HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- Physics

SEPTEMBER 2013
TIME: 3 HRS

Total 150

Instructions

1. Answer ALL the questions.

2. This question paper consists of TWO sections:

3. SECTION A (25)
   SECTION B (125)

   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

SECTION A

QUESTION 1: ONE-WORD ITEMS

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

1.1 The basic principle on which electric generators function
1.2 Rate of flow of charge.
1.3 The law that describes the interaction between two point charges at rest
1.4 Waves propagated as magnetic and electric fields that oscillate perpendicularly to each other.
1.5 The type of line spectrum observed when electrons in an atom move from the excited state to the ground state.

[1 x 5 =5]

QUESTION 2: 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 (2.1 – 2.5) in the ANSWER BOOK.

2.1 Power is defined as the rate …

A of change of velocity.
B at which work is done.
C of change of momentum.
D of change of displacement.

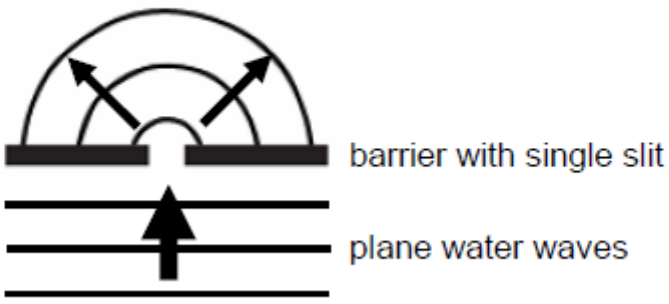
2.2 Two identical small metal spheres on insulated stands carry equal charges and are a distance *d* apart. Each sphere experiences an electrostatic force of magnitude *F*.

The spheres are now placed a distance $\frac{1}{2}d$ apart.

The magnitude of the electrostatic force each sphere now experiences is …

A $\frac{1}{2}F$
B F
C $2F$
D $4F$

2.3 The diagram below shows plane water waves that spread out after passing through a single slit.



The wave phenomenon observed after the water waves pass through the slit is …

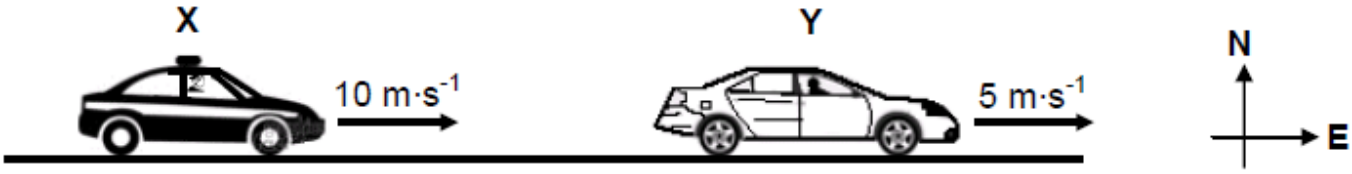
A reflection.

B diffraction.

C refraction.

D photoelectric effect.

2.4 Two cars, **X** and **Y**, are travelling in an easterly direction along a straight level road as shown in the diagram below. The velocity of car **X** is 10 $m \cdot s^{-1}$ relative to the ground and the velocity of car **Y** is 5 $m \cdot s^{-1}$ relative to the ground.



The velocity of car **X** relative to car **Y** is …

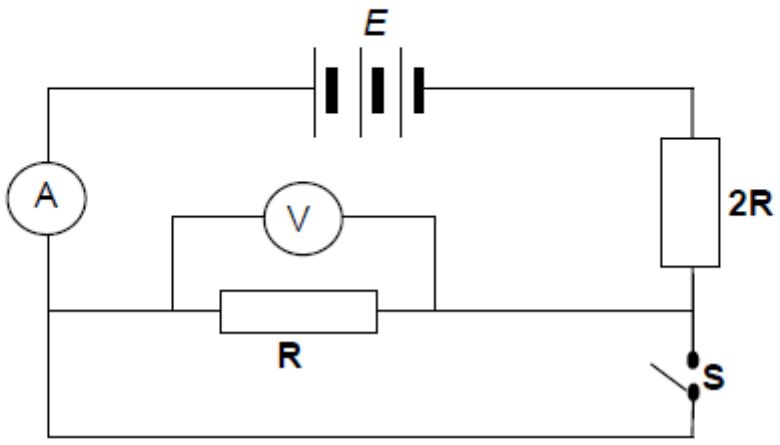
A 5 $m \cdot s^{-1}$ east.

B 5 $m \cdot s^{-1}$ west.

C 15 $m \cdot s^{-1}$ east.

D 15 $m \cdot s^{-1}$ west.

2.5 In the circuit diagram below, the internal resistance of the battery and the resistance of the conducting wires are negligible. The emf of the battery is *E*.



When switch **S** is closed, the reading on voltmeter V, in volts, is ...

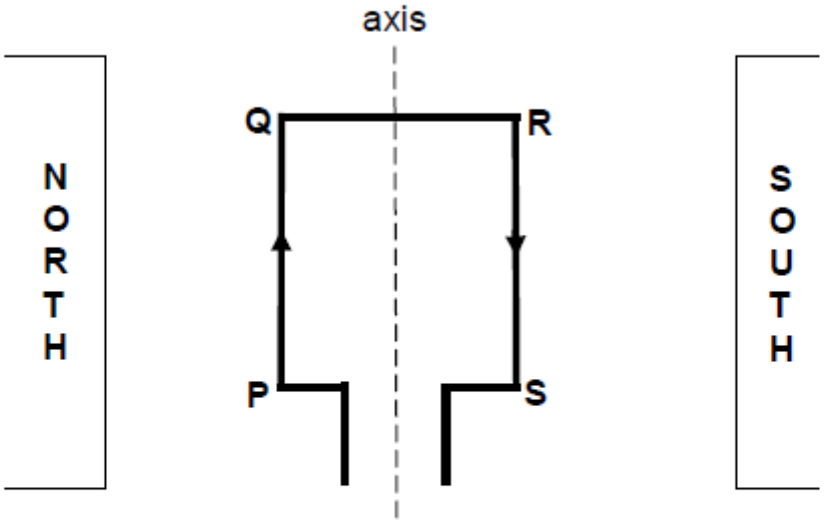
A 0

B $\frac{1}{3}E$

C $\frac{2}{3}E$

D E

2.6 A rectangular current-carrying coil, **PQRS**, is placed in a uniform magnetic field with its plane parallel to the field as shown below. The arrows indicate the direction of the conventional current.



The coil will ...

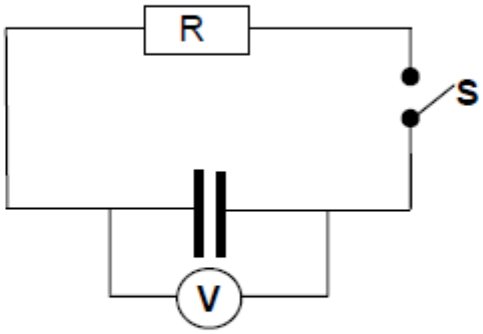
A rotate clockwise.

B remain stationary.

C rotate anticlockwise.

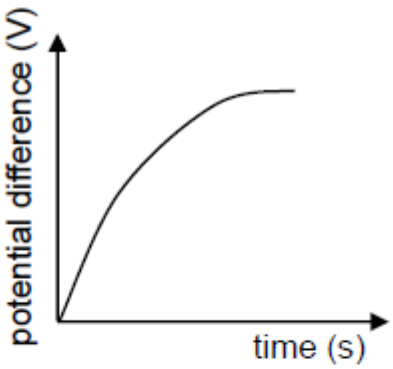
D rotate clockwise and then anticlockwise.

2.7 A fully charged capacitor is connected in a circuit, as shown below. The capacitor discharges when switch **S** is closed.

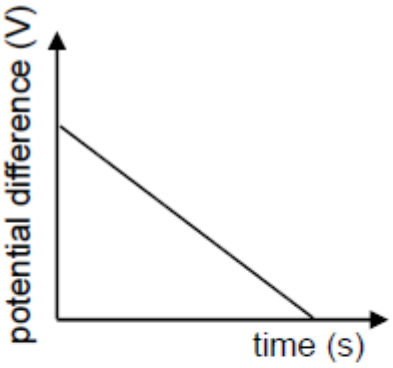


Which ONE of the following graphs correctly shows the change in the voltmeter reading with time when switch **S** is closed?

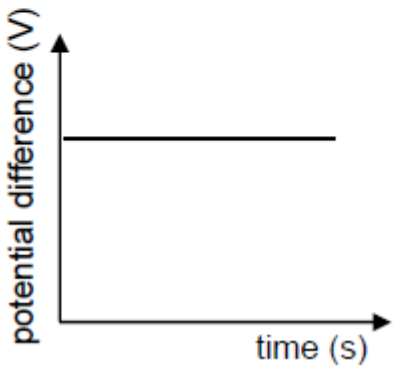
A



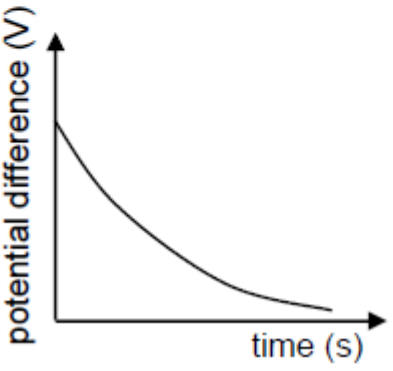
B



C



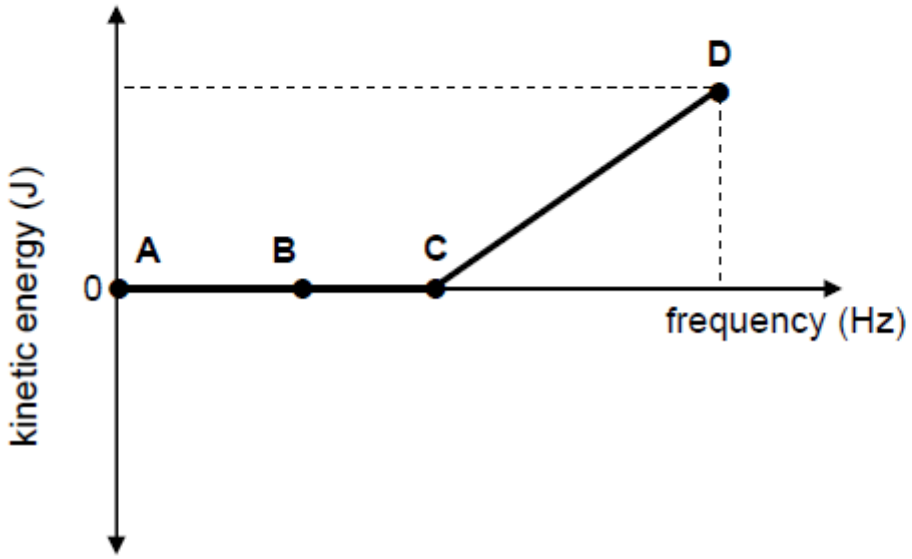
D



2.8 A constant resultant force is being applied to a body which can move freely. Which ONE of the following cannot be changed by continuing to apply this constant resultant force?

A momentum
B acceleration
C kinetic energy
D gravitational potential energy

2.9 When light shines on a metal plate in a photocell, electrons are emitted. The graph below shows the relationship between the kinetic energy of the emitted photoelectrons and the frequency of the incoming light.



Which ONE of the points (**A**, **B**, **C** or **D**) on the graph represents the threshold frequency?

A A

B B

C C

D D

2.10 The momentum of a motor car is p while the kinetic energy of the motor car is K. Which ONE of the following expressions can be used to determine the velocity of the car?

A K/p
B $2K/p$
C $K^{½}p$
D $K^2/2p$

[2 x 10 = 20]

SECTION B

INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 3.1 and QUESTION 3.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO decimal** places

QUESTION 3

A ball of mass 0,2 kg is dropped from a height of 0,8 m onto a hard floor. It bounces to a maximum height of 0,6 m. The floor exerts a force of 50 N on the ball. Ignore the effects of friction.

3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)

3.2 Calculate the:

3.2.1 Velocity at which the ball strikes the floor (4)

3.2.2 Time that the ball is in contact with the floor if it bounces off the floor at a speed of 3,43 $m \cdot s^{-1}$ (4)

3.3 The ball takes 0,404 s from the moment it is dropped until it strikes the floor.

Sketch a graph (not to scale) of position versus time representing the entire motion of the ball. USE THE GROUND AS ZERO REFERENCE.

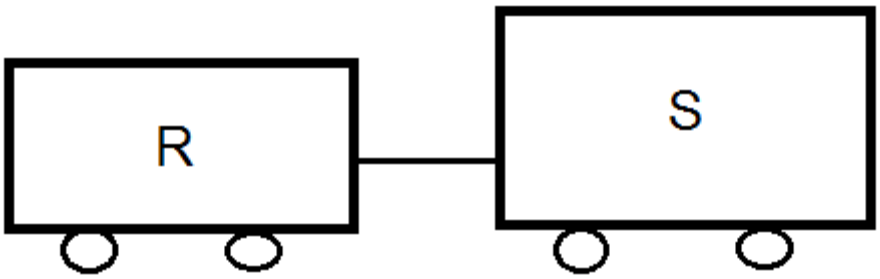
Indicate the following on the graph:

- Height from which the ball is dropped
- Height reached by the ball after the bounce
- Time at which the ball bounces off the floor (5)

[15]

Question 4

A trolley, R of mass **2 kg** is connected to trolley S of mass **6 kg** by a light rubber band. Trolley R and trolley S are held at rest on a horizontal **frictionless surface** with the rubber band stretched out as shown below.



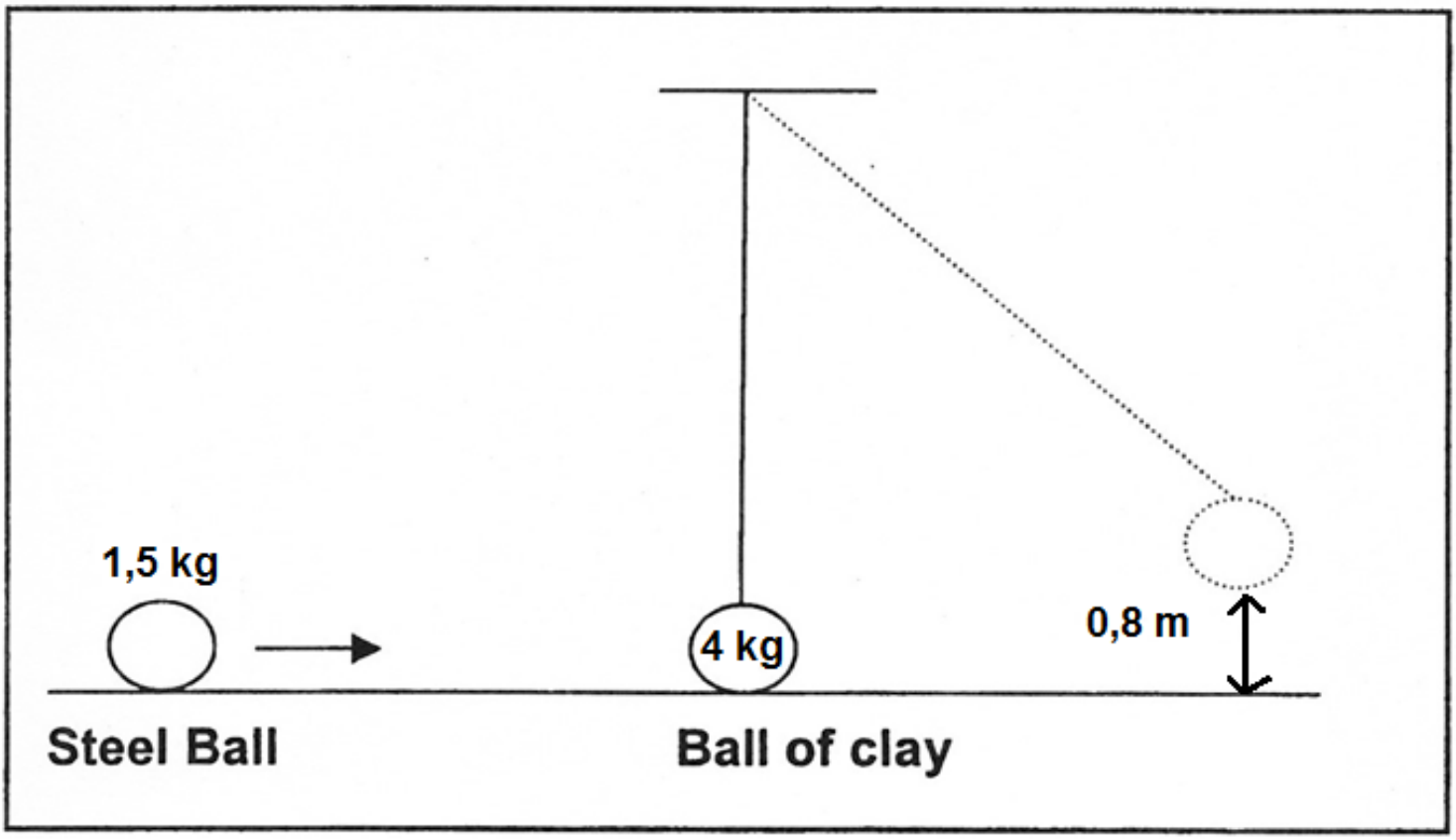
R and S are then simultaneously released and the rubber band gives up 48 J of energy as it contracts to its natural length. No energy is lost.

Calculate the speed acquired by trolley R when both R and S are simultaneously released. (9)

Question 5

A learner wants to determine the speed with which he can roll a steel ball of mass **1,5 kg** along a horizontal distance. He sets up an experiment as follows:

He suspends a ball of clay of mass **4 kg** from a string of negligible mass and rolls the steel ball towards the stationary ball of clay.



The steel ball collides with the ball of clay and becomes embedded in it. The ball of clay with the steel ball embedded in it swings to a height of 0,8 m above the ground.

5.1 Name TWO conservation laws that the learner will need to use in order to calculate the speed with which the steel ball collided with the ball of clay. (2)

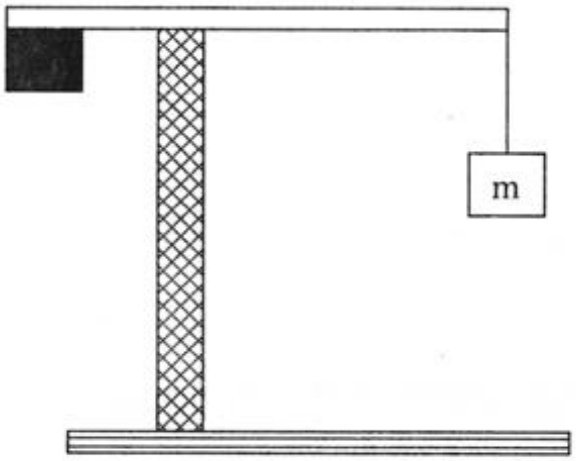
5.2 Name ONE condition that the experimental set up described above must satisfy for the conservation laws names 5.1 above to be valid. (1)

5.3 Show by means of calculations that the steel ball collided with the ball of clay with a speed of 14,52 $m.s^{-1}$. (6)

[9]

Question 6

6.1 At a construction site a crane lifts a block of mass, m, vertically upwards through a height of 70 m at constant speed by means of a strong cable. The block experiences a force of magnitude 8 N as a result of air friction as it is lifted vertically upwards.



6.1.1 Draw a labelled free-body diagram showing ALL the forces acting on the block of mass m, while being lifted upwards. (3)

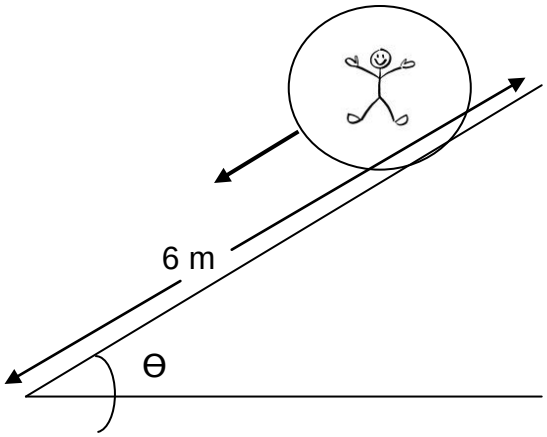
6.1.2 The cable does 377 860 J of work in moving the block through a height of 70 m. Calculate the mass of the block. (5)

[8]

Question 7

Excited to try out the new sport of zorbing, a girl climbs into a large, transparent ball called an orb.

The orb is held **stationary** at the top of a 6 m long ramp, whilst the girl harnesses herself to the inner wall of the orb. When the orb is released it rolls downhill, reaching a speed of **7 m·s^{-1}** at the bottom of the ramp. The combined mass of the girl and orb is 80 kg and the frictional force between the girl's orb and the ramp is 200 N.



7.1 Draw a labelled, free-body diagram to show all the forces acting on the orb as it rolls down the ramp. (3)

7.2 Use the work-energy theorem to calculate the total work done on the orb in rolling from the top to the bottom of the ramp. (4)

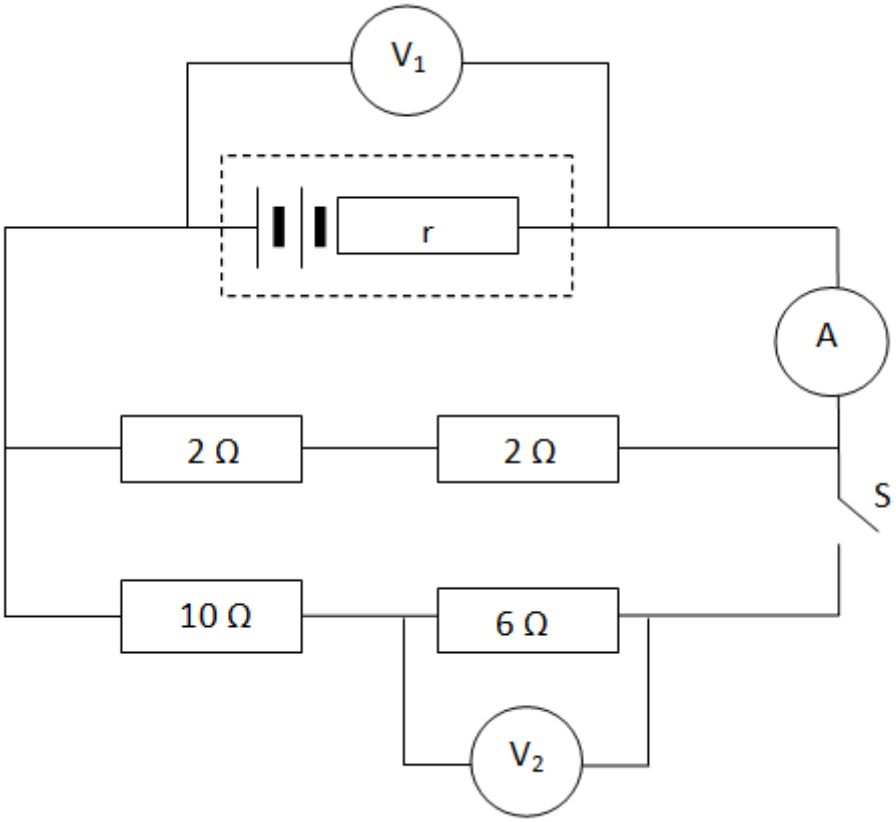
7.3 Calculate the work done by friction on the orb. (3)

7.4 Calculate the angle Θ the ramp makes with the horizontal. (6)

[16]

Question 8

A battery of emf 24 V and of internal resistance **r** is connected in a circuit as shown below.



The switch **S** is **closed** and the ammeter reading is 6 A.

8.1 Show by means of a calculation that the effective resistance of the external resistors is 3,2 Ω. (3)

8.2

8.2.1 Calculate the reading on voltmeter $\mathbf{V_1}$. (3)

8.2.2 Calculate the reading on voltmeter $\mathbf{V_2}$. (4)

8.2.3 Calculate the internal resistance of the battery. (3)

8.3 Switch **S** is now **opened**. State whether the following will INCREASE, DECREASE or REMAIN THE SAME:

8.3.1 The reading on voltmeter $\mathbf{V_1}$. (1)

8.3.2 The reading on voltmeter $\mathbf{V_2}$. (1)

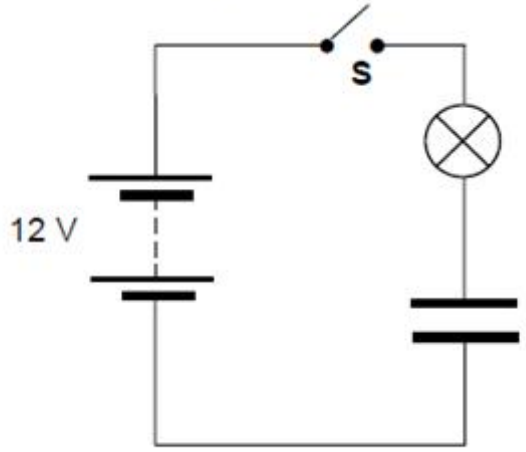
8.3.3 The reading on ammeter **A**. (1)

[16]

Question 9

9.1 Write down the main function of a capacitor in a circuit. (1)

A high-resistance light bulb and an uncharged parallel plate capacitor are connected in series with a 12 V battery and a switch **S**, as shown below. The internal resistance of the battery and the resistance of the connecting wires should be ignored.



Switch **S** is now closed and the capacitor charges.

9.2 Describe how the brightness of the light bulb changes during the charging process. (1)

The capacitor is NOW fully charged.

9.3 Write down the potential difference across the:

9.3.1 Light bulb (1)

9.3.2 Capacitor (1)

9.4 The distance between the plates of the capacitor is 5,4 mm.

For the fully charged capacitor, calculate the magnitude of the:

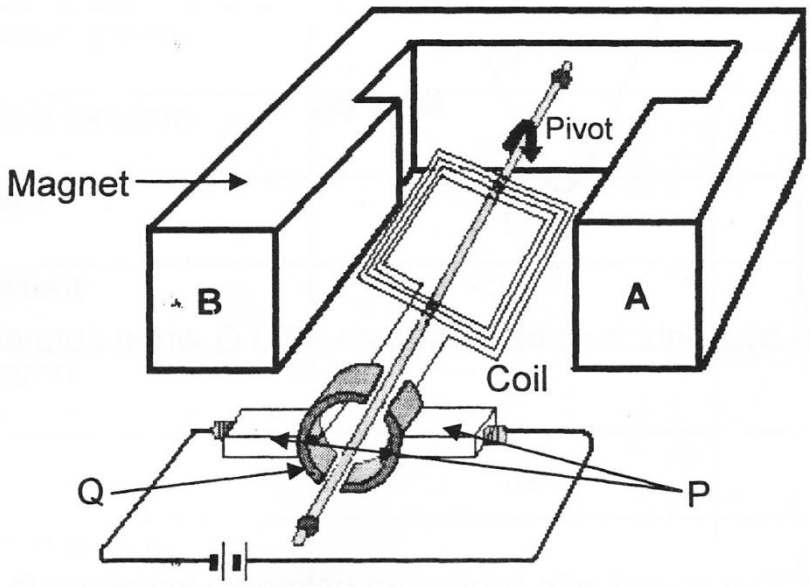
9.4.1 Electric field between the plates (3)

9.4.2 Electrostatic force exerted on an electron between the plates (3)

[10]

Question 10

The diagram below represents a simplified sketch of a motor.



10.1 Does the above sketch represent a DC or AC motor? Give a reason for your answer. (2)

10.2 State the energy conversion associated with the motor represented in the above sketch. (1)

When the motor is functioning, the coil rotates in a clockwise direction, as shown in the sketch.

10.3 Give the name of the component which ensures continuous rotation of the coil. (1)

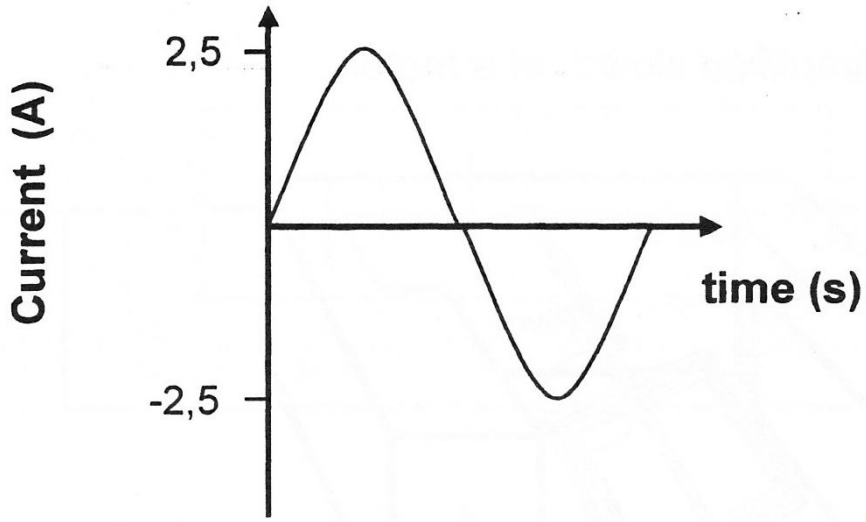
10.4 Does the letter B in the sketch represent the north or south pole of the magnet? (1)

10.5 Write down what effect the following will have with regards to the motor shown in the sketch…

10.5.1 The emf of the battery is increased (1)

10.5.2 The polarity of the battery is reversed. (1)

10.6



Calculate the power dissipated by a light bulb of resistance 4,8 Ω when connected to the above generator. (5)

[12]

Question 11

The main source of X-rays is discharge tubes. X-rays have a wavelength ranging from 0,03 nm to 3 nm.

11.1 Give ONE use of X-rays. (1)

11.2 State ONE harmful effect of X-rays on humans. (1)

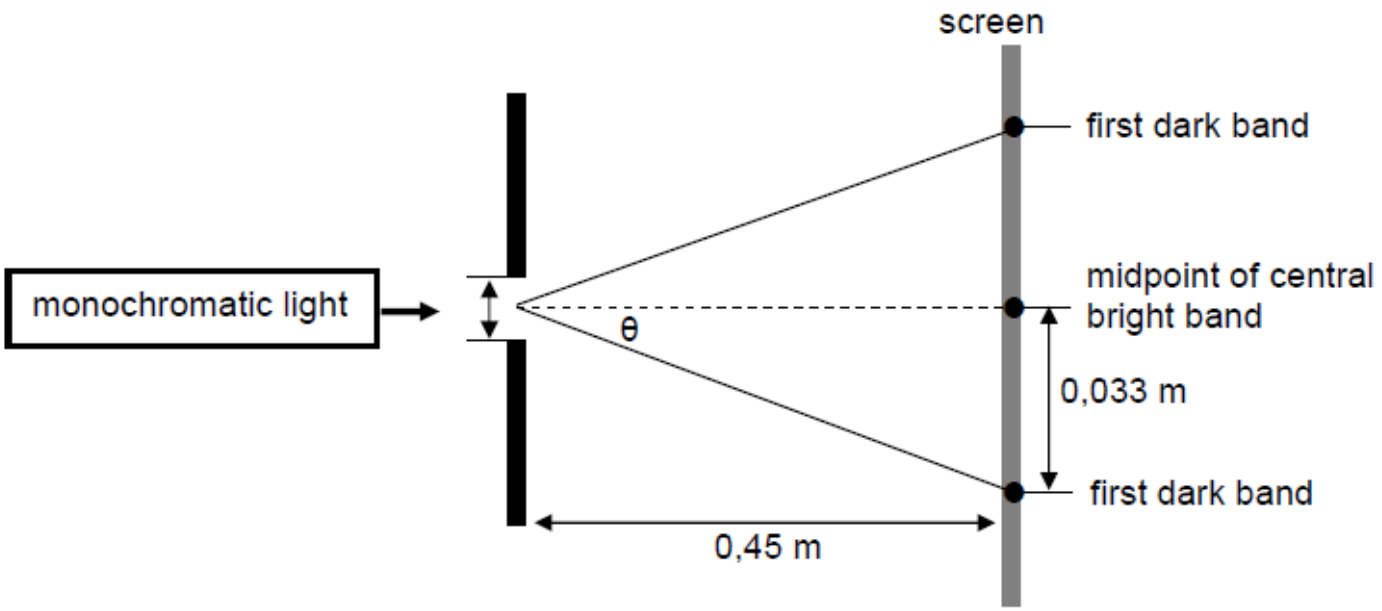
11.3 Name ONE electromagnetic radiation that has a frequency higher than X-rays. (1)

[3]

Question 12

Learners investigate the change in the broadness of the central bright band formed when monochromatic light of different wavelengths passes through a single slit.

They set up the apparatus, as shown in diagram below, and measure the broadness of the central bright band in the pattern observed on the screen. The width of the slit is $5,6 \times 10^{-7}$ m.



12.1 Write down an investigative question. (2)

12.2 Which TWO variables are kept constant? (2)

12.3 In one of their experiments, the distance from the midpoint of the central bright band to the first dark band is measured to be 0,033 m.

Calculate the wavelength of the light used in this experiment. (5)

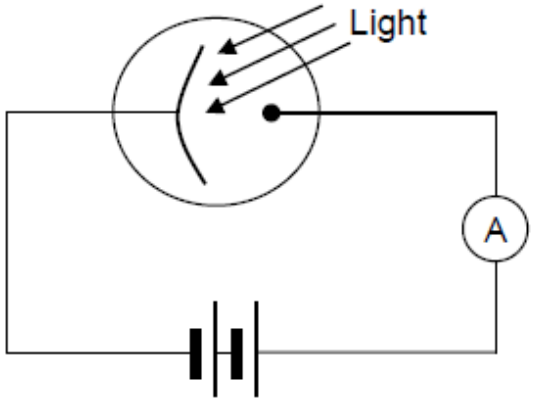
12.4 How will the broadness of the central bright band of red light compare with that of blue light? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)

[11]

Question 13

Light shines onto the cathode of a photocell as shown below. The ammeter registers a reading.



13.1 Define the term *photon*. (2)

13.2 Each photon of light has an energy of $6,9 \times 10^{-19}$ J. The cathode has a work function of $6,4 \times 10^{-19}$ J.

Calculate the:

13.2.1 Wavelength of the light (5)

13.2.2 Kinetic energy of the photoelectrons (3)

13.3 How will the reading on the ammeter change if:

13.3.1 Light of the same frequency, but of higher intensity, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)

13.3.2 Light of the same intensity, but of higher frequency, is used

Write down INCREASES, DECREASES or REMAINS THE SAME.
Fully explain the answer. (3)

[16]

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

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	ε_0	$8,85 \times 10^{-12}\ F{\cdot}m^{-1}$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ 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

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ 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* $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS

$F=\frac{kQ_1Q_2}{r^2}$	$E=\frac{kQ}{r^2}$
$E=\frac{V}{d}$	$E=\frac{F}{q}$
$U=\frac{kQ_1Q_2}{r}$	$V=\frac{W}{q}$
$C=\frac{Q}{V}$	$C=\frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS

$R=\frac{V}{I}$	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

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$	/	$I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$
$V_{rms}=\frac{V_{max}}{\sqrt{2}}$	/	$V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$

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