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HeronBridge
COLLEGE

PHYSICAL SCIENCE
EXAMINATION
PAPER 1 - PHYSICS

GRADE 12

SEPT 2018

TIME: 3 hrs

MARKS: 200

Examiner: M Janneker

Moderator: B Beukes

INSTRUCTIONS

1. This examination consists of:
 - a question paper of 16 pages;
 - an answer sheet of 2 pages; and
 - a data and formulae sheet (pages i – ii).

Please make sure that your question paper is complete.

2. Read the questions carefully.
 3. It is in your own interest to write legibly and to set your work out neatly.
 4. Use the data and formulae whenever necessary.
 5. Show your working in all calculations.
 6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
-

NAME: _____

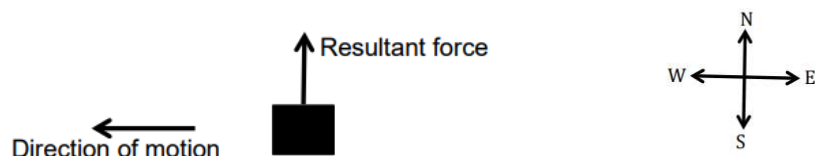
GRADE 12____

QUESTION 1 MULTIPLE CHOICE

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Answer this question on the ANSWER SHEET. Mark the answer of your choice with an X.

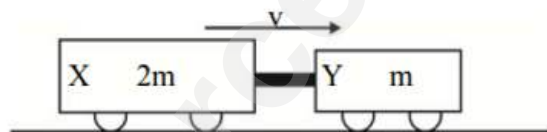
- 1.1 Which group of quantities contain only vectors?
- A acceleration, momentum, speed
 - B velocity, weight, electric field
 - C energy, momentum, velocity
 - D work, electric field, acceleration
- 1.2 Two identical bodies fall from different heights in a vacuum. When at a height of 1 m above the ground both bodies have the same
- A momentum.
 - B kinetic energy.
 - C velocity.
 - D acceleration.
- 1.3 A 20,4 kg box remains at rest on a horizontal surface whilst the box is acted upon by a horizontally applied force of 60 N. The coefficient of static friction between the box and the surface is 0,60.
- What is the force of friction acting on the box during the push?
- A 200 N
 - B 140 N
 - C 120 N
 - D 60 N

- 1.4 An object is sliding due west at constant velocity on a frictionless surface. The object suddenly experiences a resultant / net force that acts due north.



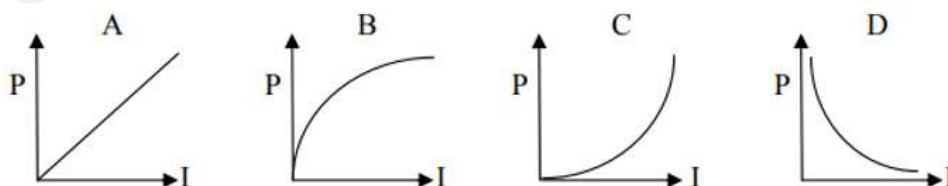
In which direction will the object accelerate?

- A North
 - B West
 - C North of west, but closer to north than west
 - D North of west, but closer to west than north
- 1.5 Two trolleys, **X** and **Y**, of masses **2m** and **m** respectively, move to the right across a horizontal frictionless surface with speed **v**. They are joined by means of a compressed spring. When the spring is released, the trolleys are pushed apart.

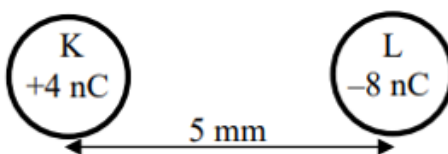


The magnitude of the change in momentum of trolley **X** is **p**. The magnitude of the change in momentum of trolley **Y** is:

- A $\frac{p}{2}$
 - B $\frac{p}{3}$
 - C **p**
 - D **2p**
- 1.6 Which one of the following graphs best represents the relationship between electrical power (**P**) and current (**I**) for a resistor of constant resistance?

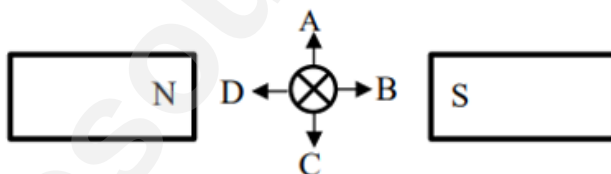


- 1.7 A metal sphere K has a charge of $+4 \text{ nC}$ and an identical sphere L has a charge of -8 nC . When the spheres are 5 mm apart, sphere K exerts a force F on sphere L.



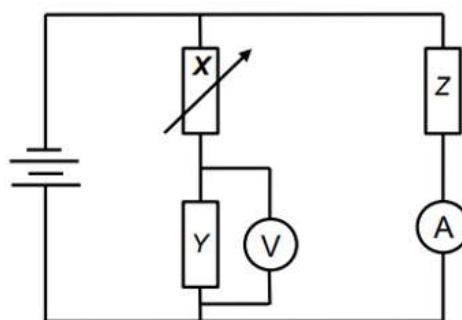
The spheres are then touched together and then replaced in their original position 5 mm apart. What is the magnitude of the force that sphere K now exerts on sphere L?

- A $\frac{1}{8}F$
 B $\frac{1}{4}F$
 C $\frac{1}{2}F$
 D F
- 1.8 A conductor carries a current perpendicularly into the page between the poles of two magnets as shown in the diagram. In what direction will the conductor experience a force?



- 1.9 An electrical circuit with three different resistors is connected as shown across a battery of negligible internal resistance.

How do the readings on the ammeter and voltmeter change as the resistance of the variable resistor X is increased?



	Ammeter	Voltmeter
A	Decreases	Increases
B	Increases	Decreases
C	No change	Decreases
D	No change	Increases

- 1.10 Light of a certain frequency causes electrons to be emitted from the surface of a metal. Which one of the following changes to the light will increase the number of electrons emitted per second from the surface of the metal? Using light with a greater

A frequency.
B intensity.
C wavelength.
D energy.

[10x2=20]

QUESTION 2

- 2.1 A ball is thrown vertically upwards from a point on top of a tall building. It just misses the building on the way back down and passes a point 48,77 m below its starting point 5 s after it leaves the thrower's hand. Ignore any frictional forces acting on the ball.

2.1.1 Show that the ball was thrown upwards with an initial velocity of 14,75 m.s⁻¹. (5)

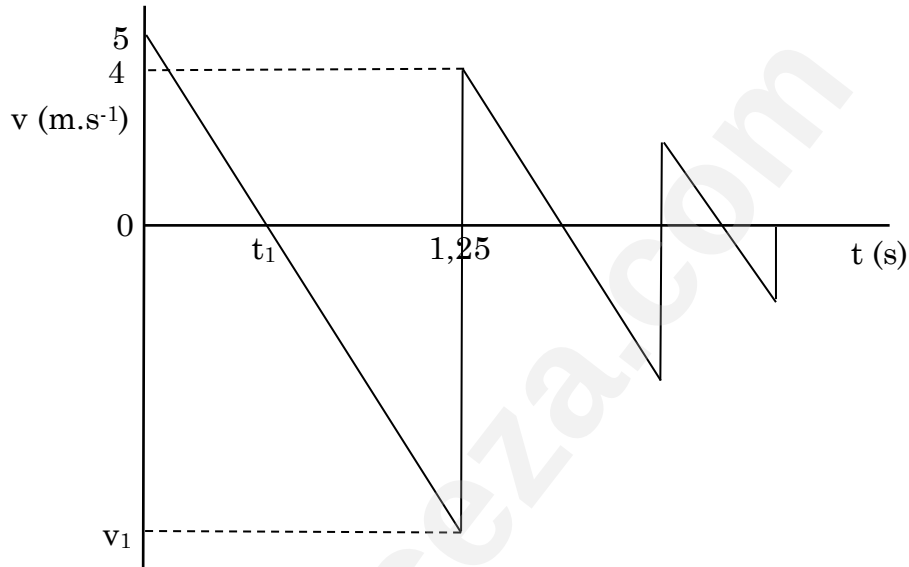
2.1.2 How high did the ball rise above its starting point? (4)

2.1.3 What was the magnitude of its velocity as it passed a point 19,5 m below the starting point? (4)

[13]

- 2.2 A tennis player tosses a ball vertically upwards but fails to strike the ball with the racquet whilst attempting a serve. The ball falls to the ground and bounces before eventually coming to rest. Ignore any frictional forces acting on the ball.

The sketch graph of velocity against time for the tennis ball is given below.



- 2.2.1 With what velocity was the ball tossed upwards? (1)
- 2.2.2 Calculate the time t_1 . (3)
- 2.2.3 What does this time t_1 value represent? (1)
- 2.2.4 Calculate the magnitude of the velocity v_1 . (3)
- 2.2.5 What happened at the time of 1,25 s? (1)
- 2.2.6 Use properties of the given graph to determine the height from which the ball was tossed by the player. (4)

[13]

- 2.3 A student determined to test the law of gravity for himself walks off a skyscraper 274,3 m high, stopwatch in hand and starts his *free fall* (zero initial velocity). Five seconds later, Superman arrives at the scene and dives off the roof to save the student.

2.3.1 What is meant by “*free fall*”? (1)

2.3.2 Calculate the time it will take the student to strike the ground below. (4)

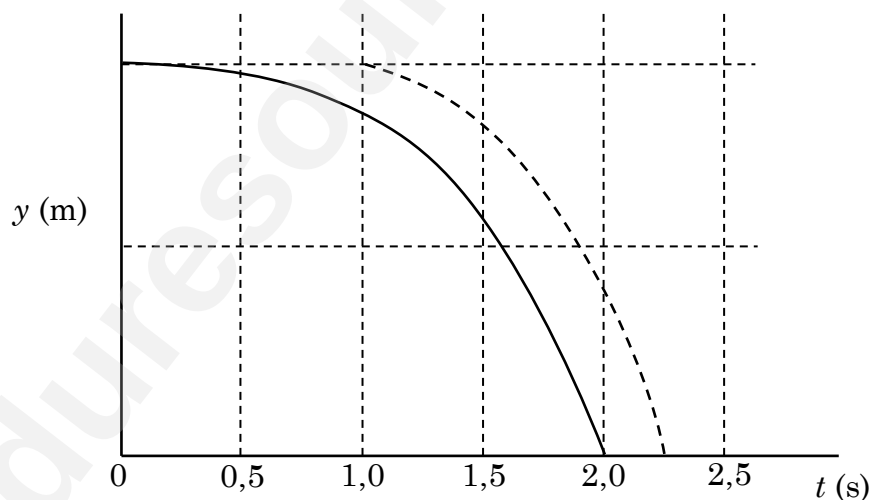
2.3.3 What must Superman’s initial velocity be in order that he catch the student just before the ground is reached? (Assume that Superman’s acceleration is that of any freely falling body.) (4)

[9]

- 2.4 At time $t = 0$, apple 1 is dropped from a bridge onto a road beneath the bridge. One second later, apple 2 is thrown down from the same height.

The graph below gives the vertical positions y of the apples versus t during the fall until both apples have hit the road. Ignore any frictional forces acting on the two apples.

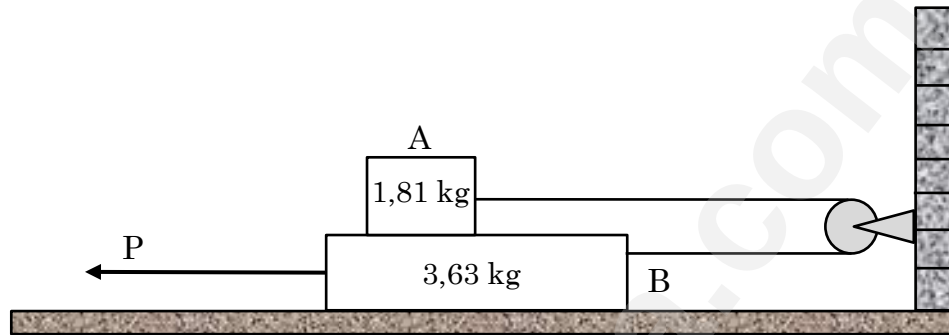
With approximately what speed is apple 2 thrown down? [7]



[42]

QUESTION 3

Block **A** in the diagram below has a mass of 1,81 kg and block **B** has a mass of 3,63 kg. The coefficient of static friction between **all** the surfaces is 0,25. Blocks **A** and **B** are connected by a light flexible cord passing around a small frictionless pulley that is fastened to a wall. The cord will not stretch when it is pulled at its ends.



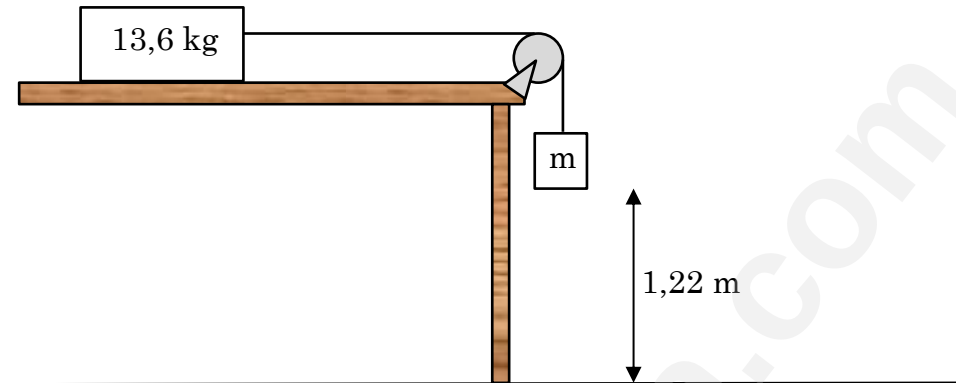
The magnitude of the applied force **P** is such that the block **B** is **just about to move**.

- 3.1 Define a *friction force* due to a surface. (2)
- 3.2 Draw separate free body diagrams for the two blocks. Label the force diagrams clearly. (5)
- 3.3 The horizontal forces acting on each of the two blocks are balanced. Explain what is meant by saying the '*forces are balanced*'. (1)
- 3.4 Calculate the magnitude of the frictional force acting on block **A**. (3)
- 3.5 What is the magnitude of the tension in the cord connecting blocks **A** and **B**? (2)
- 3.6 Calculate the magnitude of the frictional force acting on block **B** due to the surface on which it rests. (3)
- 3.7 Find the magnitude of the force **P**. (3)

[19]

QUESTION 4

A 13,6 kg block on a level frictionless surface is attached by a light, inelastic, flexible cord passing over a small frictionless pulley to a hanging block **m** originally at rest 1,22 m above the floor.



When the hanging block is released, it strikes the floor in 2 s.

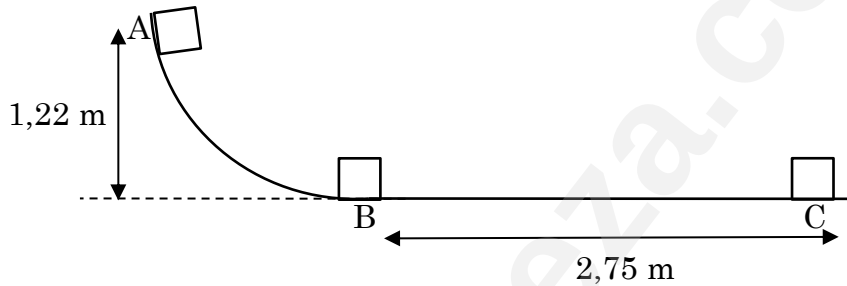
- 4.1 State *Newton's second law of motion*. (2)
- 4.2 Calculate the acceleration of the block **m**. (4)
- 4.3 Find the mass of the hanging block **m**. (5)
- 4.4 Calculate the tension in the cord while both blocks were in motion. (2)

[13]

QUESTION 5

A block of mass $0,5 \text{ kg}$ is released from rest at point A on a track. Point A is at a vertical height of $1,22 \text{ m}$ above the horizontal section B to C. The block slides down the track and reaches point B with a speed of $3,66 \text{ m}\cdot\text{s}^{-1}$.

From point B it slides on the horizontal section a distance of $2,75 \text{ m}$ to point C, where it comes to rest.

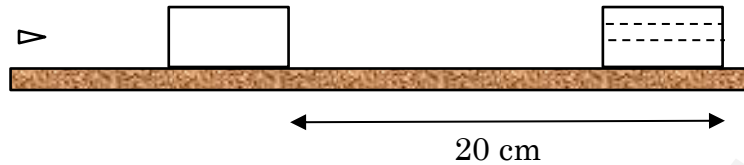


- 5.1 Calculate the gravitational potential energy of the block at point A. (3)
- 5.2 Calculate the block's kinetic energy when it reaches point B? (3)
- 5.3 How much work was done against friction as the block slid down the circular arc from A to B? (2)
- 5.4 Calculate the coefficient of sliding friction on the **horizontal surface** between B and C. (6)

[14]

QUESTION 6

A bullet of mass 2 g, travelling in a horizontal direction with a velocity of 500 m.s^{-1} , is fired into a wooden block of mass 1 kg, initially at rest on a horizontal surface.



The bullet passes through the block and emerges with its velocity reduced to 100 m.s^{-1} . The block slides a distance of 20 cm along the surface from its initial position before coming to rest again.

- 6.1 State the *law of conservation of linear momentum*. (2)
- 6.2 Determine the velocity of the block immediately after the bullet has exited the block. Assume that the block's mass is unchanged as a result of the bullet passing through it. (5)
- 6.3 Determine whether the collision is *elastic* or *inelastic*. (5)
- 6.4 Use the work-energy theorem to determine the magnitude of the average friction force acting on the block as it slides across the horizontal surface. (5)

[17]

QUESTION 7

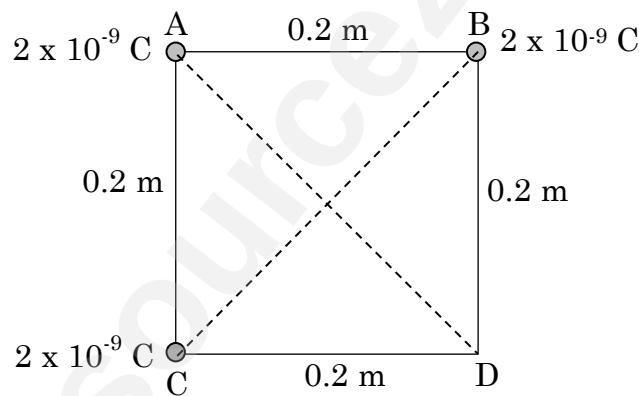
- 7.1 The gravitational acceleration on a planet can be calculated using the equation below:

$$g = G \frac{M}{r^2}$$

The gravitational acceleration on Earth is $9,8 \text{ m.s}^{-2}$.

If the mass of the Moon is $\frac{1}{81}$ times smaller than the Earth's mass, and its radius $\frac{1}{4}$ that of Earth's, show that the gravitational acceleration on the surface of the Moon is approximately one-fifth that of Earth. [4]

- 7.2 Three point charges of $2 \times 10^{-9} \text{ C}$ are situated at each of three corners of an imaginary square ABCD whose side is 0.2 m . The diagram below is not drawn to scale.



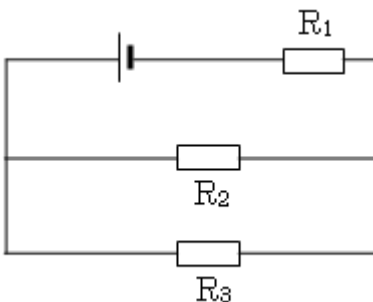
- 7.2.1 State *Coulomb's Law*. (2)
- 7.2.2 Draw a diagram to show the electric field lines for a small positive point charge. (3)
- 7.2.3 A fourth small point charge of $-1 \times 10^{-9} \text{ C}$ is placed at the centre of the square. Explain why the net or resultant force on this point charge due to the charges at **B** and **C** in the square is zero. (2)
- 7.2.4 Calculate the magnitude and direction of the net or resultant force on the point charge of $-1 \times 10^{-9} \text{ C}$ at the centre of the square? (4)

[11]

[15]

QUESTION 8

- 8.1 In the electrical circuit below, the battery has an $emf = 6\text{ V}$, $R_1 = 100\ \Omega$, $R_2 = 300\ \Omega$ and $R_3 = 600\ \Omega$. The battery has negligible internal resistance.



Calculate:

- 8.1.1 the equivalent resistance of the 3 resistors. (4)
- 8.1.2 the potential difference across R_1 . (4)
- 8.1.3 the current through R_3 . (3)
- 8.1.4 the power generated (or rate of energy transfer) by R_3 . (3)
- [14]
- 8.2 This question refers to the circuit in 8.1 above.

If the battery had in fact some measurable *internal resistance*, give a qualitative indication of the amount of lost volts (i.e. small or large) during the operation of the circuit. Support your answer with a suitable reason. [3]

- 8.3 Two filament type light bulbs are marked “60 W, 120 V” and “40 W, 120 V”.

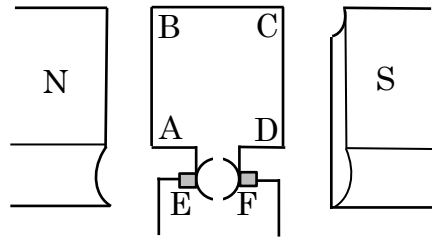
This information tells us that if the potential difference across each of the light bulbs is 120 V, they will generate 60 W and 40 W of power respectively. Since the power rating of a light bulb is a measure of its brightness, the 60 W light bulb will burn brighter than the 40 W light bulb.

If these two light bulbs are now connected in series across a potential difference of 120 V, calculate the power generated by each light bulb. (Assume that the resistance of the filaments does not vary with current.) [8]

[25]

QUESTION 9

9.1 The diagram below is a simplified representation of a simple d.c. motor.



9.1.1 Name the energy conversion that occurs during the operation of the motor. (2)

9.1.2 When the brushes labelled E and F are connected to a battery, the coil (armature) labelled ABCD will begin to rotate.

If the brush E is connected to the positive terminal and brush F connected to the negative terminal of the battery, in which direction will the coil (armature) rotate?

(2)

Answer either CLOCKWISE or ANTI-CLOCKWISE.

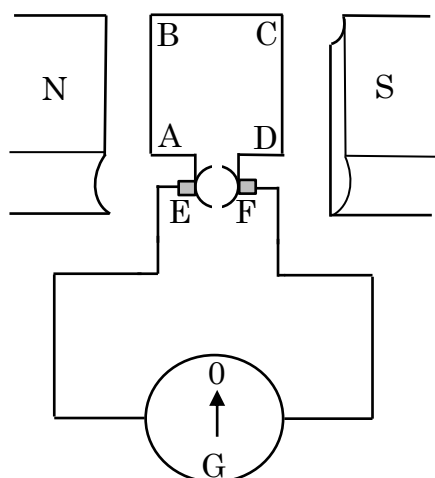
9.1.3 The split ring commutator plays an important role in the operation of the motor. Describe the function(s) of the split ring commutator. (2)

9.1.4 In larger electric motors, the turning force of the coil (armature) is increased to meet the specific requirements for its application.

Name TWO way in which the turning force of the coil (armature) can be increased. (2)

[8]

- 9.2 The battery that was connected to the d.c. motor in 9.1 above, is replaced with a sensitive galvanometer.



When the coil (armature) of the motor is turned (rotated) by hand in a clockwise direction, the needle of the galvanometer is seen to deflect from zero to the right and then back to zero. This movement of the needle of the galvanometer will only occur when the coil is rotated. Furthermore, the movement of the needle from zero to the right and back to zero occurs for every clockwise half cycle of rotation of the coil.

When the coil (armature) of the motor is rotated by hand in the anti-clockwise direction, the needle of the galvanometer is seen to deflect from zero to the left and back to zero for every half cycle rotation.

- 9.2.1 The d.c. motor is now being operated as a new device. Identify this new device. (1)
- 9.2.2 Name the principle on which the device identified in 9.2.1 functions. (1)
- 9.2.3 Name the rule that can be applied to the device to identify the direction of the induced current that flows in the coil (armature). (1)
- 9.2.4 The coil ABCD is initially in the horizontal position as indicated in the diagram. The coil is rotated in an anti-clockwise direction. Identify the direction of the induced current in the coil for the first half cycle of rotation.

Answer either ABCD or DCBA. (2)

- 9.2.5 Draw a sketch graph of current against cycle of rotation for one complete rotation of the coil. Start with the coil in the horizontal position. (2)

[7]

- 9.3 A step-down transformer is to be connected to a 120 V alternating current source in order to deliver 6 V at the secondary terminals.
(Assume there are no energy losses during the operation of the transformer.)

9.3.1 If the secondary coil has 80 turns of wire, how many turns should the primary coil have? (3)

9.3.2 If the secondary current is 30 A, calculate the primary current. (3)

9.3.3 What is the power output of the transformer. (2)

[8]

[23]

QUESTION 10

The *threshold frequency* of copper metal is 9.4×10^{14} Hz.

10.1 Define *threshold frequency*. (2)

10.2 How much work is needed to free an electron from the surface of copper, in joules (J)? (3)

10.3 How much work is needed to free an electron from the surface of copper, in electron-volts (eV)? (2)

10.4 Light of wavelength 3.0×10^{-7} m is shone onto the clean surface of copper.

Calculate the maximum kinetic energy this light can give to an ejected electron.

(5)

[12]

TOTAL : 200 MARKS