PHYSICAL SCIENCE

EXAM-BASED QUESTIONS

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SUPPORT PAPER ONE

SECTION A

QUESTION 1: ONE-WORD ITEMS (5)
Give ONE word/term for EACH of the following descriptions.

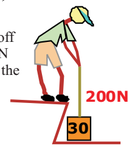
1.1 the product of force and constant velocity (1)
1.2 type of collision where both momentum and kinetic energy is conserved (1)
1.3 the phemenon that makes the sky look blue (1)
1.4 the product of a charge's potential difference and magnitude (1)
1.5 type of light that is of single frequency (1)

QUESTION 2: FALSE ITEMS (10)
Correct each of the following false statements

2.1 Airbags are designed to decrease the change in kinetic energy of a colliding object. (2)
2.2 When an object is in freefall the rate of change of displacement is constant. (2)
2.3 If the magnitude of each of two charges is doubled, then the distance between the charges must be halved for the force to remain unchanged. (2)
2.4 Slip rings allow for continuous rotation of the loops in a DC motor. (2)
2.5 The photoelectric effect is proof that light is a wave. (2)

QUESTION 2: MULTIPLE CHOICE QUESTIONS (10)
Choose the correct answer

3.1 A boy is unsuccessful in lifting a 30kg box completely off the ground by pulling vertically up with a force of 200 N on a rope as shown. The reaction force to the weight of the box would be an upward force:

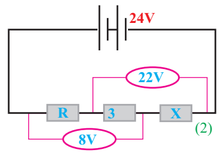


A 294N applied by the ground on the box
B 200N applied by the boy on the box
C 100N applied by the ground on the box
D 294N applied by the box on the earth (2)

3.2 Light is said to have a dual nature? This means that light:

A has both wave and particle properties
B experiences both diffraction and interference
C is both transverse and longitudinal
D displays both constructive and destructive interference (2)

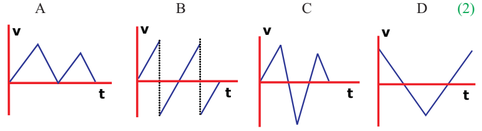
3.3 A circuit is set up as shown, with the two voltmeters reading 8V and 22V. The battery is of negligible internal resistance. What is the value of the resistor R?



A 6 B 4
C 3 D 1 (2)

3.4 A boy drops a ball. The ball bounces up from the ground, but he misses catching it. The ball bounces again, but this time he catches it. Which velocity-time graph best represents the velocity of the ball for the entire motion?

A B C D (2)



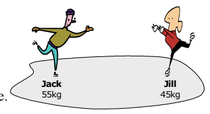
3.5 Trolley P and Trolley Q are in motion in the same straight line. P is a few meters behind Q and they both have the same constant momentum. P can collide with Q only if the mass of Q relative to P:

A is smaller B is greater C is the same
D they cannot collide irrespective of the masses (2)
[25]

SECTION B

QUESTION 4 (10)

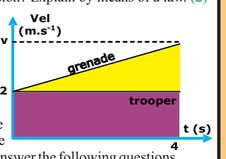
Ice skating experts Jack (55kg) ans Jill (45kg) approach each other at 7ms^{-1} and 3ms^{-1} respectively along a linear axis on ice skates of negligible mass on an ice rink. They are 20 m apart at present on the frictionless surface.



4.1 How long will it take them to collide? (4)
4.2 After they collide, they hold on to each other. How far, and in which direction, will they now slide in in 5s? (4)
4.3 During the collision, the force that Jack exerts on Jill is F. What magnitude of force will Jill exert on Jack during the collision? Explain by means of a law. (2)

QUESTION 5 (11)

A paratrooper, falling at a constant velocity of magnitude 2ms^{-1}, loses his grip on a hand-grenade. It free-falls accidentally, separating from the pin, and will explode in 4 seconds. In order to be leaving the pin behind, and will explode in 4 seconds. In order to be safe from the explosion, he must be at least 75m away from the point of explosion. Use only graph methods to answer the following questions.

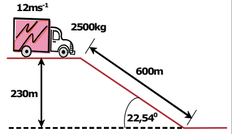


Assume that the paratrooper continues falling at 2ms^{-1} after dropping the grenade, and the grenade free-falls.

5.1 What physical quantity is represented by the area shaded as: (1)
5.2. What physical quantity is represented by the area shaded as: (1)
5.3. What is the value of the slope labelled "grenade". (1)
5.4. Calculate the velocity of the grenade at the point of explosion. (4)
5.5. Determine whether the paratrooper will be safe from the explosion. (4)

QUESTION 6 (19)

Movement of heavy duty vehicles down slopes can be very dangerous. Their immense weight makes it problematic to descend at safe speeds.
A 2500kg truck is moving at a constant speed of 12ms^{-1} towards a very smooth incline, the dimensions of which are provided in the diagram.



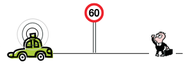
6.1. Calculate the trucks kinetic energy at the top of the slope. (3)
6.2.1. Should the driver not press the brakes, the kinetic energy would increase as the truck moves down the slope. Account for the increase in kinetic energy? (2)
6.2.2 Calculate the acceleration the truck would experience (ignoring friction) (5)
6.3. The driver instead decides to descend at the constant speed of 12ms^{-1}
6.3.1. Calculate the energy required by the brakes in order for the truck to descend at the constant speed of 12ms^{-1}. (3)
6.3.2. How long will it take to reach the bottom (3)
6.3.3. Calculate the power of the brakes. (3)

QUESTION 7 (7)

A stationary police car is 90m behind a suspects car. The police gives chase at a constant acceleration of 2ms^{-1} east, whilst the suspects drive at a constant velocity of 9ms^{-1} east. Calculate how long it will take the police to catch the suspects. (7)

QUESTION 8 (11)

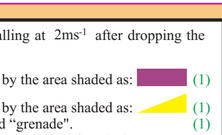
A car is moving at an unknown speed towards a stationary listener in a 60km.h^{-1} zone. The car emits a siren at a frequency of 410Hz, and the speed of the sound is 330ms^{-1}. The listener records that he hears the frequency of the sound at 426Hz.



8.1. Are sound waves longitudinal or transverse? (1)
8.2. State what is meant by the Doppler Effect. (2)
8.3. Calculate the speed of the car in m.s^{-1} (4)
8.4. Is the car breaking the speed limit? (2)
8.5. Will the frequency the man hears be greater than 426Hz, equal to 426Hz or lesser than 426Hz after the car passes him? (2)

QUESTION 9 (18)

A light beam L is shone through a single slit **a** of width 1.13 x 10^{-4}m. The diffraction pattern is formed on the screen which is placed 0,3m away from the slit. The width of the entire central band (XZ) of light is 4mm.



9.1. The phrase "Each point on a wave front can be considered to be a centre of disturbance for a new source of waves" is referred to as ..... (1)
9.2. What is the distance from the central band midpoint to the first dark band (length YX)? (1)
9.3. Consider the equation $\sin \frac{m}{a}$
9.3.1. Calculate the value of the angle labeled D. (5)
9.3.2. Calculate the wavelength of the light. (5)
9.3.3. Alongside is the frequency range of the visible light spectrum. Determine the colour of the light L used in the above diffraction experiment (4)

violet	7,7 x 10^{14}Hz to 7,0 x 10^{14}Hz
indigo	7,0 x 10^{14}Hz to 6,6 x 10^{14}Hz
blue	6,6 x 10^{14}Hz to 6,0 x 10^{14}Hz
green	6,0 x 10^{14}Hz to 5,2 x 10^{14}Hz
yellow	5,2 x 10^{14}Hz to 5,0 x 10^{14}Hz
orange	5,0 x 10^{14}Hz to 4,8 x 10^{14}Hz
red	4,8 x 10^{14}Hz to 3,8 x 10^{14}Hz

9.4. A second identical slit is made close to the first slit. What effect will this have on the spectral pattern on the screen? (2)

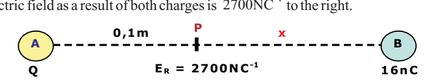
QUESTION 10 (18)

A learner is given a single metal plate of total area 100cm^2. He is required to make a capacitor. He cuts the metal plate into two identical rectangles of 5cm by 10cm each. The supply he is required to use is 12V DC.

10.1. Where would he place the dielectric? (1)
10.2. He connects the capacitor to the DC source and observes the charge rate of the capacitor. Does the charge rate **increase**, **decrease** or **remain constant**? (1)
10.3. The final charge on each plate is 4 x 10^{-11}C , with a potential difference of 12V.
10.3.1 Calculate the capacitance of this capacitor if the dielectric is air. Write your answer in pF (4)
10.3.2 Calculate the distance between the plates, in millimetres. (4)
10.4. If the area of the plates is halved, what must be done to the distance between the plates if the capacitance is to remain unchanged? Explain. (3)
10.5. At the back of a TV, a sign warns ***"Do not open even if disconnected from wall socket"***. Explain why this warning is important. (3)
10.6. With regard to capacitors and batteries, state:
10.6.1 one similarity (1) 10.6.2 one difference (1)

QUESTION 11 (18)

Study the diagram showing two point charges in a straight line. Charge A is 0,1m from point P, and charge B is **x** meters away from charge B. The resultant electric field as a result of both charges is 2700NC^{-1} to the right.

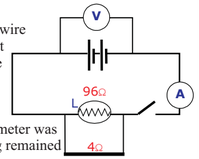


When charge B was completely REMOVED from the system, the electric field intensity at P **increased by a third** with no change in direction.

11.1. What would be the electric field intensity at P after B is removed? (3)
11.2. Calculate the charge at A. (5)
11.3. Calculate the distance that B was from P, i.e. calculate the distance x (5)
11.4. An electron is released at point P while both charges are present.
11.4.1. In which direction will the electron accelerate, **towards A** or **towards B**? (1)
11.4.2. Will the acceleration of the electron be **constant** or **not constant**? (1)
11.5. If the charge at A was constantly increased (without B present), sketch a graph of **E** vs **Q** where E is the electric field at P, and Q is the increasing charge at A. (3)

QUESTION 12 (17)

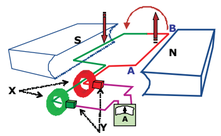
A portable polystyrene cutter uses a resistance wire of 4? to heat up and cut polystyrene. L is a pilot light which indicates when the cutter is on. The system is powered by a battery of 2 cells in series of **significant internal resistance.**



With the switch S open the reading on the voltmeter was 30V. When S was closed the voltmeter reading remained constant at 24V. The switch is now closed.

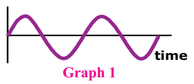
12.1. Calculate the reading on the ammeter. (5)
12.2. Calculate the internal resistance of each cell. (5)
12.3. Calculate the power of the cutting element. (4)
12.4. If the pilot light L fused (stopped working), will the power of the cutting element **increase**, **decrease** or **remain unchanged**? Explain. (3)

QUESTION 13 (12)
Study the device drawn alongside.

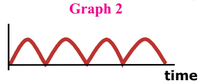


13.1. Is this device an AC Generator, DC Generator, or DC Motor (1)
13.2. State the energy conversion that occurs in this device. (1)
13.3. Name the parts labelled X. (1)
13.4 Name the parts labelled Y. (1)
13.5. Does the position of the loops show a position of maximum or minimum current? (1)

Graph 1



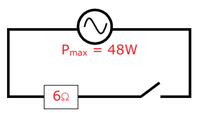
Graph 2



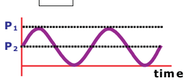
13.6. Consider the loop next to the north pole of the magnet. Is current being induced in the direction **A to B** or **B to A**? (1)
13.7.1. Explain why the graph of the induced current appears as in Graph 1, **and** state whether this current is **AC** or **DC**. (3)
13.7.2. Describe what change must be made in the above device so that the induced current graph appears as in Graph 2, **and** state whether this current is **AC** or **DC**. (3)

QUESTION 14 (11)

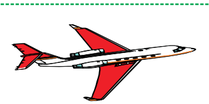
A 6 device is set up in an AC circuit as shown. The source is of maximum power 48W AC. The switch is now closed.



14.1. State what is meant by AC? (1)
14.2. Study the AC Power graph alongside. Determine the power values represented by P_1 and P_2 (2)



14.3. Calculate the V_{RMS} for the device. (4)
14.4. It has been decided that a fuse must be included in series with the device. Which one of the following fuses will be most suitable. Motivate your choice.
fuse 1: 2,0A **fuse 2**: 2,5A **fuse 3**: 3,0A (4)



QUESTION 15 (16)

A metal **X** has a work function of 7 x 10^{-19}J. Light of frequency 4 x 10^{-15}Hz is shone onto it.

15.1. Explain what is meant by the "work function" of **metal x.** (2)
15.2. Calculate the kinetic energy of the ejected **photoelectrons**. (5)
15.3. Calculate the speed of the ejected **photoelectrons**. (4)

15.4. What effect would increasing the frequency of the light have on the:
15.4.1. Ek of the ejected electrons (1) 15.4.2. speed of the photons (1)

15.5. When metal **X** was replaced with another metal **Y**, it was noticed that the speed of the ejected electrons had increased.
15.5.1. Does metal Y have a **smaller** or **larger** work function than metal X? (2)
15.5.2. In order to obtain the same electron speed as in 15.3, should the wavelength of the incident photon be increased or decreased? (2)

QUESTION 16 (6)

An electron is in the ground state.

16.1. Calculate the energy of the photon required to excite this electron. (4)

16.2. Name the process if the electron:
16.2.1. drops back to ground state on its own (1)
16.2.2. drops back to ground state after being struck by another photon (1)
[175]

Total Paper 1: 200

SUPPORT PAPER TWO

SECTION A

QUESTION 1: ONE-WORD ITEMS (5)
Give ONE word/term for EACH of the following descriptions.

1.1 The type of organic molecules that are typically used as fuels (1)
1.2 The type of solution where equilibrium exists between the solute and the solvent (1)
1.3 The type of chemical reaction where the total mass of the compounds remain constant (1)
1.4 The part that keeps the two half cells neutral in a galvanic cell (1)
1.5 The process for the industrial preparation of nitric acid (1)

QUESTION 2: FALSE ITEMS (10)
Correct each of the following false statements.
Do not answer in the negative

2.1 The simplest ester has 1 carbon. (2)
2.2 A fuel with a high octane rating has a low activation energy. (2)
2.3 The cell notation for nickel-cadmium cell is Ni/Ni^{2+}//Cd^{2+}/Cd (2)
2.4 A secondary cell can be used only once. (2)
2.5 Iron metal is recovered from bauxite. (2)

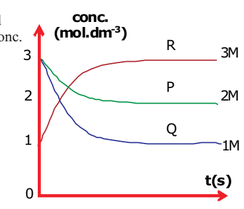
QUESTION 3: MULTIPLE-CHOICE QUESTIONS (10)
Choose the correct answer.

3.1 Study the following compound. The correct name for this compound is:

A nitroethane
B 2-amine-2-methyl-methane
C N-methylmethanamine
D N-2,3-dimethylethane (2)

3.2 How many hydrogen atoms would be present in a pure alkane if the molecular mass is 86?
A 86 B 6 C 14 D 20 (2)

3.3 P, Q and R are reacted in a closed container. The graph shows the conc. vs. time graph for
xP + yQ zR
where x, y and z balance the equation. If the volume of the container is 2dm3 what are the values of x, y and z?



	x	y	z
A	3	3	1
B	2	1	3
C	1	2	4
D	1	2	2

(2)

3.4 A reaction is performed in a test-tube. The test-tube then feels cold to the touch. Which one of the following is correct?

	Reaction Type	Energy of Products compared to Reactants
A	endothermic	lesser
B	endothermic	greater
C	exothermic	lesser
D	exothermic	greater

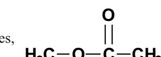
(2)

3.5 A high N value in the N:P:K ratio…
A promotes leaf growth and forms proteins and chlorophyll
B contributes to root, flower and fruit development
C contributes to stem and root growth and the synthesis of proteins
D promotes algae growth (algae bloom) (2)
[25]

SECTION B

QUESTION 4 (12)

The family to which compound X belongs, is used for a variety of things, the main being producing fragrances, and providing artificial flavouring to softdrinks. They are the combination of a carboxylic acid and an alcohol, and they have a wide spread variety of smells!

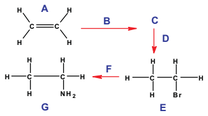


Compound X

4.1. Name the **class** to which compound **X** belongs. (1)
4.2. Name compound **X** in accordance to **IUPAC.** (2)
4.3. Identify by **name,** the two ORGANIC compounds used to prepare **X.** (2)
4.4. Write down the reaction using STRUCTURAL FORMULAE. Identify the catalyst used. (2)
4.5. Name this type of reaction. (1)
4.6.1. Draw ONE isomer (of a different class) of compound **X**, and name this isomer. (3)
4.6.2. Would you expect this isomer to have a **higher**, **identical**, or **lower** boiling point than **X**? (1)

QUESTION 5 (9)
Study the sequence of organic reactions alongside.

The reactions begin with **A** and end at **G**. **Compound C** is typically found in wines, whiskey and brandy, and is also used in the manufacture of many medicines. It has a **hydroxyl group** as its functional group.

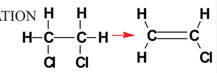


5.1. What is the functional group of compound **A**? (1)
5.2. Give the **IUPAC** name for **A** (1)
5.3. Write down the formula for compound **B**. (1)
5.4. Name the type of reaction that converts **A** to **C**. (1)
5.5. Name compound **C** using **IUPAC** rules. (1)
5.6. Compound **C** is converted to **E** (bromoethane). Identify reagent **D**. (1)
5.7. Name the type of reaction that converts **C** to **E**. (1)
5.8. Name reagent **F**. (1)
5.9. Name compound **G**. (1)

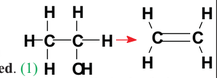
QUESTION 6 (13)

The alcohol propan-1-ol has a boiling point of 82°C, whilst the compound glycerol has a boiling point of 290°C.

6.1. Draw the structure of propan-1-ol. (2)
6.2. Glycerol is also called propan-1,2,3-triol. Draw this structure. (2)
6.3. The molar mass of glycerol is approximately 50% more than propan-1-ol, yet the boiling point of glycerol is almost 3,5 times greater than propan-1-ol. Explain the reason for such a difference in the boiling points. (3)
6.4. Consider the DEHYDROHALOGENATION reaction shown alongside. This is an elimination reaction. Write down the **formula** of the **molecule** that has been **eliminated**. (1)



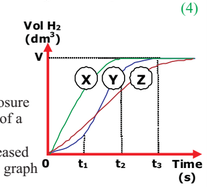
6.5. The following elimination reaction involves the DEHYDRATION OF ALCOHOLS. Write down the **formula** of the **molecule** that has been **eliminated**. (1)



6.6. Cracking of hydrocarbons is common practice especially in the fuel industry. Distinguish between **thermal cracking** and **catalytic cracking**. (4)

QUESTION 7 (15)

A learner performs a "Rates of Reaction" experiment with a 10g piece of zinc that has a thin coating of zinc oxide as a result of exposure to air. He reacts the zinc with a large amount of a 2mol.dm^{-3} hydrochloric acid solution.
He measures the volume of hydrogen gas released over regular time intervals, and the following graph is plotted.



He then repeats the experiment using HCl of concentration 1mol.dm^{-3} and then 3mol.dm^{-3}. But this time he uses clean pieces of zinc, each of mass 10g.

7.1. What can be measured in the units dm3.s^{-1} ? (1)
7.2. Which part of the graph indicates the **rate of the reaction?** (1)
7.3. Which graph show the greatest rate of reaction? (1)
7.4. Name one factor that must be kept constant in the experiment. (1)
7.5. Match the acid concentrations with the appropriate graph.
1mol.dm^{-3} = Graph …
2mol.dm^{-3} = Graph …
3mol.dm^{-3} = Graph … (3)
7.6. Why is the rate of reaction slower from **0 -t$_1$** than from **t$_1$** to **t$_2$** in Experiment Y. (2)
7.7. Explain why the graphs are not straight lines. (4)
7.8. Why do all three graphs level out at volume V? (2)

Questions continued in next article