Name: _____

| GRADE 12 | **PHYSICAL SCIENCE** | 3 HOURS |
| TRIALS | **PAPER 1 (PHYSICS)** | 150 MARKS |

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PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- a question paper of 8 pages
- a data and formula booklet of 2 pages

   Make sure that your question paper is complete.

2. Remove the pages of data and formulae from the end of this question paper.

3. Use the data and formulae whenever necessary.

4. Read the questions carefully.

5. It is in your own interest to write legibly and to set your work out neatly.

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QUESTION 1   PENDULUM EXPERIMENT

An experiment is performed in order to determine the frictional force exerted by a horizontal surface. A pendulum bob with a mass of 0,5kg is released from a vertical height of 600mm (as illustrated in the diagram) with an initial velocity of $2\text{m}\cdot\text{s}^{-1}$. When it reaches the lowest point of its swing, it collides with a stationary cube of mass 100g. The bob and the cube are in contact for 0,006 seconds. After the collision, the cube slides along the horizontal surface being investigated with an initial velocity of $3,5\text{m}\cdot\text{s}^{-1}$.
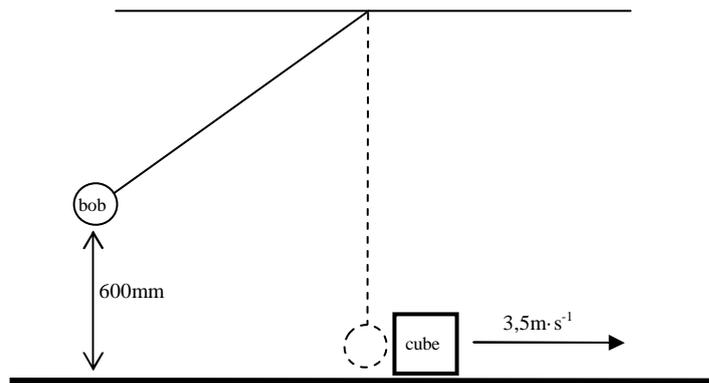
1.1   Calculate the kinetic energy of the bob as it is released from its initial position.   (2)

1.2   Use the principle of conservation of mechanical energy to show that the magnitude of the velocity of the bob is 4 m·s^{-1} when it hits the cube.   (4)

1.3   Determine the velocity of the bob after it collides with the cube.   (4)

1.4   Is the collision elastic? Support your answer with suitable calculations and explanations.   (4)

1.5   Calculate the force exerted by the bob on the cube during the 0,006s that they are in contact.   (3)

The experiment described above is used by a scientific consulting company in order to determine the frictional force exerted by various flooring materials for use in a supermarket. A frictional force of at least 5N must be exerted on the cube in order for the flooring to meet safety standards.

1.6.1   State the independent variable in this experiment.   (1)

1.6.2   State the dependent variable in this experiment.   (1)

The scientist performing the experiment measures the distance travelled by the 100g cube before it comes to rest. She then uses this measurement in order to calculate the frictional force exerted by the surface.

1.7   Suggest an alternative measurement that could be made, in place of the distance measurement.   (1)

1.8   Determine the deceleration of the cube that would be produced by a 5N frictional force.   (3)

1.9   Determine the maximum distance that the cube can slide after being hit by the bob before coming to rest in order for the flooring material to meet the prescribed safety standards.   (3)

QUESTION 2   CASEY ON THE CLIFF

Casey is standing at the top of a cliff when a helicopter, rising vertically from the ground below the cliff, goes past at 25 m·s^{-1}. At the exact moment when the helicopter passes the top of the cliff, Adrian (a boy in the helicopter) throws his sister's favourite toy vertically downwards out of the helicopter with a speed of 5m·s^{-1}. It takes 8 seconds for the toy to reach the ground below the cliff. Air resistance can be ignored.

$v_{helicopter} = 25m·s^{-1}$
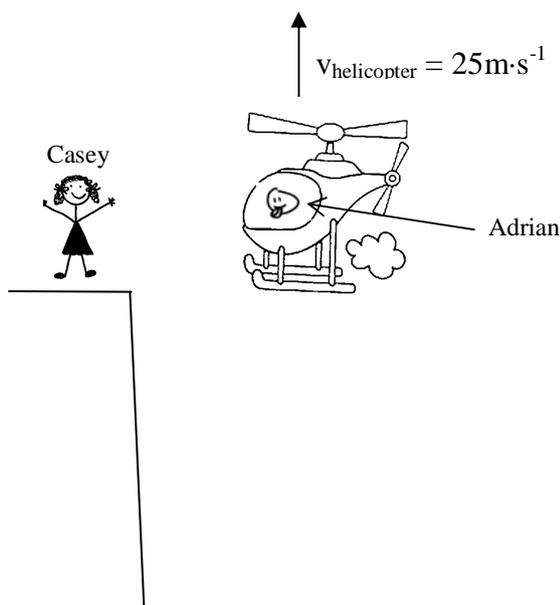
Casey

Adrian

2.1   Convert the speed of the helicopter into units of km·h^{-1}.   (1)

2.2   What is the initial velocity of the toy relative to Adrian?   (2)

2.3   What is the initial velocity of the toy relative to Casey?   (2)

2.4   Calculate the height of the cliff.   (3)

2.5   Sketch a labelled velocity-time graph for the toy for the 8 seconds that it is in the air. Include all significant velocity and time values.   (4)

QUESTION 3   POWERFUL MOTOR

A shipping company uses a motor to pull crates upwards by means of a rope that winds around a spool as the motor turns. The table shown indicates the maximum constant velocity that can be maintained by the motor when it is lifting various loads at full power.

spool   motor

rope

crate
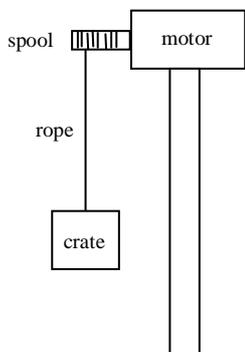
mass of load (kg)	velocity (m·s^{-1})
250	8
400	5
500	4
800	2,5
1250	1,6

3.1   State the energy conversion performed by a motor.   (2)

3.2   Use the information from the table to calculate the power of this motor.   (3)

3.3   Eskom charges R0.60 per kilowatt-hour (kWh) of electrical energy used. Calculate the cost to the shipping company of operating this motor for 20 days, 6 hours a day.   (3)

QUESTION 4   COLOURED SHIRTS

A company that specialises in dyeing textiles is using some new dye formulations. The pigments of cyan, magenta, and yellow are used to dye t-shirts to a wide range of colours.

4.1   Which colour t-shirt will result if yellow and magenta dyes are mixed? Explain your answer by describing the behaviour of white light when it encounters the shirt (use words and/or a diagram). (3)

4.2   Alana buys a <u>green</u> t-shirt which was dyed using the new formulations. After she washes her t-shirt two or three times in hot water it becomes <u>yellow</u>. Explain what has happened and make a recommendation to the dye company.   (4)

The table below indicates the approximate wavelength for various colours of light.

colour	red	green	blue
wavelength (nm)	660	540	470

4.3   Calculate the frequency of light that corresponds to green light.   (3)

4.4   A beam of light containing the three colours listed in the table is passed through a glass prism. Sketch what will be observed to emerge from the prism. Explain your prediction.   (4)

4.5   Simon is wearing sunglasses with lenses that only allow light with wavelengths longer than 600nm to pass through. What colour will a white t-shirt appear to Simon when he is wearing his sunglasses?   (2)

QUESTION 5   SOUND TECHNICIANS

The sound crew for a touring rock band is setting up the sound system prior to a large concert. Technician A positions two loudspeakers, one on each side of the stage and both facing directly out into the area where the audience will stand. In order to test loudness settings, he broadcasts a sound of a **<u>single frequency</u>** simultaneously from each speaker. Technicians B and C are standing in the audience area in order to gauge if the loudness settings are suitable. Technician B hears an extremely loud sound and says that the volume should be reduced. Technician C hears almost nothing at all and says that the volume should be increased.

5.1   Sketch a diagram to illustrate the wavefronts emanating from the two speakers. Include a heavy dot to indicate a position where Technician B might be standing.   (4)

5.2   Name the wave phenomenon that leads to Technician C hearing almost no sound whatsoever.   (2)

After discovering that Technicians B and C are hearing two different things, the 3 technicians assume that their sound equipment must have been damaged during transport. They begin to pace around the audience area, trying to decide what to do next. As they walk from one side of the audience area to the other (parallel to the stage) they discover that there are alternating regions of loud and quiet. The technicians are perplexed. They obviously don't remember their Grade 12 Physics lessons!

5.3   List two changes which will cause the width of the alternating regions to <u>decrease</u>.   (4)

5.4   Technician D is standing in a corridor at the back of the concert hall, about 10 metres from an open doorway leading to the hall. Name the phenomenon that allows him to hear the sounds coming from the hall, despite the fact that the walls are sound-proof.   (1)

5.5   Briefly explain why the pattern of loud and soft regions is not detected by the audience during the actual rock concert.   (2)

QUESTION 6   BURGLAR ALARM

Some motion-sensing burglar alarms make use of ultrasound waves (frequency 30 kHz). Waves sent out from the device are reflected by all objects in the room. If the reflecting objects are stationary then the reflected waves that reach the device's receiver have the same frequency as the outgoing wave (30 kHz). If something moves in the room then the frequency of the reflected waves is altered. Such a change will trigger the siren. The speed of sound in air is 340 m·s^{-1}.

6.1   Name the scientific phenomenon upon which this technology is based.   (2)

6.2   Calculate the wavelength of the waves being generated by the device.   (3)

6.3   How would the frequency change if a wave is reflected off a person walking towards the device? (1)

6.4   Calculate the frequency detected if a burglar is moving towards the device at a speed of 3m·s^{-1}.   (3)

6.5   Calculate the velocity (magnitude and direction) of the burglar if the detected wave has a
        frequency of 29 500 Hz.   (4)

QUESTION 7   ELECTRICITY

The diagram below is an induced emf versus time graph for a generator.
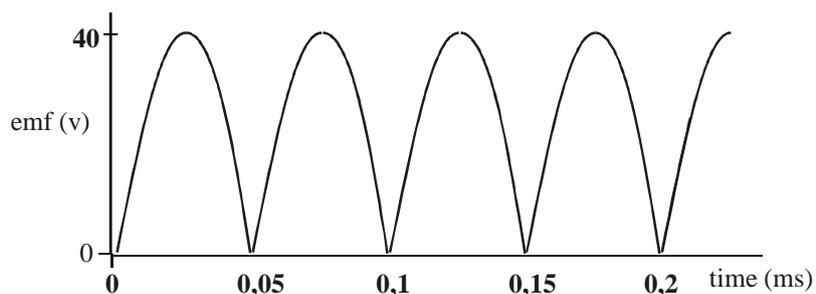
7.1   Does this graph represent an AC generator or a DC generator? Explain.   (2)

7.2   State the structural change could be performed on this generator in order to convert it to the other
        type of generator.   (2)

7.3   Which of the following diagrams correctly illustrates the position of the coil at time of 0,05ms?   (2)

A   **B**
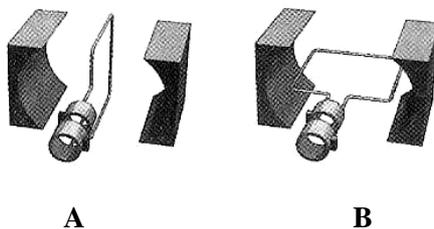
7.4   State two reasons why a generator will be less than 100% efficient, ie. state two ways that energy
        is converted into forms other than electrical energy by a generator.   (2)

7.5   Sketch a graph similar to the one above, but modify it to represent induced emf vs time if the
        generator's coil was rotated twice as fast. Be sure to include values on both axes.   (4)

7.6   List 2 methods of increasing the output of a generator <u>without</u> affecting the frequency of the
        induced emf.   (2)

Most electrical supplies are AC (alternating current) sources but many common appliances and devices require DC (direct current). Fortunately, diodes can be used to convert AC into DC. They can also be used to prevent damage to electronic devices that may be sensitive to unintended current flows.

7.7   State the characteristic behaviour of a diode which allows it to perform the functions above.   (1)

7.8   One special type of diode is the LED.

    7.8.1   What does LED stand for?   (1)
    7.8.2   List two everyday uses of LEDs.   (2)

The diagram below shows a <u>cross-sectional view</u> of a coil carrying an electric current between the poles of a magnet. The left-hand segment of the coil carries current into the plane of the paper and the right-hand segment of the coil carries current out of the plane of the paper, as shown.
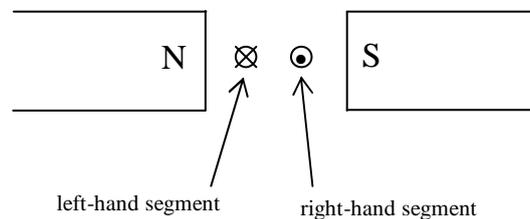
7.9   In which direction will the left-hand segment of the coil experience a force?   (1)

7.10   List 2 factors which will increase the force experienced by each segment of wire.   (2)

7.11   How will the coil as a whole move as a result of the forces on each segment?   (1)

QUESTION 8   RADIATION

The electromagnetic spectrum includes microwaves, ultraviolet light, gamma rays, and visible light.

8.1   Briefly describe the propagation of electromagnetic radiation through space.   (4)

8.2   Arrange the four types of EM radiation listed above in order of increasing wavelength.   (4)

8.3   Which of the types of EM radiation listed above has the greatest penetrating power?   (1)

8.4   Name 3 other types of EM radiation.   (3)

8.5   Read the following article and answer the questions which follow.

Solar radiation and ozone
The ability of atmospheric O_2 (oxygen) and O_3 (ozone) to absorb ultraviolet light has important consequences, both for the atmosphere and for life on Earth. These molecules ensure that the Sun's ultraviolet rays are intercepted before they reach the troposphere, which all forms of life inhabit. The formation and destruction of ozone can be represented by the following cycle:
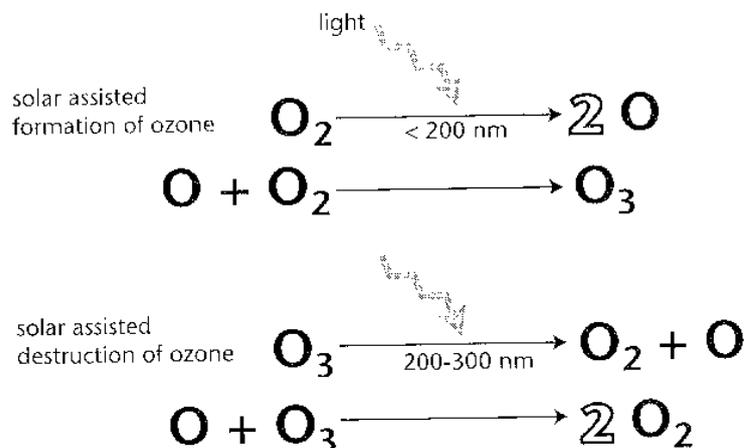
When an oxygen molecule absorbs a photon of light with a wavelength shorter then 200 nm, the energy splits the molecule into two oxygen atoms. One of these atoms can react with another oxygen molecule to form an ozone molecule.

When an ozone molecule absorbs a photon of light with a wavelength between 200 and 300nm, the energy splits the molecule into an oxygen molecule and an oxygen atom. The atom can then combine with a second ozone molecule to form two oxygen molecules.

Up to 98% of the sun's high-energy ultraviolet light is absorbed by the destruction and formation of atmospheric ozone.

Taken and adapted from Study and Master Physical Science Learner's book Gr 12 published by Cambridge University Press (2007) pg 181

8.5.1   Which takes more energy to split, an oxygen molecule or an ozone molecule? Explain.   (3)

8.5.2   Explain how the atmospheric reactions described above have important consequences for life on Earth.   (3)

QUESTION 9   EINSTEIN'S GENIUS

In 1905 Albert Einstein received the Nobel Prize for his explanation of the photoelectric effect. He was able to explain the unexpected result whereby the frequency of light, rather than its intensity, is the key determining factor in photoelectric experiments.

9.1   Describe what is meant by the photoelectric effect.   (4)

9.2   State the main impact that the photoelectric effect had on scientific knowledge and beliefs.   (2)

A solar calculator uses the photoelectric effect in order to produce an electric current. The metal used in the solar cells of a particular calculator has a work function of 2,48eV.

9.3   Calculate the wavelength of the light that will be just sufficient to make this calculator work.   (5)

9.4   Explain what will happen if light of a <u>shorter</u> wavelength than calculated in 9.3 is used.   (2)

QUESTION 10   STREET LIGHTS

Many street lamps and light tubes in advertising displays contain hot gaseous elements, such as sodium, mercury, argon or neon. Sodium street lamps are yellow, while neon signs are red.

10.1   What type of spectrum is produced by a hot gaseous element?   (1)

10.2   Describe how this type of spectrum is produced.   (3)

10.3   Explain why sodium lamps produce a different colour of light than neon signs.   (3)

10.4   If yellow light has a frequency of $5,2 \times 10^{14}$ Hz, determine the energy of a photon of yellow light. (2)

TOTAL FOR THIS PAPER: 150 MARKS