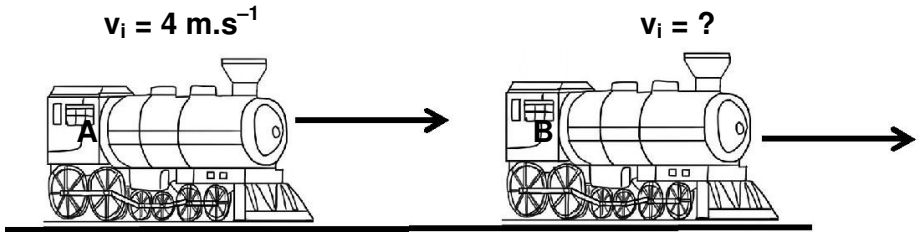
4.1 Calculate the total impulse experienced by object Q in 10 s. (3)

4.2 Compare without any calculations the total impulse for object P with that of object Q. Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)

4.3 Calculate the final velocity of object Q. (4)
[8]

QUESTION 5

Two railway locomotives A, with an unknown mass and B, which has a mass double that of object A, are moving on a straight horizontal track in the same direction at different constant speeds as shown in the sketch.



The two locomotives collide, link together and move at 3 m.s^{-1} in the original direction immediately after the collision.

5.1 Calculate the initial velocity of the locomotive B before the collision. (4)

5.2 Determine, using a calculation, whether the collision elastic or inelastic (5)

[9]

QUESTION 6

A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to point **P** as shown in the diagram below. It then moves along a frictionless horizontal portion **PQ** and finally moves up a second rough inclined plane. It comes to a stop at point **R** which is 3 m above the horizontal.

The frictional force, which is a non-conservative force, between the surface and the block is 18 N.

6.1 Using ENERGY PRINCIPLES only, calculate the speed of the block at point **P**. (4)

6.2 Explain why the kinetic energy at point **P** is the same as that at point **Q**. (2)

6.3 Explain the term *non-conservative force.* (2)

6.4 Calculate the angle (θ) of the slope **QR**. (7)

[15]

QUESTION 7

The siren of a stationary fire truck emits sound waves of frequency 1800 Hz. A car, travelling on a straight horizontal road at a constant speed of 30 $m.s^{-1}$, passes the fire truck and continues at the same constant speed.

7.1 Name the medical instrument that makes use of the Doppler Effect. (1)

7.2 How does the pitch of the siren, heard by the driver of the car, change when the car is moving: (State only **increase**, **decrease** or **remain the same)**

7.2.1 Towards the fire engine? (1)

7.2.2 Away from the fire engine? (1)

7.3 Calculate the frequency detected by the driver as the car moves towards the fire truck. (Take the speed of sound in air as 330 $m.s^{-1}$) (5)

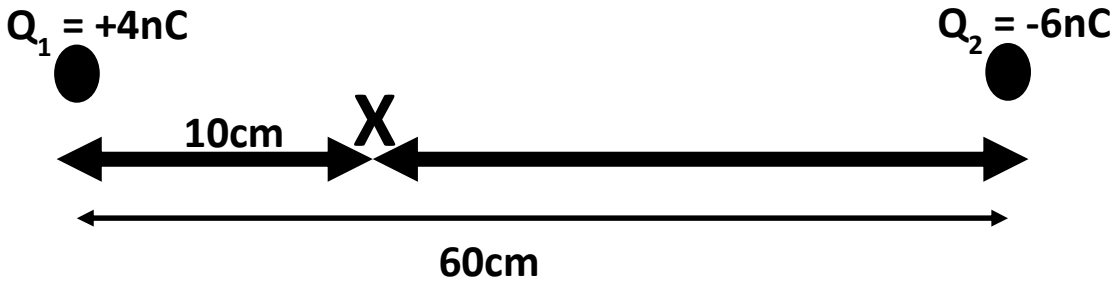
7.4 Sketch a graph to show how the frequency heard by the driver changes as a function of time as the driver approaches and then passes the fire truck. (No numerical values are required).

(3)

[11]

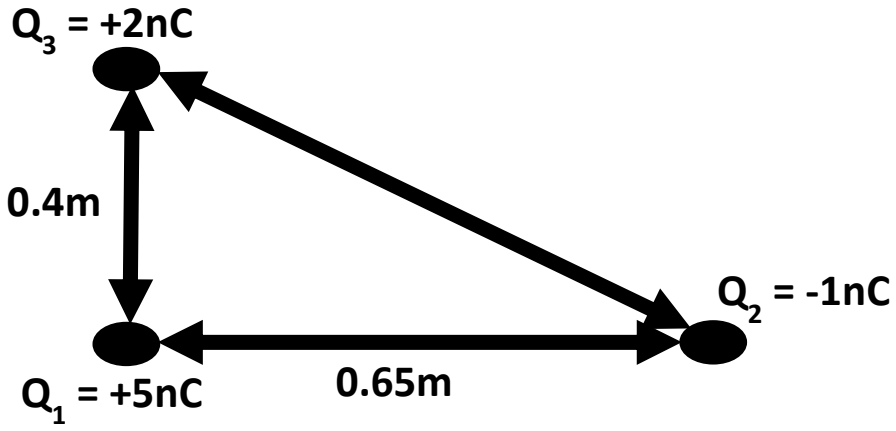
Question 8

8.1 In the diagram below, two charges of Q_1 = +4nC and Q_2 = -6nC are separated by a distance of 60cm. What is the **net electric** field strength at point X that is 10cm from Q_1. (5)



8.2 State Coulomb's law. (3)

8.3 Calculate the resultant force on Q_1 given the charge configuration below.

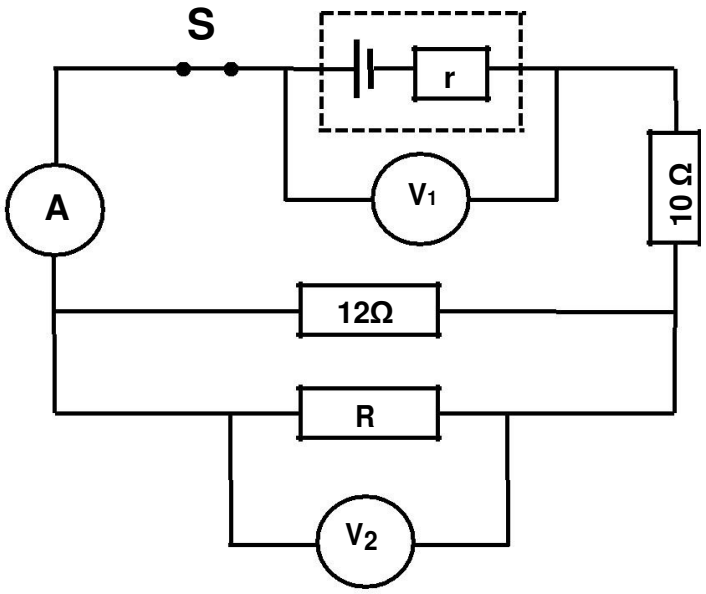


(6)

[14]

QUESTION 9

The battery in the circuit, represented in the diagram below, has an internal resistance **r**. When switch **S** is closed the reading on voltmeter V_2 is 18 V and resistor R dissipates 13,5 W.



9.1 Calculate the resistance of resistor R. (3)

9.2 Calculate the reading on the ammeter. (5)

9.3 Explain, in words, what is meant by the term *INTERNAL RESISTANCE*. (2)

9.4 Calculate the potential difference across the 10Ω resistor. (3)

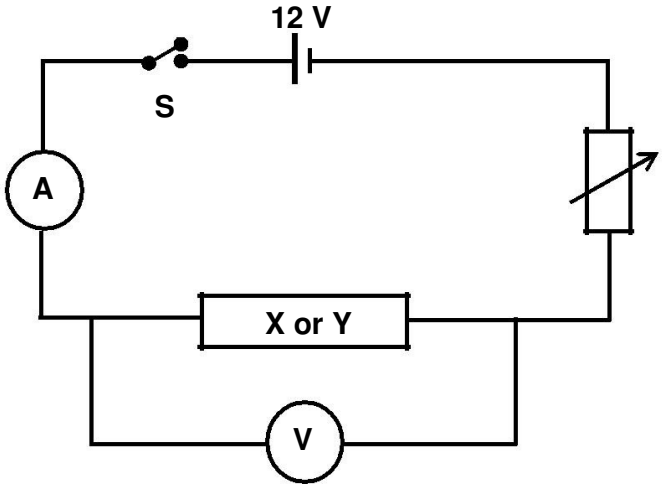
9.5 When switch S is opened the reading on voltmeter V_1 changes to 45,9 V. Hence, calculate the internal resistance of the battery. (5)

9.6 Does the external resistance in the circuit **INCREASE**, **DECREASE** or **REMAIN THE SAME** when the resistor R is removed? (1)

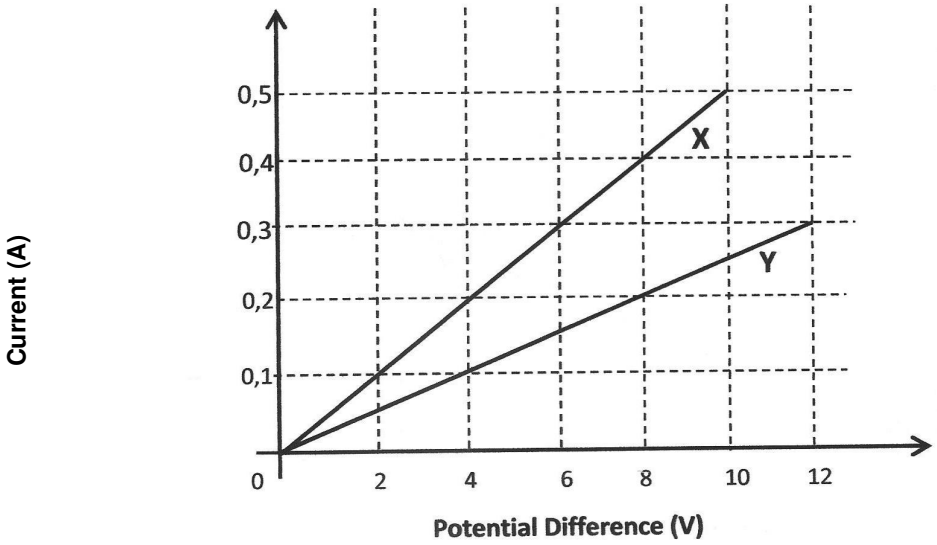
[19]

QUESTION 10

A learner sets up the circuit shown below to investigate the relationship between potential difference and current for each of two unknown resistors X and Y. Ignore internal resistance.



The learner obtained the following graphs from the investigation's results.



10.1 State Ohm's Law, in words. (2)

10.2 What does the gradient of the above graph represent? (1)

10.3 Without any calculation, state which resistor, X or Y, has the greater resistance. Provide a reason for your answer. (2)

10.4 Use the graph to determine the resistance of resistor X. (4)

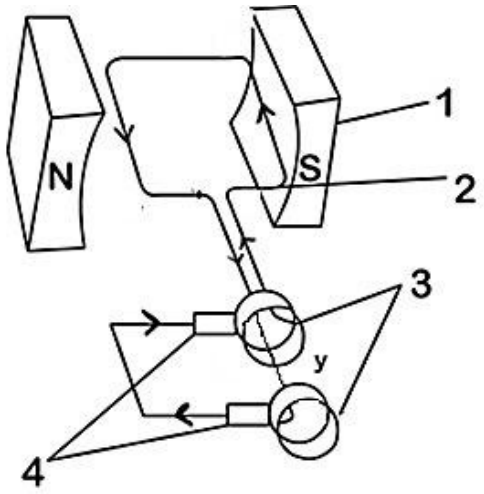
[9]

QUESTION 11

Electric generators are described as either AC or DC generators.

11.1 What energy conversion takes place in all electric generators? (1)

11.2 Consider the simplified sketch of a generator below. The direction of the initially induced current is indicated on the sketch.



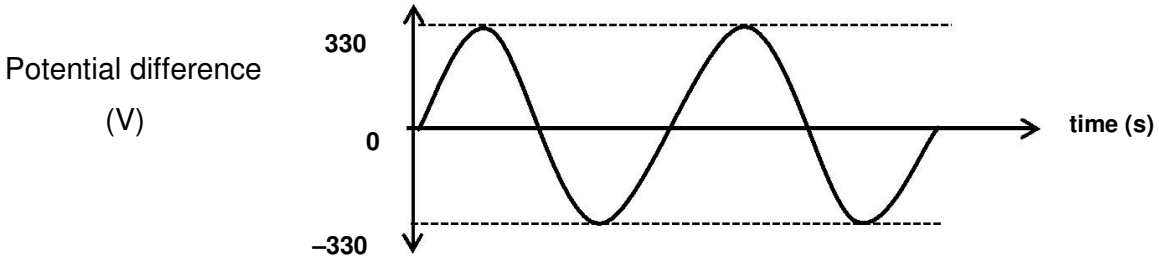
11.2.1 Is the above generator an *AC* or a *DC* generator? (1)

11.2.2 Which specific part of the generator in the above sketch, **1, 2, 3, or 4** helps to identify the type of generator? (1)

11.2.3 In which direction (**clockwise or anti-clockwise**) is the coil between the magnets being rotated? (1)

11.2.4 Briefly explain why the induced emf is at a maximum when the coil is parallel to the magnetic field. (1)

11.3 The graph of potential difference and time for the generator in question 11.2 is shown below.

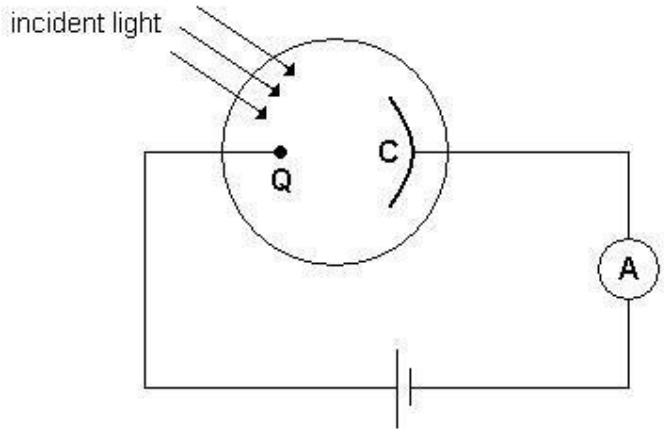


If an rms current of 15 A is produced, determine the rate at which the generator will transfer energy.

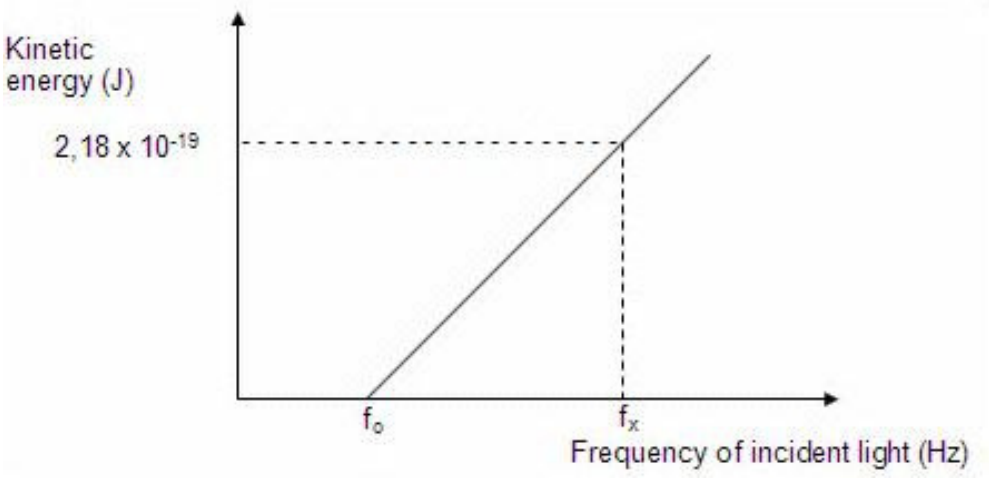
(5)
[10]

QUESTION 12

Learners in a physics class perform an experiment using a photo cell to investigate the relationship between photo electrons emitted and the frequency of the incident light.



A graph is plotted of the maximum kinetic energy (E_k) against the frequency of the incident light. When the straight line graph is extrapolated, it intercepts the x-axis at $f_o = 4{,}29 \times 10^{14}$ Hz.



12.1 Write an investigative question for this investigation. (2)

12.2 What is the frequency, f_0, in the graph called? (1)

12.3 Calculate the frequency, f_x, in the graph. (5)

12.4 Draw a sketch-graph of the **kinetic energy** of the photo-electrons (on the y-axis) **versus** the **intensity** of the incident light. (No values needed on the graph.) (3)

[11]

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	$9{,}11 \times 10^{-31}\ kg$

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*

$F_{net} = ma$	$p = mv$	$f_K = \mu_K F_N$ $f_S = \mu_S F_N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$	

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P = Fv$	

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* $E_k = \frac{1}{2}mv^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$V = \frac{W}{q}$	

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 = VIΔt W= $I^2R\,\Delta t$ W= $\frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ P = VI P = I^2R P = $\frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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