ALEXANDER ROAD HIGH SCHOOL

NOVEMBER 2021 2 HOURS

PHYSICAL SCIENCES Paper 1 Physics

PE TOTAL = 100

GRADE 10

Instructions

- The question paper consists of 8 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- Round off to two (2) decimal places where necessary.
- A formula sheet has been provided on the back of the answer sheet.
- A list of physical constants has been provided at the end of the question paper.

SECTION A

- Answer on the answer sheet -

QUESTION 1: Multiple choice

Four possible options are provided as answers to the following questions. Each question has only 1 correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.7) on the answer sheet.

1.1 Which of the lists below consists of only vector quantities?

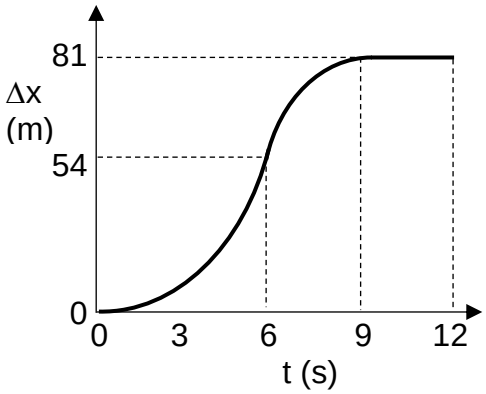
A. Weight, mass, velocity

B. Force, weight, displacement

C. Acceleration, velocity, distance

D. Force, direction, pressure

The graph alongside shows the **displacement vs time** graph for an object moving in a straight line in the **positive direction.**



Use this graph to answer the next two questions.

1.2 The object is travelling ….

A. forwards for the first 6 seconds and backwards for the next 3 seconds.

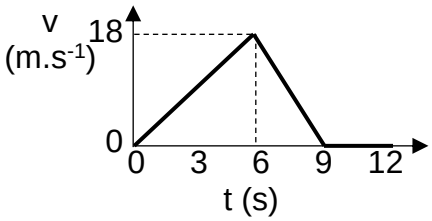
B. speeding up for the first 6 seconds and slowing down for the next 3 seconds.

C. is stationary after 9 seconds.

D. both B & C correct.

1.3 The corresponding velocity time graph is

A.



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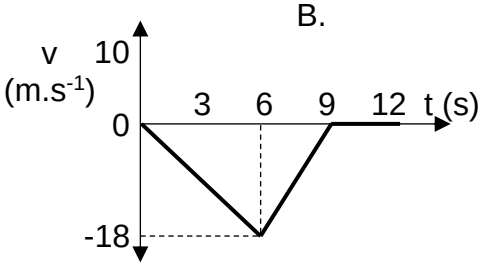

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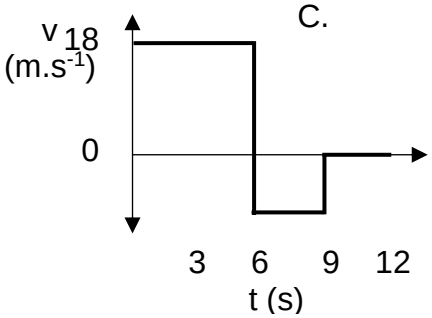

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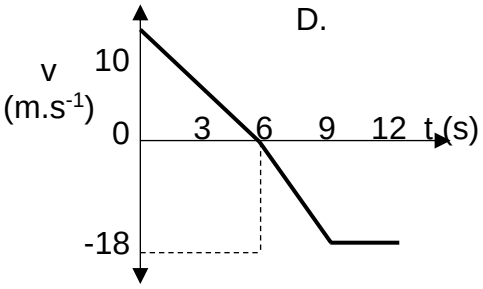


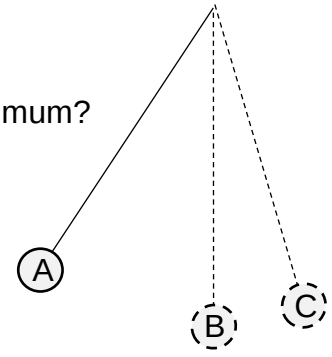
1.4 Consider a pendulum swinging in a vacuum.
At which position is the mechanical energy maximum?

A.at A

B. at B

C. at C

D. At all positions.



1.5 The correct order for increasing wavelength of electromagnetic waves is

A. radio waves, infrared, blue light, gamma rays.

B. x-rays, Ultraviolet, Infrared, microwaves.

C. gamma rays, microwaves, ultraviolet, radio waves.

D. TV waves, red light, green light, blue light.

1.6 The equivalent unit for a volt is:

A. joule per coulomb

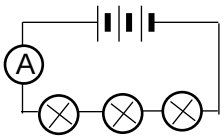
B. ampere per ohm

C. joule per ampere

D. coulomb per second

1.7 All light bulbs are the same in the following circuits. In which circuit will the ammeter reading be biggest

A



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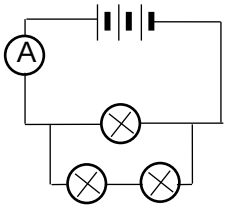

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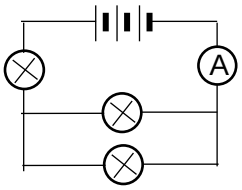

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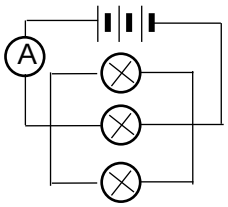
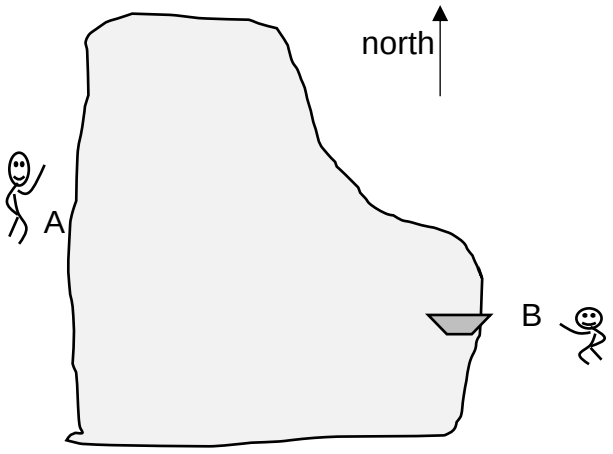


[14]

<u>QUESTION 2 (Vectors)</u>:

Sipho walks (from A) around the north side of a lake to meet a friend with his boat (at B).
He walks 300 m north then 300 m east & then 600 m on a bearing of 135^0 in 10 minutes.



2.1 Define **resultant vector**. (2)

2.2 Determine by accurate scaled diagram what his final displacement is from A to B. (Use scale 1cm : 10m) (4)

2.3 On what bearing must they paddle back to where Sipho started if they decided to go in the boat? (1)

2.4 Calculate Sipho's average speed when walking around the lake from A to B. (3)

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QUESTION 3 (Motion):

Two vehicles P and Q are approaching a traffic light intersection at 20 $m.s^{-1}$ The light turns orange when they are 30 m from the intersection.
Vehicle P puts on its brakes and slows down to stop at the intersection.
Vehicle Q accelerates at 4 $m.s^{-2}$ through the intersection for 3 seconds before continuing at a constant velocity.

3.1	Define **velocity**.	(2)
3.2	Convert 20 $m.s^{-1}$ to $km.h^{-1}$	(1)
3.3	Calculate the acceleration of vehicle P.	(3)
3.4	Calculate the final velocity of vehicle Q.	(3)
3.5	Sketch the velocity-time graphs for both vehicles on the same set of axes. Label the relevant velocity and time values.	(5)

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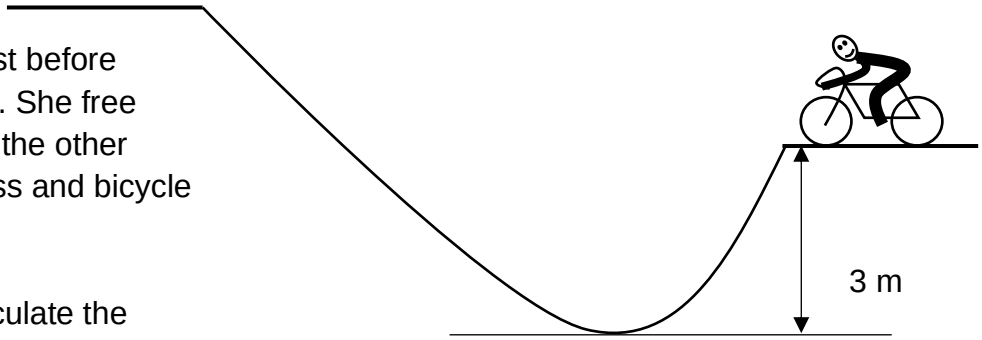
QUESTION 4 (Energy):

A cyclist travels at 6 $m.s^{-1}$ just before going down a dip in the road. She free wheels down the dip and up the other side until she stops. Her mass and bicycle combined are 60 kg.
Assume there is no friction.
Use energy principles to calculate the answers in 4.2 and 4.3



4.1	Define **gravitational potential energy**.	(2)
4.2	What is the fastest speed she reaches at the bottom of the dip?	(4)
4.3	Calculate the height she will reach on the other side when she stops.	(4)
4.4	What is the name of the principle used in the calculation above?	(1)

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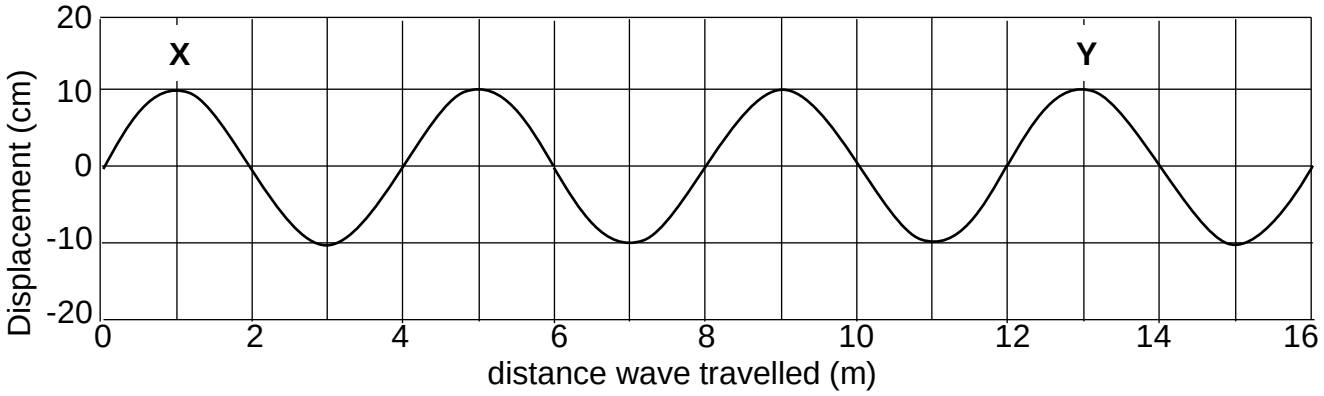
QUESTION 5 (Waves):

5.1 The speed of sound is 320 $m.s^{-1}$. A person counts 5 seconds between seeing lighting and hearing the thunder. How far away is the storm? (3)

5.2 Given the snapshot of a transverse wave below, answer the following questions. Use the diagram on the **answer sheet** to answer 5.2.2.

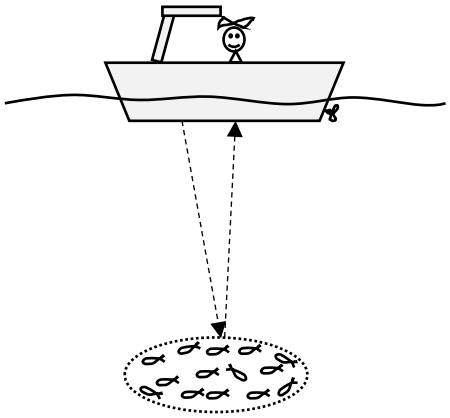


5.2.1 Define the term **wavelength**. (2)

5.2.2 On top of the diagram draw a wave with twice the amplitude and twice the period. Use the diagram on the **answer sheet.** (2)

5.2.3 If it takes the crest at **X** 6 seconds to move to position **Y** calculate:
a) the frequency of the wave. (3)
b) The speed of the wave. (3)

5.3 A fishing boat uses echolocation to detect schools of fish.
If the speed of sound in water is 1200 $m.s^{-1}$ and it takes 0,4 seconds for the echo to be heard, how deep is the school of fish below the boat? (3)



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QUESTION 6 (Light):

The wavelength of red light is 300 nm.

6.1 Calculate its frequency. (3)

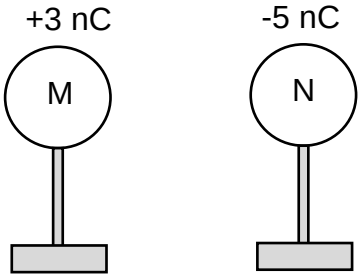
6.2 What is the name of the "package of energy" which red light is made of? (1)

6.3 Calculate the energy of one of these 'packages of energy'. (3)

[7]

QUESTION 7 (Electrostatics):

Two spheres of identical size, and on insulated stands, have the charges Q_M = +3 nC and Q_N = -5 nC respectively. They are a short distance apart.



7.1.1 State the principle of "conservation of charge". (2)

7.1.2 How many electrons are in excess or shortage on sphere M? (4)

7.1.3 State whether they were transferred TO or FROM sphere M. (1)

7.2.1 The two spheres are now brought together so that they touch and then are separated again. What is the final charge on sphere N? (2)

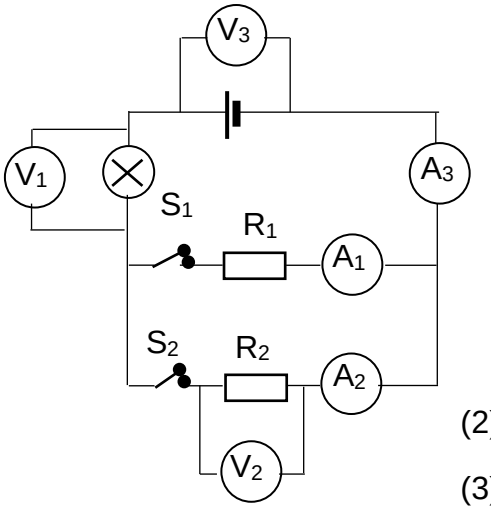
7.2.2 In which direction did the charges move between the spheres, from M to N or from N to M? (1)

[10]

QUESTION 8 (Circuits):

In the circuit alongside: $R_1 = 4\ \Omega$ and $R_2 = 2\ \Omega$.

When both switches, S_1 and S_2, are closed, $V_2 = 4$ V.



8.1 Define the term **current strength**. (2)

8.2 Calculate the effective parallel resistance. (3)

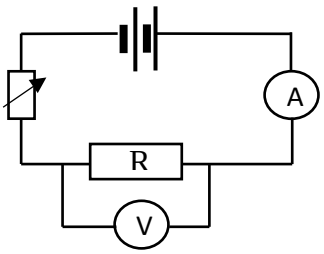
8.3 Calculate the reading on ammeter A_2 when both switches are closed. (3)

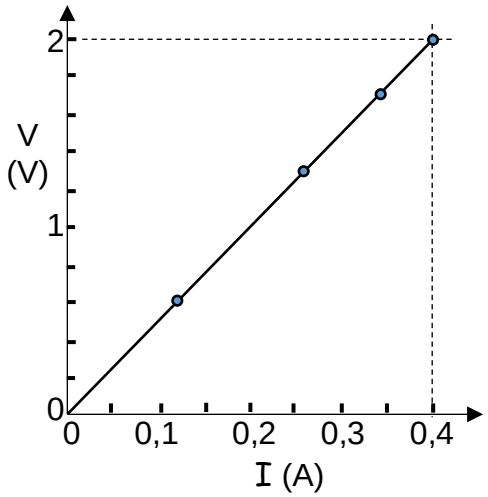
8.4 Calculate the current through the light bulb when both switches are closed. (2)

8.5.1 What happens to the brightness of the bulb when switch S_2 is opened?
Write only: INCREASES, DECREASES, STAYS THE SAME or GOES OUT. (1)

8.5.2 Explain your choice in 8.5.1 above. (2)

8.6 In an experiment the following circuit was used. The data measured is shown in the table and plotted on the graph.





Current (A)	Voltage (V)
0,12	0,6
0,26	1,3
0,34	1,7
0,40	2,0

8.6.1 Write an investigative question for this experiment. (2)

8.6.2 Determine the gradient of the graph. (2)

8.6.3 What does the gradient of the graph represent? (1)

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TOTAL: 100

List of Physical Constants

Name	Symbol	Value
Acceleration due to gravity	g	$9{,}8\ m.s^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m.s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J.s$
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$

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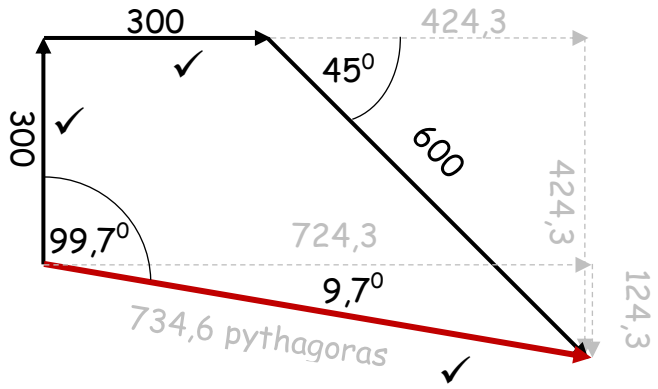
1.1 B 1.2 D 1.3 A 1.4 D 1.5 B 1.6 A 1.7 D

2.1 Resultant – is a single vector that has the same effect of two or more vectors.

2.2



R = 735 ± 5m
bearing $100^0 \pm 2^0$

2.3 Back bearing = 90 + 9,7 + 180 = $279,7^0$✓ $280^0 \pm 2^0$

2.4 Speed = dist/time ✓= 1200/(10x60)✓ = 2m.s^{-1} ✓

3.1 Vel = rate of change✓ of position ✓

3.2 20 x 3,6 = 72 km.h^{-1} ✓

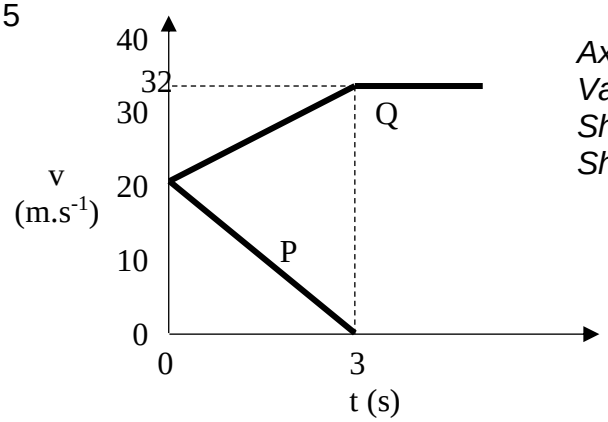
3.3 $v_f^2 = v_i^2 + 2a\Delta x$ ✓

$0 = 20^2 + 2.a.30$ ✓

a= 400/60 = -6,67 m.s^{-2} ✓ slowing down / deceleration / positive in reverse

3.4 $v_f = v_i + at$ ✓ = 20 +4x3✓ = 32m.s^{-1} ✓

3.5



Axes correctly labelled with units (-1 if missing)
Values 32, 20 & t=3✓✓✓
Shape Q ✓
Shape P ✓does NOT have to cut t-axis at 3 s.
This was not a required calc.

4.1 Ep = is the energy of an object due to its position✓ in a gravitational field✓

4.2 E mech top = E mech bottom ✓

Top: Ep + Ek = mgh + ½mv^2 = 60x9,8x3 + ½ x60x6^2 = 1764 + 1080 = 2844 J ✓✓

Bottom Ep + Ek = 0 + ½ x60x v^2 = 2844

$\therefore$ v^2 = 2844/30 = 94,8

$\therefore$ v = $\sqrt{}$94,8 = 9,74 m.s^{-1} ✓✓

□□□ Ep + Ek top other side = 2844 = mgh + 0 ✓

$\therefore$ 60 x 9,8 x h = 2844 ✓ $\therefore$ h= 2844/(69 x 9,8) = 4,84 ✓

4.4 Conservation of mechanical energy✓

5.1 Dist = Speed x time✓ = 320 x 5✓ = 1600 m ✓

5.2.1 Wavelength = shortest distance between two points in phase ✓✓ (2 or 0)

5.2.2 2xAmp ✓ 2x Period✓

5.2.3 a) 3 waves in 6 sec therefore 1 wave every 2 s f=1/T ✓= ½ = 0,5 Hz ✓✓

b) 3 wavelengths = 12m in 6 s = 2m.s^{-1} OR Dist/time✓ = 12/6✓ = 2 m.s^{-1}✓

5.3 Dist = speed x time ✓= 1200 x 0.2 ✓= 240m✓ deep

(or use 0,4 sec & halve total distance)

6.1 c=fλ $\therefore$ f=c/λ ✓= 3x10^8/ 300x10^{-9} ✓=1x10^{15} Hz✓

6.2 Photon✓

6.3 E=hf ✓= 6,6x10^{-34} x 10^{15} ✓= 6,6x10^{-19} J✓

7.1.1 Conservation charge – total charge in an isolated system remain constant✓✓

7.1.2 n = Q/q$_e$ ✓ = 3x10^{-9}/1,6x10^{-19} ✓= 1,875x10^{10} ✓electrons

7.1.3 electrons rubbed FROM sphere M✓

7.2.1 Q = (Q$_1$ + Q$_2$)/2 ✓= (+3-5)/2 ✓= -1 nC✓

7.2.2 electrons transferred from N to M✓

8.1 Current strength: rate of flow of charge ✓✓ (2 or 0)

8.2 $1/R_p = 1/r_1 + 1/r_2$ ✓= ¼ + ½ = ¾ ✓

$\therefore R_p = 4/3 = 1{,}333\ \Omega$ ✓ □□□□□□□□□□□□□□□□□□□□□□

8.3 V=IR ✓ 4=Ix2✓ ∴I=4/2 = 2 A✓

8.4 $I_1 = V/R = 4/4 = 1$ A✓ (or□□□□□□□□□□□□□□ □□□□□□□□)

$\therefore I_{bub} = 2 + 1 = 3$A✓

8.5.1 DIMMER✓

8.5.2 Resistance increases ✓ (removing a pathway)∴ current decreases✓ ∴ DIMMER

8.6.1 How does the changing current✓ affect the voltage✓ across the resistor? *(must be a question that contains the 2 variables)*

8.6.2 $\Delta V/\Delta I = 2/0{,}4$✓ = 5✓ 5.6.3 Resistance✓ in ohms