CAPE WINELANDS PLC COMMON PAPER

PHYSICAL SCIENCES - PAPER 1 **SEPTEMBER 2018**

GRADE 12 **TIME: 3 HOURS**

EXAMINERS: CWED PLC **TOTAL: 150**
MODERATOR: A WESSELS & MZ MOERAT

INSTRUCTIONS AND INFORMATION

1. Write your name in the space below and submit the Examination Paper with your Answer Book.

   NAME: ……..

2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.

3. Number the answers correctly according to the numbering system used in this question paper

4. Leave ONE line between two sub questions, 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 motivations, discussions etc where required.

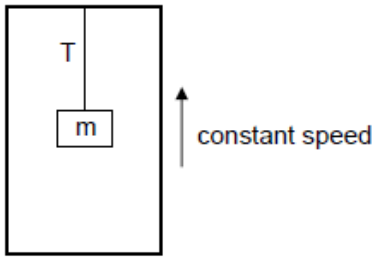
QUESTION 1 (Multiple-choice)

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) on your ANSWER BOOK.

1.1 Which ONE of the following forces always acts perpendicular to the surface on which a body is placed?

A Normal force
B Frictional force
C Gravitational force
D Tension force (2)

1.2 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 is equal to **mg**.
B is less than **mg**.
C is greater than **mg**.
D cannot be determined without knowing the speed of the lift cage. (2)

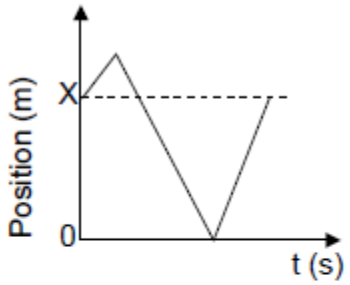
1.3 Which ONE of the following statements is always TRUE for inelastic collisions in an isolated system?

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

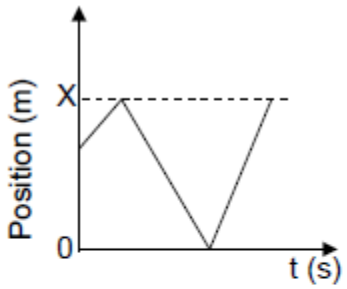
(2)

1.4 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?

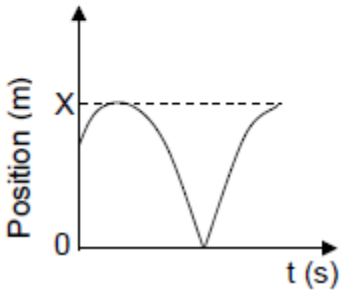
A



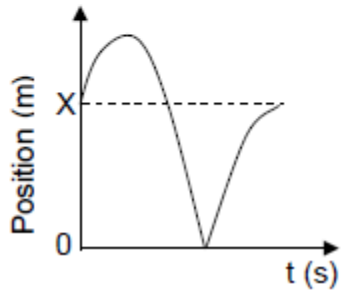
B



C



D



(2)

1.5 The speed of a bicycle increases from 2 m•s^{-1} to 8 m•s^{-1}. Its kinetic energy increases by a factor of

A 4.
B 6.
C 8.
D 16.

(2)

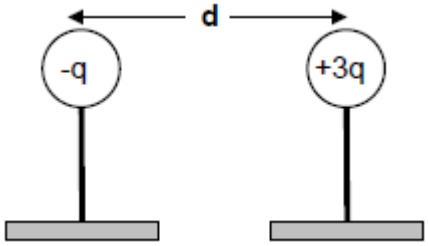
1.6 The hooter of a car emits sound of constant frequency as the car moves away from a stationary listener.

Which of the following properties of the sound heard by the listener will NOT change?

A Velocity
B Frequency
C Both wavelength and frequency
D Both frequency and loudness

(2)

1.7 Two small identical metal spheres, on insulated stands, carry charges **-q** and **+3q** respectively.
When the centres of the spheres are a distance **d** apart, the spheres exert an electrostatic force of magnitude **F** on each other.



The spheres are now made to touch and are brought back to the same positions as before.

The magnitude of the electrostatic force which the spheres now exert on each other, in terms of **F**, is:

A $\frac{4}{3}F$

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

C $\frac{1}{2}F$

D $3F$

(2)

1.8 The minimum value of the resistance that can be obtained by connecting two 4 Ω resistors is …

A 1 Ω
B 2 Ω
C 3 Ω
D 8 Ω

(2)

1.9 Which ONE of the energy conversions below takes place when a DC motor is in operation?

A Kinetic to electrical
B Heat to mechanical

C Mechanical to electrical
D Electrical to mechanical (2)

1.10 Light of a certain frequency is shone onto a metal **M** and electrons are ejected from the surface. The same source of light is shone onto another metal **N**.

The electrons ejected from the surface of metal **N** have a much higher kinetic energy than that from metal **M**.

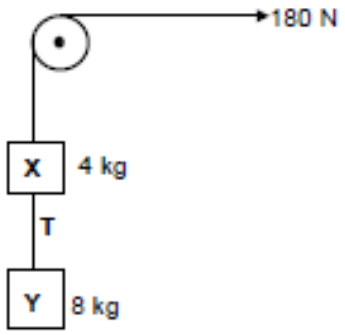
This means that …

A metal **N** has the same work function as metal **M**.
B metal **N** has a larger work function than metal **M**.
C the threshold frequency of metal **N** is higher than that of metal **M**.
D the threshold frequency of metal **N** is lower than that of metal **M**. (2)

[20]

QUESTION 2 (Start on a new page)

2.1 Block **X** of mass 4 kg is connected to block **Y** of mass 8 kg by a light, inextensible string. Another light, inextensible string attached to block **X** runs over a frictionless pulley. The system is pulled by means of a constant force of 180 N as shown in the diagram below. The magnitude of the tension between the two blocks is **T**. Ignore the effects of air resistance.



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

2.1.2 Draw a labelled free body diagram showing ALL the forces acting on object **X**. (3)

2.1.3 Calculate the:

(a) tension **T** in the string connecting the two blocks. (5)

(b) magnitude of the acceleration of block **X**. (2)

2.2 A 400 kg research satellite is orbiting the Earth at a certain average height above the Earth's surface. The Earth exerts a force of 2×10^3 N on the satellite to keep it in orbit.

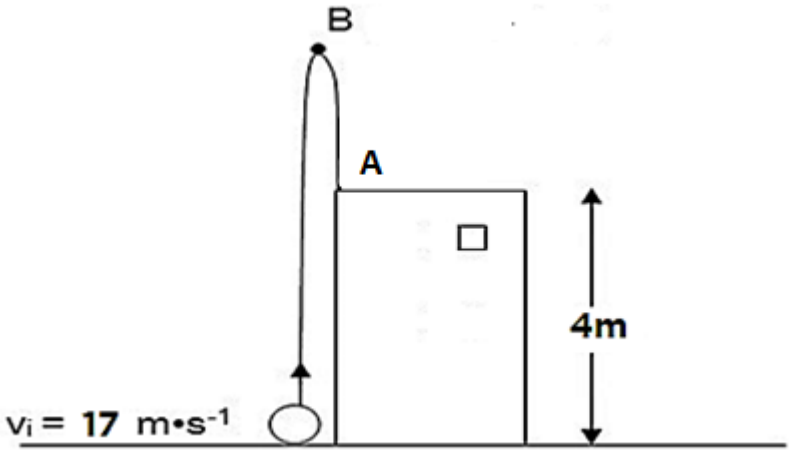
2.2.1 What magnitude of force does the satellite exert on the Earth? (1)

2.2.2 Calculate how many kilometers **above** the Earth's surface the satellite is moving. (5)

[18]

QUESTION 3 (Start on a new page)

A ball is projected vertically upwards from the ground with a speed of 17 m•s^{-1}. It passes the roof of a 4 m tall building on its way up and reaches its maximum height at **B**. On its way down, the ball strikes the roof of the building at point **A** as shown in the diagram below. Ignore the effects of air friction.



3.1 Write down the magnitude and direction of the acceleration of the ball at point **B**. (2)

3.2 Calculate the following regarding the ball:

3.2.1 The time taken to reach point **B** above the ground. (3)

3.2.2 The velocity at the instant it strikes the roof at point **A**. (3)

3.3.3 The total time it takes from the instant it is projected to the time it strikes the roof at point **A**. (4)

3.3 Sketch the velocity-time graph for the motion of the ball from the ground up until it hits the roof of the building.

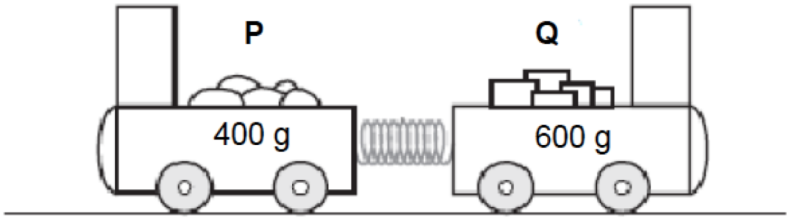
Indicate the following on your graph:

i) initial velocity
ii) time at point **B** (the maximum height)
iii) final velocity (4)

[16]

QUESTION 4 (Start on a new page)

The diagram below shows two trolleys, **P** and **Q**, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of **P** and **Q** are 400 g and 600 g respectively.



When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley **Q** then moves to the right at 4 $m.s^{-1}$.

4.1 State the *Principle of Conservation of Linear Momentum* in words. (2)

4.2 Calculate the:

4.2.1 Velocity of trolley **P** after the trolleys are released. (4)

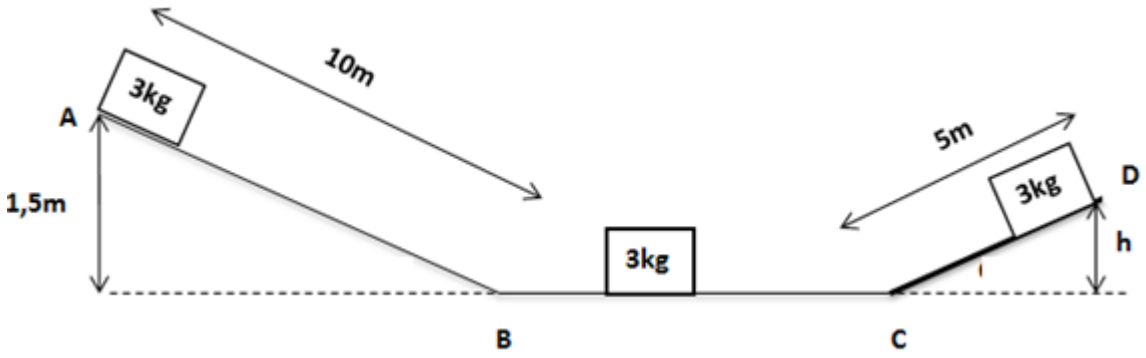
4.2.2 Magnitude of the average force exerted by the spring on trolley **Q.** (4)

4.3 How does the acceleration of trolley **P** compare to that of trolley **Q?** Choose from GREATER THAN, SMALLER THAN and THE SAME AS. (1)

[11]

QUESTION 5 (Start on a new page)

A 3 kg block is released from rest at point **A** from a height of 1,5 m and slides down a 10 m long frictionless incline to point **B** as shown in the diagram below. It then moves along a frictionless horizontal surface **BC**, and finally slides up a 5 m long rough inclined plane **CD**. It comes to a rest at point **D** at an unknown height **h** above the ground.



5.1 Use energy principles to show that the velocity of the block at point **B** is 5,42 $m.s^{-1}$. (3)

5.2 What is the net work done on the block from point **B** to **C** ? Give a reason for your answer. (2)

The work done by friction on the block while it moves up the incline **CD** is 30 J.

5.3 State the *Work- Energy Theorem* in words. (2)

5.4 Draw a free body diagram and show ALL the forces acting on the block as it moves up the incline from **C** to **D.** (3)

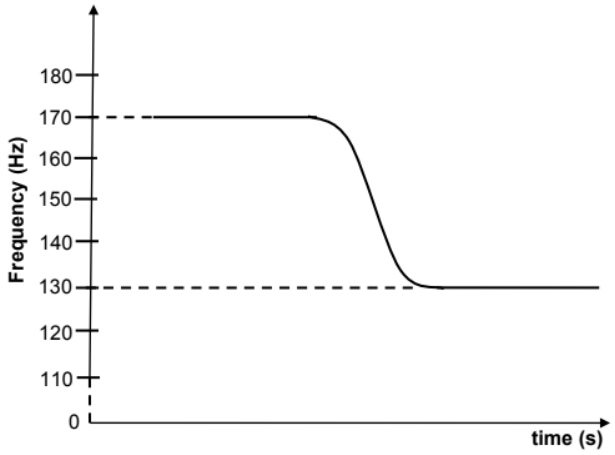
5.5 Calculate the height **h** of the incline **CD**. (5)

[15]

QUESTION 6 (Start on a new page)

A police car moving at constant velocity with its siren on, passes a stationary listener.

The graph below shows the changes in the frequency of the sound of the siren detected by the listener.



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

6.2 Write down the frequency of the sound detected by the listener as the police car:

6.2.1 Approaches the listener. (1)

6.2.2 Moves away from the listener. (1)

6.3 Calculate the speed of the police car. Take the speed of sound in air to be 340 $m.s^{-1}$. (6)

The Doppler effect is applicable to both sound and light waves. It also has very important applications in our everyday lives.

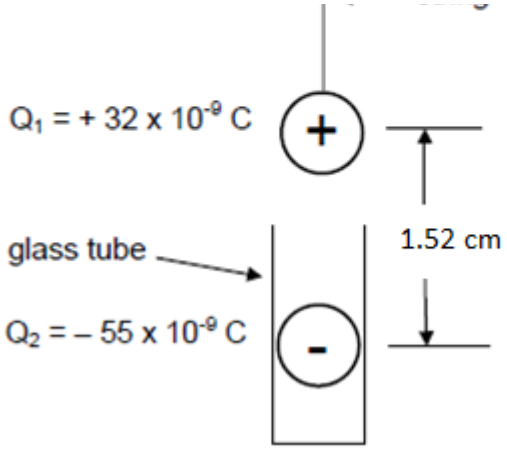
6.4 Name ONE application of the Doppler effect. (1)

6.5 Use your knowledge of the Doppler effect to explain red shifts. (2)

[13]

QUESTION 7 (Start on a new page)

A small sphere, $\mathbf{Q_1}$, with a charge of +32 x 10^{-9} C, is suspended from a light string secured to a support. A second, identical sphere, $\mathbf{Q_2}$, with a charge of – 55 x 10^{-9} C, is placed in a narrow, cylindrical glass tube vertically below $\mathbf{Q_1}$. Each sphere has a mass of 7 g. The spheres come to equilibrium when $\mathbf{Q_2}$ is 1,52 cm from $\mathbf{Q_2}$, as shown in the diagram. Ignore the effects of air friction.



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

7.2 Draw a labelled free-body diagram showing all the forces acting on sphere $\mathbf{Q_1}$. (3)

7.3 Calculate the magnitude of the tension in the string. (5)

[10]

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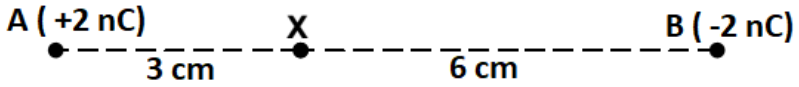
QUESTION 8 (Start on a new page)

The diagram below shows two small, identical metallic spheres, **A** and **B**. Sphere **A** carries a charge of +2 nC, while sphere **B** carries a charge of -2 nC. **X** is a point between **A** and **B**. The distance between sphere **A** and point **X** is 3 cm, while the distance between sphere **B** and **X** is 6 cm.



8.1 Define the term *electric field at a point.* (2)

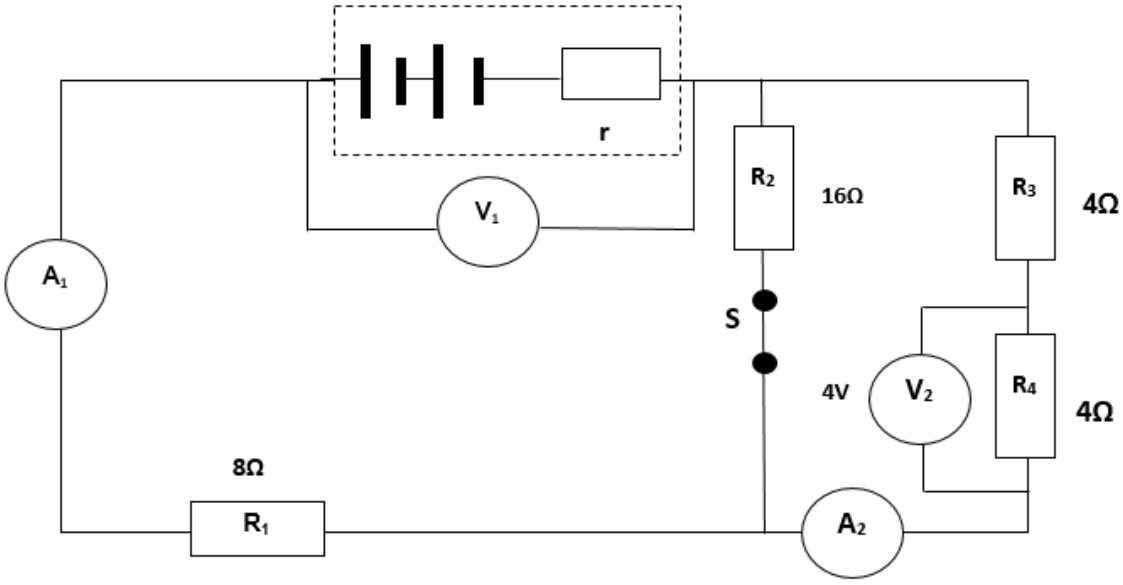
8.2 Draw the electric field pattern surrounding the two spheres **A** and **B**. (3)

8.3 Determine the magnitude and direction of the net electric field strength at point **X**. (6)

[11]

QUESTION 9 (Start on a new page)

The battery has an emf of 24 V in the circuit shown below. When switch **S** is closed, the reading on $\mathbf{V_1}$ is 20 V and the reading on $\mathbf{V_2}$ is 4 V. The resistance of the different resistors is shown in the diagram. The resistance of the ammeter and connecting wires can be ignored.



9.1 Calculate the reading on ammeter $\mathbf{A_2}$. (3)

9.2 Calculate the reading on ammeter $\mathbf{A_1}$. (3)

9.3 Calculate the resistance for the parallel combination. (3)

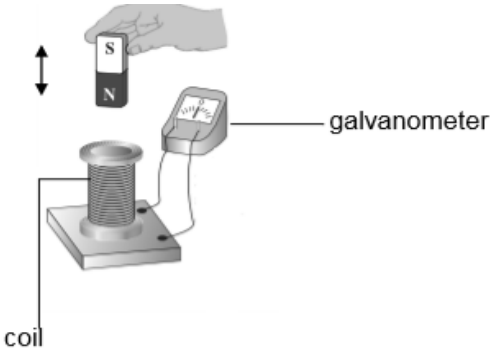
9.4 Calculate the internal resistance of the battery. (3)

9.5 Explain how the reading on $\mathbf{V_1}$ is influenced if switch **S** is opened. (2)

[14]

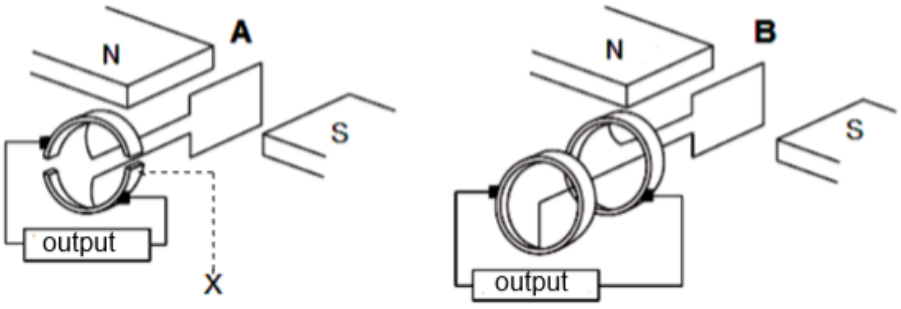
QUESTION 10 (Start on a new page)

10.1 A teacher demonstrates how current can be induced using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



Briefly describe how the magnet has to be moved in order to obtain a GREAT deflection on the galvanometer. (2)

10.2 The two devices, **A** and **B**, below operate on the principle described in QUESTION 10.1 above.



10.2.1 Write down the name of the principle. (1)

10.2.2 Write down the name of part **X** in device **A**. (1)

10.3 A 220 V, AC voltage is supplied from a wall socket to an electric kettle of resistance 40,33 Ω. Wall sockets provide rms voltages and currents.

Calculate the:

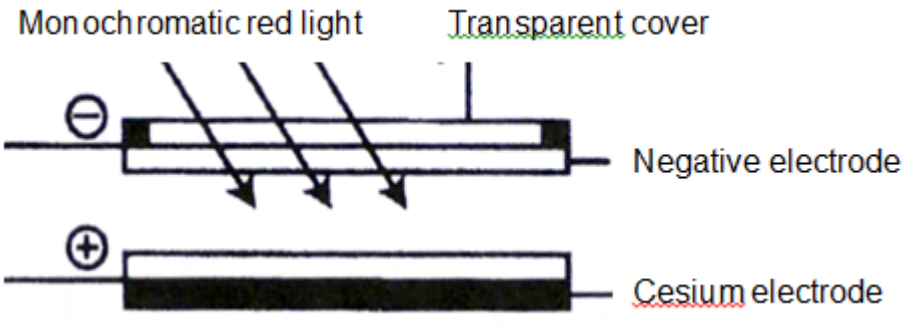
10.3.1 Electrical energy consumed by the kettle per second. (3)

10.3.2 Maximum (peak) current through the kettle. (4)

[11]

QUESTION 11 (Start on a new page)

11.1 The picture below shows the components of a photocell used in the light meter of a camera.



The photocell consist of 'n cesium cathode with a small work function. When monochromatic red light from a 50 W bulb reaches the cathode of the photocell, a small electric current is registered on the light meter.

11.1.1 Name the phenomenon illustrated above. (1)

11.1.2 What is the effect on the current when the 50 W bulb is replaced with a 100 W bulb of the same color? Give a reason for your answer. (2)

11.1.3 What is the effect on the kinetic energy of the photo electrons if the 50 W red light is replaced with a 50 W blue light? Give a reason for your answer. (3)

11.2 A photon from infrared light with energy $2{,}95 \times 10^{-20}$ J is incident on a metal surface with a work function of 1×10^{-20} J. Calculate the speed of the photoelectron that is emitted. (5)

[11]

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