GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2020

10841

PHYSICAL SCIENCES: PHYSICS

PAPER 1

TIME: 3 hours

MARKS: 150

17 pages + 3 data sheets and an answer sheet

P.T.O.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 10 questions. Answer the questions in the ANSWER BOOK and on the ANSWER SHEET provided at the end of the question paper.
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 open between two sub-sections, 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, discussions, et cetera where required.
11. Write neatly and legibly.

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) of your choice next to the question number (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Which of Newton's laws is associated with being a conservative force?

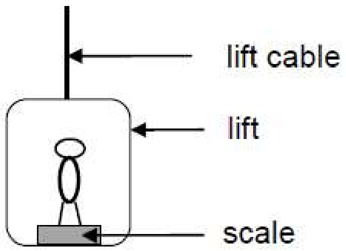
A First law

B Third Law

C Second Law

D Law of Universal Gravitation (2)

1.2 A person stands on a bathroom scale that is fixed to the floor of a lift, as shown in the diagram below.



The reading on the scale is zero when the lift moves …

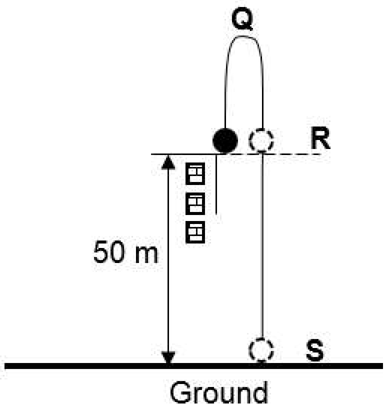
A if the lift cable is broken.

B upwards with increasing speed.

C upwards at constant speed.

D downwards at constant speed. (2)

1.3 In the diagram below, a ball is thrown vertically upwards from the top a building of height 50 m. The path of the ball is labelled, **Q**, **R** and **S** as shown in the diagram.



Study the three statements below.

The change in position of the ball at:

(i) **Q** is 50 m

(ii) **R** is zero

(iii) **S** is 50 m

Which ONE of the following statements is true?

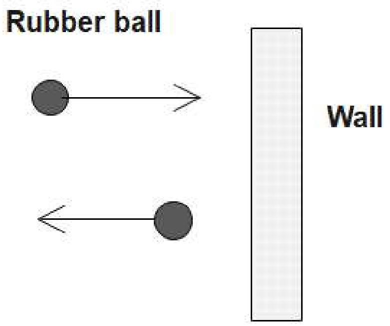
A (i) and (iii)

B (i) only

C (i) and (ii)

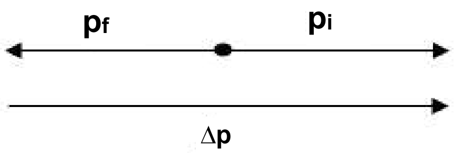
D (ii) and (iii) (2)

1.4 In the diagram below, a rubber ball is thrown towards a wall and bounces back.

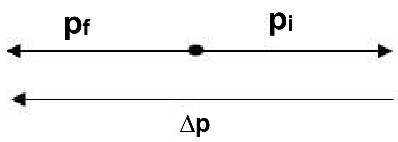


Which ONE of the diagrams below represents the correctly labelled momentum vectors for the rubber ball?

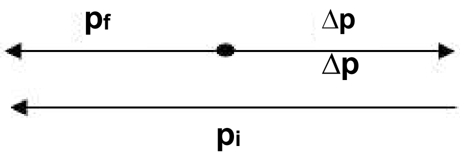
A



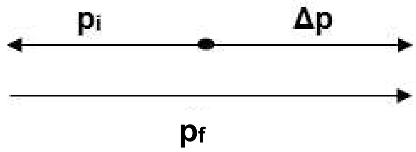
B



C



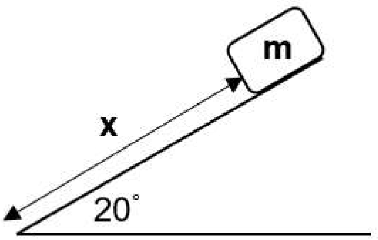
D



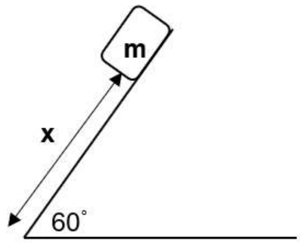
(2)

1.5 Block **m** moves down the slope for a distance **x** in all the diagrams below. The magnitude of **m** and **x** are the same in each diagram. None of the diagrams are drawn to scale. Ignore all effects of friction.
In which ONE of the diagrams below will W_{net} be the greatest?

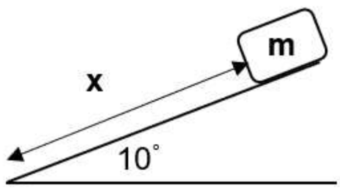
A



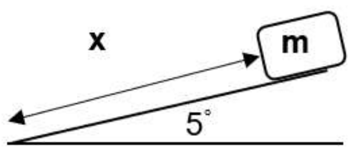
B



C



D



(2)

1.6 When a DC electric current flows through a single current-carrying conductor, the right-hand rule helps us to determine the …

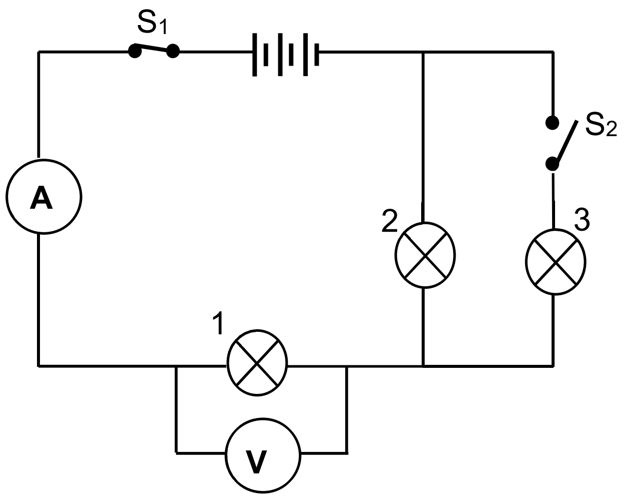
A force on the conductor.

B field on the conductor.

C direction of induced emf.

D direction of the electric field around the conductor. (2)

1.7 In the circuit below, the battery has negligible internal resistance. Bulbs 1, 2 and 3 are identical. Switch S_1 is closed and switch S_2 is open.

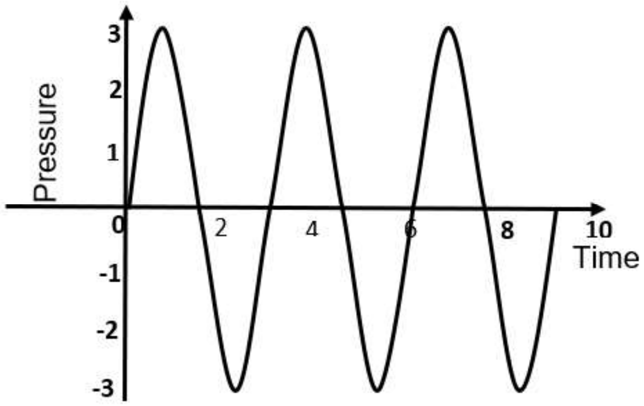


Which ONE of the following is true concerning the ammeter and the voltmeter readings when switch S_2 is closed?

	Ammeter reading A	**Voltmeter reading V**
A	Decreases	Increases
B	Increases	Increases
C	Decreases	Decreases
D	Increases	Decreases

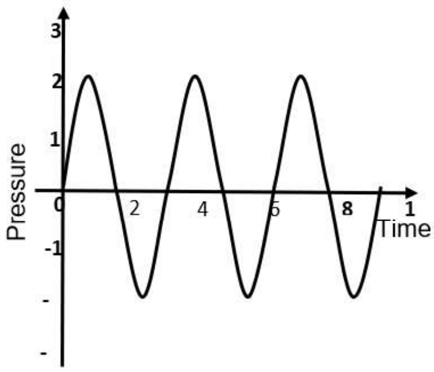
(2)

1.8 The pressure vs time graph for a stationary source, relative to the observer, is shown below.

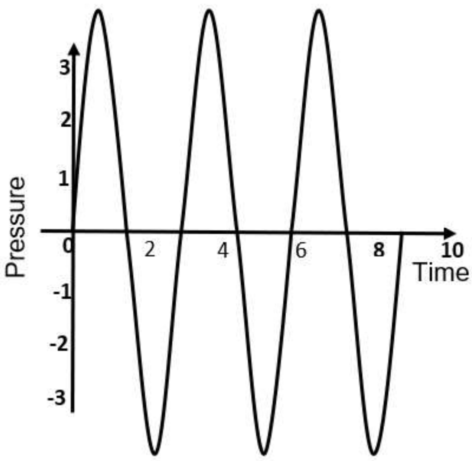


Which of the following sound waves best represents the sound wave if the source is moving towards the observer?

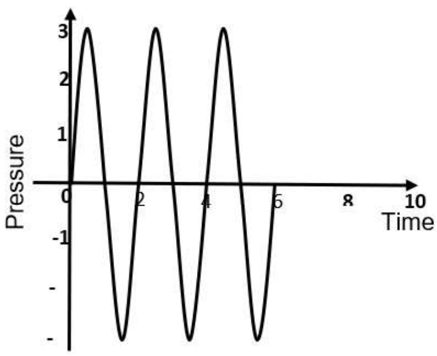
A



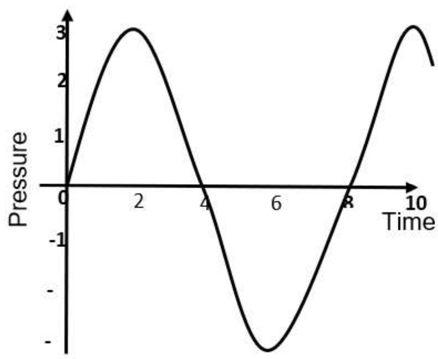
B



C

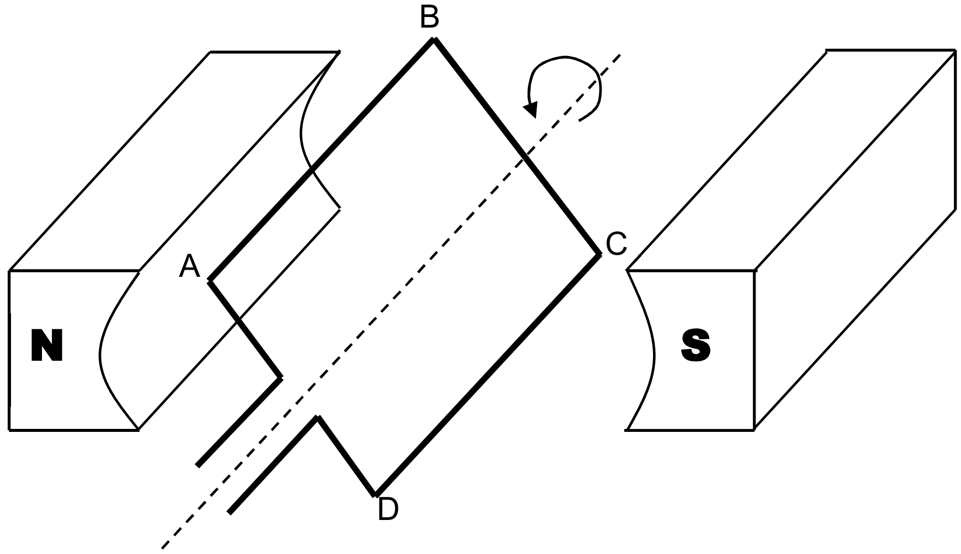


D



(2)

1.9 A rectangular wire loop ABCD is rotated between two poles of a magnet as shown below.



Which of the following is true concerning the induced emf and induced current in the coil when the loop is at the position shown in the diagram above? The loop is being rotated anti-clockwise.

	Induced emf	**Induced current**
A	Increasing	Decreasing
B	Increasing	Increasing
C	Decreasing	Decreasing
D	Decreasing	Increasing

(2)

1.10 When light of a certain frequency is shone on a metal surface, no electrons are ejected from the surface. Which of the following changes may result in electrons being ejected from the metal surface?

A Use a metal with a larger work function.

B Increase the surface area of the metal.

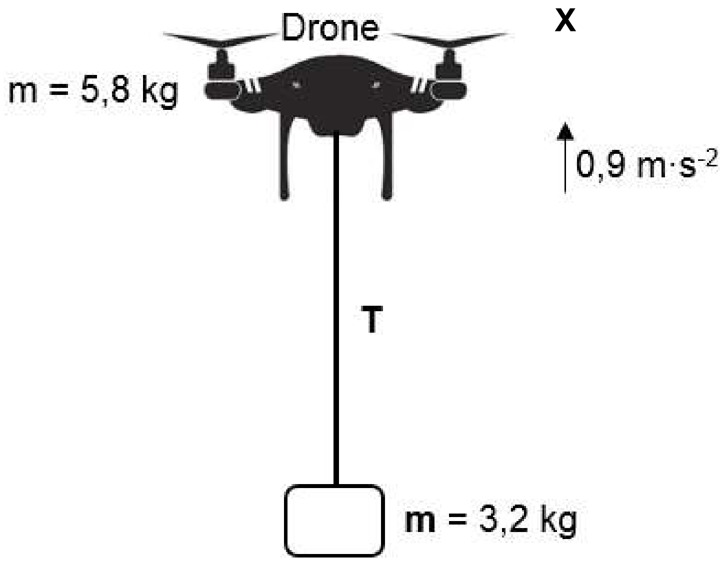
C Increase the intensity of the light.

D Use light with a much higher frequency. (2)

[20]

QUESTION 2 **(Start on a new page.)**

In the diagram below a drone, with a mass 5,8 kg, is used to lift a mass, **m** = 3,2 kg by using an inextensible cable of negligible mass. The tension in the cable is **T**, and the drone accelerates vertically upwards at 0,9 m·s^{-2}. The lifting force of the drone is 180 N. The frictional force **f** experienced by the drone and the mass **m**, as they move upwards, is the same.



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

2.2 Draw a fully-labelled, free-body diagram for the mass **m**. (3)

2.3 Calculate the magnitude of the frictional force experienced by the drone and **m**. (7)

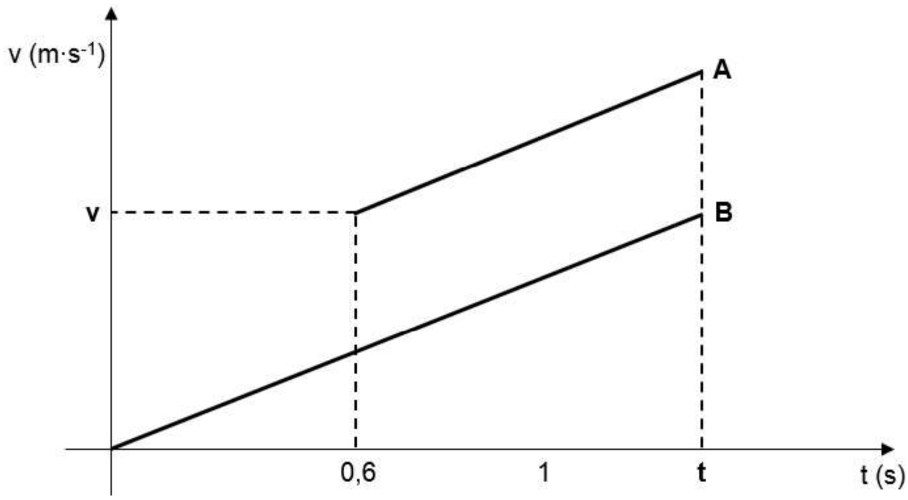
2.4 Calculate the tension in the cable. (2)

2.5 The drone reaches its maximum constant speed of 19,7 m·s^{-1} after it has passed point **X**. The lifting force does not change.

Calculate the power of the motors of the drone. (3)
[17]

QUESTION 3 Start on a new page.)

The two velocity-time graphs below, are for two objects **A** and **B** falling vertically towards the ground. Both objects start from a height of 8 m and strike the ground at the same time **t**. Ignore the effects of friction.



3.1 Explain the term *projectile*. (2)

3.2 3.2.1 Which ONE of the objects, **A** or **B,** was projected (thrown) downwards? Choose from **A** or **B**. (1)

3.2.2 Give a reason for your answer to QUESTION 3.2.1. (1)

3.3 Calculate the following values on the graph.

3.3.1 Time **t** (4)

3.3.2 Velocity **v** of object **A** (4)

3.4 How does the area under graph **A** compare with that of graph **B**?

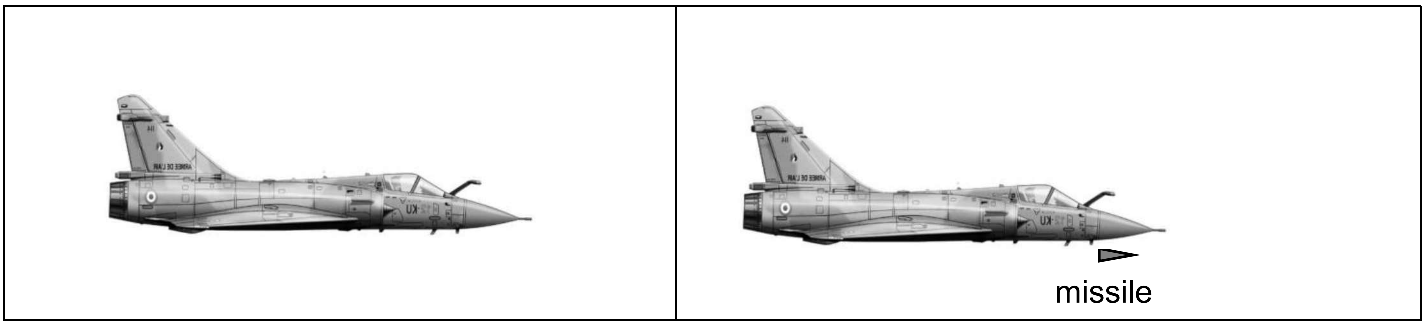
Choose from: SAME AS, GREATER, LESS THAN.

Give a reason for your answer. (2)

3.5 Write the magnitude and direction of the vector represented by the gradient. (2)
[16]

QUESTION 4 (Start on a new page.)

In the diagram below, a fighter jet is flying in a straight line at a constant speed of 275 m·s^{-1}. The pilot fires a missile forward so that the missile leaves the jet with a speed of 700 m·s^{-1}. The mass of the jet is 5 000 kg and that of the missile is 50 kg.



4.1 Define *impulse* in words. (2)

The missile takes a time of 1,5 s to reach the speed of 700 m·s^{-1} from rest.

4.2 Use the impulse-momentum theorem to calculate the magnitude of the net force on the missile. (4)

4.3 Treat the system as an isolated system and calculate the velocity of the fighter jet immediately after the missile has been fired. (5)

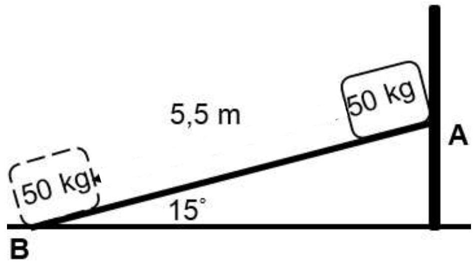
4.4 Explain why the system must be treated as an isolated system to calculate the speed of the jet after the missile has been fired. (2)

[13]

QUESTION 5 (Start on a new page.)

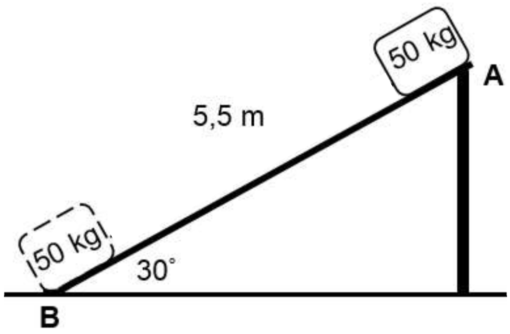
In Diagram 1 below, a slide of length **AB** equal to 5,5 m is inclined at an angle of 15°. In a test, a 50 kg mass, travels the length of **AB** at **CONSTANT** speed. The kinetic friction of the slide is unknown.

Diagram 1



In Diagram 2 below the inclined angle of the same slide of length 5,5 m is increased to 30°. The mass of 50 kg starts from rest at **A** and slides down the slide to point **B**.

Diagram 2



The kinetic coefficient of friction for the slope in Diagram 1 and Diagram 2 are identical.

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

5.2 Use energy principles to calculate the …

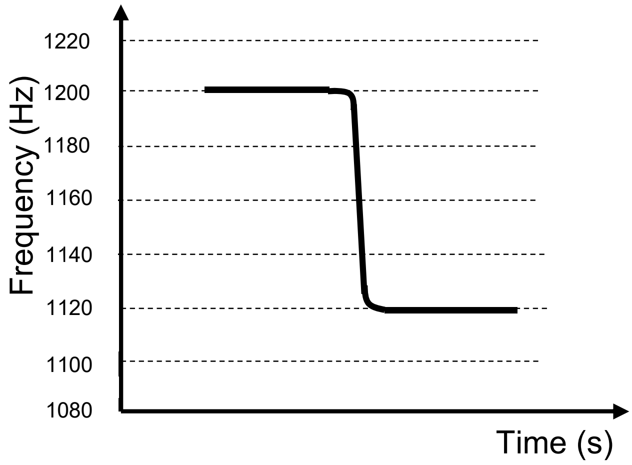
5.2.1 kinetic coefficient of the surface. (6)

5.2.2 speed of the mass at point **B** in Diagram 2. (5)

[13]

QUESTION 6 (Start on a new page.)

A racing car approaches a data capturing centre at a racetrack. The motion-monitoring machine produces a frequency versus time trace as shown below.



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

6.2 Write down the frequency detected by the machine as the race car …

6.2.1 approaches the data centre. (1)

6.2.2 moves away from the data centre. (1)

6.3 Calculate the speed of the race car if the frequency produced by the motion-monitoring machine is 1 160 Hz.
Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.4 Doctors use the Doppler flow meter for diagnostic purposes on patients who have blocked arteries.

6.4.1 State what is measured in a human using the Doppler flow meter. (1)

6.4.2 Explain how the Doppler effect works in the answer to QUESTION 6.4.1. (2)

6.5 While studying the stars through a telescope it is noticed that a red colour is observed behind the stars.

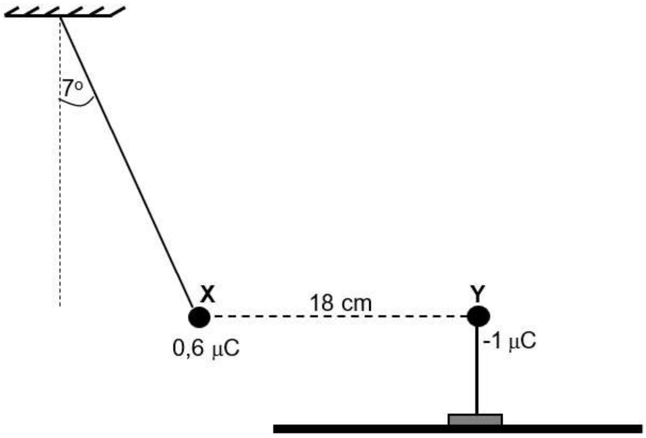
6.5.1 What is this phenomenon called? (1)

6.5.2 Should the people on earth be worried about this occurrence?
Give a reason for your answer by referring to the motion of the star. (2)

[15]

QUESTION 7 (Start on a new page.)

Ball **X** carries a charge of + 0,6 μC and is suspended from the ceiling with an inelastic thread as shown below. Another ball, **Y**, on an insulated stand, carries a charge of –1 μC and is brought to a distance of 18 cm from ball **X**. Ball **X** moves towards ball **Y** due to electrostatic attraction so that it suspends at an angle of 7° from the vertical and remains in equilibrium.

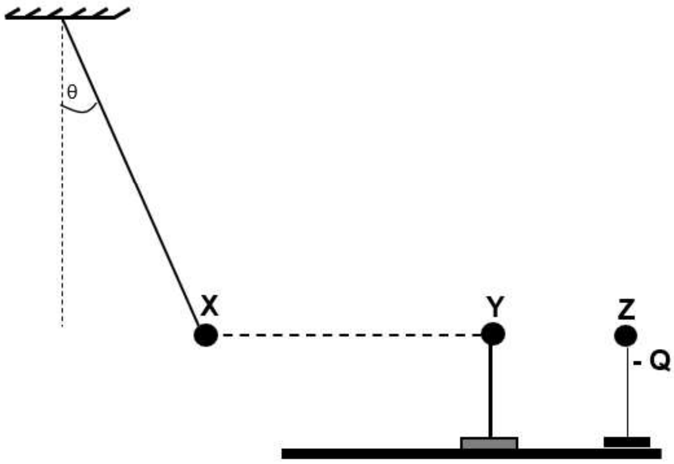


7.1 State *Coulomb's law* in words. (2)

7.2 Draw a labelled, free-body diagram showing ALL the forces acting on ball **X**. (3)

7.3 Calculate the magnitude of the tension in the string. (4)

7.4 A third small ball **Z**, on an insulated stand, is placed to the right of **Y**, but not touching **Y**, as shown below. Ball **Z** carries a negative charge.



7.4.1 What effect will the charge on ball **Z** have on the angle of inclination of **X**? State only: INCREASE, STAY THE SAME, DECREASE. (1)

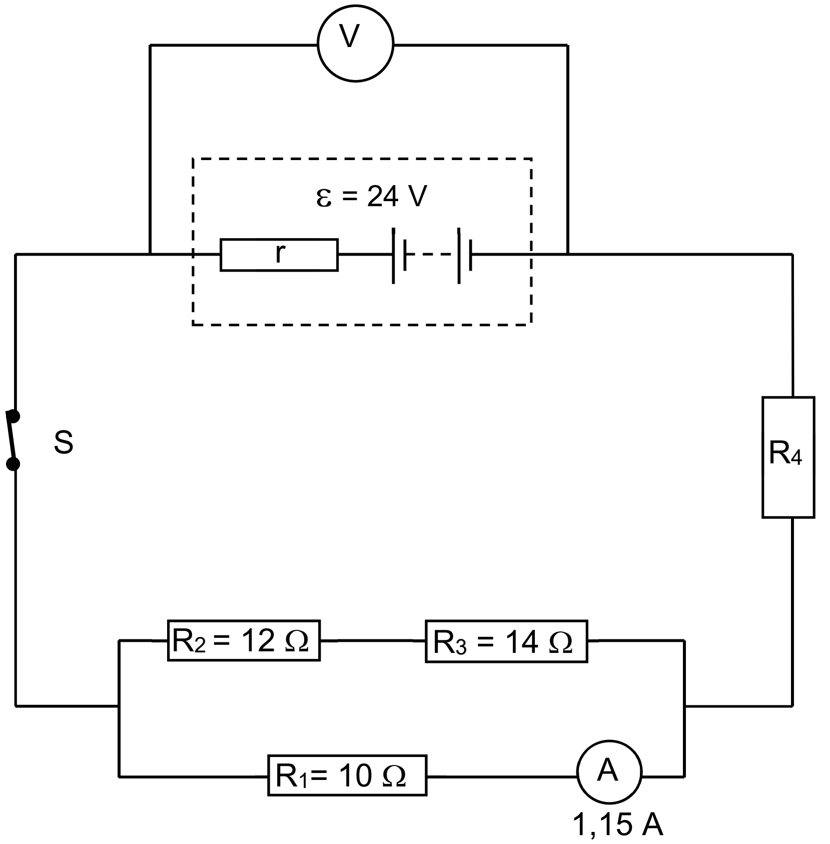
7.4.2 Explain the answer to QUESTION 7.4.1. (2)

7.4.3 Explain why balls **Y** and **Z** must be placed on insulated stands. (2)

[14]

QUESTION 8 (Start on a new page.)

The circuit below consists of a battery with an emf of 24 V and an unknown internal resistance, **r**. Three ohmic resistors R_1, R_2, and R_3 have resistances as shown in the diagram. Resistance of R_4 is not known. When switch S is closed, the reading on voltmeter **V** is 21,5 V whilst the ammeter reads 1,15 A.



8.1 Explain the term *ohmic resistor.* (2)

8.2 Calculate the following:

8.2.1 Magnitude of the current through resistor R_2 (4)

8.2.2 Resistance of resistor R_4 (4)

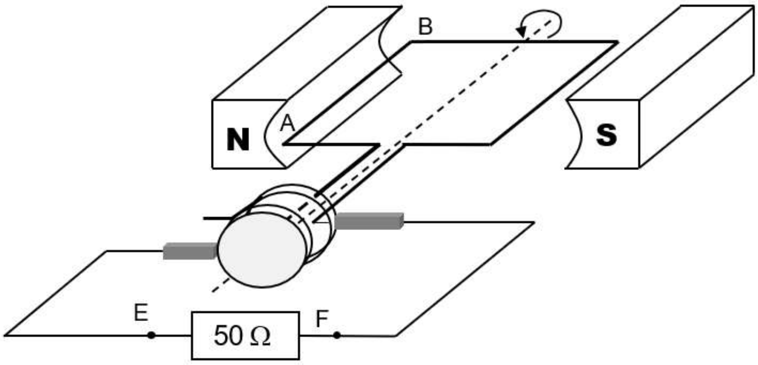
8.2.3 Internal resistance of the battery (3)

8.3 By referring to energy transfer in the battery, explain why the reading on voltmeter **V** decreases when switch **S** is closed. (2)

[15]

QUESTION 9 (Start on a new page.)

The diagram below shows a generator with copper coils being rotated between poles of permanent magnets.



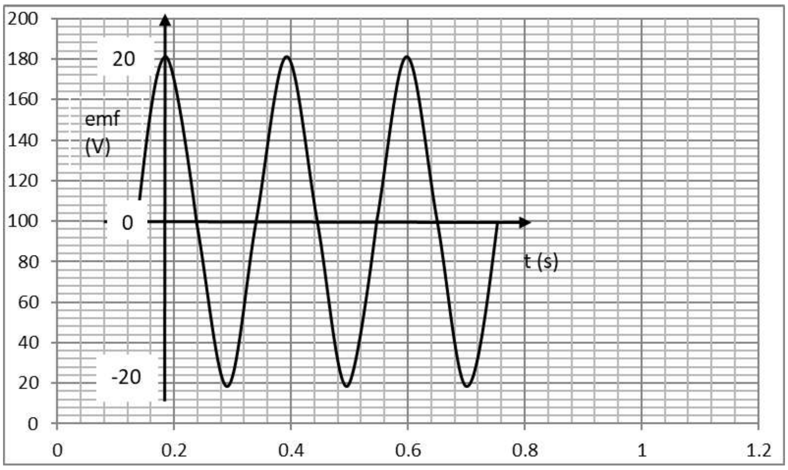
9.1 State …

9.1.1 the direction of the induced current in the left side of the coil marked AB. State only (A to B, or B to A). (1)

9.1.2 the name of the law that relates the induced emf to the rate of change of magnetic flux in the coil. (1)

9.1.3 what should be done to change this generator to a DC generator. (2)

9.2 The shape of the emf of this generator between the points **E** and **F** is shown below**.** The peak emf output is 20 V as shown in the graph.



9.2.1 The above output is reproduced for you on the ANSWER SHEET attached to the question paper. On the same set of axes, draw the output emf if the speed of the coil is halved. (2)

9.2.2 Explain the change, if any, on the emf graph. (2)

9.3 Calculate the average power of this generator. (5)
[13]

QUESTION 10 (Start on a new page.)

An experiment was conducted to demonstrate the photoelectric effect. Light of a certain frequency was shone onto a metal surface of a photocell and the corresponding maximum kinetic energy of the released electrons was measured. This was repeated for several other frequencies while still using the same metal. The results are recorded in the table below.

Frequency of photons ($\times 10^{14}$ Hz)	**Maximum kinetic Energy $E_{k\,(max)}$ ($\times 10^{-19}$ J)**
5,49	0,72
6,91	1,63
7,41	1,92
8,23	2,53
9,61	3,39
11,83	4,83

10.1 Define the term *photoelectric effect*. (2)

10.2 Formulate an investigative question for this investigation. (2)

10.3 Identify the …

10.3.1 independent variable. (1)

10.3.2 controlled variable. (1)

10.4 Use the information given in the table above and draw a graph of maximum kinetic energy ($E_{k(max)}$) versus frequency on the attached ANSWER SHEET. (4)

10.5 Use the graph to determine the …

10.5.1 threshold frequency of the metal in the photoelectric cell. (1)

10.5.2 work function of the metal used as the cathode in the photocell. (3)

[14]

TOTAL: 150

END

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m\cdot s^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
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	$9{,}11 \times 10^{-31}\ kg$
Mass of earth	M	$5{,}98 \times 10^{24}\ kg$
Radius of earth	R_E	$6{,}38 \times 10^{6}\ m$

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 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE

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

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ or $E_P = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

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

ELECTROSTATICS

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

ELECTRIC CIRCUITS

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

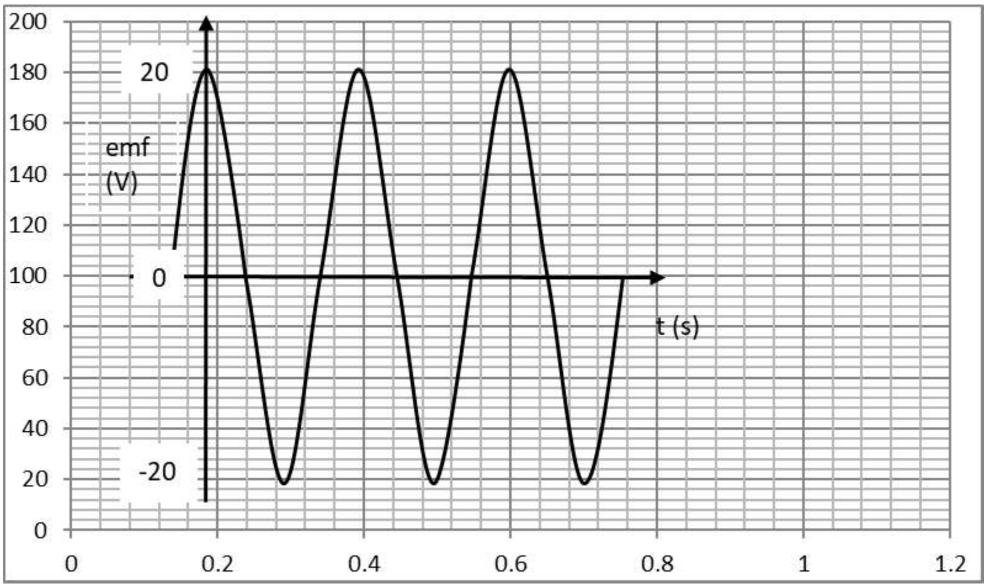
ALTERNATING CURRENT

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

ANSWER SHEET

Name: ____

QUESTION 9.2.1



QUESTION 10.4