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Physical Sciences

Physics exemplar examination

This support pack consists of a **Physics exemplar examination paper** for the **Physical Sciences Grade 12 CAPS curriculum** and provides valuable practice in writing the examinations. An answer memo is provided separately for you to check learners' answers. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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Physics exemplar examination paper

SECTION A

Question 1

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 in the ANSWER BOOK.

1.1 The velocity of an object is doubled. If the mass of the object does not change, then:

A its momentum is doubled and its kinetic energy is doubled
B its momentum is doubled and its kinetic energy is quadrupled
C its momentum remains the same and its kinetic energy is quadrupled
D its momentum remains the same and its kinetic energy is doubled. (2)

1.2 A box lies stationary on a flat table. If the force exerted by the table on the box is F, then the force exerted by Earth on the box is:

A F
B $-F$
C $2F$
D $-2F$. (2)

1.3 An example of a conservative force is:

A gravitational force
B frictional force
C tension in a string
D a braking force. (2)

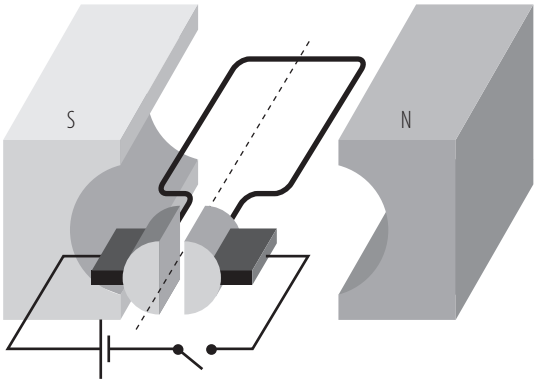
1.4 A taxi is travelling along a road at constant velocity and the driver of the taxi is sounding his hooter. A car is travelling behind the taxi with the same velocity as the taxi. The driver of the car will hear the hooter of the taxi at:

A the same frequency as that heard in the taxi
B a higher frequency than that heard in the taxi
C a lower frequency than that heard in the taxi
D a higher pitch than that heard in the taxi. (2)

1.5 Two identical spheres X and Y have charges of $-Q$ and $+Q$, respectively. The spheres are brought into contact and then separated. After contact, the charge on each sphere will be:

A 0 after electrons were transferred from X to Y
B 0 after electrons were transferred from Y to X
C $\frac{Q}{2}$ after electrons were transferred from X to Y
D $\frac{Q}{2}$ after electrons were transferred from Y to X. (2)

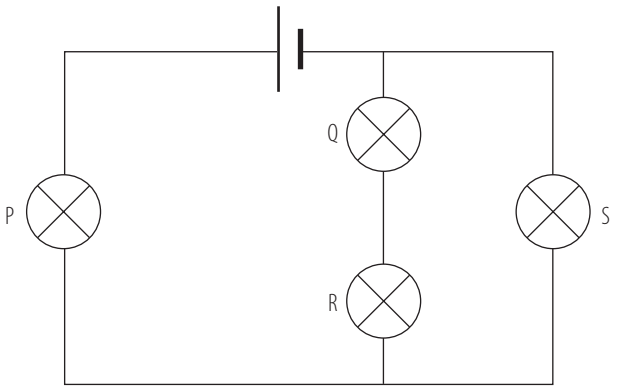
1.6 The following diagram shows a simple electric motor.



When the switch is closed, the coil will rotate:

A in a clockwise direction and then anticlockwise after half a cycle
B in an anticlockwise direction and then clockwise after half a cycle
C in a continuous clockwise direction
D in a continuous anticlockwise direction. (2)

1.7 In the following circuit, the bulbs have identical resistances and the battery has negligible internal resistance.



If bulb Q burns out in the circuit, then:

A all the remaining bulbs will burn equally bright
B R and S will burn equally bright but less bright than P
C R and S will burn equally bright but brighter than P
D S and P will burn equally bright. (2)

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SECTION B

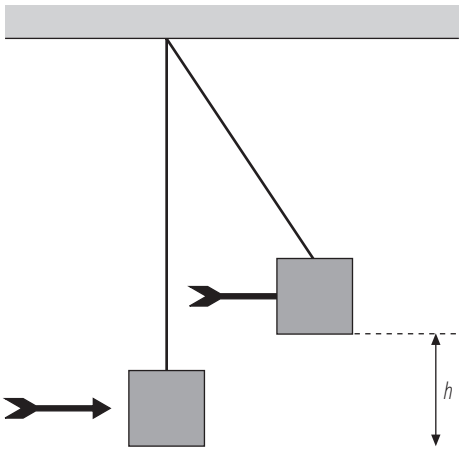
Question 2

2.1 State:

2.1.1 the law of conservation of momentum (2)

2.1.2 the law of conservation of mechanical energy. (2)

2.2 A wooden block, of mass 2 kg, is suspended by a piece of string from the ceiling. An arrow, of mass 50 g, strikes the block horizontally and becomes embedded in it, causing the block to swing to a maximum vertical height, *h*, of 20 cm, as shown in the diagram below.



Ignore air resistance. Calculate:

2.2.1 the speed of the arrow-block combination immediately after the arrow strikes the block (5)

2.2.2 the speed of the arrow before it collides with the block. (4)

2.3 If the mass of the arrow was larger, would the following increase, decrease or remain the same?

2.3.1 The velocity with which the arrow-block combination begins its swing (2)

2.3.2 The maximum height, *h*, reached by the arrow-block combination (2)

[17]

Question 3

3.1 A ball, of mass 100 g, is thrown vertically upwards from the edge of a cliff at 20 $m \cdot s^{-1}$. It strikes the water below the cliff 4,8 s later. Ignore air resistance and calculate:

3.1.1 the vertical height of the cliff above the water (4)

3.1.2 the velocity of the ball when it strikes the water (4)

3.1.3 the force with which the ball strikes the water. (4)

3.2 Assume that the ball in Question 3.1 experiences a constant net force as it slows down in the water. Sketch a graph of the net force acting on the ball against time from the moment the ball was thrown upwards to when it comes to rest in the water. (3)

3.3 State Newton's Law of Universal Gravitation in words. (3)

3.4 In the absence of air resistance, the acceleration of a meteor within Earth's gravitational field will increase. Explain why. (4)

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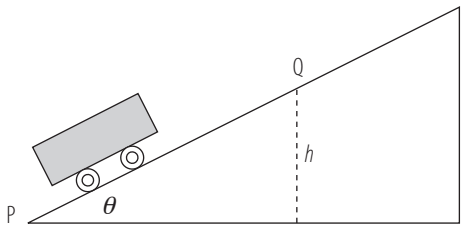
Question 4

4.1 State the work-energy theorem. (2)

4.2 A trolley, of mass 2 kg, is pushed up an incline at P at 20 $m \cdot s^{-1}$ and comes to rest at a point Q along the incline.



4.2.1 Draw a free-body diagram to show all the forces acting on the trolley as it moves up the incline. (3)

4.2.2 If the vertical height, h, at Q is 10 m, calculate the work done by the frictional force. (4)

4.2.3 If a constant frictional force of 12 N acts on the trolley while it is moving along the incline, calculate the angle of inclination, θ. (4)

[13]

Question 5

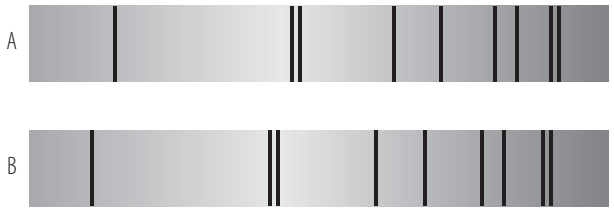
5.1 A train is approaching a road crossing at a constant speed. The driver of the train sounds the train's whistle at a frequency of 510 Hz and a stationary motorist at the crossing hears this whistle at a frequency of 540 Hz.

5.1.1 Explain, in terms of wavelength, why the motorist hears the whistle at an increased frequency. (4)

5.1.2 Calculate the speed of the train, taking the speed of sound in air to be 340 $m \cdot s^{-1}$. (5)

5.1.3 Will the observed frequency be greater than, the same as or smaller than 540 Hz if the train was travelling at twice the speed calculated in Question 5.1.2? Briefly give an explanation for your answer. (3)

5.2 The diagrams below show the absorption spectrum of the same element, with A being observed in a laboratory on Earth and B being that of a distant star.



5.2.1 Is the star moving towards or away from Earth? (1)

5.2.2 Give an explanation for your answer to Question 5.2.1. (4)

[17]

Question 6

The diagram below shows two point charges $Q_1 = -50$ nC and $Q_2 = -30$ nC at rest and separated by 20 cm from each other.

6.1 How many electrons were added to Q_1 to give it a charge of −50 nC? (2)

6.2 Sketch the electric field lines associated with the two charges. (2)

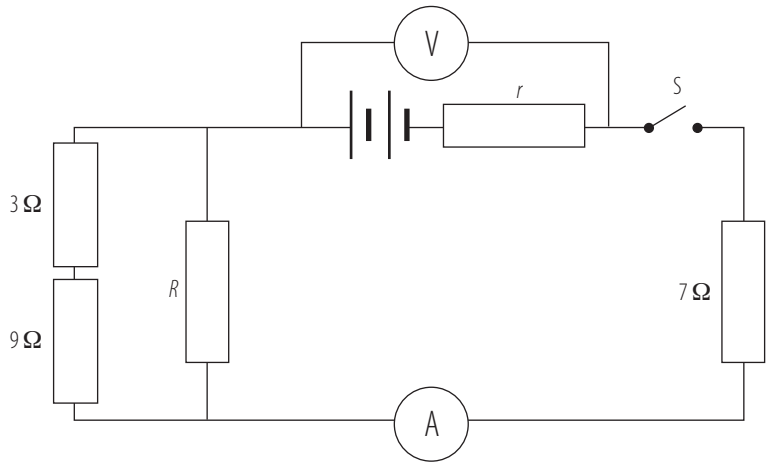
6.3 Calculate the magnitude and direction of the electrostatic force that charge Q_1 will exert on Q_2. (4)

6.4 Determine the resultant electric field (both magnitude and direction) at a point P that is on the line joining the two charges and 8 cm to the left of Q_2. (5)

[13]

Question 7

In the circuit below, the battery has an unknown internal resistance *r* and the rating of the resistor *R* is '9 W; 6 V'. The reading on the voltmeter is 24 V when the switch is open.



7.1 What is the emf of the battery? (1)

7.2 Determine the resistance of the resistor *R*. (2)

7.3 Calculate the reading on the ammeter when the switch is closed and the resistor *R* operates at its rated value. (5)

7.4 Find the internal resistance of the battery. (4)

7.5 Will the reading on the voltmeter increase, decrease or remain the same if the resistor *R* is removed from the circuit? (1)

[13]

Question 8

The following diagrams show an electric generator (Diagram A) and the current produced by the generator (Diagram B).

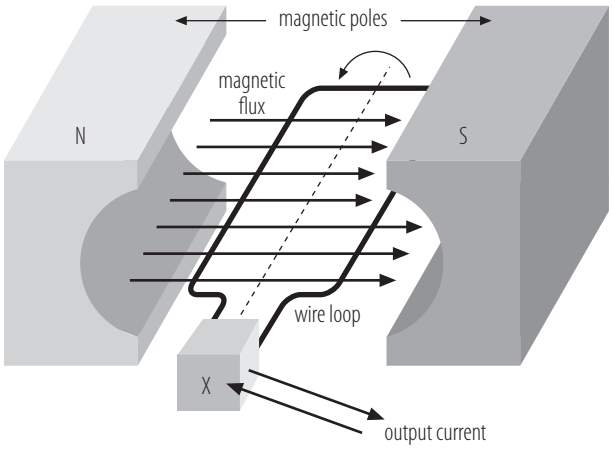


Diagram A

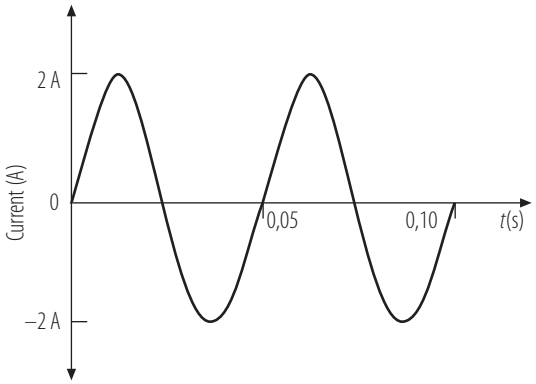


Diagram B

8.1 Must the box marked X in Diagram A contain slip rings or a commutator in order to produce the current shown in Diagram B? (1)

8.2 What is the maximum current produced by the generator? (1)

8.3 Must the coil be in the vertical or in the horizontal position with respect to the magnetic field to produce this maximum current? (1)

8.4 Determine the frequency of rotation of the coil. (3)

8.5 If the peak voltage of the coil is 10 V, what is the maximum power output of the motor? (2)

8.6 Draw a graph of power output versus time for the generator. Show clearly the maximum power, 0 power and the corresponding time values on your graph. (4)

[12]

Question 9

The power of a type of CD player operating at 220 V rms is 36 W.

9.1 Determine the maximum power of the CD player. (3)

9.2 Calculate the peak current in the CD player. (4)

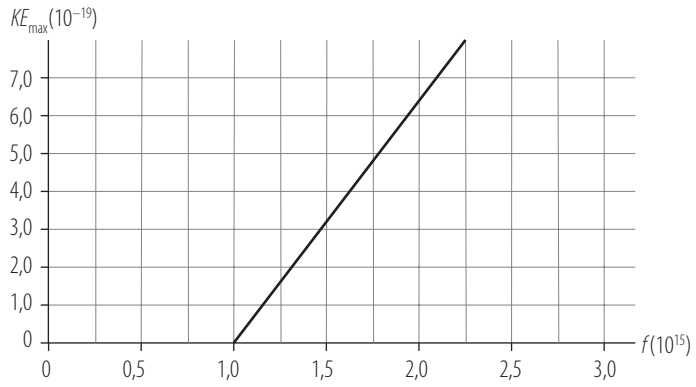
9.3 Determine the resistance of the CD player. (2)

9.4 Explain why the power that is most commonly used in homes and industries is AC power instead of DC power. (4)

[13]

Question 10

An experiment was conducted to determine the relationship between the frequencies (f) of light radiated on a photodiode and the maximum kinetic energy of the ejected electrons (KE_{max}). The following graph was drawn from the results.



10.1 Name the physical phenomenon on which this experiment is based. (1)

10.2 Use the graph to determine the maximum kinetic energy of the electrons when a frequency of $1{,}75 \times 10^{15}$ Hz is used. (2)

10.3 Use your answer to Question 10.2 and a relevant equation to calculate the work function of the metal used in the photodiode. (4)

10.4 Use the graph to determine the threshold frequency for the metal used in the photodiode. (2)

10.5 The following diagram shows the spectrum obtained from a hypothetical element.

10.5.1 Is this an emission spectrum or absorption spectrum? Give a reason for your answer. (3)

10.5.2 The hypothetical atom has three energy states: the ground state, the first excited state and the second excited state. Which one of three wavelengths shown corresponds to an atomic transition between the ground state and the second excited state? Justify your answer. (4)

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TOTAL: 150